RESEARCH PROJECT REPORT

California Almond Board
1 May 2004

Project Leader: Marshall W. Johnson, Associate Extension Specialist, Dept of Entomology, UC Riverside; Phone: (559) 646-6519, FAX 646-65; Email: mjohnson@uckac.edu

Location: Kearney Agricultural Center, 9240 S. Riverbend Ave, Parlier, CA 93648

Cooperating Personnel: Mark Freeman, Farm Advisor, UCCE-FRESNO
Richard Coviello, Farm Advisor, UCCE-FRESNO
Walter Bentley, Regional IPM Entomologist, UCCE, Kearney Ag Center
Frank Zalom, Entomology, UC Davis
Michael McKenry, Plant Patholgy, UC Riverside
Michael Klein, USDA-ARS, Wooster, OH
Albrecht Koppenhofer, Entomology, Rutgers Univ., New Brunswick, NJ
Harry Kaya, Entomology, UC Davis

Project Title: *Biology and Management of Tenlined June Beetle in Almonds*

Current Report Period: 1 August 2003 to 1 May 2004

Objectives:

1. Develop, conduct, and analyze a formal survey of growers and Pest Control Advisors regarding Tenlined June Beetle (TLJB).
2. Evaluate new soil insecticides available for scarab grub control.
3. Evaluate the potential of using insect pathogens for TLJB control.
4. Determine horticultural factors (such as rootstocks, water stress management) that may influence TLJB damage.
5. Develop grower usable sampling methods for TLJB detection.

General Progress:

Field studies on TLJB were initiated in mid-June 2003 and conducted through September 2003. These studies included a) establishment of light trap surveys to detect and estimate TLJB infestations as indicated by numbers of adult beetles; b) development of methods to detect and sample for the immature stages of TLJB within the soil substrate of almond orchards; and c) efforts to observe the scoliid wasp *Campsomeris pilipes* (Saussure) that parasitizes the beetle grubs. Due to the importance of sampling techniques to estimate TLJB grub and adult densities for biology and control studies, the goals of Objective 5 were the initial focus of the work to date. Experimental units were designed to conduct laboratory tests on various aspects of grub biology (Obj. 4) and susceptibility to soil pesticides (Obj. 2) and insect pathogens (Obj. 3). The soil column units for studying grub susceptibility to soil insecticides are still being refined. Fresno County Farm Advisor Mark Freeman provided valuable assistance during Summer 2003 in

regards to locating grower cooperators; carrying out the light trap surveys; and other work on the project. Detailed information follows relative to the various objectives. Two part-time laboratory assistants (Luis Rodriguez and Martha Gerik) were hired on the project in March 2004 to assist with the work for Spring and Summer 2004. Mr. Rodriguez previously helped on the project when employed by Mark Freeman.

One challenge that was not anticipated is the difficulty in obtaining sufficient numbers of beetle grubs to conduct tests. Given that the TLJB has a two-year developmental cycle (from egg to adult), one cannot quickly and easily grow the beetle in the laboratory to obtain the numbers of grubs needed for various tests. It is not unusual to need as many as 500 to 1,000 individual grubs for testing pesticides, insect pathogens, or various aspects of the insect's biology (e.g., effects of various rootstocks on grub development, influence of soil composition on grub survival, etc.). We have been collecting grubs from infested orchards, bringing them back to the laboratory, and then holding them in soil (and feeding them carrots) until we need them. Digging for the grubs is laborious, and we are trying to work out more effective collection techniques. It was found that running the soil through sieves helped to quickly locate 2nd and 3rd-instar grubs in the soil. However, we have not encountered too many 1st-instars nor pupae. To obtain TLJB eggs and 1st-instars, we may have to collect fertilized females and hold them in the laboratory for egg production. Once in the laboratory, it was found that we could feed the grubs organic carrots and they readily feed upon them.

Specific Progress:

Objective 1. This work is being conducted in close collaboration with Fresno County Farm Advisor Mark Freeman. Questions for a formal grower survey on TLJB have been developed, and we are currently seeking assistance on the best way to organize and present the survey so that it will be scientifically rigorous and can be used to evaluate the effectiveness of our research and extension efforts. We expect the send the questions out to growers before May 20 and have them evaluated before July 15.

Objective 2. Halofenozide (Mach 2 / Grub-X), imidacloprid (Merit / Marathon), Thiamethoxam (Meridian), Oxamyl (Vydate), Carbaryl (Sevin), and Chlorpyrifos (Lorsban) will be evaluated for their ability to kill the grub stages of the TLJB. Given the difficulty in accurately locating TLJB infestations in orchards, the spotty distribution of the grubs within the orchards, and the amount of work needed to find and collect the grubs after a field treatment, it was decided to conduct the initial screening work in the laboratory. Currently, we are trying to refine a "soil column" to test the efficacy of the various insecticides after penetrating various soil depths (e.g., 3, 6, 9, 12, 15, 18, 21 inches). The columns are made from PVC irrigation pipe. The column will be filled with sandy soil and the "test" insecticides will be dripped through the soil using various application techniques to determine the optimum chemical movement method. "Test" grubs will be placed at the bottom of the column to determine insecticide penetration through the soil. A 12-inch diameter soil column was initially constructed, but was unsuitable for the work (too many leaks, uneven penetration of solution). A 6-inch diameter soil column is now being developed and tested. Once effective compounds and application techniques are identified, we will conduct field tests.

Objective 3. Work with the insect pathogens is also dependent on construction of the soil columns (see Obj. 2) to test soil penetration. Contact has been made with Dr. Robert Fritz, Certis Corporation (Columbia, MD), to acquire the entomopathogenic nematode (attacks insects) known as *Steinernema riobrave* Cabanillas, Poinar & Raulston, which is commercially sold by for augmentative purposes. This species was suggested by Dr. Larry Duncan, University of Florida at Gainesville, and is used in Florida to control the citrus root weevil, *Diaprepes abbreviatus*, which is found in sandy soil. I plan also to examine the entomopathogenic nematode *Heterorhabditis bacteriophora* that is indigenous to California and produced in southern California by Ricon-Vitova Insectaries, Inc., Ventura, CA. A grower reported some success with this species in an almond orchard east of Madera. This work should be completed by July 30. I also hope to bring in two other insect parasitic nematodes, which are *Steinernema kushidai* and *Steinernema scarabaei*. The latter species may be obtained from Rutgers University in New Brunswick, New Jersey. USDA Importation permits or Interstate Movement Permits may be needed for these latter two species. Lastly, we will look at the pathogen *Paenibacillus* (= *Bacillus*) *popilliae*, which causes milky spore disease in beetle grubs. Initial tests will be conducted in the soil columns.

Objective 4. Ten special testing units, resembling giant ant farms, have been constructed from plastic sheets to conduct experiments for this objective. We will initiate tests on the preference of TLJB grubs for various rootstocks during May 2004. These will run for 2 to 3 weeks at a time. For each test, 5 different rootstocks will be established in the soil in the test unit and 10 to 15 gruns will be introduced to the unit. Amounts of damage to the rootstocks will be determined. We will also use the testing units to examine the influence of other horticultural factors on the grubs such as soil composition, soil water content, and cover crops (e.g., grasses).

Objective 5. We found that 2nd and 3rd instar grubs are usually found adjacent to tree roots. Random soil samples using soil cores and a power auger rarely produced grubs because tree roots could not be included in the sample. Surveying for beetle grubs was physically demanding and time consuming work. Standardized soil sampling methods need to be developed so grub densities within and among orchards can be accurately compared. Adult beetles were rarely found in soil samples. We will continue to develop standardized soil sampling methods during Spring and Summer 2004.

Light traps were maintained adjacent to five almond orchards in the Carruthers area (southwest of Fresno) and adult beetles were collected at all sites with high variation in trap counts among sites. Light traps appear to be an effective way to monitor for male adult beetles, but ratios of male to female beetles within traps were generally 99 males :1 female, indicating either that the females do not readily fly at night or that they are not attracted to traps. Checking traps on a weekly basis resulted in traps in some areas being "swamped" with beetles and other insects, thereby leading to less accurate beetle counts because at some point the trap filled up and no more beetles were trapped. We are still processing beetle material captured during the Summer / Fall 2004 period. Work is needed to refine trapping procedures.

Male beetles tend to hide in leaf litter and under objects (e.g., boards, rocks) within or near almond orchards during the daylight hours. Male beetles may be found among tree foliage in some stone fruit trees, but this is an uncommon event.

Female adults of the scoliid parasitoid *Campsomeris pilipes* (Saussure) can be easily found searching for beetle grubs during the early morning hours in highly TLJB infested orchards.

Adult wasps locate potentially grub-infested sites and quickly tunneled down through the soil to the grubs to parasitize them. More information is needed on the impact of the parasitoid on TLJB densities. By accident it was discovered that adult *C. pilipes* males will enter into holes (about 2 inches diameter and 6 inches deep) within the orchard floor and are unable to escape if the sides of the hole are smooth. Efforts will be made to utilize this knowledge to design a monitoring method to estimate wasp densities among almond orchards.