Integrated Pest Management of Insect Pests in Alfalfa Hay

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ABSTRACT

Studies were conducted on key insect pests of alfalfa hay in California. The efficacy of registered and experimental insecticides on Egyptian alfalfa weevil and pea aphids, and impact on beneficial insects, was examined. Lorsban, Furadan, Imidan, Pounce, and Imidan + Pounce generally provided good weevil control; treatments with Pounce reduced densities of beneficials much more than the other treatments. Several studies were conducted on the ground mealybug, an emerging pest of alfalfa in the state; little is known about this pest. There were three generations of this pest per year. In terms of hosts for this subterranean insect, there were no differences among ten alfalfa varieties; however, there were trends among 12 different crop host plants. Finally, the clover root curculio is another soil-borne insect pest that commonly occurs in parts of the state. The possible impact of this pest on alfalfa production is discussed.

INTRODUCTION

Alfalfa fields in the Central Valley harbor a tremendous population of insects. Many of these insects are beneficial and many others are of no importance. A few insects in alfalfa are pests; these insects defoliate alfalfa stems, remove plant juices, or feed on root tissue. The most serious insect pest of alfalfa hay in California is the Egyptian alfalfa weevil (EAW). This pest became prevalent in California in the 1960's. It occurs throughout the Central Valley, coastal areas, and intermountain regions. Fields in the Central Valley often require one insecticide application in the spring to prevent yield losses from EAW larvae. This study evaluated the use of selective insecticides for EAW that have minimal effects on non-target beneficial insects. These beneficial insects are important for providing biological control of pea aphids and lepidopterous larvae later in the growing season.

The ground mealybug (GMB) is an important insect pest of alfalfa, primarily in the Sacramento Valley. This insect is small (about 1/16"), whitish, and relatively soft-bodied. GMB spend its entire life cycle in the soil and feed on alfalfa roots, which causes stunting and yellowing of plants. The infestation generally starts in small circular areas near the field border and gradually increases as size. Within the infested areas, the plant stand is sparse and existing plants yield poorly. Research-based information on this pest is extremely limited. Our research has examined the seasonal population levels of this pest in alfalfa, the susceptibility of various alfalfa varieties to this pest, and the host range for GMB.

The clover root curculio (CRC) is another root-feeding insect pest of alfalfa. The larvae of this pest feed on and tunnel in alfalfa roots. Larvae are small, grublike and whitish with a dark head. This damage alone can reduce alfalfa yield and stand longevity. However, more importantly, these feeding sites readily allow the entry of root-rotting fungal organisms into the roots. This combination of pests can lead to a rapid decline in alfalfa productivity. The clover root curculio occurs in California; however, the distribution and damage potential are unknown.

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PROCEDURES

Egyptian Alfalfa Weevil

The efficacy of registered and experimental insecticides was evaluated on EAW adults and larvae in replicated field plots in Yolo county in 1991-93. Treatments were applied as the field population reached the economic threshold of 20 EAW larvae per sweep, generally in late March. Densities of EAW larvae, pea aphids, and beneficial arthropods were determined with sweep net samples at 1, 3, 7, 14, and 21 days after treatment. Beneficial arthropods considered were big-eyed bugs, minute pirate bugs, damsel bugs, lady beetles, and spiders. Treatments were applied with a CO_2 backpack sprayer to plots (12 x 25 ft x 4 replicates).

Ground Mealybug

We studied GMB biology from July 1992 to June 1994. Soil samples, to determine field population levels, were taken about every 14 days from an infested alfalfa field in Yuba County during the spring, summer, and fall and once per month during the winter. A 75 in^3 soil core sample was used. Three samples were taken at 0-6, 6-12, and 12-18 inch depths in each of four quadrants. A soil sieving/flotation method was devised to separate the mealybugs from the soil particles. GMB occurrence in the soil has been associated with high levels of soil moisture. Therefore, additional soil samples were taken on each date for evaluation of soil moisture. Samples were weighed wet and again following drying for 48 hr. at 120°F.

Previous field observations indicated that not all alfalfa varieties were equally susceptible to infestations from ground mealybugs. In particular, root knot nematode resistance in alfalfa varieties is thought to impart some resistance to GMB. Three greenhouse studies were conducted to test this idea. Ten alfalfa varieties, as shown in Table 1, were studied. These varieties represented four dormancy classes and various degrees of root knot nematode resistance. Each alfalfa variety was grown from seed in 2.5 gallon pots (10 replicates per variety) within a mixture of sterilized silt loam soil and peat moss. At 10 weeks after planting, each pot was thinned to 6 plants. One hundred GMB adults per pot were introduced at 10 weeks after plant thinning. All pots were watered twice weekly to maintain plant growth. Plant growth was harvested at about monthly intervals at the initiation of bloom and the foliage was quantified for the number of stems, average stem length, and biomass dry weight. One preinfestation and four post-infestation harvests were conducted. Following fourth post-infestation alfalfa harvest, the plants were destructively sampled for the GMB presence in the soil. Samples were processed as previously described.

Table 1. Alfalfa varieties examined for susceptibility to ground mealybugs.

Fall Dormancy Rating	RKN Resistant	RKN Susceptible
5 (moderately dormant II)	Archer	Crockett, Washoe
6 (semidormant)	ABI700[a]	Lahanton
7 (moderately nondormant)	Sutter	WL457
8 (nondormant)	Yolo	Pierce, Falcon

[a] Moderately resistant.

One of the key questions for GMB management is whether this pest survives on other plant species. Insecticidal control of GMB is unlikely. Crop rotation could be an important aspect of managment strategies if this pest has a narrow host list. The susceptibility of 11 crop plant species to GMB infestation was compared in a greenhouse study. Alfalfa, kidney beans, field corn, acala cotton, cantaloupe, potatoes, nonflooded rice, safflower, sugarbeets, tomatoes, and wheat were grown in 16 oz. plastic cups within vermiculite. Ten ground mealybugs per cup were infested about 5 weeks after planting. Ten replicates of each plant were grown (a vermiculite only control treatment was also included). Cups were destructively sampled at 10 weeks after infestation and GMB density determined.

RESULTS

Egyptian Alfalfa Weevil

The percentage control of EAW for five registered treatments is shown in Fig. 1. Treatments were Imidan 50WP (0.75 lb. AI/A), Furadan 4F (0.75 lb. AI/A), Lorsban 4E (0.75 lb. AI/A), Pounce 3.2EC (0.15 lb. AI/A), and Pounce 3.2EC + Imidan 50WP (0.75 + 0.1 lb. AI/A). Control at 3 DAT ranged from 72% for Furadan 4F to 95% for the Imidan + Pounce treatment. At 14 DAT, all treatments provided 90+% control. Of these five treatments, only Furadan and Lorsban provided >80% control at 21 DAT. However, during many years, if the application is made at the economic threshold, 14 days of control will be adequate. Products not registered in California on alfalfa, such as Mustang 1.5EW and Asana XL were tested and provided excellent EAW control. Registered products, including Guthion 3F and Sevin XLR Plus, were tested in 1993 and provided ~80% EAW control.

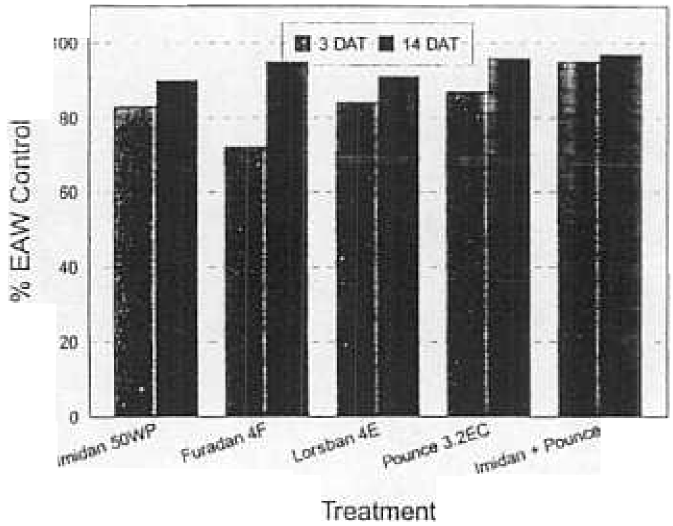

Fig. 1

Pea aphids may build to damaging levels in May/June. The efficacy of the EAW treatments on pea aphids is shown in Fig. 2. Although the sweep net is not the recommended way to sample for pea aphids, it is meaningful for comparing these five treatments. At 3 DAT, the pea aphid density in the five treatments was less than the density in the

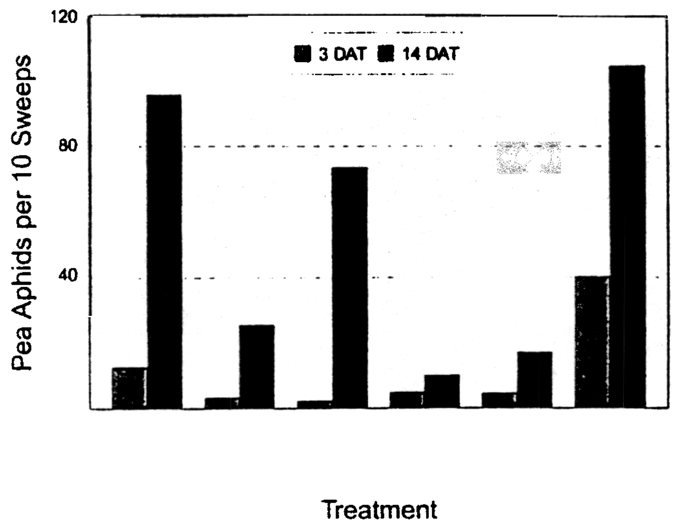

Fig. 2

untreated. The pea aphid density, at 14 DAT, was lowest in the Pounce and Imidan + Pounce treatments, intermediate in the Furadan treatment, and highest in the Lorsban and Imidan treatments. The density in the latter two treatments did not differ significantly from the density in the untreated. More importantly, pea aphid levels in the none treatments exceeded the level in the untreated. This can often happen if insecticides "flare" populations of secondary pests.

Another aspect of the pea aphid population increase is the disruption of biological control by treatments targeted for EAW. Predators such as big-eyed bugs, minute pirate bugs, damsel bugs, lady beetles, and spiders feed upon aphids. The critical period for pea aphid population build-up is generally about 4-6 weeks after EAW treatments. Therefore, broad-spectrum materials, which kill beneficial arthropods, may contribute to aphid population increases. Of these five treatments, Imidan, Lorsban, and Furadan reduced the predator densities by 42-56% and by 30-41% at 3 and 14 DAT, respectively (Fig. 3). Pounce and Pounce + Imidan treatments reduced the predator density much more (an average of 77%). However, the relatively small plot size may have reduced the apparent impact of the treatments on predator levels; predators may have quickly moved back into treated areas.

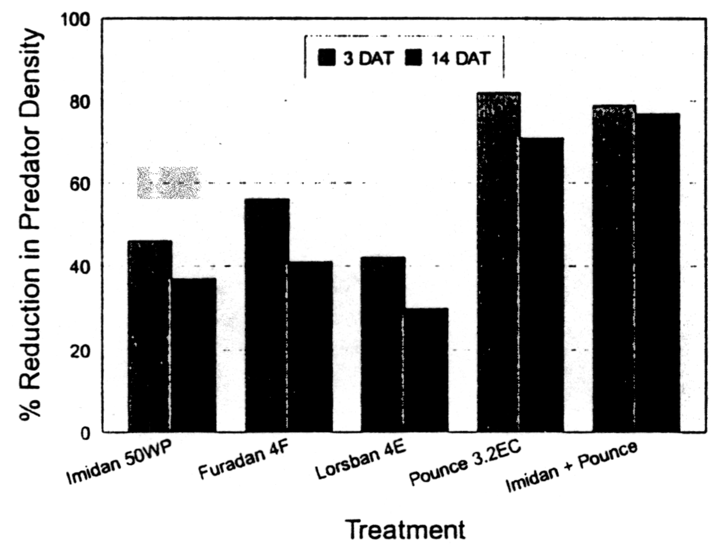

Fig. 3

Ground Mealybug

In 1992, ground mealybug population density exhibited two peaks; the initial peak was in August/September and the second peak occurred in late fall/early winter (Fig. 4). The highest mealybug density recorded was 39.7 mealybugs per 75 in^3 soil sample in October 1992. GMB density was overall lower in 1993 than 1992. During the second year of sampling, population peaks occurred in July/August, December/January, and March/April. It appears that this pest in California has three generations per year, with peaks in early winter, spring, and mid-summer. The spring generation was not prevalent in 1993 possibly because of very wet, nearly saturated, soil moisture conditions. The soil moisture level was near the field capacity (~21%) from January to April 1993.

Generally, more mealybugs were found at 6-12 inch (7.27 per sample) and 12-18 inch (8.89 per sample) depths than at the 0-6 inch (2.17 per sample) depth. Mealybug incidence was believed to be associated with moist soils. Soil moisture was similar at all three depths 0-6 inch (14.4%), 6-12 inch (14.4%), and 12-18 inch (15.0%). On one sampling date (28 June 1993), the soil moisture was stratified to a greater extent with soil depth (8.3 to 13.0% at 0-6 to 12-18 inch depths). On this date, ground mealybug density was 1.5, 7.3, and 20.8 per sample at 0-6, 6-12,

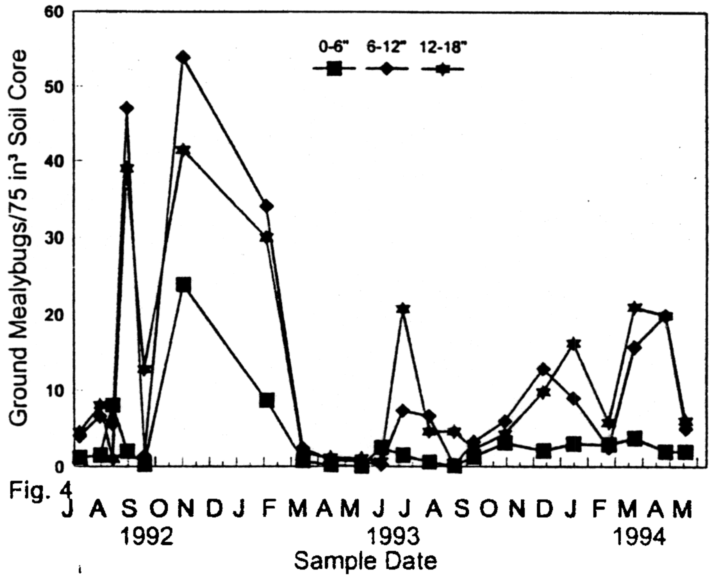

Fig. 4

and 12-18 inch depths, respectively. However, over all the sampling dates, there was no significant relationship between soil moisture and mealybug density. The highest ground mealybug population density was generally found at intermediate soil moisture conditions; however, some individuals were found in soils at 7% moisture.

There were no trends in GMB population density with alfalfa variety. Alfalfa growth was significantly different among the ten varieties; however, these differences did not appear to be related to root knot nematode resistance or to GMB density. Apparently all varieties are equally susceptilbe to this pest.

Significant differences were found in ground mealybug survival among the 12 host plant treatments (Table 2). The density of mealybugs found in tomatoes and potatoes was significantly higher than that found in sugar beets, field corn, kidney beans, and the vermiculite control. Some level of survival/reproduction was found in all crop plant species. Reproduction on alfalfa was intermediate among the crop species. This study needs to be conducted in the field to supplement these greenhouse results.

Table 2. Survival and reproduction of ground mealybugs on several crop plant species.

Host Plant	Num. of Ground Mealybugs[a]
Alfalfa	7.0ab
Kidney Beans	0.2b
Field Corn	0.6b
Acala Cotton	2.8ab
Cantaloupe	2.1ab
Vermiculite Control	0.0b
Potato	11.1a
Dryland Rice	4.2ab
Safflower	7.2ab
Sugar Beets	1.2b
Tomato	13.1a
Wheat	2.9ab

Means within columns followed by the same letter are not significantly different with SNK test ($P < 0.05$).

[a] Out of ten ground mealybugs infested 10 weeks before sampling.

Clover Root Curculio

The impact of CRC in alfalfa production in California is unknown. This insect has been found throughout the state and is quite common, and presumably important, in areas with lighter soils. Research I conducted on this pest in Kentucky showed that it can reduce alfalfa yield by ~12%, nutrient quality, and stand longevity by ~2 years. The below-ground habits of CRC larvae make this pest difficult to detect. Future reseach needs to investigate this insect pest in California.

SUMMARY

Current research programs are aimed at developing integrated approaches to the major insect pests of alfalfa hay in California. Considerable progress over the years has been made on the foliage-feeding pests, although data gaps still exist. Information on the soil-borne insect pests is critically lacking and IPM programs are yet to be designed for these pests.