Pest Management Alliances Final Report

Agreement No. 00-0212S

Development of an Integrated System for Controlling San Jose Scale, Peach Twig Borer and Oriental Fruit Moth in Clingstone Canning and Fresh Shipping Peaches, Plums and Nectarines

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Prepared for California Department of Pesticide Regulation

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ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

The objective of this ongoing project is to develop an integrated and sustainable pest management program for peaches, plums, and nectarines in California. The research has focused on San Jose scale (SJS), peach twig borer (PTB), oriental fruit moth (OFM), omnivorous leafroller (OLR), and Western flower thrips (WFT). Most elements of the Pest Management Alliance (PMA) grant's activities are being presented at grower and pest control advisor (PCA) demonstration plots and meetings. In addition, information developed as a part of this research effort is being disseminated through grower newsletters and on both the CTFA website and the Kearney Agricultural Center website.

Stone fruit production has traditionally relied upon organophosphate (OP) and carbamate insecticides to control the majority of pests. Due to environmental and human health concerns, a movement away from these types of materials has been initiated. The testing of commercially available oils, pheromone dispenser systems and reduced risk pesticides in controlled research situations has provided the basis for the development of best management practices for utilizing more integrated pest management approaches. In addition, the evaluation and development of an augmentative biological control program may increase SJS, PTB, OFM and thrips parasitism levels and further reduce the need for insecticide applications.

During the third year of a multi-year project progress towards meeting the objectives continues. First, efficacy trials of two commercially available oils as the single component in a dormant spray for controlling SJS have been conducted. The results suggest that both oil formulations should abate overwintering populations of SJS under low to moderately infested conditions. Second, a preliminary survey of endemic and commercially reared natural enemies of SJS is in progress. One commercially available and two endemic enemies have been identified. Insectary rearing of these potential parasitoids for augmentative release and field testing is underway. Third, field comparisons and aging studies of commercially available PTB and OFM pheromone formulations and dispensers have yielded data to further refine application rates. Refinement is continuing. Fourth, the reduced risk chemical Success® has shown potential to be an alternative to the industry standard, Carzol®, for thrips control. The information will be used to develop practical recommendations designed to reduce grower uncertainty and potential failure when utilizing this technology. Fifth, biology of secondary pests, such as katydids, continues especially in regards to their actions since the implementation of reduced risk practices. Finally, industry education and information dissemination continues through industry sponsored educational field days, research newsletters and several websites.

While measuring the success of this project is very difficult, there are some trends that are emerging that point to the Industry adopting reduced risk practices. Evaluations from several of the PMA grower/pest control advisor (PCA) meetings indicate that a significant number, representing a significant amount of the stone fruit acreage, are adopting reduced risk practices. This trend is supported by DPR's Pesticide Use Report (PUR) data that verifies that use of several OPs and carbamates have declined in recent years.

Report

A. Introduction

The project is intended to develop and promote a truly integrated and sustainable pest management program for control of the various pest complexes found in stone fruit orchards throughout California. Research, demonstration and educational outreach programs are being conducted in a variety of locations extending from Kern County in the South up to Sutter / Yuba Counties in the North. The research includes work on SJS, PTB, OFM, Western flower thrips, katydids and soft scale, with no one area of the research promising complete solutions to the problems currently being experienced by the stone fruit industry. Technical challenges, including increasing evidence SJS may be resistant to OPs, growers experiencing unacceptable fruit damage using pheromone mating disruption for PTB and OFM, the influx of secondary pests as a result of implementing reduced risk practices and grower concerns of economic loss during the transition to instituting reduced risk practices have been barriers to developing a comprehensive integrated pest management program for clingstone canning and fresh shipping peaches, plums and nectarines. The testing of commercially available oils, pheromone dispenser systems and reduced risk pesticides in commercial settings under controlled research methodology will provide actual representations for development of best management practices. In addition, development of a biological control program of augmentation of natural enemies may increase SJS, PTB and OFM parasitism levels and further reduce the need for pesticide applications. All elements of the proposed program have been adapted and implemented in grower demonstration plots where comprehensive grower education and information dissemination has and will continue to take place. In addition, information developed as a part of this research effort will continue to be disseminated in grower and PCA newsletters, commodity group and pest management websites, and through the University of California's Integrated Pest Management Guidelines.

B. Materials and Methods (Objectives)

1. <u>Continue to assess the SJS population dynamics and evaluate the potential of natural and augmented biological control.</u>

The tasks include: a) Continue to assess the SJS population dynamics and evaluate the potential of natural and augmented biological control. Field monitoring of adults and immatures will be accomplished using a variety of sampling techniques: Pheromone traps, visual inspection of plant material, and double sided adhesive tapes will all help in determining the distribution and abundance of SJS in the field. b) To evaluate parasitoid activity, SJS infested squash will be placed in selected orchards for a 2–3 week period and later the squash will be returned to the insectary to determine parasitoid composition and percent parasitism. Field collections of parasitoids will also be made throughout the season to assess levels of parasitism and distribution within the tree canopy. Destructive samples will also be obtained to correlate plant infestation data with trap data. The appropriate experimental designs and statistical analyses will be utilized to evaluate population information. The principal investigator for this project is Dr. Kent Daane, University of California Center for Biological Control Entomologist. Cooperating with Dr.

Daane to collect and analyze data will be Glenn Yokota, Staff Research Associate, and Rodrigo Krugner, Laboratory Assistant, of the UC Kearney Ag Center.

2. Determine the effect of "soft" insecticides, (e.g., Success®, Confirm®) on selected natural enemies of SJS. [Note: This objective changed from proposal due to miscommunication from researcher.]

The tasks include: a) Determine the effect of "soft" pesticides, (e.g., Success®, Confirm®) on selected natural enemies of SJS. To test the effect of soft pesticides on natural enemies of SJS, field and laboratory trials will be conducted. Leaf or twig samples will be collected from peach trees treated with soft pesticides to conduct a leaf-dip bioassay. Leaves will be dipped in different soft pesticides at different percentages of a field-rate dilution. Leaf material will be allowed to dry and then placed in open-ended glass tubes. Parasitoids will be added to the tubes, which will be sealed with organdy cloth. Each day thereafter, the condition (live or dead) of the parasitoids will be determined. The second test will be more complex. At the Kearney Agricultural Center, trees will be sprayed with the same pesticides at label rates and at the appropriate time. Thereafter, leaves will be removed from the trees on different days after soft pesticide application dates. These "field-sprayed" leaves will be used to bioassay SJS parasitoids as described above (leaf-dip bioassay), which will determine the number of days after field application the pesticides cause mortality of parasitoids. The value of this experiment is that it provides a more realistic determination of a soft pesticide's effect on parasitoids after a number of days following application, with soft pesticide degradation progressing under actual field conditions. This work is needed to determine if small amounts of residual soft pesticides cause mortality of parasitoids. The principal investigator for this project is Dr. Kent Daane, University of California Center for Biological Control Entomologist. Field and laboratory trials will be accomplished through the efforts of GlennYokota, and Rodrigo Kugner, of the UC Kearney Ag Center.

3. Examine the effects of reduced risk materials, e.g., oils and the Insect Growth Regulators (IGRs), Esteem® and Applaud®, on various life stages of male and female SJS to determine the most effective timing for application of the materials. Second, determine if OP resistant SJS have any cross-resistance to the IGRs. Results will be incorporated into the development of a comprehensive resistance management plan for stone fruits.

The tasks include: a) Examine the effects of reduced risk materials, e.g., oils and the Insect Growth Regulators (IGRs), Esteem® and Applaud® on various life stages of male and female SJS to determine the most effective timing for application of the materials. First, second and third instars of male and female SJS will be tested for their susceptibility to oils and the IGRs Esteem® and Applaud®. b) The second part of the objective will be accomplished by testing the OP resistant and susceptible colonies of SJS with each of the IGRs Esteem® and Applaud® to see if there is any cross-resistance between these materials. All information collected on the nature, mechanism, and level of resistance present in SJS will enable researchers to develop a comprehensive resistance management plan to be used in an overall pest management strategy for stone fruit pests in California orchards. Dr. Beth Grafton-Cardwell, UC Riverside Entomologist stationed at the Kearney Agricultural Center will be in charge of this project.

Other participating individuals include: Walt Bentley, UC IPM Entomologist and Yuling Ouyang, SRA III, UC Riverside Entomology, Kearney Ag Center.

4. Demonstrate and compare the efficacy and economics of pest control techniques that *do not* rely on OP, carbamate, or pyrethroid inputs to control stone fruit pests in "grower participant" sites in several counties throughout California. In addition to the grower sites in Fresno, Kings and Yuba Counties established during the previous year of the project, this objective seeks to expand the project to include 3-4 additional grower participant sites in Kern, Madera and Tulare Counties.

The tasks include: a) Demonstrate and compare the efficacy and economics of pest control techniques that *do not* rely on OP, carbamate, or pyrethroid inputs to control stone fruit pests in "grower demonstration" sites in several counties throughout California. In addition to continuing the grower demonstration plots established in Fresno, Kings and Yuba/Sutter Counties, potential cooperators in Kern, Madera and Tulare Counties have been identified and will be asked to participate. Reduced risk pest management practices developed during the previous year of the PMA demonstration project will be implemented in these additional grower sites. Reduced risk practices include: pre-dormant application mite and scale damage assessment; OP free dormant application (oil only); use of *Bacillus thuringiensis* and pheromone mating disruption for control of PTB and OFM; monitoring of PTB and OFM with pheromone baited traps and shoot strike evaluations; SJS monitoring with double sided sticky tapes, fruit samples and pheromone traps to determine both scale and parasitoid populations and percent damage at the time of harvest. Monitoring of traps will be accomplished weekly for each site. Mites and katydids will also be monitored and low impact oils or pesticides will be used according to labeled rates. The reduced risk material Success® (Spinosad), will be used to control katydids and thrips. Mite control will be accomplished with the reduced risk material Apollo®, (Clofentezine). Each site will be compared to a comparable acreage of a monitored commodity treated with traditional OP dormant and in-season sprays. In addition, the costs associated with the relative levels of control in the non-disruptive and conventional pest management programs will be recorded to illustrate the competitiveness of the reduced risk approaches. Several of these sites will also be used for demonstration at grower / PCA field days. The principal investigators for this project are Walt Bentley, UC IPM Entomologist, and Dr. Kent Daane, University of California Center for Biological Control Entomologist. Assisting in the collection and analysis of data will be Shawn Steffan, UC Staff Research Associate. Assisting in establishment of the demonstration sites will be Gary Van Sickle, CTFA Research Director, Heidi Sanders, CCPGAB Research Coordinator, Kevin Day, UCCE Tulare County Farm Advisor, Harry Andris, UCCE Fresno County Farm Advisor Janine Hasey, UCCE Sutter/Yuba County Farm Advisor, Bob Beede, UCCE Kings County Farm Advisor and Brent Holtz, UCCE Madera County Farm Advisor.

5. Study and document the biology of secondary pests (i.e., katydids and soft-bodied scale) that have increased in population, in certain environments, due to implementation of reduced risk practices.

The tasks include: a) Study and document the biology of secondary pests (i.e., katydids and soft-bodied scale) that have increased in population, in certain environments, due to implementation

of reduced risk practices. Sampling methods during the growing season will include leaf damage assessment, sweep net counts and beating tray counts for katydids. Katydid eggs will be collected from "cages" and maintained for evaluation of over-wintering emergence and survival in the spring. Soft-bodied scale will be surveyed in the field and counts will be recorded. The principal investigator for this objective will be Walt Bentley, UC IPM Entomologist. Assisting with the collection and analysis of data will be Shawn Steffan, UC Kearney Agricultural Center, Staff Research Associate.

6. Continue to enhance communication and information dissemination to the stone fruit grower community.

The tasks include: a) Continue to enhance communication and information dissemination to the stone fruit grower community. The communications infrastructure of CTFA and CCPGAB, along with cooperating University of California Cooperative Extension personnel, will continue to enhance the exchange of information regarding project progress between researchers, growers, and PCAs. Both industry organizations will provide clingstone canning and fresh market peach, nectarine and plum growers with quarterly updates of project progress through industry websites and newsletters. In addition, CTFA will coordinate 5 field days, one each in late March or early April, June, July, August and October in cooperation with the University of California, so researchers may communicate directly with growers and PCAs. CCPGAB will coordinate at least 2 field days at demonstration orchards in Yuba County. CTFA and CCPGAB will provide an annual report of research progress published in their respective Annual Research Reports. Research results will be incorporated into appropriate internet sites and University Pest Management guidelines. Gary Van Sickle, CTFA Research Director and Heidi Sanders, CCPGAB Research Coordinator will be responsible for completion of this portion of the project.

C. Results

1. Continue to assess the SJS population dynamics and evaluate the potential of natural and augmented biological control.

This season large parasitoid populations were found in the PMA blocks, which mirrors last season's findings. The parasitoids are very host-specific and well-synchronized early in the season; preliminary sampling using sentinel scale hosts indicated that the activities of *Encarsia* and *Aphytis* were removing over 50% of the scale population.

Six orchard blocks (these were other orchards than in the PMA project) were sampled and there was a wide range of SJS damage. Damage was also recorded for worms, katydids and birds – all of which were low. Conventional orchards using a dormant treatment of oil and insecticide (Supracide or Sevin) or an in-season spray (Lorsban for OFM and moths and Carzol for thrips) had low SJS infestations (<3%). More important for this work is the variation in SJS infestation in those blocks without insecticide treatments, which ranged from 0-20%. Few blocks had no SJS damage; however, many of the blocks with SJS infested fruit had <5 SJS per infested fruit. (Table 1.)

A sticky card baited with a SJS pheromone lure is one of the best methods to monitor the change in SJS density during the season. The cards provide information on SJS males (indicating peak flight periods and can be used to time insecticide sprays) and levels of *Encarsia perniciosi,* the most common SJS parasitoid. For this past season a wide variation was found in SJS male flight densities. [This data is not yet fully finalized and will be submitted at a later date.]

From a cursory analysis of the data, similar patterns of parasitoids and scale evident in 2000 were present again in 2001. In conventional systems SJS was again very low. Nevertheless, *Encarsia perniciosi* was found in both conventional blocks monitored. The initial material collected on pheromone baited SJS cards is the *Encarsia* parasitoid. Even with a dormant season application of oil and an OP, the first emergence of *Encarsia* is much larger than the SJS. In late May through June, the first large flight of SJS is noticed, followed by a second in July and August and a third in September and October. During the later part of the season, the SJS flights overlap and densities do not drop to zero until colder weather comes in November and December. The last flight in October through December does not mean that males have left the orchard, only that the male scale (like the females) have slowed their development. The small number of males caught in March and April actually represent last season's male populations (from December) completing their development.

In the sustainable blocks the dormant oil remained, but the OP was removed. Carzol was used for thrips control in spring. In these blocks 1% and 7% SJS infestations were found. The 7% infestation was in a plum orchard, with about 11 scale per infested fruit. In both blocks, there were large *Encarsia* populations recorded in March and April. These parasitoid peaks were seen again in March, June, July, August and September, most likely representing different generations. *Encarsia* and *Aphytis* will have 2-3 generations for every SJS generation. The SJS numbers never were higher than parasitoid numbers; not surprisingly there were no SJS infested fruit.

After removal of a dormant OP, the next step towards a "less-toxic" program is removal of broad-spectrum summer treatments. In the two "organic blocks" monitored the insect control program consisted of nothing for SJS or thrips, Bt for PTB and pheromone confusion for OFM. Harvest samples found some SJS (about 10%) but few worms, katydids or thrips. The growers of each block decided that the average SJS per infested fruit was manageable and did not warrant the additional cost of insecticide coverage. In both blocks there was a large *Encarsia* population recorded on the pheromone-baited SJS traps in spring.

In all three orchard categories (Conventional, Sustainable and Organic), there was a distinct pattern of parasitism, with *Encarsia perniciosi* populations stronger at the beginning of the season and *Aphytis* spp. more common towards the end of the season. In 1999 and 2000, squash infested with SJS were used to compare parasitoid effectiveness and species composition in June and September. Recovery of both parasitoid species was poor in June and September collection periods. In June, from 10 squash (infested with ~1000 SJS each) there was a recovery of 100 parasitoids. At initial emergence (40 days) there were 74 *Encarsia perniciosi*, 1 *Aphytis aonidiae* and 3 *Aphytis* nr. sp. *vandenboschi*; at secondary emergence (90 days – which may include a second generation inside the emergence containers) there were 65 *Encarsia perniciosi*, 0 *Aphytis*

aonidiae and 35 *Aphytis* nr. sp. *vandenboschi*. In September, at initial emergence (40 days) there were 18 *Encarsia perniciosi*, 2 *Aphytis aonidiae* and 10 *Aphytis* nr. sp. *vandenboschi*; at secondary emergence (90 days) there were 5 *Encarsia perniciosi*, 1 *Aphytis aonidiae* and 52 *Aphytis* nr. sp. *vandenboschi*. So this pattern of *Encarsia perniciosi* densities higher at the beginning and *Aphytis* spp. stronger in August and September held true in 2001 as well. There was also a difference between orchards with or without insecticides, but this is a poor comparison because the difference in SJS density (and hence the number of parasitoids in the field) was not taken into consideration.

Augmentation Trials. One of the more difficult projects has been the investigation of an augmentation program. The work described above, regarding following SJS and parasitoid density in six orchard blocks, brought one aspect of augmentation into better focus. It appears that the mass production and release of *Encarsia perniciosi* early in the season would not be beneficial. This parasitoid is in all orchards with SJS, regardless of insecticide use, and early season release would probably not be able to add significantly to parasitoid population.

One of the biggest hurdles for an augmentation program is the development of insectary procedures to mass-rear viable and effective natural enemies. As mentioned above, colonies of *A. vandenboschi* and *E. perniciosus* have been established. Laboratory studies are currently being conducted on parasitoid preference for SJS stages. These test will help to better determine when to release the parasitoids, parasitoid fecundity and host feeding limits, and will ultimately aid in a better determination of the release rates needed to suppress SJS.

Work in 2001 focused on *Encarsia* and *Aphytis vandenboschi*. While *Encarsia* is far more common on the traps, it is clearly more common early in the season and may parasitize more SJS at that time period. It may not, however, be the most important parasitoid from June through August. Initial studies with augmentation suggest this hypothesis to have some validity. *Aphytis*, while it may not parasitize as many SJS throughout the season, may kill considerably more due to the process of "host feeding." Host feeding refers to the process in which the parasitoid punctures the SJS with its ovipositor to cause "bleeding." The parasitoid feeds on the SJS juices to help develop its eggs and the "poked" SJS eventually dies. Host feeding is far more common on small SJS, while larger SJS are used for egg deposition. Furthermore, initial collections of overwintered SJS indicate a greater presence of *Aphytis* than previously recorded. Parasitism was increased, as compared with the controls, in all trials. [Final data from augmentation of *A. vandenboschi* and *E. perniciosus* trials in 2001 is still being processed.]

Parasitoid Biology. Temperature development trials have not yet been completed for *A. vandenboschi*. Initial results show parasitoid development increasing steadily until 90°F, after which there wasn't any SJS or *A. vandenboschi* development. Studies are now beginning on host feeding and SJS development stage preference. Studies with *Encarsia* have proven difficult because the parasitoid colony has not been easy to maintain. It is suspected the proper host stages or the exposure times to produce a strong and abundant colony has not yet been determined. Results of temperature cabinet work are summarized in Table 2, but it is believed that the higher temperatures must be repeated (many of the replicates are not included for those trials that died at 90°F).

Financial Summary for Task 1: The total cost for achieving the objectives of *Task 1* was budgeted at $25,000. To date, $29,848 has been spent towards completing *Task 1.*

2. Determine the effect of "soft" insecticides, (e.g., Success®, Confirm®) on selected natural enemies of SJS.

Insecticide Screening Trials. From 1998 to 2000, "diet-incorporated" bioassays were used to develop LD50s and LD90s for Dimilin®, Confirm® and Success® for control of PTB. In 1999 and 2000, field studies were completed on the efficacy of these products against PTB and navel orange worm (NOW). All three products were found to be effective against PTB; less control against NOW was evident. In 2000, tests were initiated for potential negative effects of Dimilin®, Confirm® and Success® on natural enemies of NOW and SJS. A high application rate was used (4 X the label rate). Some affect on beneficial insects, particularly parasitoids was detected.

In 2001, field tests of these products were completed on commonly found beneficial insects. Almond trees were treated, using commercial methodologies, with the label rate for each product and compared with a no-spray control (randomized block design; 3 replicates). Nuts from those trees were collected at 1, 7 and 14 days after spray application and placed, individually, in plastic rearing cells. To each cell, a green lacewing larva, a common orchard predator, *Goniozus legneri* adult, a common navel orange worm parasitoid, or *Aphytis vandenboschi,* a common San Jose scale parasitoid, was added. The insects were checked daily and their condition (alive or dead) recorded.

Results from this study are still being processed. Data suggest that both Dimilin® and Success® cause mortality of *Goniozus legneri* and *Aphytis vandenboschi.* There was less mortality of tested beneficial insects in the Success® treatment. This winter theses studies with a twig-dip bioassay will be completed. [A summary of preliminary results is provided in Table 3.]

Financial Summary for Task 2: The total cost for achieving the objectives of *Task 2* was included in the budget for *Task 1.* Expenditures have been included under Task 1.

3. Examine the effects of reduced risk materials, e.g., oils and the Insect Growth Regulators (IGRs), Esteem® and Applaud®, on various life stages of male and female SJS to determine the most effective timing for application of the materials. Second, determine if OP resistant SJS have any cross-resistance to the IGRs. Results will be incorporated into the development of a comprehensive resistance management plan for stone fruits.

Results for one of the reduced risk materials Dr. Grafton-Cardwell is studying, volck oil, has been found to provide the best control for SJS first and second instars when at a 4-6% concentration level compared to concentrations of 1 or 2%. (Table 4.) The third instar stage female is very difficult to control, but during the dormant time period most of the instars present are first and seconds, which are the life stages that are more susceptible to the oil. Fecundity, sex ratio and rate of development of three populations, one from a susceptible group, one from an OP

resistant population from apples and one a resistant population from plums, were compared. The experiment was conducted by placing 100 scale crawlers from each colony on a banana squash and counting the number of progeny they produced when they reached maturity. There was not a large difference in the developmental time or number of crawlers per female. But the susceptible colony was found to have a much higher ratio of females/males than the two resistant populations, which would allow that population to increase at a faster rate. The lower number of females could be because OP resistance causes a reduction in sex ratio of the resistant populations. Another possible answer could be because the susceptible colony has been in culture on squash for many years and has adapted to the squash better. (Table 5.) This data will help direct the industry as to the best concentration of oil and volume of oil to maximize control of SJS.

Dr. Grafton-Cardwell is in the middle of experiments to develop baseline data for the response of San Jose scale to Esteem and Applaud. She had to wait until small wild gourds were available in the fall to infest with scale for dipping in the pesticides. Preliminary data suggests that male scales are much easier to kill than female scales. This is probably due to the fact that they have much more complex development than the females. Insect growth regulators act on the molting process. Once the baseline data is established, Dr. Grafton-Cardwell will be able to check for cross-resistance between organophosphates and insect growth regulators.

While more on the order of meeting objective 6, Dr. Grafton-Cardwell held a two-day workshop to train industry PCA's about San Jose scale. The dates were March 20-21, 2001. The first day participants studied the life stages of San Jose scale using microscopes and laboratory-reared San Jose scale. In the afternoon they studied what scale looks like when parasitized by *Aphytis* or *Encarsia* wasps. They then examined San Jose scale on field-collected plum twigs and discussed the difference between healthy and parasitized scale. Lectures were presented by Walt Bentley, Dr. Kent Daane and Dr. Grafton-Cardwell on various aspects of scale and parasite biology. At the end of the day a 10 point quiz was given questioning topics discussed during the day and the average score was 80% correct. On the second day, Walt Bentley took the group out to a plum orchard to discuss how to estimate scale densities by examining plum spurs. There were 16 participants (PCAs and farm advisors) who attended.

Financial Summary for Task 3: The total cost for achieving the objectives of *Task 3* was budgeted at $33,600. To date, $23,826 has been spent towards completion of Task 3.

4. Demonstrate and compare the efficacy and economics of pest control techniques that *do not* rely on OP, carbamate, or pyrethroid inputs to control stone fruit pests in "grower participant" sites in several counties throughout California. In addition to the grower sites in Fresno, Kings and Yuba Counties established during the previous year of the project, this objective seeks to expand the project to include 3-4 additional grower participant sites in Kern, Madera and Tulare Counties.

Prior to the 2001 bloom, additional grower participant sites were recruited to become a part of the PMA project for this year. Gary Van Sickle, Walt Bentley and Janine Hasey met with the potential participants to explain the program to them and the expectations of participants. For

2001 several participant sites joined the project. They include: Daybreak Farms (Tulare County), Rubicon Orchards (Tulare County), Pinkham Bros. (Tulare County), Kovacevich & Sons (Kern County), Hundal Farms (Sutter County)(replaced Quinco Corporation) and Deniz Packing Co. (Madera County). This increases the number of grower sites involved in the project from 3 up to 8 for this year. [Two of the additional growers are already practicing reduced risk farming and a comparison was not available at their sites.] The stone fruit acreage involved grew to approximately 120 acres, a 3-fold increase over last year's acreage. Fifteen varieties from the eight cooperators were examined. Harvest dates ranged from May 3 to September 12. Tables 6 & 7 present overall insect infestation and harvest dates from the orchards sampled. Primary insect and mite pests and beneficial arthropods were monitored from dormancy to harvest in all orchards.

YTD Demonstration Results:

Dormant Season: The dormant application of high-rate, high-dilution mineral oil in the PMA blocks produced results similar to those of 2000. A substantial number of San Jose scale were eliminated with the mineral oil, although not to the same degree that typical organophosphate applications suppress scale populations. However, much higher parasitoid populations are being found in the PMA blocks, which mirrors last season's findings. The parasitoids are very host-specific and well-synchronized early in the season; preliminary sampling using sentinel scale hosts indicates that the activities of *Encarsia* and *Aphytis* are removing over 50% of the scale population. The use of high-rate, high-dilution mineral oil for the dormant application can save growers approximately $20/acre.

Bloomtime: The Spinosad (Success) bloomtime application provided control of thrips populations, as indicated by low thrips scarring on early-season fruit. To-date, no differences can be found between fruit damage in the blocks with spinosad and blocks where Carzol (formetanate hydrochloride) was applied.

In-season: Insect trapping of Oriental fruit moth, omnivorous leafroller, peach twig borer, San Jose scale, *Encarsia perniciosi, Aphytis* wasps, and codling moth was conducted weekly during the 2001 season.

Oriental fruit moth pheromone trap counts were low in both the PMA and Conventional programs which used mating disruption in 2001. The exception was the Angeleno/Santa Rosa plum orchard in Madera County that did not use OFM mating disruption and the Kern Queen Crest orchard that used no OFM control technique. Two types of OFM mating disruption were used last year. The primary product used was Isomate M100® (Pacific Biocontrol). It was applied at 150 ties per acre. This application provides 30 grams active ingredient with each application. The other product used was Gowan Corporation's Confuse®. Confuse® is formulated in a 22% paraffin emulsion, 60% water, 10% oil and 5% OFM pheromone. Treatments were made at 30 grams active ingredient per acre and the emulsion was squirted onto the tree where it solidified. Confuse® is currently not registered but a research authorization was granted to incorporate this product into the project. Four orchards utilized Confuse®.

The PMA comparisons all had two applications of pheromone, the first at biofix in March and the second in mid June. Mating disruption for OFM has become the conventional method of managing OFM in early to mid season varieties. Only two orchards did not use mating disruption in the Conventional comparison block. These were in Madera and Kern County. All trap counts for OFM were low. The greatest number of moths trapped (131) was in the Fresno County Summer Red Conventional comparison. Where mating disruption was used, seasonal OFM trap counts ranged from 0 (nine orchards) to 47.5 (one orchard).

The two orchards that resulted in any detectable OFM infestation were harvested in September. These were the Arctic Snow nectarines (Tulare County) and the Sweet September peaches (Fresno County). Moth flight was not detected until late August in both of these blocks, indicating a third application of disruptant was warranted.

A more reliable method of detecting breakthrough in mating disruption is the use of shoot strikes caused by feeding of larvae. OFM will infest terminal vegetative shoots prior to moving into the fruit. Watching for this is a reliable early warning for a breakthrough in mating disruption. An example is seen in the Arctic Snow variety where no shoot strikes were detected from May through June. In early July, averages of 10 strikes per tree were detected. By late July this level reached 25 strikes per tree. Harvest occurred in early September and OFM damage was 7%. Alternately, Zee Lady peaches averaged only 3 shoot strikes per tree in late June. The peaches were harvested on July 17 and had 0.4% damage. Clearly, the later the harvested fruit, the more potential for damage and shoot strikes can be used as a guide to infestation. In the Bright Pearl nectarines, approximately 8 strikes were found per tree on July 2. This was found in both the Gowan Paraffin product (Confuse®) and the Isomate M100®. Harvest occurred on July 13 and no OFM damage was found. However, subsequent strike counts taken on August 21 averaged 12 per tree in the Paraffin treated block and 39 per tree in the Isomate M100® treated areas. Strike counts continued to climb and in September there were 30 per tree in the Paraffin treated and 49 per tree in the Isomate treated area. A tentative treatment threshold is 5 OFM shoot strikes per tree in orchards utilizing mating disruption.

PTB was managed primarily with Spinosad or *Bacillus thuringiensis* (Bt) sprays timed during the bloom period. However, 4 sites tested the puffer technology (Suttera®). The sites tested with this technology (Bright Pearl, Zee Lady and Arctic Snow in Tulare County, and Red Jim in Fresno County) had very few trapped moths throughout the season. Counts of PTB were exceedingly low, but a substantial difference between the disrupted and non-disrupted block was seen at the Hanford/Red Jim site. (Table 8.) Puffers were removed from the Farmersville site after the harvest (July 11) and the PTB counts went up considerably soon afterwards. (Table 9.)

The greatest PTB catch occurred in Kern County. Here the Conventional comparison (454 moths per trap per season) received a dormant oil and Asana® spray. The PMA comparison (240 moths per trap per season) received a single Dipel spray. Overall, PTB moth catch in all orchards was extremely low. No PTB infested fruit were found in any of the fruit harvested in the San Joaquin Valley. Moth catch was also quite low in Sutter County. The Pest Management Alliance orchards received single applications of Checkmate PTB mating disruption on May 7. In these orchards, trap catch ranged from 0 to 3. A total of 41 moths were trapped in the

Conventional Starn/Sullivan comparison. In the Conventional Sullivan comparison, an Asana® dormant and three Ambush® sprays were used during the growing season.

The leafrollers monitored included OLR (San Joaquin Valley) and OBLR (Sutter County). OLR counts ranged form 44.5 (PMA Santa Rosa/Angeleno plums in Madera County) to 867 moths per trap per season (PMA Fortune/Autumn Beaut plum in Tulare County). Two orchards in the Pest Management Alliance trapped more than 500 OLR per trap per season. Three of the Conventional comparison orchards trapped more than 500 OLR per trap per season. No orchard was found to have more than 0.7% leafroller damage. Treatments with either Bt or spinosad, or Imidan® may have regulated damage from this pest in the San Joaquin Valley. Alternatively, the levels found in the orchards may not have been high enough to cause economic damage.

Obliquebanded leafroller (OBLR) numbers were quite low in the Sutter County comparisons. Each of the orchards had some OBLR feeding with the late harvested Starn variety, under the PMA program, resulting in the greatest damage (1%). The Conventional comparison using multiple Ambush® sprays had 0.6% damage.

San Jose scale pheromone trap monitoring resulted in a wide range of populations in the San Joaquin Valley. The greatest abundance of males were trapped in orchards with scale infestation problems prior to the Pest Management Alliance program. The Bright Pearl and Fire Pearl nectarines trapped 3,862 and 2,200 male SJS per trap per season respectively in the PMA program. The Conventional comparisons resulted in 2,751 males in the Bright Pearl and 1,965 in the Fire Pearl. The lowest abundance of scale was found in the Alliance program in the Zee Lady peaches and the Artic Snow nectarines. These two varieties have been under a soft chemical approach for multiple years. The ratio of SJS parasites (*Encarsia*) ranged from 0.3 to 1 in the Conventional Bright Pearl nectarines to 3.4 to 1 in the Pest Management Alliance Santa Rosa/Angelino plum orchard. Similar counts of male scale were found in Sutter County. The highest trap catch being 4,515 SJS per trap per season in the Conventional Carson variety and the lowest catch being 870 SJS in the Conventional Sullivan peach variety. The ratio of parasites to SJS ranged from 0.1 to 1 in the PMA Carson variety to 5.1 to 1 in the Conventional Sullivan variety. In all cases, the majority of scale and parasites were trapped in March and April. No significant scale damage was found in any of the orchards. The PMA orchards relied only on dormant oil for scale control.

Plant bugs were not found in any of the sampling in either the San Joaquin Valley or Sutter County. Sampling of ground cover, in the process of sampling katydids, did not reveal plant bugs present. This technique is a good early warning system to detect both the presence of these insects as well as the stage of development. Fruit samples during the growing season did not reveal feeding.

The forktailed bush katydid was present in six of the orchard comparisons and in two of the orchards where no comparisons were made. (Table 6.) No katydid damage was found in the Sutter County orchards. Sweep net samples were made, but counts were not taken. Decisions to treat were based on the presence of katydid in the samples. First nymphs (first and second growth stage without wings) were caught in nets during early April. Based on this trapping

insecticide applications were made. In all cases spinosad was used. Older nymphs and adults will require OP or pyrethroid applications for control. Angular-wing katydids appear to be controlled well with spinosad. The Tulare County Bright Pearl and Fire Pearl nectarines were the two sites where control was not satisfactory.

The Tulare County Bright Pearl and Fire Pearl site also had a severe Western spotted cucumber beetle (*Diabrotica undecimpunctata)* infestation and feeding closely resembles feeding damage of katydid. Damage attributed to katydid, at this site, may have been caused by migrating spotted cucumber beetle. Spinosad does not appear to be effective against the beetle. Spotted cucumber beetle was collected at the Tulare Bright Pearl/Fire Pearl orchards during harvest and subsequent feeding tests identified it as causing fruit damage. Monitoring traps will be used to detect movement of spotted cucumber beetle in 2002. Imidan® was utilized in both blocks to mange the beetle.

The insect causing the greatest amount of overall damage in nectarines and plums was Western flower thrips. Each of the nectarine blocks (Bright Pearl, Fire Pearl, Red Jim, Summer Red, and Arctic Snow) was treated at petal fall. In each of these blocks adults were detected during bloom and a decision to treat was made. Of the four sites where a conventional treatment (Carzol) was compared to the PMA treatment (spinosad), the PMA treatment had less damage at 3 sites. An average of 3.3% thrips scarring was found in the spinosad treated orchards and 4.0% in the Carzol treated orchards. Each of the nectarine varieties had some level of thrips scarring. The two plum orchards (Fortune/Autumn Beaut and Santa Rosa/Angeleno) were not treated for thrips. Damage was greater in abundance but not in severity at these sites. The Angeleno variety had 3% scarring in the PMA portion of the orchard and 4.6% in the Conventional portion of the orchard. No thrips damage was found in the Sutter County orchards.

Fruit Harvest: Harvest samples (500 to 1000 fruit) were collected from each of the orchards prior to damage sorting by picking crews. This was done throughout the orchard. Fruits and twigs were sampled from spring to harvest to detect incipient pest problems prior to producing fruit damage.

Table 6 presents the damage due to various pest insects. In the southern San Joaquin Valley there was a 0.6% difference in damage between the two pest management approaches (PMA versus Conventional). Overall insect damage averaged 8.5% in the Pest Management Alliance orchards and 7.9% in the Conventional orchards. Specifically, the PMA orchards averaged 0.6% OFM and the Conventional orchards averaged 0.8% OFM. For the second year, no damage was found due to PTB. The greatest amount of damage from OFM occurred in the Arctic Snow variety. The damage was 6.6% and there was no Conventional comparison. Harvest of Arctic Snow peaches occurred on September 3. The Sweet September variety also had an infestation of OFM. In this case there was a comparison between the PMA and the Conventional program. The PMA program resulted in 4.2% infestation and the Conventional program had 5.4% OFM infestation. Harvest of Sweet September peaches was September 6.

In Sutter County, worm damage attributed to OFM was also detected in the latest harvested Starn variety (harvested on August 22). Damage attributed to worms (thought to be predominately

OFM) was 4.2%. The Conventional comparison (Sullivan variety harvested on 8/27) had 0.4% due to OFM. The earlier harvested varieties all had less than 1.5% damage due to OFM.

Leafroller damage was minimal in the southern San Joaquin Valley. All leafroller (OLR) damage was less then 1%, with the Bright Pearl nectarines under the Conventional program, having the greatest amount of damage (0.71%). Sutter County had extremely low levels of leafroller (OBLR) damage, unlike last year. The late harvested Starn variety, following the PMA approach, had 1% damage and the Sullivans, under Conventional management, had 0.6% leafroller damage. The remaining varieties had less than 1% damage in Sutter County.

San Jose scale was a minor problem in the orchards studied in 2001. Each of the PMA orchards in the southern San Joaquin Valley received a single dormant oil spray, while the Conventional comparisons had a combination of oil and organophosphate or pyrethroid. In Sutter County, both the PMA and Conventional orchards received a dormant pyrethroid and oil application. The Fortune plums had 5.6% infestation and the Autumn Beaut variety had 3.4% infestation. There was no Conventional comparison orchard. The Red Jim variety had 1.4% infestation in the Conventional blocks, while the PMA comparison had 0.2% infestation. The Fire Pearl nectarine had 1.4% and 1% infestation in the PMA and Conventional blocks respectively. No SJS was detected in Sutter County. Interestingly, the Sutter County orchards best ratio of *Encarsia* to SJS was 5.1 to 1. In the Southern San Joaquin Valley, the greatest ratio of the parasite to SJS was 3.4 to 1.

Forktailed bush katydid continued to be a problem in the southern San Joaquin Valley. Damage was particularly severe in the Bright Pearl and Fire Pearl nectarines in Tulare County. Damage attributed to katydid in the Bright Pearl variety was 6.4% and 2.7% for the PMA and Conventional blocks respectively. Damage in the Fire Pearl was 4.9% and 7.9% for the PMA and Conventional blocks respectively. Damage caused by this pest is quite random and somewhat localized; sampling location has a great bearing on the amount of damage. The remainder of the orchards had less than 1% damage.

The Western spotted cucumber beetle was last recorded as being a problem in fresh market fruit prior to World War II. It was a pest in both the Bright Pearl and Fire Pearl nectarines in Tulare County in 2001 (Table 6). This new secondary pest and its feeding damage will be studied in more detail this season.

Spider mites were treated in only two orchards, the Red Jim nectarines in Kings County and the Zee Lady peaches in Tulare County. Sampling had indicated increased mite abundance when cooperating growers treated the orchards. Spider mites were not treated in the Sutter County comparisons.

There was a 0.6% difference in total insect damage between the two management practices in the San Joaquin Valley. The Pest Management Alliance approach resulted in an average of 8.5% damage and the Conventional program averaged 7.9% damage. The 2000 Pest Management Alliance program averaged 5.7% insect damage and the Conventional program averaged 5.6% damage. Western flower thrips (plums and nectarines) and katydid contributed most to fruit

damage in the San Joaquin Valley. Peaches harvested in September were the only ones that resulted in OFM damage for both the PMA and Conventional program (Table 6). No damage was recorded for PTB in either 2000 or 2001. Only one variety had substantial SJS damage. This was the Fortune plum harvested on July 13 (5.6% damage).

Damage in Sutter County was quite low in 2001. The PMA program averaged 2.6% damage and the Conventional program averaged 0.7% damage. Only two species of insect damage was found at harvest, OFM and OBLR. The Starn Pest Management Alliance orchard had 4.2% damage and was harvested in late August. The Conventional comparison, also harvested in late August, received only 0.4% damage. Unlike 2000, little damage was found from plant bugs.

Treatment Costs: Treatment costs are presented in Tables 10-21. The costs of the programs varied considerably and were dependent upon the crop, the harvest date, and the location. Application costs were not included in this analysis. For general purposes the costs of running a dilute spray rig through the orchard is estimated to be $20 per acre. The cost of hanging Isomate ties is estimated at $10 per acre. The cost of spraying paraffin emulsion is $3 per acre. These figures can be plugged into the material cost sheets. If a private consultant is used, a cost of $30 per acre is estimated. All of the PMA programs utilized a pest management consultant and four of the seven orchards in the Conventional program utilized a pest management consultant or farm hired entomologist. The remaining three cooperators utilized agrochemical pest management personnel, whose salary was not directly paid by the farmer.

For the San Joaquin Valley, the average per acre material cost for the Pest Management Alliance program was $148. The average per acre material cost of the Conventional program was $159 per acre. Nectarines averaged $188 for the PMA program and $227 for the Conventional program. The average cost of the PMA program in plums was $88 per acre and $78 in the Conventional program. The average per acre cost of the PMA program for peaches was $127 and $78 for the Conventional program. The lowest cost PMA program was in the Angeleno plum orchard which cost the farmer $47 per acre. The highest cost PMA program was in the Red Jim nectarines which cost the farmer $217 per acre. The lowest cost Conventional program was in the Queen Crest peaches (harvested in May) and cost the farmer $37 per acre. The highest cost Conventional program was in the Red Jim, which had $301 in material cost.

The cost comparisons were not as favorable in the Sutter County comparisons. However, the cling peach growers do not rely on organophosphate or carbamate insecticides in the Conventional comparison orchards. Because of the lack of spider mite problems in these locations, farmers have used up to 4 pyrethroid sprays to manage all of their pest problems. This would not be possible in the San Joaquin Valley, where Pacific mite, *Tetranychus pacificus*, control would be required. Technically, the Conventional comparison is meeting one of the goals of this project which is to lessen the reliance on organophosphate and carbamate insecticides. The approach would not be considered a soft approach but is the most economical. The PMA comparisons made in Sutter County resulted in an average material cost of $161 per acre. The Conventional pyrethroid approach resulted in material costs of $50.00 per acre.

(Tables 18 through 21) The $111 difference is a major impediment to utilizing mating disruption in these areas. Interestingly, the Conventional program in the San Joaquin Valley averaged $159 per acre, more than three times of the cost of the Conventional program in Sutter County.

Financial Summary for Task 4: The total cost for achieving the objectives of *Task 4* was budgeted at $115,000. To date, $110,000 has been spent towards completion of Task 4.

5. Study and document the biology of secondary pests (i.e., katydids and soft-bodied scale) that have increased in population, in certain environments, due to implementation of reduced risk practices.

Katydids are now becoming one of the major sources of damage to peaches and nectarines in the stone fruit PMA project. During the time when OPs and carbamates were more commonly used for OFM control the katydid was seldom a problem. As the industry moves to mating disruption and nondisruptive insecticide use in stone fruits katydids will continue to be a problem.

Katydid biology and control investigations were continued from last season's work. Forktailed bush katydids and angular-winged katydids are being studied in cages at the Kearney Ag. Center. The forktailed bush katydids appear to emerge over a long duration in winter and spring, with early nymphs being found in late-March and the latest nymphs from this early generation being found in early-June. By mid-July very small nymphs were again found, suggesting that these are the second generation of katydids. From the cage trials, it was found that not all the eggs from the winter/spring generation hatch in the summer. Some remain dormant throughout the summer and hatch the following winter/spring. The evidence for this is the fact that eggs laid in spring 2000 emerged in the spring of 2001. Additionally, eggs laid in the summer of 2000 emerged in spring, 2001. Thus, the katydids effectively distribute their young in both space and time. The only non-organophosphate tested on katydids was spinosad, which worked very well on young nymphs, especially when applied by early May. Older nymphs and adults will still require OP or pyrethroid applications. Angular-winged katydids are also controlled well with spinosad, though they are rarer and don't emerge until May. They appear to have only one generation a year. Both species are in culture at Kearney Ag. Center and will have alternative materials tested on them next year.

The forktailed bush katydid was present in six of the orchard comparisons and in two of the orchards where no comparisons were made (Table 6.). Sweep net samples were made, but counts were not taken. Decisions to treat were based on the presence of katydid in the samples. First nymphs (first and second growth stage without wings) were caught in nets during early April. Based on this trapping insecticide applications were made. The Tulare County Bright Pearl and Fire Pearl nectarines were the two sites where control was not satisfactory. This site also had a severe spotted cucumber beetle infestation and its feeding closely resembles feeding damage of the katydid. Damage originally attributed to katydid at this site, may have been caused by migrating spotted cucumber beetle. No katydid damage was found in the Sutter County orchards.

Thrips and katydids contributed most to the fruit damage in the San Joaquin Valley. Damage from the forktailed bush katydid was particularly severe in the Bright Pearl and Fire Pearl nectarines in Tulare County. Damage attributed to katydid in the Bright Pearl variety was 6.4% and 2.7% for the PMA and conventional blocks respectively. Damage in the Fire Pearl was 4.9% and 7.9% for the PMA and conventional blocks respectively. Damage caused by this pest is quite random and somewhat localized; sampling location has a great bearing on the amount of damage. The remainder of the orchards had less than 1% damage.

Financial Summary for Task 5: The total cost for achieving the objectives of *Task 5* was included in the budget for *Task 4*. Expenditures have been included under Task 4.

6. Continue to enhance communication and information dissemination to the stone fruit grower community.

Seven PMA field days sponsored and publicized by California Tree Fruit Agreement, California Cling Peach Growers Advisory Board and the University of California were conducted. The events were held to inform growers, pest control advisors, pest control operators, the stone fruit industry and the public about progress made on the PMA project.

On April 17 a spring update meeting was held at the Kovacevich demonstration block located in Kern County. There were approximately a dozen growers who attended. A second spring PMA update meeting was held on April 25 in Traver (Tulare County) at the Daybreak Farms' demonstration block. Approximately 45 growers and PCAs attended. There was also a film crew from the PBS series "American Environmental Review" who attended, shot footage and interviewed some of the participants. The clip started airing on the show late in the summer. A cling peach spring PMA update meeting was held on April 26th at the demonstration block located in Sutter County with 26 attending the event.

On August 9 a mid-season PMA meeting was held at the Kearney Ag. Center. Approx. 90 growers, PCAs and interested persons were in attendance. The meeting started with a showing of the film clip that was filmed at the spring update meeting at Traver. (Agenda attached – page 39.)

In the fall post-season meetings were held. On October 25 there was a workshop held at Kearney Ag Center in Parlier. As part of the meeting there was a 60 minute roundtable discussion led by 3 of the PCAs involved with the project in the San Joaquin Valley. Also on the program was Pat Weddle from the Center for Ag. Partnerships. He spoke to the group on how to measure success of demonstration programs. After the workshop meeting the participants were asked to complete a meeting evaluation. Several questions on the evaluation asked if they were a grower or PCA and if they applied any of the reduced risk practices presented at the PMA meetings to their operations. It is noteworthy that out of those returning the evaluation, 45 were growers and/or PCAs representing 39,284 acres of fruit, out of a total of 112,500 acres (exclusive of cling peaches). Out of that group were 30, representing 28,804 acres, who stated they were applying what they learned at the PMA meetings to their operations. Thus, it could be suggested that

approximately 2/3rds of fresh market stone fruit growers, on 2/3rds of the acreage, are now practicing reduced risk practices from the PMA project.

On November 27 there was a workshop held for growers in the Sacramento Valley at Yuba City. There were 35 in attendance at the meeting. This meeting also included an update on measuring the success of demonstration programs and a panel discussion as to what worked or didn't work during the past season.

Most recently, on February 13, 2002, a winter PMA day was conducted at Kearney Ag. Center in Parlier. This meeting provided an update on mating disruption, most notably that Gowan will not be pursuing the registration for the paraffin emulsion, information on proper trap placement in orchards and data/information collected during the past season. In order to attract attendees the meeting started at 8 a.m., was kept to one hour, provided one hour of PCA credit and offered a light breakfast to those attending. This successful format will be repeated again in March. There was a post-meeting evaluation provided to attendees similar to the one from the October meeting. Of the 19 who responded, 17 were growers or PCAs. Of that group, 12, representing 37,510 acres (which is 1/3 of the stone fruit acreage, not including cling peaches) indicated they were using reduced risk practices and 2, representing 430 acres, indicated they have not yet adopted any reduced risk practices. There were 3 who did not respond as to their reduced risk practices.

Also, during the month of May (9, 16, 23 & 30) a series of Brown Bag Lunch meetings were held at various PMA plots in Tulare, Kings and Madera counties. Attendance was very disappointing, but those few who attended got an hour of almost one-on-one time with the UC researchers. The low attendance should not be interpreted as low interest; May is a busy month for growers as many are thinning, starting to pack and involved in treatments for various pests.

Project information was included in newsletters targeted at stone fruit growers. CTFA's April issue (copy attached – page 40) of the research newsletter, *A Closer Look*, summarized key points and progress through the second year of the project. CTFA's July issue provided an update of activities for the current year, including work done during the dormant period, at bloomtime and early in-season. The September issue contained an update on the project along with an article outlining IPM guidelines for replanting stone fruit orchards without using methyl bromide.

CTFA's newsletter is mailed to over 2,600 growers, PCAs, PCOs, shippers, packers and other parties associated with the clingstone canning and fresh market stone fruit industries. CCPGAB also mailed newsletters to over 400 cling peach growers, PCAs and PCOs explaining progress made on the PMA project. Information from the project has also been made available to the public via CTFA's and KAC's web site. CTFA's and CCPGAB's annual research reports, which included the individual progress reports from the UC researchers associated with the PMA project, were published in April and made available to growers/PCAs.

Posters explaining various aspects of the project were exhibited at several events, including the "Partnerships for Sustaining California Agriculture: Profit, Environment and Community"

seminar on March 27-28 at Woodland and at the annual Spring Meetings of the California Tree Fruit Agreement at Visalia on May 3, and at the Brown Bag Lunch meetings.

Financial Summary for Task 6: The total cost for achieving the objectives of *Task 6* was budgeted at $46,650.66. To date, approximately $21,777.30 has been spent towards meeting the objectives of Task 6.

D. Discussion

The results of the 2001 Stone Fruit Pest Management Alliance program were quite similar to the 2000 program. Overall insect damage in the San Joaquin Valley in 2000 was 5.6% in the conventional approach (utilizing some organophosphates) and 5.7% damage in the PMA program. In the San Joaquin Valley in 2001, the conventional program averaged 7.9% and the PMA program averaged 8.5% damage. During both years in the San Joaquin Valley, OFM damage was minimal until the September fruit harvest and PTB was nonexistent. San Jose scale problems were also minimal. It appears that the PMA program does not contribute to outbreaks of the pest considered the primary target of OP and carbamate materials. The two insects causing the greatest damage in the San Joaquin Valley were thrips and katydids. There was no difference in damage by these two pests between the two approaches to controlling them.

In Sutter County, damage from insects was considerably lower than 2000. In 2000, damage averaged 6% in the PMA program and 4.7% in the conventional program. In 2001, damage in the PMA program averaged 2.6% and the conventional program (relying on pyrethroids) averaged 0.7%. The difference in damage between the two years appears to be related to a reduction in OBLR and plant bug damage. Neither of these two pests caused economic damage in 2001.

Overall, in the San Joaquin Valley, dollars expended on pest management materials were less in the PMA program than in the conventional program, but the difference was minor. A major concern being voiced by many farmers is the loss of organophophates and carbamates because of the results of this project. There are reasons these materials should be kept. One is the occurrence of migrating plant bugs such as stinkbug, boxelder bug, and lygus bug. None of the soft materials provided control of these pests. Although the pyrethroid class insecticides do control them, the resulting Pacific spider mite problems, as a result of their use, make them an unwise choice in the San Joaquin Valley. Miticides ranged in cost from $25 to $70 per acre. The cost of the PMA in Sutter County was approximately 3 times that of the standard pyrethroid approach.

A continuing problem in mating disruption orchards is the breakdown of the OFM pheromone confusion products in August. In the current program, two applications of either Isomate M® or Confuse® paraffin emulsion protected fruit from infestation through August. A cost effective method of application is necessary to reapply products (preferably in late July) that would extend the mating disruption into September. The development of the sprayable confusion products by Suterra and 3M should make this possible. These products will be tested in the 2002 program.

The use of "strike" counting appears to be a good technique to warn of disruption failure. In the late harvested peach varieties, increases in the number of strikes per tree gave a clear picture of the need to for additional OFM control. Currently, a threshold of five strikes per tree is being used as a trigger for treatment. Sprayable pheromones will also be incorporated into the PMA program in 2002. The OFM paraffin emulsion product will not be marketed by Gowan Corporation in the future, but it performed quite well in 2001.

The challenges that remain include better sampling techniques and control methods for forktailed bush katydid and spotted cucumber beetle. A separate study will be done on these two pests to gather this information. Late season movement of forktailed bush katydid has become a particular problem in stone fruit.

Another key issue of concern is the management of organophosphate runoff. This is less of a problem in the Southern San Joaquin Valley, but still is an issue that must be dealt with. In this demonstration there has been management of San Jose scale and European red mite with oil sprays alone. Although this does not control peach twig borer, the use of either Bt sprays or spinosad sprays during bloom or at the proper development timing in the late spring, has kept this pest under control. The timing for PTB appears to have worked for the OLR and OBLR as well. More importantly to the grower, the cost of this approach in the San Joaquin Valley has been less than his standard program. Because farmers in the Sacramento Valley rely on pyrethroid sprays for both PTB and OFM control, their approach is less costly than the integration of OFM mating disruption. Multiple pyrethroid sprays work well currently, but this approach will not be sustainable. As was the case with the organophosphates, resistance will develop to the use of these broad spectrum sprays. Growers cannot be faulted for using the sprays, which are currently working. A cost savings of $100 per acre in the Sacramento Valley is too much for them to sacrifice. The integration of less costly and more easily applied mating disruption products appears to be feasible.

Thus, technical challenges, including increasing evidence SJS is resistant to OPs, growers experiencing unacceptable fruit damage while using pheromone mating disruption for OFM, and grower concerns of economic loss during the transition of instituting reduced risk practices, have been barriers to developing a comprehensive integrated pest management program for clingstone canning and fresh shipping peaches, plums and nectarines. The testing of commercially available oils, pheromone dispenser systems and reduced risk pesticides in a controlled research environment has provided a representation of best management practices for utilizing a more intense integrated pest management approach. Furthermore, development of a biological control program with augmentation of natural enemies may increase SJS, PTB and OFM parasitism levels and further reduce the need for OP/carbamate applications.

Overall, advancement in meeting the objectives was completed during the third year of the project. An analysis of the data from last year, and again this past season, indicates SJS, PTB and OFM populations should be maintained below an economic injury level in stone fruit without, or with minimal use of, OPs and carbamates. Thus, 8 grower demonstration plots were established during the winter/spring of 2000-01, which have incorporated the reduced risk practices outlined in this project. The implementation of these demonstration blocks intend to

addresses the dynamic pest management pressures in a commercial setting, from dormant sprays to beyond harvest. The successful performance of the combination of replacing OPs with oil, pheromone mating disruption and augmenting with natural enemies, under conditions and acreages growers typically contend with, should increase grower confidence in the efficacy of alternative materials and reduced risk practices.

E. Summary and Conclusions

This was the third year of a comprehensive pest management project where a systems approach (intensive field monitoring, use of mating disruption, use of biological agents and implementation of reduced risk materials) was taken to examine reduced risk alternatives for controlling SJS, PTB and OFM in clingstone and fresh market peaches, plums and nectarines. The objectives of this multi-year project distinctly seek to substantially reduce reliance on OP's and/or carbamates and provide a model sustainable pest management system for stone fruit growers throughout the state of California.

Previously the project compared the efficacy of commercially available horticultural oil as the single component in a dormant spray for controlling SJS, compared to a traditional OP application, and found moderate populations of scale could be reduced under dilute application conditions.

Work has also progressed in developing a biologically and economically viable inundating release program for natural enemies of SJS. Commercial orchards have been surveyed and endemic natural enemies of SJS have been identified. As a result, laboratory colonies of two potential groups of parasitoids, *Aphytis vandenboschi* and *Encarsia perniciosi*, have been established for future use as potential augmentative biological control agents against SJS. Preliminary sampling of sentinel scale host plants revealed that the activities of these two parasitoids could remove a significant number of the scale population from the orchard.

The CTFA and CCPGAB continue to utilize their communications infrastructures to: sponsor and publicize UC grower education days, publish quarterly newsletters and maintain active websites highlighting progress made on the PMA project. Through this continued effort, hundreds of growers and professional crop care consultants are being exposed to alternative, reduced-risk practices that effectively address the pest complexes of the stone fruit industry.

Successful demonstration utilizing horticultural oils in dilute dormant applications in combination with pheromone mating disruption, use of new reduced-risk materials and the development of an augmentative parasitoid program in a commercial setting, should increase grower confidence in the efficacy of alternative materials and reduced risk practices. Post-season evaluations have been conducted with an objective of trying to measure the trend of implementation of the reduced risk practices demonstrated in this project.

After the October 25 workshop meeting the participants were asked to complete a meeting evaluation. Several questions on the evaluation asked if they were a grower or PCA and if they applied any of the reduced risk practices presented at the PMA meetings to their operations. It is

noteworthy that out of those returning the evaluation, 45 were growers and/or PCAs representing 39,284 acres of fruit, out of a total of 112,500 acres (exclusive of cling peaches). Out of that group were 30, representing 28,804 acres, who stated they were applying what they learned at the PMA meetings to their operations. Thus, it could be suggested that approximately 2/3rds of the fresh market stone fruit growers, on 2/3rds of the acreage, are now practicing reduced risk practices from the PMA project.

After the February 13 meeting another post-meeting evaluation was provided to attendees. Of the 19 who responded, 17 were growers or PCAs. Of that group, 12 individuals, representing 37,510 acres (which is 1/3 of the stone fruit acreage, not including cling peaches) indicated they were using reduced risk practices and 2, representing 430 acres, indicated they have not yet adopted any reduced risk practices. There were 3 who did not respond as to their reduced risk practices.

Lastly, this project can now start analyzing DPR's PUR data for usage trends. (Table 22) A comparison of the use of Diazinon, a major OP used in dormant and in-season sprays reveals a downward usage trend. For the years 1997, which was prior to the initiation of the PMA project, through 2000, which was after the second year of the PMA project, the usage for peaches has declined by 36%, for nectarines by 47% and for plums by 52%. Likewise, for the OP Methidathion (Supracide®) usage has also declined. For the years 1997 through 2000, the usage for peaches has declined by 41%, for nectarines by 80% and for plums by 56%. Formentanate HCl (Carzol®), a carbamate used primarily to control thrips in nectarines, has decreased in usage by 22%. Phosmet (an OP with a short re-entry time) usage is equal or up slightly during this timeframe. It is used by many growers practicing IPM when they have an in-season pest infestation and have to spray. There has been a tremendous increase in the usage of spinosad (Success®) since it received its Section 3 registration. Thus it is clear that stone fruit farmers are attempting to decrease their reliance on OPs and carbamates and increase their usage.

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Bentley, Walt, Pest Management in Stone Fruits, a Demonstration and Feasibility Evaluation. California Tree Fruit Agreement, Research Report, 2001.

Daane, Kent M., San Jose Scale Natural Enemies: Investigating Natural or Augmented Controls. California Tree Fruit Agreement, Research Report, 2001.

Grafton-Cardwell, Elizabeth. Laboratory Evaluation of the Effects of Oils and Insect Growth Regulators on San Jose Scale. California Tree Fruit Agreement, Research Report, 2001.

Appendix

Table 1. Fruit Damage.

Orchard	SJS	SJS per fruit	Worms	Katydid	Thrips	Bird
M- RDN	0.2 ± 0.1	0.3 ± 0.3	0	0	0	0
Y – SBN	0.5 ± 0.3	0.6 ± 0.4	1.6 ± 0.3	2.7 ± 1.4	0.4 ± 0.4	0
Br – FSN	1.0 ± 0.3	6.8 ± 1.4	1.9 ± 1.1	3.4 ± 1.4	0.5 ± 0.2	0
Ma – CP	7.6 ± 2.3	11 ± 2.5	0.1 ± 0.1	0	0	0
N – EHP	11.8 ± 3.2	18.5 ± 3.8	0.2 ± 0.2	0	0	0
B – MGN	8.9 ± 2.6	2.9 ± 1.0	0	0	0.5 ± 0.3	0

Table 2. The Influence of Temperature on *A. vandenboschi* Development

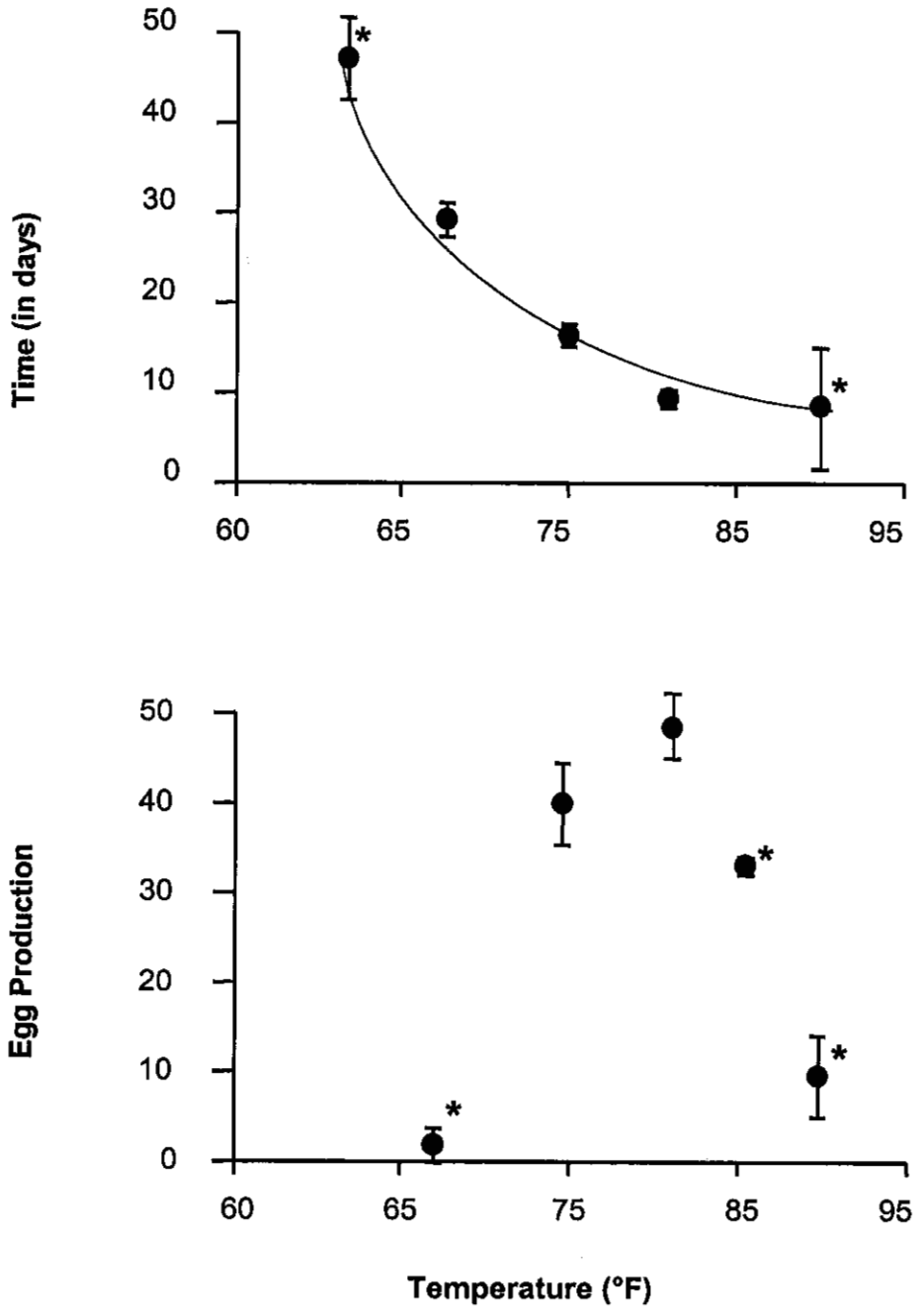


Table 3.

Residual Effect of Field-treated Nuts on Pests/Beneficials
Data Compared to Control at 4 & 14 days after Spray

	Days	NOW	PTB	L-wings	*Goniozus*	*Encarsia*	*Aphytis*
Success	4	+	++	--	+	+	+
	14	--	++	--	--	--	--
Dimilin	4	--	++	+	--	+	--
	14	+	+	--	--	--	--
Confirm	4	++	++	--	--	--	--
	14	--	+	--	--	--	--

-- No effect on target insect (compared to controls)
+ >50% higher mortality (as compared with controls)
++ >75% higher mortality (as compared with controls)

Table 4. Effect of Spraying Volck Oil on San Jose Scale Stages.

Figure 2

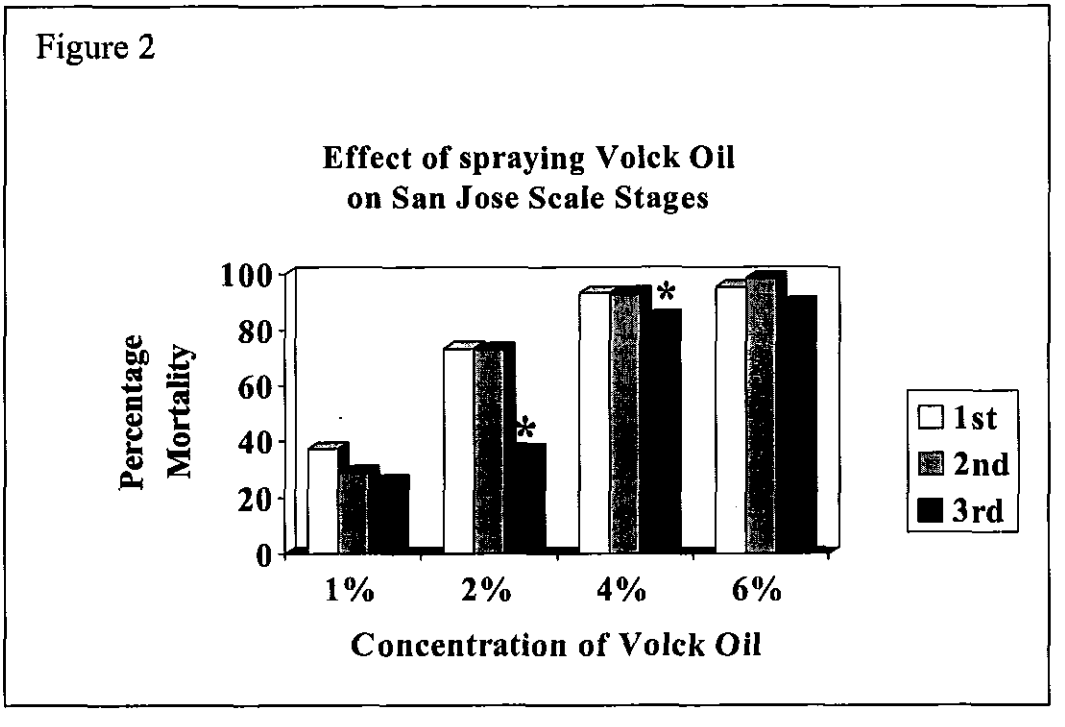


Table 5.

Survivorship, Sex Ratio, Fecundity and Developmental Time of San Jose Scale

Colony	% Survivor	% Female	Developmental time from crawler to crawler (days)	Average crawlers/ female	Average Crawlers/ 100 scales
Susceptible	85.2	61.97	38	262.66	14,052.25
Plum	79.8	31.64	40	361.22	9,843.25
Apple	81.8	26.45	40	415.16	8,822.25

Table 6. Damage Due to Various Insects in Stone Fruit Pest Management Alliance Orchards in the San Joaquin Valley, 2001.

San Joaquin Valley County/Variety	OFM	PTB	OLR	SJS	Katy-did	Cuke Beetle	NOW	Thrips	Total	Harvest Date
Kern/Queen Crest										
PMA	0	0	0	0	0	0	0	0	**0**	3 May
Standard	0	0	0	0.01	0	0	0	0	**0.01**	3 May
Tulare/Fortune										
PMA	0	0	0.4	5.6	0	0	0	10.2	**16.2**	12-Jul
Tulare/Bright Pearl										
PMA	0	0	0.43	0.71	6.4	3.7	0	4	**15.3**	13-Jul
Standard	0	0	0.71	0.43	2.7	1.6	0	4.4	**9.9**	13-Jul
Tulare/Zee Lady										
PMA	0.4	0	0	0.2	0.4	0	0	0	**1**	17-Jul
Fresno/Elegant Lady										
PMA	0.2	0	0	0.2	0.6	0	0	0	**1**	18-Jul
Standard	0.6	0	0	0	0.4	0	0	0.2	**1.2**	18-Jul
Tulare/Fire Pearl										
PMA	0	0	0	1.4	4.9	5	0	2.9	**14.1**	18-Jul
Standard	0	0	0	1	7.9	3.3	0	3.4	**15.5**	18-Jul
Kings/Red Jim										
PMA	0	0	0.2	0.2	0.2	0	0	4.8	**5.4**	7-Aug
Standard	0.6	0	0	1.4	0.2	0	0	2	**4.2**	7-Aug
Fresno/Summer Red										
PMA	0.2	0	1	0	0.6	0	2	2.6	**6.4**	13-Aug
Standard	0	0	2.2	0	0.2	0	0.4	6	**8.8**	13-Aug
Madera/Angeleno										
PMA	0	0	0.4	0	0.8	0	0.6	3	**4.8**	14-Aug
Standard	0	0	0.6	0	0.4	0	0	4.6	**5.6**	14-Aug
Tulare/Arctic Snow										
PMA	6.6	0	0.6	0.4	0.8	0	0	1.8	**9.6**	3-Sep
Fresno/Sweet September										
PMA	4.2	0	0.6	0	0	0	0	0	**4.8**	6-Sep
Standard	5.4	0	0.4	0	0	0	0	0	**5.8**	6-Sep
Tulare/Autumn Beaut										
PMA	0	0	0	3.4	0.6	0	0	6	**10**	12-Sep

Average San Joaquin Valley comparison-blocks County/Variety	OFM	PTB	OLR	SJS	Katy-did	Cuke Beetle	NOW	Thrips	Total
PMA	0.6	0	0.2	0.5	2.5	1.7	0.12	2.9	**8.5**
Standard	0.8	0	0.3	0.6	2.2	1.0	0	2.9	**7.9**

Table 7. Damage Due to Various Insects in Stone Fruit Pest Management Alliance Orchards in the Sacramento Valley, 2001.

Sacramento Valley County/Variety	OFM	PTB	OBLR	SJS	Katydid	Diabrotica	NOW	Thrips	Total	Harvest Date
Sutter/ Hundal Farms										
PMA (Carson)	1.4	0	0.4	0	0	0	0	0.2	**2.0**	Mid-season
Standard (Andross)	0.4	0	0.2	0	0	0	0	0	**0.6**	
Sutter/ Hundal Farms										
PMA (Monaco)	1.2	0	0.8	0	0	0	0	0	**2.0**	Late-season
PMA (Halford)	1	0	0	0	0	0	0	0	**1.0**	
Standard (Ross)	0.2	0	0.2	0	0	0	0	0	**0.4**	
Sutter/ Hundal Farms										
PMA (Starn)	4.2	0	1	0	0	0	0	0	**5.2**	Extra-late
Standard (Sullivan)	0.4	0	0.6	0	0	0	0	0	**1.0**	

Average Sacramento Valley comparison blocks County/Variety	OFM	PTB	OBLR	SJS	Katydid	Diabrotica	NOW	Thrips	Total	
PMA	2.2	0	0.6	0	0	0	0	0.1	**2.6**	
Standard	3.3	0	0.3	0	0	0	0	0	**0.7**	

Table 8. Puffer Trial Data - Hanford

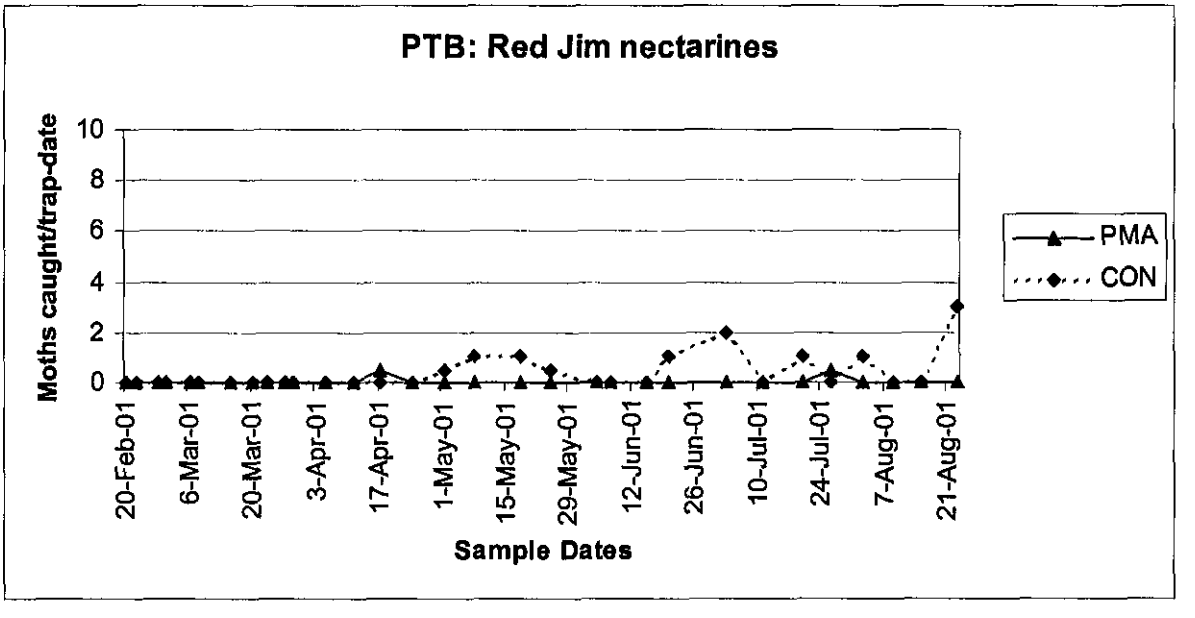


Table 9. Puffer Trial Data - Farmersville

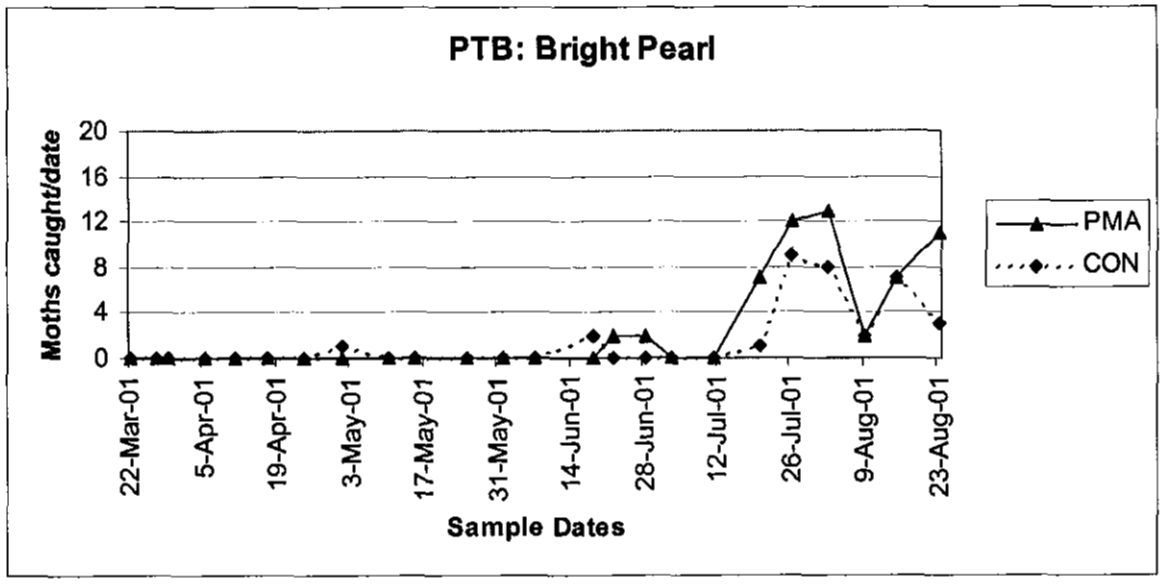


Table 10. Insecticide and Miticide Costs, Queen Crest Peaches, Kern County, 2001

	PMA block				Standard block			
Stage	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**
DORMANT (Nov-Jan)	Hort Oil	1/26	6 gal	$21	Hort Oil	1/29	8 gal/400 gal	$21
					Asana	1/29	8 oz	$16
Subtotal				**$211**				**$37**
BLOOM (Mar-Apr)	OFM Emulsion	3/15		$40				
Subtotal				**$40**				**$37**
IN-SEASON	Bt (Deliver)	4/30	1 lb	$26				
(May-harvest)	OFM Emulsion	6/28		$40				
Total				**$127**				**$37**

Table 11. Insecticide and Miticide Costs, Fortune and Autumn Beaut Plums, Tulare County 2001

	PMA block (Fortune plums)				PMA block (Autumn Beaut plums)			
Stage	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**
DORMANT (Nov-Jan)	Hort Oil	2/8	6 gal	$18	Hort Oil	2/8	6 gal	$18
Subtotal				**$18**				**$18**
BLOOM	Isomate M100	3/21	150	$54	Isomate M100	3/21	150	$54
(Mar-Apr)	Crymax	3/22	1 lb	$12	Crymax	3/22	1 lb	$12
Subtotal				**$84**				**$84**
IN-SEASON (May-harvest)	Isomate M100	5/21	150	$44	Isomate M100	5/21	150	$44
Total				**$128**				**$128**

Table 12. Insecticide and Miticide Costs, Bright Pearl Nectarines, Tulare County, 2001

	PMA block				Standard block			
Stage	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**
DORMANT (Nov-Jan)	Hort Oil	1/26	6 gal	$18	Hort Oil	1/26	4 gal/acre	$12
					Lorsban	1/26	2 qt	$20
Subtotal				**$18**				**$32**
BLOOM	Success	3/29	6 oz	$29	Carzol	3/29	1 lb	$25
(Mar-Apr)	Isomate ties	3/1	110	$36	Isomate ties	3/1	110	$36
Subtotal				**$83**				**$93**
IN-SEASON	Success	5/12	8 oz	$38	Success	5/12	8 oz	$38
	Success	6/1	6.4 oz	$30	Success	6/1	6.4 oz	$30
(May-harvest)	Imidan	6/30	4 lbs .	$26	Imidan	6/30	4 lbs .	$26
	Hort Oil	6/30	1 gal/100gal	$3	Hort Oil	6/30	1 gal/100gal	$3
Total				**$180**				**$190**

Table 13. Insecticide and Miticide Costs, Zee Lady Peaches, Tulare County, 2001

	PMA Block			
Stage	**Product**	**Date**	**Rate/acre**	**Cost/acre**
DORMANT (Nov-Jan)	Hort Oil	1/15	8 gal	$24
Subtotal				**$24**
BLOOM (Mar-Apr)	DiPel ES	3/10	1 qt	$12
	Isomate M100	3/12	3 oz.	$12
	Success	3/29	6 oz.	$29
Subtotal				**$77**
IN-SEASON (May-harvest)	Kelthan 50 WSP	6/26	2 lbs.	$24
	Savey	6/26	3 oz	$48
	Hort Oil	6/26	1 gal	$3
Total				**$152**

Table 14. Insecticide and Miticide Costs, Fire Pearl Nectarine, Tulare County, 2001

	PMA block				Standard block			
Stage	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**
DORMANT (Nov-Jan)	Hort. Oil	1/26	6 gal	$18	Hort Oil	1/26	4 gal/acre	$12
					Lorsban	1/26	2 qt	$20
Subtotal				**$18**				**$32**
BLOOM (Mar-Apr)	Success	3/29	6 oz	$29	Carzol	3/29	1 lb.	$25
	Isomate ties	3/1	110	$36	Isomate ties	3/1	110	$36
Subtotal				**$83**				**$8**
IN-SEASON	Success	5/12	8 oz	$38	Success	5/12	8 oz	$38
	Success	6/1	6.4 oz	$30	Success	6/1	6.4 oz	$30
(May-harvest)	Imidan	6/30	4 lbs	$26	Imidan	6/30	4 lbs	$26
	HortOil	6/30	1 gal/100gal	$3	HortOil	6/30	1 gal/100gal	$3
Total				**$180**				**$190**

Table 15. Insecticide and Miticide Costs, Red Jim Nectarines, Kings County, 2001

	PMA block				Standard block			
Stage	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**
DORMANT (Nov-Jan)	Hort Oil	1/26	6 gal	$18	Hort Oil	1/3	5 gal	$15
					Diazinon 4E	1/3	4 pt	$15
					Asana XL	1/3	8 oz	$16
Subtotal				**$18**				**$46**
BLOOM (Mar-Apr)	Isomate	3/3	9.4 oz	$35	Isomate M100	3/3	9.4 oz	$35
	DiPel	3/12	1 lb	$12	DiPel DF	3/12	1 lb	$12
	Success	3/16	6 oz	$29	Carzol	3/16	1 lb	$25
Subtotal				**$94**				**$118**
IN-SEASON (May-hrvst)	Success	5/1	6 oz	$29	Success	5/12	6 oz	$29
	Omite	6/13	5 lb	$30	Apollo	5/12	3 oz	$34
	Isomate	6/13	9.4 oz	$35	Imidan 70	6/28	4 lb	$26
	Success	7/23	6 oz	$29	Omite	7/9	5 lb	$30
					Carzol	7/19	1 lb	$38
					Imidan 70	7/19	2 lb	$26
Total				**$217**				**$301**

Table 16. Insecticide and Miticide Costs, Angeleno Plums, Madera County, 2001

	PMA block				Standard block			
Stage	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**
DORMANT (Nov-Jan)	Hort Oil	1/26	6 gal	$18	Hort. Oil	1/29	6 gal./300 gal	$18
					Asana	1/29	8 oz	$16
					Diazinon AG600	1/29	0.4 gal	$15
Subtotal				**$18**				**$49**
BLOOM (Mar-Apr)								
Subtotal				**$18**				**$49**
IN-SEASON (May-harvest)	Bt (Deliver)	6/30	1 lb	$26	Imidan	6/30	4 lbs	$26
	Hort Oil	6/30	1 gal/100gal	$3	Hort Oil	6/30	1 gal/100gal	$3
Total				**$47**				**$78**

Table 17. Insecticide and Miticide Costs, Arctic Snow Peaches, Tulare County, 2001

	PMA block			
Stage	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**
DORMANT (Nov-Jan)	Hort. Oil	1/26	8 gal	$24
Subtotal				**$18**
BLOOM (Mar-Apr)	Isomate M100	3/12	3 oz.	$12
	Success	3/29/201	6 oz.	$29
Subtotal				**$65**
IN-SEASON (May-harvest)	Success	5/4	6 oz.	$29
	Isomate M100	6/10	3 oz.	$12
	Success	7/25	6 oz.	$29
	DiPel	8/6	1 qt.	$12
	Imidan	8/17	4 lb.	$26
Total				**$173**

Table 18. Insecticide and Miticide Costs, Carson and Andross Peaches, Sutter County, 2001

	PMA Block (Carson peaches)				Standard Block (Andross peaches)			
Stage	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**
Dormant	Sunspray	1/6	4 gal	$9.00	Sunspray	1/6	4 gal	$9.00
	Asana	1/6	8 oz	$7.00	Asana	1/6	8 oz	$7.00
Subtotal				**$16.00**				**$16.00**
Pheromone Application	OFM Isomate M-100	3/9-3/12	150	$49.00				
	Ckmate PTB	5/7-5/8	150	$43.00				
	OFM Flowable	6/4		$15.00				
	OFM Isomate M-100	6/23	150	$49.00				
Subtotal				**$156.00**				
In-Season					Ambush	5/25	12 oz	$10.00
					Ambush	6/21	14 oz	$12.00
					Ambush	7/16	14 oz	$12.00
Subtotal								**$34.00**
Total				**$172.00**				**$50.00**

Table 19. Insecticide and Miticide Costs, Halford and Ross Peaches, Sutter County, 2001

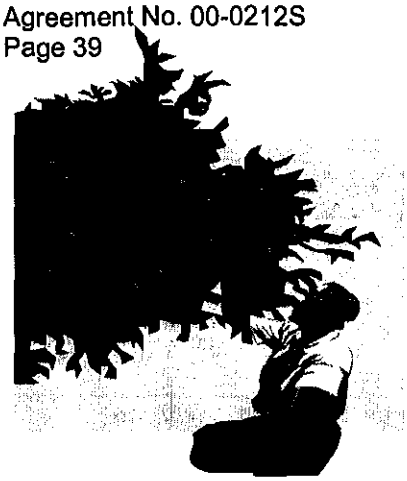
	PMA Block (Halford)				Standard Block Ross)			
Stage	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**
Dormant	Sunspray	1/6	4 gal	$9.00	Sunspray	1/6	4 gal	$9.00
	Asana	1/6	8 oz	$7.00	Asana	1/6	8 oz	$7.00
Subtotal				**$16.00**				**$16.00**
Pheromone Application	OFM Isomate M-100	3/8-3/12	150	$49.00				
	Ckmate PTB	5/7-5/8	150	$43.00				
	OFM Isomate M-100	6/11	150	$49.00				
Subtotal				**$141.00**				
In-Season	Ambush	7/16	14 oz	$12.00	Ambush	5/25	12 oz	$10.00
					Ambush	6/212001	14 oz	$12.00
					Ambush	7/16	14 oz	$12.00
Subtotal				**$12.00**				**$34.00**
Total				**$169.00**				**$50.00**

Table 20. Insecticide and Miticide Costs, Monaco and Ross Peaches, Sutter County, 2001

	PMA Block (Monaco)				Standard Block (Ross)			
Stage	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**
Dormant	Sunspray	1/6	4 gal	$9.00	Sunspray	1/6	4 gal	$9.00
	Asana	1/6	8 oz	$7.00	Asana	1/6	8 oz	$7.00
Subtotal				**$16.00**				**$16.00**
Pheromone Application	Ckmate OFM	7-Mar	108	$36.00				
	Ckmate OFM	3-Jun	108	$36.00				
Subtotal				**$72.00**				
In-Season	Success	15-May	6 oz	$30.00	Ambush	5/25	12 oz	$10.00
	Success	19-Jun	6 oz	$30.00	Ambush	6/21	14 oz	$12.00
	Bt	28-Jul	1 qt	$10.00	Ambush	7/16	14 oz	$12.00
Subtotal				**$70.00**				**$34.00**
Total				**$158.00**				**$50.00**

Table 21. Stone Fruit Pest Management Alliance Insecticide Application Economic Analysis, Sutter County, 2001

	PMA Block (Starn)				Standard Block (Sullivan #4)			
Stage	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**
Dormant	Sunspray	1/6	4 gal	$9.00	Sunspray	1/6	4 gal	$9.00
	Asana	1/6	8 oz	$7.00	Asana	1/6	8 oz	$7.00
Subtotal				**$16.00**				**$16.00**
Pheromone Application	Ckmate OFM	3/1	108	$36.00				
	Ckmate PTB	5/7-5/8	150	$43.00				
	Ckmate OFM	6/3	108	$36.00				
Subtotal				**$115.00**				
In-Season	Ambush	7/16	14 oz	$12.00	Ambush	5/25	12 oz	$10.00
					Ambush	6/21	14 oz	$12.00
					Ambush	7/16	14 oz	$12.00
Subtotal				**$12.00**				**$34.00**
Total				**$143.00**				**$50.00**



Tree Fruit Pest Management Meeting

Sponsored by the University of California, CTFA, CCPGAB, CSU-Agricultural Research Initiative, CA Dept. of Pesticide Regulation, U.S. EPA, Gowan, Dow AgriSciences, and Exxon

Thursday August 9, 2001
9:00 am to 12:15 p.m.

Kearney Ag Center
9240 S. Riverbend
Parlier, Ca
2.5 Hours PCA Credits Applied For

Agenda

8:45 – 9:00 Registration

Moderator - Gary Van Sickle, Research Director, CTFA

9:00 a.m.	PBS Documentary Film of Prior PMA Day	Marilyn Dolan, CTFA
9:30 a.m.	Break	
9:45 a.m.	Katydid Biology; Electrostatic Sprayers	Walt Bentley, UC IPM Advisor
10:05 a.m.	San Jose Scale Susceptibility to Dormant Oil	Beth Grafton-Cardwell, Entomologist
10:30 a.m.	Ants and Earwigs as Possible Stone Fruit Pests	Rich Coviello, UCCE Fresno Co. Advisor
10:45 a.m.	Management of Nematodes Without Methyl Bromide	Michael McKenry, Nematologist
11:10 a.m.	Native Gray Ant as a Top Predator	Kent Daane, UCCE Bio-Control Specialist
11:35 a.m.	PMA Project Status; Paraffin Emulsion for OFM Disruption	Shawn Steffan, UC Research Associate
11:50 a.m.	Q&A with Personnel & Growers	
12:15 p.m.	Lunch	

Lunch will be provided by the California Tree Fruit Agreement at 12:15 p.m.
Lunch will be provided only to those who register prior to August 1, 2001. Space is limited to the first 200 registrants. Please send or fax the form below to:

Attn: Amy Chelgren
California Tree Fruit Agreement
PO Box 968
Reedley, CA 93654
ph: 559-638-8260
fax: 559-638-8842

Names: _____ _____

_____ _____

Company Name and Address: _____

Phone/Fax/E-mail: _____

2001 Grower Participants: Daybreak Farms, Deniz Packing Co., Kovacevich & Sons, Pinkham Bros., Quinco Corporation, Rubicon Orchards, Schellenberg Farms, and Tos Farms.

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A CLOSER LOOK

CALIFORNIA TREE FRUIT AGREEMENT
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This Newsletter provides information on research supported by the California Tree Fruit Agreement

Preconditioning/Pre-ripening Tips for Peaches, Plums and Nectarines

Contributed by Dr. Carlos Crisosto, University of California
Kearney Agricultural Center (carlos@uckac.edu)

Principle Findings

- Controlled delayed cooling can be used to precondition stone fruit susceptible to internal breakdown in order to maintain flavor and extend market life. Delayed cooling can also be used to pre-ripen susceptible and non-susceptible stone fruit varieties in order to deliver a more "ready to eat" product to the consumer. It is important to know what you want to accomplish with each cultivar before changing your program.

    1. In general, a 48-hour cooling delay at 68°F is the most effective preconditioning treatment to extend market life of internal breakdown susceptible peaches and nectarines.

    2. For peaches, nectarines and plums, the use of ethylene during the cooling delays (Preconditioning/Pre-ripening) did not increase market life with respect to internal breakdown symptom development.

    3. To pre-ripen stone fruit, delay cooling at 68°F for the minimum period of time necessary to achieve the desired level of ripeness (up to 6-8 lbf for peaches and nectarines, 5 lbf for plums measured on the weakest position on the fruit).

- Flesh firmness must be monitored on the weakest position on the fruit during the preconditioning/pre-ripening treatment. Peaches and nectarines become very susceptible to vibration injury during transportation when flesh firmness is <5 lbf.

- Peach, nectarine and plum market life is longer when the fruit is stored at 32°F rather than 41°F.

- Rapid cooling after preconditioning is important to stop further fruit flesh softening, senescent breakdown, decay and prevent prolonged exposure to 41°F temperatures. More refrigeration capacity may be needed to execute this system.

- More information can be found at http://www.uckac.edu/postharv/ http://postharvest.ucdavis.edu/, http://fruitsandnuts.ucdavis.edu/ and http://pom.ucdavis.edu/. A full research report will be published in the 2000 CTFA Research Report. A detailed article entitled "Preconditioned/Pre-ripening, A New California Fruit Delivery System Overview" is being prepared for publication as a University of California, DANR Publication Series.

Demonstration Days Planned

Stone fruit growers will have several chances this season to view results of the Pest Management Alliance (PMA) Demonstration Orchards. The test plots have incorporated reduced risk practices side by side with conventional practices. The project is a

partnership with the following sponsors: University of California, CA State University-Agricultural Research Initiative, CA Department of Pesticide Regulation, CA Cling Peach Growers Advisory Board, CA Tree Fruit Agreement, Gowan, Dow AgriSciences, and Exxon. Grower participants this season includes: Daybreak Farms, Deniz Packing Co., Kovacevich & Sons, Pinkham Bros., Quinco Corporation, Rubicon Orchards, Schellenberg Farms, and Tos Farms.

Growers will have an opportunity to view one of the test plots at a PMA Field Day to be held April 25 at Daybreak Farms in Traver, CA. The event will begin at 8:30 a.m. with registration and coffee. Results from the 2000 season research will be presented at 9:00 a.m. Throughout the morning UC researchers will provide information on control of several pests from San Jose Scale to thrips to katydids. Brown rot control will also be discussed. Representatives from the U.S. Environmental Protection Agency and CA Department of Pesticide Regulation will also be present to offer their thoughts on the project. The event will last until noon. Several hours of PCA credits have been requested.

Growers in the south valley will have an opportunity to hear a condensed version of the presentation in their own area on April 17 from noon to 1:00 p.m. at Kovacevich & Sons Ranch in Wheeler Ridge. Box lunches will be provided at 11:45 a.m. to those who RSVP to Gary Van Sickle @ (800)-636-8260.

Growers in the north valley will have an opportunity to attend the PMA Field Day for cling peaches. The meeting will be held on April 26 from 10:00 a.m. to 11:30 a.m. at the Hundal Ranch, on the south edge of Yuba City. Mating disruption of OFM and PTB will be discussed. Information is available from Heidi Sanders @ (530) 673-8526.

PMA Results From 2000

Extensive monitoring of both the reduced risk and the conventional plots has produced valuable information for future use by the stone fruit industry. Trends between the two programs remain consistent. The data obtained from this past year's demonstration blocks illustrates, in general, higher insect activity in the PMA plots, compared to the conventional plots. However, there were also higher populations of the SJS parasitoids, Aphytis spp. and Encarsia perniciosi.

To gauge the profitability of the program that did not use OPs or carbamates, researchers have used the percentage of fruit "culled" because of insect damage, as an indication of how the reduced risk program performed, compared to the conventional program. The data illustrates that within each variety there was no statistical difference between the two pest management programs. Furthermore, this was also true of the overall performance when both pest control methods were grouped in their respective programs. The PMA orchards averaged a cull rate of 5.69%, while the conventional averaged a cull rate of 4.53%.

The costs of the programs used varied considerably between varieties and between the northern Sacramento Valley cling peaches and the southern San Joaquin Valley plots. Also, the approach to managing pests in the PMA orchards had a bearing on cost. In the San Joaquin Valley, the per acre least costly PMA program was $160 for Grand Rosa plums and the most costly PMA program was $331 for Summer Red nectarines. The conventional program costs, per acre, ranged from $156 for Elegant Lady peaches to $322 for Summer Red nectarines. The average per acre cost of the PMA programs in the southern San Joaquin Valley was $221. The average conventional program cost was $222.

Results of the cling peach comparison blocks

in Yuba County varied more than those in the south. The costs for the 3 PMA plots ranged from $221 to $278. The costs for the conventional programs ranged from $103 to $171. The per acre average cost of the PMA plots was $240, compared to the conventional orchards at $141.

Mark Your Calendar

April 17 - Pest Management Alliance Demonstration Day – Kern County. To be held at the Kovacevich Ranch at Wheeler Ridge, 12 noon to 1:00 p.m. RSVP to Gary Van Sickle for map. (559) 638-8260. A copy of the meeting notice and map is on the internet at http://www.uckac.edu/treefruitipm/PMA_1.htm.

April 25 - Pest Management Alliance Demonstration Day – Traver. To be held at Daybreak Farms, 36060 Burke Drive, Traver, CA, 8:30 a.m. to 12 noon. PCA Credits available. A copy of the meeting notice and map is on the internet at http://www.uckac.edu/treefruitipm/PMA_1.htm.

April 26 – No. Calif. Pest Management Alliance Demonstration Day. To be held at the Hundal Ranch at George Washington and Best Road, south of Yuba City, 10:00 a.m. to 11:30 a.m. Call Heidi Sanders for information @ (530) 673-8526.

May 3 – CTFA Spring Meeting, Visalia Convention Center, Visalia, CA, 7:30 a.m. to 4:30 p.m. Please RSVP to Dovey Plain, (559) 638-8260, if you plan to attend.

PMA Brown Bag Lunch Series. To be held at various grower orchard plots who are cooperators in the PMA program each Wednesday, May 9, 16, 23, and 30. Each session will be held during the lunch hour (12 noon to 1:00 p.m.) and feature an informal opportunity to hear from the researchers as to what the monitoring program is finding, what the current pest pressures are and what could be a potential threat in the near future. Bring your lunch and an appetite for knowledge. Call Gary Van Sickle for dates and maps to each of the sites at (800)-636-8260. A copy of the meeting schedule and maps will be on the internet at http://www.uckac.edu/treefruitipm/PMA_1.htm.

Table 22. OP & Selected Reduced Risk Chemicals Usage – Acres Treated

Nectarines	Trade Name	1997	1998	1999	2000
Bt		27,177	30,076	23,765	15,727
Chlorpyrifos	Lorsban	9,761	11,458	12,365	20,127
Diazinon		18,532	11,101	9,800	9,814
Formetanate Hydrochloride	Carzol	36,314	38,187	37,417	28,455
Malathion		18	52	5	27
Methidathion	Supracide	7,830	3,225	3,825	1,559
Methomyl	Lannate	12,377	12,170	11,513	11,714
Phosmet	Imidan	9,587	12,118	15,798	10,685
Spinosad	Success	8	0	156	19,793

Peaches	Trade Name	1997	1998	1999	2000
Bt		26,678	23,883	23,260	16,318
Chlorpyrifos	Lorsban	7,651	11,770	12,867	17,465
Diazinon		29,101	19,614	16,488	18,572
Formetanate Hydrochloride	Carzol	1,233	2,408	1,488	961
Malathion		40	113	1	8
Methidathion	Supracide	16,765	8,777	8,341	9,837
Methomyl	Lannate	1,133	1,296	1,732	1,892
Phosmet	Imidan	15,060	20,475	21,477	17,828
Spinosad	Success	6	2	385	16,684

Plums	Trade Name	1997	1998	1999	2000
Bt		15,129	16,967	11,163	10,290
Chlorpyrifos	Lorsban	7,915	9,763	10,735	10,832
Diazinon		14,220	8,147	7,440	6,850
Formetanate Hydrochloride	Carzol	427	609	760	501
Malathion		24	84	21	4
Methidathion	Supracide	10,575	6,580	5,528	4,701
Methomyl	Lannate	95	13	26	42
Phosmet	Imidan	9,195	8,218	9,505	7,800
Spinosad	Success	0	0	1,239	7,057

*Source: DPR-Pesticide Use Report Data