ALFALFA WEEVILS : A NEW LOOK AT AN OLD PEST

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ABSTRACT

Alfalfa fields can act as an "insectary" (producer of beneficial insects) for other neighboring crops in the Central Valley and other areas. However, several insect pests also injure alfalfa plants reducing crop yields and quality. The alfalfa weevil complex, comprised of the Egyptian alfalfa weevil (EAW), *Hypera brunneipennis*, and alfalfa weevil, *Hypera postica*, is the most damaging arthropod in California alfalfa. An insecticide application is commonplace in the late winter/early spring to control this pest. Organophosphate, carbamate, and pyrethroid materials as well as other products are used. These treatments are generally effective and the effects on populations of natural enemies appear fairly short-term. However, the occurrence of organophosphate insecticides in surface waters, particularly chlorpyrifos (Lorsban®), coinciding with the timing of treatment for EAW larvae, has placed added emphasis on refining IPM programs for this pest in alfalfa. Pyrethroid insecticides have also recently been implicated in some environmental concerns. We initiated studies in 2002 to re-evaluate the EAW treatment threshold under current production practices and to improve sampling strategies for this pest. Preliminary data were collected from one site in 2002-03 and 2004 and 2005 studies were expanded to several locations. At the Davis location, first harvest yield losses from EAW larvae were very severe in 2002 (~50% from 10 larvae per sweep), moderate in 2003 (25% from 10 larvae per sweep), no losses from 35 larvae per sweep in 2004, and ~10% from 10 larvae per sweep in 2005.

INTRODUCTION

Alfalfa fields, as a short-term perennial agroecosystem, support a wide range of arthropods, most of which have neither positive nor negative effects on the crop. In fact, alfalfa fields are important contributors to the biodiversity of agricultural systems. Unfortunately, a few of these insects feed significantly on the alfalfa plants and therefore are classified as "pests". The most serious of these arthropod pests is the alfalfa weevil complex, which includes the Egyptian alfalfa weevil (EAW), *Hypera brunneipennis*, and the alfalfa weevil, *Hypera postica*. These pests were introduced from the Mediterranean region to the U.S. in the early-mid 1900's.

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The economic threshold is central to any integrated pest management system. Lacking this threshold value, or lacking a reliable, grower accepted value, management efforts resort to preventative treatments. Koehler and Rosenthal (1975) published results supporting a threshold of 20 EAW larvae per sweep. This threshold has been effectively used for numerous years such that an insecticide application prior to the first cutting for EAW is routine in the Central Valley. The research in the 1970's is limited by assumptions of hay values of \$50-\$70 per ton, treatment costs of \$6-8 per acre and low productivity (2500 lbs/A yields) alfalfa cultivars such as 'Lahontan', 'El Dorado Improved', and 'Caliverde'. Newer cultivars could be more tolerant of weevil larval feeding or they could be more susceptible. Updating this treatment and increasing the confidence in it within the alfalfa community has recently taken on added importance given the scrutiny of late winter to early spring pesticide applications in alfalfa and the surface water protection issue. This is particularly important for organophosphate insecticides (Long et al. 2001) and more recently for pyrethroid materials. Organophosphate insecticides have historically been relied upon for EAW larval control and in recent years pyrethroid insecticides are becoming more commonly used.

An additional trend that is influencing management of EAW in central CA is the use of alfalfa cultivars with higher levels of fall/winter dormancy. Increased levels of dormancy result in less alfalfa growth in the fall after the last yearly cutting and reduced amounts of alfalfa growth in the early portion of the cycle before the first seasonal cutting. This latter trait hinders sampling EAW larval populations with a sweep net, which is commonly used to make a treatment decision. Other sample techniques could play a role in assessing populations for this early-season management decision.

Studies were started on IPM of alfalfa weevil pests in alfalfa in 2002 and expanded in 2004 and 2005. Alfalfa yield and nutrient quality are being evaluated in plots exposed to various levels of EAW pressure.

PROCEDURES

Impact of Weevil Larvae on Alfalfa Productivity. This work was a continuation of studies started in 2002. The work was only done on the UC-Davis campus in 2002 and 2003 and in 2004 additional sites in San Joaquin Co., Colusa Co, Shasta Co., and Siskiyou Co. were included (Godfrey & Putnam 2002, Lewis et al. 2003, Godfrey et al. 2004). In 2005, studies were continued at the same locations with an additional site in Tulare Co. included. The goal of these studies was to update the economic threshold (treatment threshold) for Egyptian alfalfa weevil and alfalfa weevil on alfalfa. In terms of the amount of damage this pest inflicts on alfalfa, both the number of larvae and the length of time they are feeding will be important. Therefore, two approaches were used for the plots on the UC-Davis campus in all 4 years. For approach one, separate plots were treated at 5-7 day intervals with an effective EAW control product (Warrior® at 3.8 oz./A) starting at the initiation of egg hatch. Once a treatment regime was started, if larval populations started to increase a second application was made. Up to five timings along with a sixth treatment with no insecticide applied were planned. This allowed for the evaluation of weevil pressure for different lengths of time, i.e., what is the effect of delaying treatment for 1 week, 2 weeks, etc. For the second approach, yield samples were collected from an insecticide efficacy comparison study that contained 18 treatments in 2005. Many of the treatments were very effective on EAW larvae; therefore, two to four treatments/rates were added that would be moderately to marginally effective. Some of the insecticides were fairly broad-spectrum and killed weevil larvae as well as any other arthropods present. However, during this early potion of the growing season, weevil larvae were really the only insect pest present so interference from control of multiple pests was not a factor. The goal was to establish a gradient of EAW larval populations (by removing various percentages of the larval population) near the point where the population reached the existing 15-20 threshold. Each treatment timing or treatment insecticide was replicated four times in plots (20 x 25' each) within a randomized complete block design. EAW larval populations were quantified in each plot every 7 days (timing study) and every 3-4 days (treatment study) using the standard sweep net sampling method. Plots were harvested with a flail harvester and fresh weight and dry matter yields and nutrient quality (% crude protein, %IVDDM) were determined. The timing approach was also conducted in the grower field sites in Tulare, San Joaquin, Colusa, Shasta, and Siskiyou Co. (2 different sites).

One observation from the 2002-04 studies was that the timing of EAW larval feeding relative to the timing of alfalfa harvest largely determined the extent of the yield loss (numbers of larvae were important as well). For instance in 2002, the larval population peaked at ~25 per sweep and the feeding stopped (the larvae pupated) about the same time as the harvest. Therefore, all the damage was still present at harvest and the alfalfa had no time to compensate, regrow, following the damage. In 2002, regression analyses showed a ~50% first harvest yield loss from 10 larvae per sweep. In 2003, the synchrony was different between the insect and crop development. EAW larval populations peaked at only 14 per sweep but due to a cool period the larvae were present for a long period (~5 weeks). However, the alfalfa was not ready to harvest for another 2 weeks after the larval feeding stopped and some compensation occurred. This mitigated the yield loss but it was still substantial (~25% for 10 larvae per sweep), but not as much as in 2002. In 2004, the larval population was the highest seen at the Davis site during this study (peaking at 35 per sweep), but the yield loss was the lowest. Why?? The larval population was present for only 10 days (due to a warm period the larvae developed very fast) and the alfalfa harvest occurred about 10 days after the population was gone (time for compensation). Based on these data, additional samples were taken in 2005 to examine alfalfa biomass accumulation relative to the EAW larval population. Alfalfa samples (two 1 sq. ft samples per plot) were clipped at soil level twice per week at the Davis site and about weekly at the Tulare, San Joaquin, and Colusa Co. sites. Data collected were fresh weight, number of stems, leaf and stem fresh weights, stem and leaf dry weights and nutrient quality of the leaf and stem tissue. These samples were taken from the untreated and most intensive (earliest) treatment of the timing study.

<u>Sampling Studies.</u> Studies were conducted in Davis, Tulare Co., San Joaquin Co. and Colusa Co. sites to evaluate a revised sampling technique for EAW larvae. The recommended method in the rest of the U.S. is to carefully collect alfalfa stems, rap the stems within bucket with enough force to dislodge weevil larvae, and count larvae within the bucket. Larval counts from this technique were compared with those from sweep net sampling. The final sampling method was

a visual rating of damage (% of the stem terminals with pinhole or defoliation feeding).

RESULTS

Impact of Weevil Larvae on Alfalfa Productivity. EAW larval populations developed in the Davis field plots in late February in 2005. Larval populations peaked at 24.1 per sweep. Insecticide treatments for the treatment study were applied on 10 March. Efficacy results are shown in Fig. 1. Several products provided very good control – pyrethroids (Baythroid, Warrior, Mustang), organophosphates (Lorsban), carbamates (Fursdan), as well as Imidan and Steward. New active ingredients for EAW control are uncommon. Some new formulations of existing products were tested (data not shown).

Larval population numbers from the timing study at Davis are shown in Fig. 2. Populations peaked at slightly less than 25 larvae per sweep. The largest increase in numbers occurred between March 4 and 11, therefore the treatment regime starting on 4 March prevented this peak and the populations never exceeded 5 per sweep. Yields collected on 15 April showed that the highest yield corresponded with the earliest treatment timing (3900 lbs./A dry weight) and the lowest yield was from the untreated plots (2890 lbs./A dry weight). Yields from the other timings were intermediate with the second treatment timing (4 March) being 3620 lbs/A and the March 11 to March 24 timings giving yields ranging from 3080 to 3250 lbs./A.

Fig. 3 shows the effects of larval feeding on stem and leaves fractions of the alfalfa plant. The larvae feed primarily on leaf tissue but stem growth can also be influenced. These data were collected from the 25 Feb. and the no treatment regimes in the timing study; larval numbers are shown in Fig. 2. Larval numbers peaked on 11 March and on 15 March there were significant differences in the leaf tissue weights between damaged and undamaged plots. These differences continued through 22 March. Stem dry weights were significantly reduced by weevil feeding only on 18 and 22 March. The later sample dates (after 22 March) showed a trend for more leaf and stem tissue in the plots protected from EAW larvae than the unprotected plots, but the differences were slight and not significant. By the last week in March, the majority of the larvae had pupated and alfalfa compensated in terms of growth. Part of this compensation can be seen through the data on number of stems; on 9 April, for instance, the damaged plots had 54 stems per sq. ft. and the undamaged plots had only 37 stems per sq. ft.

Sampling Studies. Sampling EAW larvae on short alfalfa growth with a sweep net is impractical. This is becoming more of an issue depending on the time of egg-laying/egg hatch in the late winter and early spring and the dormancy value of the alfalfa cultivar, i.e., early year growth. Table 1 shows results from three sampling methods used for EAW larvae in the Davis plots. The goal is not to produce identical numbers from these methods but rather to "calibrate" the methods and the relate each to the need for treatment. On the early growth (6 inches or less), the bucket sampling method captured many more larvae than the sweep net. Terminal damage was also evident on these early dates. These numbers from the bucket samples and the terminal samples, although appearing high, do not necessarily indicate a damaging (treatable) population at this time. This work needs to done over several years and locations to allow some interpretation of these numbers.

Data from additional results from the other sites in Tulare, San Joaquin, Colusa, Shasta, and Siskiyou Co. are still being summarized and analyzed. These results will provide additional insights in EAW management in California alfalfa. In summary, the synchrony of EAW larval population and alfalfa growth/harvest appears to be very important in the yield loss determination. At the Davis location, first harvest yield losses from EAW larvae were very severe in 2002 (50% from 10 larvae per sweep), moderate in 2003 (25% from 10 larvae per sweep), no losses from 35 larvae per sweep in 2004, and ~10% from 10 larvae per sweep in 2005.

ACKNOWLEDGEMENTS

Partial funding was provided by Environmental Protection Agency, Region 9, Pesticide Environmental Stewardship Program Grant, 2004 and EPA Food Quality and Protection Act Grant, 2005. We thank the grower cooperators for providing field sites for these studies.

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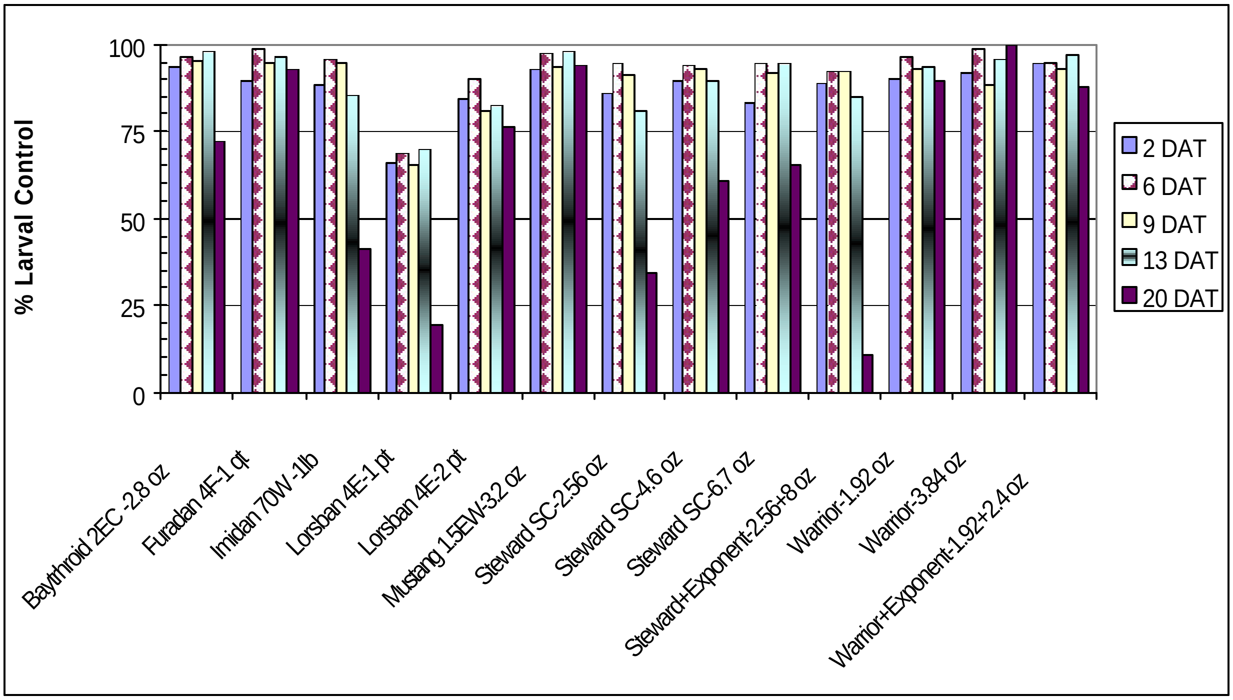

Figure 1. Percentage EAW larval control from selected treatments from the treatment study at several days after treatment (DAT) evaluations, Davis, 2005.

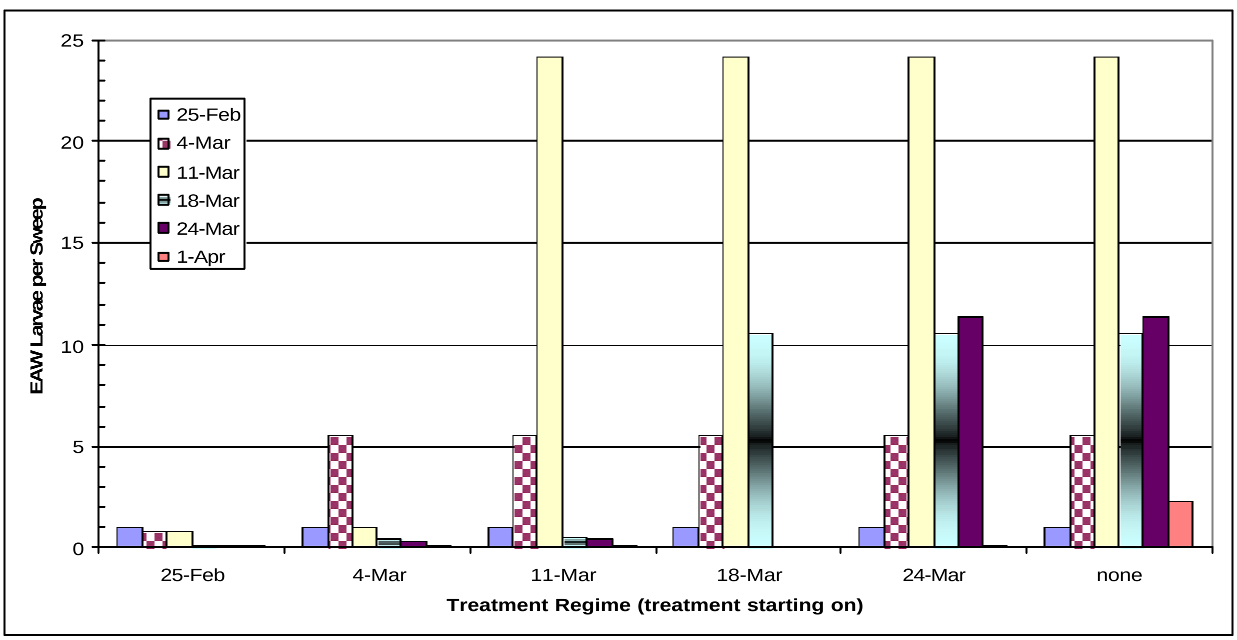

Figure 2. EAW larval data from weekly sample dates (25 February to 1 April) from timing study, Davis, 2005.

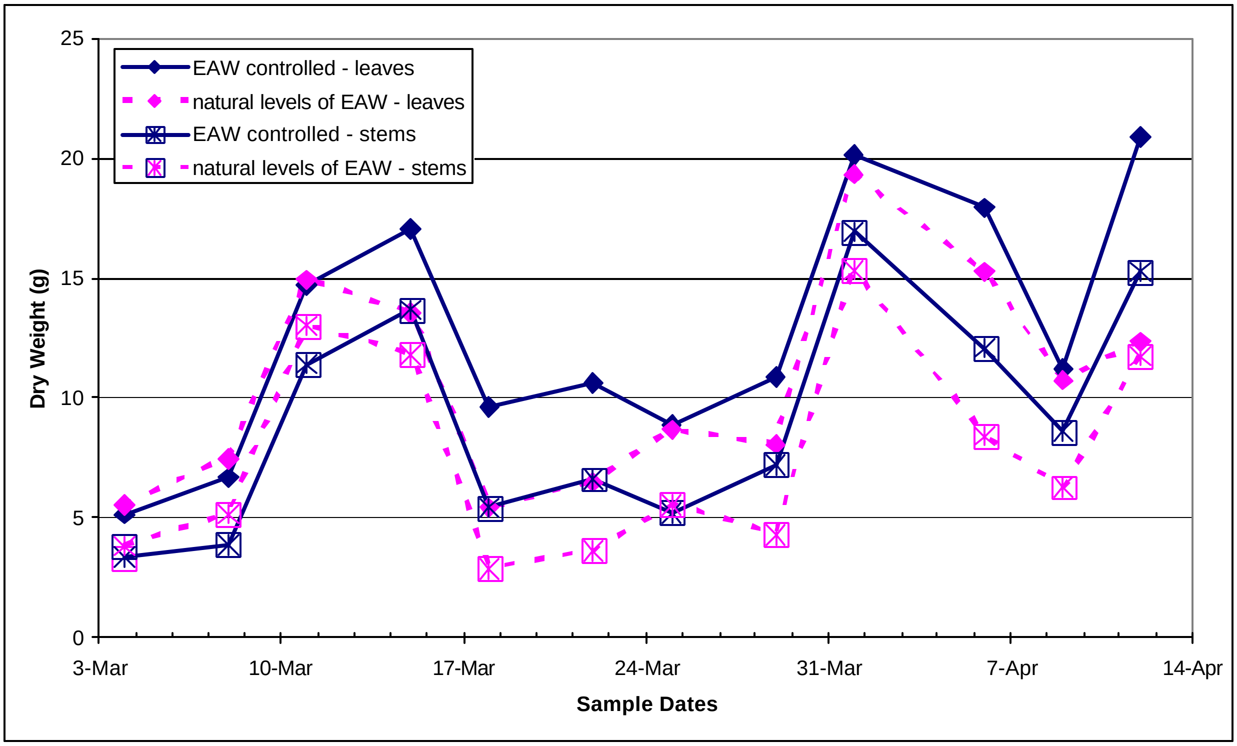

Figure 3. Effect of EAW larval feeding on alfalfa stem and leaf tissue dry weights (grams per sq. ft.), Davis, 2005.

Table 1. EAW larval population as indicated by three sampling methods, Davis, 2005.

Sample Date	EAW Larvae per 10 Stems	EAW Larvae per Sweep	% Terminals with EAW Damage	Alfalfa Height (in.)
25 Feb.	19.3	1.0	59.5	4
4 Mar.	33.6	5.5	68.5	6
11 Mar.	37	24.2	90.5	9.5
18 Mar.	10.5	10.6	95+	12
24 Mar.	3.8	11.4	95+	16
1 Apr.	1.4	2.3	95+	18