MANAGEMENT OF EGYPTIAN ALFALFA WEEVIL AND PROTECTION OF YIELDS WITH SELECTED INSECTICIDES

Larry Godfrey and Dan Putnam[1]

ABSTRACT

The Egyptian alfalfa weevil (alfalfa weevil in some areas) during most years is the most severe insect pest of alfalfa in California. These pests feed on alfalfa leaflets and stems, reducing hay yields. Several insecticides provide acceptable control of this pest. Historically, product choice has been driven by efficacy on the pest, cost, presence of other pests, i.e., aphids, days before harvest, etc. However, in recent years insecticide usage, particularly organophosphate and carbamate insecticides, in alfalfa has been under increased scrutiny and has been suggested as a factor contributing to the levels of insecticides in surface waters. New classes of products have been registered and others are being considered for registration. These new products although facilitating protection of surface waters, may not have the optimal properties for IPM in alfalfa. Studies were conducted to evaluate the fit of these materials into alfalfa IPM and to examine the impact of Egyptian alfalfa weevil populations on alfalfa productivity.

INTRODUCTION

Two species of weevils (Alfalfa Weevil [*Hypera postica*] and Egyptian Alfalfa Weevil [*Hypera brunneipennis*]) inflict damage to alfalfa in the West. These insects are very similar; the appearance of the adults and larvae is identical. These pests are examples of an insect introduced into the US from foreign sources. Separate introductions of these pests (probably three) have resulted in the two separate species designations. There are some important biological differences between the alfalfa weevil and Egyptian alfalfa weevil (EAW) with the most obvious being that the former species dominates in cooler climates and the Egyptian alfalfa weevil flourishes in the California Central Valley. The biology, damage, and insecticidal control for these two pests are identical. The weevil larvae inflict the majority of the damage to alfalfa. The early larval stages feed in the alfalfa terminals and the larger larvae feed on the leaflets. Under severe pressure, the plants can be completely defoliated. This damage generally begins in the late winter/spring (time depends location) and the damage accumulates over a 4 to 6 week period. The larvae are legless, ~0.25 inch long when fully grown and are pale green with a thin white line down the center of the back; they have a brown head.

The Egyptian alfalfa weevil generally has one generation per year. The larvae pupate in a loosely woven cocoon either on the soil surface or attached to the foliage. Within a month of pupation, the new adult emerges. Adult weevils are dark gray and about 0.20 inch long. These

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[1] L. Godfrey, Department of Entomology, One Shields Ave., Univ. of California, Davis, CA 95616; D. Putnam, Department of Agronomy and Range Science, One Shields Ave., Univ. of California, Davis, CA 95616; email: ldgodfrey@ucdavis.edu; dhputnam@ucdavis.edu; **In:** Proceedings, Western Alfalfa and Forage Conference, 11-13 December 2002, Sparks, NV, UC Cooperative Extension, Univ. of California, Davis, 95616.

adults feed on the alfalfa for a short period of time and leave the alfalfa field for sites in which to spend the summer in a state called aestivation. These sites include areas under loose bark of trees, such as Eucalyptus, or rough-barked trees such as walnut, or in any place where the adults can wedge their bodies into “protected areas”. In late fall or early winter, adults that have spent the summer in aestivation emerge and return to alfalfa fields. Soon after entering the fields, the adults mate and the females begin inserting their eggs into the stems of alfalfa. During some years, some egg hatch can occur in the fall/early winter whereas during cooler years the egg hatch occurs in the late winter/early spring in its entirety. 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 generation of weevil larvae that continue to cause damage into the second and sometimes third cuttings. Fields should be carefully monitored to be certain that no additional weevil larvae are present after the first cutting. The key period for management of alfalfa weevil and Egyptian alfalfa weevil is usually prior to the first cutting although the second cutting, as noted above, can also be damaged.

Monitoring and Management Guidelines. EAW larvae are sampled using a standard 15” sweep net. Sampling should be conducted in at least four areas of the field and by taking 5-10, 180º sweeps per area. The early stage larvae are poorly sampled with a sweep net; therefore careful attention should be given to examining terminals in the late winter/early spring. Tapping the terminals against a white background (paper, etc.) may dislodge the larvae and make them more visible. Management options include early harvest, biological control organisms, and insecticides. Early harvest, within the limits of typical alfalfa production, will kill many of the weevil larvae; however, the regrowth should be monitored for the damage from surviving larvae. Biological control with generalist predators is only marginally effective because the complex of natural enemies has not developed yet during this late winter/early spring period. Specific parasitoids have been introduced into the U.S. for these pests, but have been mostly ineffective for Egyptian alfalfa weevil. Parasitoids have been much more effective against the alfalfa weevil, especially in the eastern U.S. Minimal success has been achieved in developing alfalfa varieties resistant to Egyptian alfalfa weevil.

Therefore, insecticides are a primary means of managing weevil pests of alfalfa; one, or at most, two applications of insecticide per year generally provide good control. The economic threshold for initiating chemical control is 20 weevil larvae per sweep. Insecticides from several different chemical classes are registered for Egyptian alfalfa weevil and historically selection of materials has been based on efficacy, cost, presence of other pests, i.e., aphids, etc. However, in recent years insecticide usage in alfalfa has been under increased scrutiny. Insecticide usage in alfalfa and other croplands has been suggested as a factor contributing to the levels of insecticides in surface waters (Long et al. 2001). Organophosphate and carbamate insecticides have been especially implicated. Long and co-workers showed that pyrethroid insecticides can effectively control EAW larval populations and that these insecticides have properties that make them less likely to accumulate in surface waters. In addition, in 2001, insecticidal control of Egyptian alfalfa weevil with many insecticides was difficult and unpredictable. The exact reasons for this are unknown but most likely related to environmental conditions and/or extremely high weevil populations.

Protection of the environment is an obvious goal and desire of the alfalfa industry. However, this needs to be done through means that do not compromise the integrated pest management programs that have been developed and implemented in alfalfa over the last 25+ years. For instance, the pyrethroid insecticides have been reported to be very detrimental to populations of predators and parasitoids, i.e., low selectivity, in other field crops (Godfrey et al. 2001). Alfalfa is frequently called an insectary for beneficials within the Central Valley; fields have been shown to support over 1000 species of arthropods (Summers, 1998). These beneficials can positively impact IPM in alfalfa and in other neighboring crops. Another consideration within the alfalfa system is the potential of various aphid species to become significant pests. Most recently, the cowpea aphid has developed into a pest (Natwick & Lopez, 2000). Many insecticides, including some pyrethroids, have been shown to "promote" populations of aphids either indirectly through their effects on beneficials and/or through a direct effect on the aphid physiology (Godfrey & Rosenheim 1996, Godfrey 1998). The goal of this present study was to continue to evaluate the fit of registered and experimental insecticides for pest management programs aimed at Egyptian alfalfa weevil. Efficacy on weevil larvae, and resulting effects on alfalfa production, effects on non-targets, and influence on secondary pests were evaluated.

PROCEDURES

The efficacy of registered and experimental insecticides against EAW larvae was evaluated. Treatments were applied with a CO_2 backpack sprayer on 11 March as the population approached the treatment threshold. Plot design included 20 by 50 feet plots with 4 replicates per treatment. Insects were sampled with a sweep net and percentage EAW control was quantified at 3, 7, 10, 15, and 21 days after treatment (DAT). The effect of the treatments on beneficial arthropods was evaluated as well as EAW larval control. The beneficials studied were lady beetles, lacewings, damsel bugs, big-eyed bugs, minute pirate bugs, and spiders. These natural enemies are important for EAW management but probably more important for pea aphid management in the second and third cutting.

Alfalfa was harvested on 8 April with a Carter flail harvester. Fresh weights and dry weights were determined. A subsample of this harvest was used for crude protein and ADF analyses. In addition, square meter areas were hand-harvested from six selected treatments and separated into leaf and stem tissues. These samples were dried and leaf:stem ratios calculated. Finally, nutrient analyses were done on each of these fractions.

RESULTS

Populations of EAW adults were very low in the plot area and did not contribute to alfalfa damage. Pretreatment densities of EAW larvae averaged ~14 per sweep on the day of treatment. Populations were 45% small larvae and 55% large larvae. Over 1" of rain occurred during the 5 day period before application and this temporarily decreased the EAW population from the over

25 per sweep level previously sampled. Densities of pea aphids averaged 16 per 25 sweeps and numbers of beneficials averaged 3.4 per 25 sweeps on the day of treatment. The sweep net is not the recommended method to sample for pea aphids, therefore this value cannot be related to the pea aphid threshold.

At 3 days after treatment (DAT), the EAW larval density in the untreated had declined slightly; however, populations stayed fairly constant through 15 DAT. In fact, at 15 DAT, populations in the untreated were still ~40% small larvae, indicating a prolonged hatch and sustained pressure. All treatments at 3 DAT except the Novodor and Steward treatments reduced EAW larval numbers by greater than 65% (Fig. 1 [similar treatments deleted for clarity in this graph]). The Novodor, a biological insecticide, treatments had no effects on the population on this date or on future dates. Steward at 3 DAT reduced the larval population by about 40%. Numerically, Imidan, Warrior, Baythroid 20WP, and F0570 provided the best control although several other treatments were statistically similar. At 7 DAT, all chemical insecticides provided 69%+ EAW control. Numerically, Imidan, Steward, Baythroid 20WP, and F0570 were >80% control. Results were similar at 10 DAT. At 15 DAT, efficacy with all treatments intensified such that 90-95% control was seen with most chemical insecticides. The EAW population had declined noticeably at 21 DAT as did the efficacy with most products. Only Warrior, Baythroid 2EC, and Furadan provided greater than 80% control.

Populations of beneficials were relatively sparse in this test. At 3 DAT and 7 DAT, levels were so low it was difficult to draw any real conclusions. The best data are from the 10 DAT sampling date when the untreated averaged 6.75 per 25 sweeps (Table 1). Although there is considerable overlap in the mean separation, the following trends can be seen. Imidan, Novodor, and Lorsban had very little effects on beneficials. Steward and Baythroid 20WP were intermediate in severity and the remaining treatments had the most severe effects with a 60-80% reduction in levels.

Pea aphid populations were present in this study, but not at high levels. Aphid numbers at 10 DAT and 21 DAT will be discussed. Numerically, aphid numbers were higher in the Novodor and Steward treatments compared with the untreated at 10 DAT (Table 1). Aphid control was seen with Warrior, F0570, and Baythroid. At 15 DAT (data not shown), the aphid populations in the two Novodor treatments had declined to levels less than the untreated; however, the aphid numbers were still somewhat high in the 4.6 oz. rate of Steward. This trend continued such that there were significantly more aphids in this treatment compared with the untreated at 21 DAT (Table 1). Aphid control in the 65-70%+ range was seen with all the other treatments at 15 DAT. At 21 DAT only Warrior provided any appreciable aphid control.

Alfalfa yield was significantly influenced by the EAW population (Table 2). Fresh weight at harvest was numerically highest in the Warrior, F0570 (4 oz.), and Baythroid 20WP treatments; however, yields in all treatments except Novodor were greater than the untreated. There was a doubling of the weight in the most effective treatment compared with the untreated. Dry weight yields followed similar trends. The magnitude of these yield differences is interesting given that the EAW population was consistently below (by about 30%) the treatment threshold value.

Crude protein and ADF percentages did not differ across treatments (Table 2). This is surprising given the amount of defoliation damage and that the leaf:stem ratios were significantly different (Table 1).

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Table 1. Treatment list, effects of EAW treatments on populations of beneficials and on populations of pea aphid on selected dates, and the influence of selected treatments on alfalfa leaf to stem ratios.

Treatments	**Rate (product/A)**	**Beneficials per 25 sweeps** *		**Pea Aphids / 25 sweeps** 10 DAT		21 DAT		**% Leaf (dry weight)**	
Imidan 70W	1 lb.	9.0	a	7.0	cd	37.5	b	38.6	ab
Warrior **	3.84 fl. oz.	2.0	ab	0.25	d	12.25	b	42.5	a
Novodor (2 appl. @5 days apart) **	1 gal.	7.0	ab	23.5	a	29.75	b	--	
Furadan 4F	1 qt.	2.75	ab	5.25	cd	37.5	b	43.6	a
Lorsban 4E	1.5 pts.	7.0	ab	4.5	cd	18.5	b	42.3	a
F0570	3.2 fl. oz.	1.25	b	3.0	cd	31.25	b	--	
F0570	4 fl. oz.	1.25	b	0.75	d	18.5	b	--	
Baythroid 2EC **	2.8 fl. oz.	2.25	ab	1.5	d	23.0	b	--	
Baythroid 20WP **	0.22 lb.	3.5	ab	2.5	cd	28.25	b	--	
Steward SC	2.56 fl. oz.	3.5	ab	21.5	a	45.25	b	38.6	ab
Steward SC	4.6 fl. oz.	5.0	ab	14.0	abc	114.25	a	--	
Warrior	3.84 fl. oz.	2.25	ab	0.5	d	7.0	b	--	
Novodor **	1 gal.	6.75	ab	19.0	ab	25.25	b	--	
Untreated	---	6.75	ab	8.25	abc	22.75	b	34.0	b
* data from 10 DAT ** with crop oil									

Table 2. Treatment list, alfalfa yield, and nutrient quality results - EAW study, 2002.

Treatments	Rate (product/A)	Fresh Wt. Yield (lbs./A)		% Mois-ture		Dry Wt. Yield (lbs./A)		Crude Protein (%)		ADF (%)	
Imidan 70W	1 lb.	7623.0	cd	24.3	abc	1852.4	bc	26.8	a	26.1	a
Warrior **	3.84 fl. oz.	9674.0	a	21.6	cd	2089.6	abc	26.8	a	26.2	a
Novodor (2 appl. @5 days apart) **	1 gal.	4639.1	e	25.9	ab	1201.5	de	26.6	a	26.8	a
Furadan 4F	1 qt.	9013.3	abc	22.8	bcd	2055.0	abc	27.2	a	26.3	a
Lorsban 4E	1.5 pts.	8839.1	abc	26.0	ab	2298.2	ab	26.4	a	26.9	a
F0570	3.2 fl. oz.	8015.0	bcd	24.1	abc	1931.6	abc	27.4	a	26.8	a
F0570	4 fl. oz.	9412.6	ab	22.1	bcd	2080.2	abc	26.8	a	26.9	a
Baythroid 2EC **	2.8 fl. oz.	8893.5	abc	22.7	bcd	2018.8	abc	26.9	a	26.5	a
Baythroid 20WP **	0.22 lb.	9474.3	a	24.9	abc	2359.1	a	27.3	a	26.5	a
Steward SC	2.56 fl. oz.	6733.7	d	24.8	abc	1669.9	cd	27.0	a	26.7	a
Steward SC	4.6 fl. oz.	8040.5	bcd	25.1	abc	2018.2	abc	27.3	a	26.3	a
Warrior	3.84 fl. oz.	9376.3	ab	19.7	d	1847.1	bc	26.5	a	26.7	a
Novodor **	1 gal.	4029.3	e	27.8	a	1120.1	e	26.4	a	28.0	a
Untreated	---	4820.6	e	25.6	abc	1234.1	de	27.3	a	26.1	a
** with crop oil											

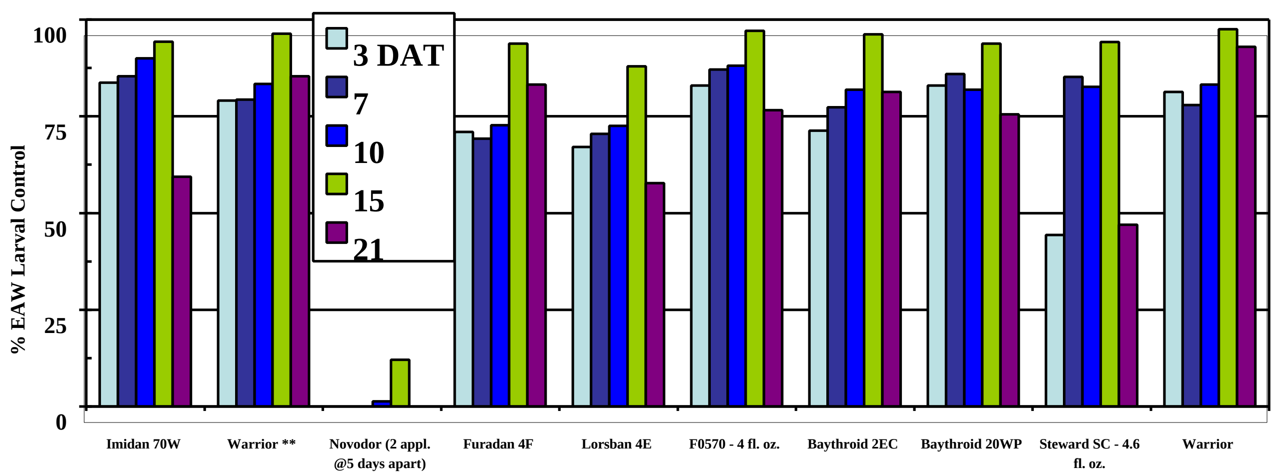

Figure 1. Egyptian alfalfa weevil larval control from selected treatments at various days after treatment (** = crop oil added); EAW population in untreated = 13.8, 8.4, 8.8, 9.8, 9.8, and 2.7 larvae per sweep at 0, 3, 7, 10, 15, and 21 DAT, respectively.