CURRENT STATUS OF BIOLOGICAL CONTROL OF ALFALFA WEEVILS IN CALIFORNIA

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ABSTRACT

Alfalfa weevils are the most damaging insect pest of California alfalfa. Although many insecticides effectively control the weevil, increasing environmental problems associated with chemical pest control add to the need for alternative tactics. Our study from 2004-2005 was conducted to assess the current level of parasitism by biological control agents of the alfalfa weevil. Eggs, larvae and adult weevils were collected from various counties throughout California and reared to determine the percent of parasitism by various introduced wasp species and a naturally-occurring fungus. The overall percent parasitism by wasps was lower than what can maintain weevil larvae under economic thresholds. Parasitism by the fungus, *Zoophthora phytonomi*, in 2005 however, was high enough in some areas to effectively control the weevil without chemical inputs.

Key Words: alfalfa weevil, biological control, IPM, *Bathyplectes* spp., parasitism, *Zoophthora phytonomi*

INTRODUCTION

The alfalfa weevil complex in California, comprised of the western strain of the alfalfa weevil *Hypera postica* and the Egyptian alfalfa weevil *Hypera brunneipennis,* is the most damaging insect pest of alfalfa. Feeding by weevil larvae can cause severe defoliation in an alfalfa field, significantly reducing yields and forage quality (Weaver et al. 1993; Koehler and Rosenthal 1975). Peak larval populations vary throughout California, determined by climatic conditions throughout the state. Larval populations first develop during January in the low desert in southern California, between February and March in central California, and April in northern intermountain regions.

Insecticides such as organophosphates, carbamates, and pyrethroids effectively control the weevil, but the occurrence of these chemicals in surface waters and soil sediment has placed added emphasis on finding alternatives for weevil pest management. Pyrethroid insecticides, recently registered in alfalfa, are non-selective for natural enemies and may pose additional environmental concerns. Regardless, minimizing chemical applications is one of the key objectives in any integrated pest management program. Biological control by parasitic wasps

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and a parasitic fungus has been effective in significant reduction of chemical applications against the *H. postica* in the Midwest and the northeastern United States (Radcliffe and Flanders 1998).

A massive number of insect-parasitic wasps (parasitoids) were released for alfalfa weevil control in California and elsewhere between 1957 and 1988. Pitcairn and Gutierrez (1989) reported that three species of these released parasitoids were recovered from fields in the Central Valley in 1982 and 1983. As most growers still find it necessary to apply insecticides at least once before the first cutting, it was our hypothesis that parasitoids and other natural enemies were not effectively controlling the weevil. Our study was intended to assess the current status of biological control agents against the alfalfa weevil in California. We focused our efforts on the regions in California that are major producers of alfalfa hay: the Low Desert, Central Valley, Sacramento Valley and Intermountain Region.

MATERIALS AND METHODS

Alfalfa weevil eggs, larvae and adults were collected from selected field sites throughout California in 2004 and 2005, depending on peak period of weevil population at each location. Counties were chosen on the basis of total acres harvested each year and accessibility to grower fields, research stations, and collaboration with University of California Cooperative Extension (UCCE) farm advisors. Counties located in areas of higher percent production of alfalfa hay were desired as they would best represent the overall status of effective biological control in their respective regions.

In 2004, at least one field site was surveyed in each county included in the study, with two sites surveyed in Yolo County. The eight counties included in the study (starting from south to north) were: Kern, Tulare, Merced, San Joaquin, Yolo, Colusa, Shasta, and Siskiyou. In 2005, most sites stated above were again sampled, but we included two southern California locations/counties: Holtville in Imperial County and Blythe in Riverside County. We did not sample Merced County in 2005. All alfalfa fields were managed under normal production practices with Woodland (Yolo Co.) being our only organic field. The areas of the field to be sampled were left unsprayed with insecticides by the grower or researcher to allow populations of alfalfa weevil to build. Samples were collected at least twice from each site according to peak larval population, with weather and collector availability being limiting factors.

Eggs were dissected from field collected stems and placed on moist filter paper to hatch. Any emergence of egg-stage parasites was noted. Larvae were collected using a standard 15” sweep net and placed in a plastic bag and kept cool with an ice pack during transport. In the laboratory, larvae were separated by size (approximate instar stage) into sub-samples and held for rearing. The rearing containers were maintained in the laboratory near a window to allow for natural daily photoperiod for weevil development. Temperature in the laboratory was kept constant at approximately 22 ºC ±5º and relative humidity of approx. 80%. Each rearing container was supplied with fresh bouquets of greenhouse-grown, chemical-free alfalfa, upon which the larvae were allowed to develop. The bouquets were replaced with fresh alfalfa as needed. Cocoons of the larval-stage weevil parasites, *Bathyplectes curculionis*, *B. anurus* and *Oomyzus (=Tetrastichus) incertus,* and newly emerged adult weevils were removed from containers daily and placed in vials for counting. Any weevil larvae that were dead or infected with the fungus

Zoopthora phytonomi, (a fungus specific to *H. postica* and *H. brunneipennis*), were also removed and counted. Adults gathered in the sweep nets at the beginning of the season (while monitoring for eggs and larvae) were dissected under a microscope and assessed for parasitism by *Microctonus aethiopoides*, a parasitoid that attacks adult weevils.

RESULTS

No egg-stage or adult-stage parasites have been recovered from our samples in 2004 or 2005. It was reported by Pitcairn and Guiterrez (1989) that *M. aethiopoides* was recovered in a small number of their samples, but we did not find any. The overwhelming parasite recovered from larval collections in 2004 was the wasp, *B. curculionis*, while the majority of parasites recovered in 2005 were the fungus *Z. phytonomi* (Figure 1). All-field parasitism of larvae reared in 2004 (n= 6626) was 8.19%, whereas all-field parasitism of larvae in 2005 (n= 5317) was 22.2%.

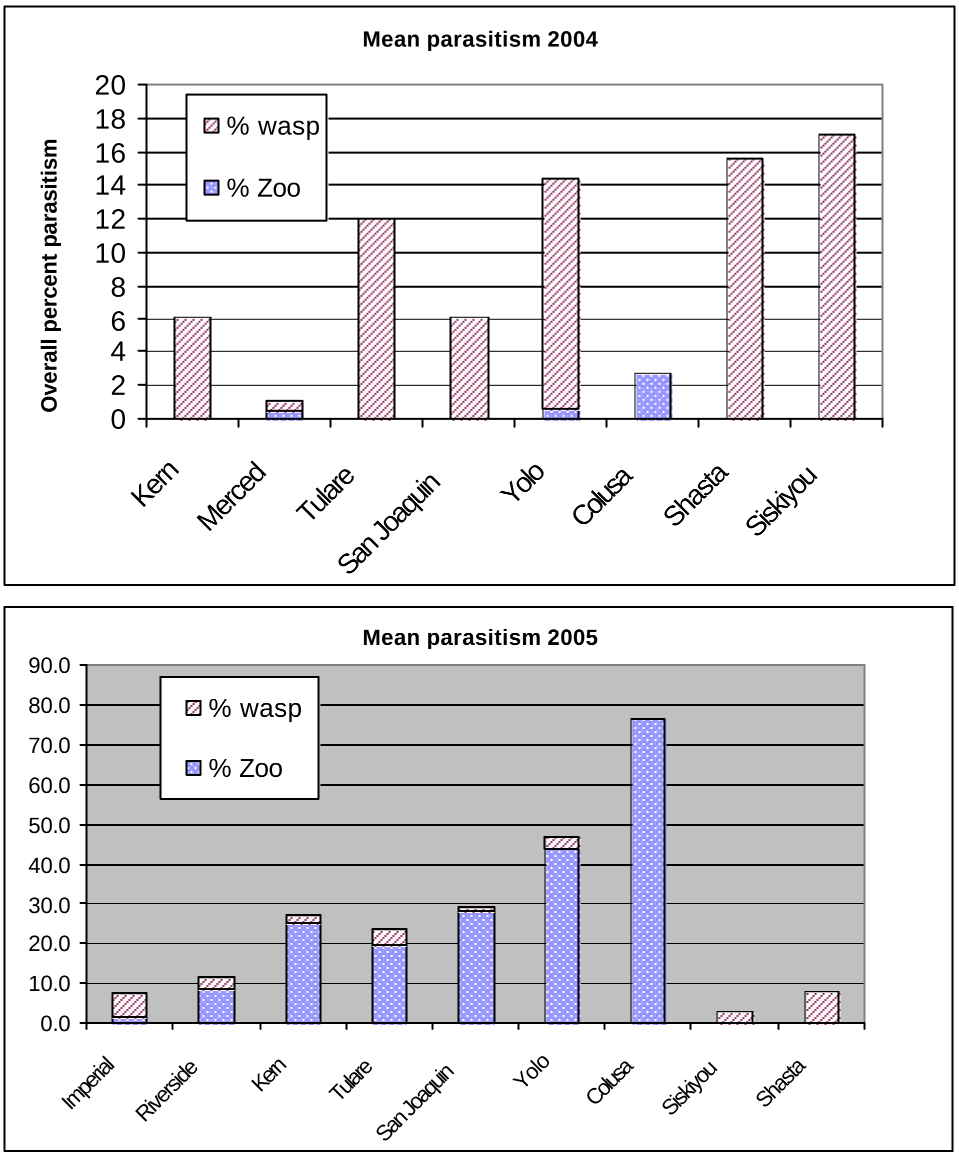

Figure 1. Mean parasitism by site from samples collected in 2004 and 2005.
[Please Note: the percent scale is different between the two graphs.]

Other parasitoids that were recovered in our samples include *Bathyplectes anurus* and *Oomyzus incertus*. Both wasps were found in less than 1% of those larvae parasitized, with only two mummies of *O. incertus* encountered over both years. In Siskiyou and Shasta counties, a large number of larvae dried up and died in the rearing containers, initially looking like a fungal infection similar to *Z. phytonomi*. Upon further inspection, the dead larvae did not contain fungal spores seen in dead larvae from Central Valley sites. We are still not certain what caused the high mortality of these larvae, but we shall continue to investigate.

DISCUSSION

According to our data, parasitism of the alfalfa weevil complex in California is generally low. Parasitism by wasps was too low in both 2004 and 2005 to effectively control the weevil population. Although infection by the fungus *Z. phytonomi* was high in some locations in 2005, the occurrence of this natural enemy is dependent on weather conditions and resulting humidity. Weather data were obtained from CIMIS for 2003 to 2005 to compare trends in rainfall and relative humidity for all sites involved in our study. California saw heavier rainfall and associated higher relative humidities in general in 2005, which resulted in an outbreak of the fungus *Z. phytonomi* in many regions throughout California. This fungus targets alfalfa weevil larvae and in some locations, like Colusa, was able to knock down the larval populations far enough below economic thresholds that there was no need to spray.

Alfalfa field conditions favorable to parasitoids and *Z. phytonomi* can be very useful in successful biological control of alfalfa weevils. Using insecticides that have minimal toxicity to parasitic wasps and other beneficial arthropods can increase populations of these organisms, benefiting alfalfa as well as nearby crops. High humidity is necessary for fungal growth of the soil-dwelling *Z. phytonomi*, but the annual seasonal humidity in many alfalfa-growing regions of California is often lower than needed for *Z. phytonomi* spore germination and outbreak.

As growers and researchers look for better methods for pest management using integrated pest management techniques, the need for “softer” chemicals, better scouting methods, and improved biological control can provide a stable, long-term solution to the weevil problem. Reduced risk insecticides have been shown to be better for the environment than organophosphates and carbamates, but these new products are not without their environmental consequences. Recently pyrethroid residues have been found in soil sediment samples and may have potential to negatively affect beneficial insects and aquatic life (Long et al. 2002). Off-site movement of chemicals continues to be an issue that alfalfa growers and researchers alike are attempting to manage.

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