

Annual Progress Report 7/15/2004

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and
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Contract Number: # 02-0750

Project Name: Olive Fly Infestation Crises in California

Report Period: January 1, 2003 – June 30, 2004

Status of the Project:

This is the first full annual report of a two year field project. The first year of experimental work has been completed.

Systematic collections of olive fruit flies were begun in September, 2002, in 12 California counties which represent diverse climatic zones suitable for conducting phenology studies. At most sites, the monitoring is being conducted in cooperation with the California Department of Food and Agriculture (CDFA) and local County Agricultural Commissioners. Additional sites are being sampled by Pest Management Associates (Exeter, CA) and by the Zalom lab. Trapping protocols were established by the Grant Recipients, and training of local cooperators at each site conducted by CDFA. The number of sites was expanded to over 20 sites in 13 counties for the 2003 field season. Fly and weather data collected from Avitel continuous temperature loggers placed at each site are being transmitted electronically to the Zalom lab at UC Davis. Female flies trapped at the study sites are being preserved in ethyl alcohol and transported to the Zalom lab where they are being dissected to determine mating status (presence of sperm using a DNA staining technique) and reproductive maturity. Seven additional sites were identified for the more intense field caging studies, and this aspect of the project was initiated in spring, 2003 and continued through fall. Caging continued at 2 of the sites (Winters and Butte County) though January, 2004. A technique for lab-rearing of recently field-collected flies which are needed for the field cage experiments was developed and sufficient flies of known age structure have been produced for all sequential infestations proposed. A technique for storing olives for fly colonies using modified atmospheres was developed during Fall, 2003, and fruit is being stored for use when field collected fruit is not available. Information on fly preference and development in varieties other than Mission and Manzanillo which were the common varieties to the 7 caging study sites was initiated with field observations in fall, 2003, and continues in the Zalom lab using fruit collected at various times during the Fall and stored at modified atmospheres. The varieties being evaluated are Arbequina, Frantoio, Mazanillo, Mission, Lecci, Koroneiki, and Sevillano.

Systematic collections of fruit were started in May, 2003, in the same 7 locations where olive flies were caged on olive fruit, and at additional sites with differing temperature regimes. Coordination of the fly caging studies with fruit development will permit linkage of fly and fruit data to determine periods of fruit susceptibility and to determine factors influencing attraction and host suitability. Collection sites are all equipped with Avitel continuous temperature loggers. Olive fruit samples and temperature records are being sent to the Ferguson lab at UC Kearney Agricultural Center (UCKAC) for evaluation. Olive fly and fruit phenology data are now analyzed for the 2003 season. Fruit collections commenced in May for the 2004 season. Fly caging studies will begin in July 2004.

Major Activities:

Olive Fly Phenology:

Fly capture and weather data from the study sites being monitored in conjunction with the Agricultural Commissioner's offices continued to be collected transmitted to UC Davis for analysis. Female flies trapped at each location are being preserved in ethyl alcohol and sent to the Zalom lab at UC Davis where they are being evaluated for mating status a reproductive development. Olive fly colonies needed for field cage infestations and other studies being conducted by the Zalom lab have been successfully established and maintained, and olive fruit are being stored under modified atmospheres for future colony maintenance. Fruit was collected from 7 varieties on two separate dates, October 8, 2003 (stored under modified atmosphere) and January 16, 2004. The fruit from each date were further divided according to ripeness. All sets of fruit samples were infested in January, 2004, and stored at our standard olive fruit fly rearing temperature and photoperiod in an environmental growth chamber. Ten fruit from each container were dissected every 2 days until no living larvae were found in the fruit (typically 2 weeks following infestation). During fruit dissection, stings (oviposition scars), eggs, larvae, pupae, and exit holes were counted and recorded. These data allowed us to evaluate varietal preference and success of fly development, as well as to determine if fly developmental rate is affected by variety. Thus far it appears there is a varietal preference that appears to be a function of fruit size and volume.

Fruit Phenology:

Protocols were established for evaluating fruit development at the outset of this project, and fruit collections were made throughout the season at the same sites where fly caging studies have been conducted. Samples were sent to the Ferguson lab at UC Kearney Agricultural Center where fruit dimensions and volume were obtained using electronic calipers with resulting data directly downloaded to a computer. During this quarter, measurements of fruit size, volume, puncture strength, and color were plotted as a function of degree-day accumulations calculated from the temperature monitors at each site.

Instruct Growers and Pest Managers:

Zalom, Ferguson and Graduate Student Hannah Burrack made presentations at industry meetings on the project and on what is known about olive fly phenology and development. Meetings at which presentations were made included Olive Day which is held in association with the annual meeting of the California League of Food Processors, the annual meeting of the California Olive Oil Council, and a meeting on the olive fruit fly at the California Farm Bureau Federation. The

web site which was implemented through the Fruit and Nut Research and Information Center: [HTTP://Fruitsandnuts.ucdavis.edu](http://Fruitsandnuts.ucdavis.edu) continues to be updated with fly trapping information from around the state as well as updates on olive fly management and Powerpoint presentations that have been presented at meetings. A *UC Pest Note* on olive fly for homeowners and urban residents written by Zalom, Burrack and Dr. Robert Van Steenwyk of UC Berkeley went through the University's peer review process and was published in January, 2004.

Objectives Addressed:

1. Determine seasonal phenology for olive fruit fly in selected table and oil cultivars throughout the various climatic zones of California. Progress - olive fruit fly phenology data collection is continuing at the sites coordinated with the Agricultural Commissioner's offices, and fruit caging continued at 2 of the 7 caging sites into January. Fruit gathered in association with these sites have been evaluated for stings and larval infestation. A study on varietal preference was conducted during this quarter. This study demonstrated a definite preference for olive cultivars with larger fruit. This was corroborated by the results of the fruit phenology study in which larger fruited cultivars also had a higher percentage of fruit with stings, egg laying and live larvae with tunnels.
2. Adapt or develop an olive fly degree-day model for California. Progress - Data obtained during 2003 have been graphed versus degree-day accumulations from each site in preparation for a regression analysis that will be conducted. These curves will be compared to the curves developed in 2004.
3. Develop a degree-day model to determine timing of fruit development in olives. Progress - Fruit collection associated with this objective commenced in May, 2003, and continued at the same 2 sites mentioned in Objective 1 through December 2003. Data on fruit development have been analyzed and development was shown to be primarily affected by temperature as proposed. Thus, a given cultivar develops more slowly in a cool location where the degree days also accumulate more slowly, relative to the same cultivar grown in a warmer location.
4. Instruct growers and pest managers in use of the phenology models to improve olive fly management and reduce damage to olives. Progress - Zalom, Ferguson and Burrack have made presentations at industry meetings on the project and on what is known about olive fly phenology and development. The web site implemented through the Fruit and Nut Research and Information Center continues to be updated. A *UC Pest Note* on olive fruit fly has been published and is available via the UCIPM worldwide web site. All experimental information is presented as preliminary. However, at a joint meeting of all olive fruit fly researchers May 28th, 2004 at UC Davis organized by Dr. Marshall Johnson, UC Riverside Entomologist and Dr. Zalom, the current UC Olive Fruit Fly Control Guidelines were reevaluated with respect to the data developed within this project. As a result, growers were encouraged to begin bait sprays slightly earlier this year due to higher degree day accumulation in April and May, 2004.

Procedures and Methods Established:

Protocols for trapping flies and collecting weather data were established and subsequently revised in June, 2003, for our cooperators in the Agriculture Commissioner's Offices. Data for 2002 and 2003 were transmitted to the Zalom lab. Procedures for dissecting flies to determine mating and reproductive status were evaluated during the spring, and stored samples continue to

be dissected. Seven sites for trapping, fruit collection and caging of flies were established in 2003, and cooperating Cooperative Extension Advisors or Pest Control Advisors trained. Flies were reared in the Zalom lab and sent to the cooperators throughout the season for caging. Effect of fruit cultivar on olive fruit fly success were assessed in the field during fall, 2003 at the USDA germplasm grove at the UC Davis Wolfskill Experimental Farm. Fruit collected from this site are being evaluated in the lab to determine if developmental rate of flies is affected by variety. This data did demonstrate a definite preference for larger fruited cultivars.

Olive fruit were collected May 15th through November 15, 2003, from the 7 caging locations, and these samples have been evaluated for developmental parameters. The data has been analyzed using both a regression analysis and now a Base T program to determine the relationship of growth and development as a function of degree-day accumulation. Infestation is also analyzed as a function of measured parameter. Thus far data demonstrates successful infestation is a function of fruit flesh volume or fruit diameter, which is first a function of cultivar and second a function of degree day accumulation. The common link of degree day accumulation is what we hope will be used predict when the fly is ready to lay eggs and the olive fruit is capable of hosting larval development. The objective is to determine the minimum degree days required for both fruit susceptibility and fly egg laying, and time sprays to destroy the fly when most damaging.

Significant Observations, Results or Impacts:

Fly populations are much greater in coastal areas than in the central valley. Flies remain attracted to yellow pheromone and ammonium bicarbonate baited sticky panel traps throughout the year in coastal areas, but are not commonly trapped by this method during mid-summer or winter in the central valley. McPhail traps appear to be more attractive to olive fruit flies during mid-summer and indicate that adults are present and can be trapped by this method. Knowledge obtained on the use of plastic McPhail traps vis a vis the yellow panels has resulted in a change by our CDFA Detection Program cooperators to the use of plastic McPhail traps. We have also observed that although fruit can be stung by olive flies at a relatively early stage of development, but the fruit is not able to host fly development until much later in the summer - perhaps August. Hopefully our approach will lead to an understanding of the mechanism driving this and prediction of when larval development can begin in the fruit. There also appears to be a significant influence of variety on success of fly development. Preliminary data suggest that the larger varieties are both preferred and more amenable to fly development.

Fruit development results are demonstrating that the olive fruit growth is highly temperature dependent as expected. Therefore olives in cooler locations grow and mature more slowly. If fruit size is one of the factors that attracts the fly makes the fruit susceptible to fly infestation and oviposition, then our data thus far suggests locations with different microclimates will require different management approaches based upon fruit development and fly phenology in a given year. Preliminary analysis suggests larger fruited cultivars are more attractive to the fly. The first year of fruit development studies also suggest puncture strength, oil and color development have little to do with fly infestation as high infestation levels were observed prior to the development of all these factors. In 2004, we will repeat the experimental investigations as done in 2003 to verify our observations.

Narrative Summary of Budget Activities and Anticipated Activity for the Next Quarter:

Graduate Student Research Assistants are employed in the Zalom lab (PhD student) and the Ferguson lab (recent MS graduate). \$44,000 has already been allocated to Cooperative Extension cooperators at 4 of the study sites who participate in the fly caging and fruit gathering parts of the research project. Additional supplies were purchased for research conducted by both labs including some funding for modified atmosphere gases used to help store olives in good condition for the fly colonies, and travel expenditures were made for research and training. Finding olives in the field early summer was a problem in terms of colony maintenance last year. In the next quarter, it is anticipated that the Zalom lab will spend funds primarily for the graduate student working on the project and for undergraduate student assistants who help with fly dissection. The Ferguson lab will continue expenditures primarily for lab assistance and travel.

Unexpected Problems or Cost Overruns:

Thus far there have been no major problems with the research other than the lack of olives at the Ventura site which was reported previously. Fly phenology data analysis from the Agricultural Commissioner's sites has been delayed by the sheer volume of data gathered. There was an outstanding response to our request for trapping information from different sites around the state, and this has tremendously increased the amount of labor necessary to look at the individual data sets in terms of degree-days. This must be done on a case by case basis before data can be prepared for the regression analysis.

We have not experienced cost overruns. we are grateful for the awarding of a no cost extension to the project though June, 2005. This will enable us to fully analyze the data that will continue to be collected through December, 2004.

Public Outreach:

During this quarter, Zalom and/or Burrack made major presentations at the Merced County PCA Update meeting (February 3, Merced), Olive Day (California League of Food Processors) (February 4, Sacramento), California Olive Oil Council annual meeting (February 6, Glen Ellen), and a California Farm Bureau Federation meeting on olive fly (February 24, Sacramento). Ferguson also made presentations on olive fruit phenology and development at the February 4 and February 24 meetings. Both Zalom and Ferguson made presentations at an update meeting for a UC Specialty Crops Research Program update meeting held on January 12 in Davis. The olive fly web site which was implemented through the Fruit and Nut Research and Information Center continues to be updated, and a *UC Pest Note* on olive fly for homeowners and urban residents was published in January, 2004.

Additional Funding:

Ferguson has use of a Minolta Colorimeter (\$2,500.00) provided by the Postharvest Physiology Lab within the department of Pomology at UC Davis. Funds for the statewide trapping program being conducted with the CDFA Detection Program and local Ag Commissioner's offices are provided by CDFA from Federal pass-through funds, and we have learned that the funds will definitely be available for the upcoming season. As previously reported, funding was obtained from the UC Specialty Crops Research Program in October, 2003, to augment this project to the amount originally requested. Zalom also obtained an additional grant from the California Olive Committee (\$9,650.00) to determine the efficacy of postharvest cultural management in reducing

olive infestations. Ferguson obtained a \$750.00 grant from the UC Davis NMR facility to determine oil content on individual olives.