Pest Management Alliance Project Final Report

Year 3

Contract number: 99-0250

Contract title: **"To Promote a Reduced-Risk System of Almond Production Through Alternative Practices"**

Principal Investigator: Chris Heintz, Director of Production and Environment, Almond Board of California

Contractor organization:

Almond Board of California
1150 Ninth St., #1500
Modesto, CA 95354
209-549-8262 (phone)
209-549-8267 (fax)
www.almondboard.com

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Acknowledgments

This report was prepared with the assistance of the following individuals as partners in the Almond Pest Management Alliance:

Almond Hullers and Processors Association

Gene Beach
2360 Lecco Way
Merced, CA 95340
(209) 723-7661
Fax: (209) 723-7943
Email: genebeach@aol.com

Community Alliance with Family Farmers

Mark Cady
P.O. Box 363
Davis, CA 95617
(530) 756-8518
Fax: (530) 756-7857**University of California**

Frank Zalom
Statewide IPM Project
Davis, CA 95616-8621
(530) 752-8350
Fax: (530) 752-6004
Email: fgzalom@ucdavis.edu

Walt Bentley
UC Regional IPM Entomologist
UC Kearney Ag Center
9240 S. Riverbend Ave.
Parlier, CA 93648
(209) 646-6527
Fax: (209) 646-6593
Email: walt@uckac.edu

Mario Viveros
Kern County Farm Advisor
1031 S. Mount Vernon Ave.
Bakersfield, CA 93307
(661) 868-6211

Fax: (661) 834-9359
Email: cekern@ucdavis.edu

Lonnie Hendricks
Merced County Farm Advisor
2145 W. Wardrobe Ave.
Merced, CA 95340
(209) 385-7403
Fax: (209) 722-8856
Email: lchendricks@ucdavis.edu

Roger Duncan
Stanislaus County Farm Advisor
3800 Cornucopia Way, Suite A
Modesto, CA 95355
(209) 525-6654
Fax: (209) 525-6840
Email: raduncan@ucdavis.edu

Carolyn Pickel
UC Area IPM Advisor - Sacramento Valley
UC Cooperative Extension
142 - A Garden Highway
Yuba City, CA 95941
(530) 822-7515
Fax: (530) 673-5368
Email: cxpickel@ucdavis.edu

Joe Connell
Butte County Farm Advisor
2279 Del Oro Ave., Suite B
Oroville, CA 95965
(530) 538-7201
Fax: (530) 538-7140
Mobile: (530) 521-8066
Email: jhconnell@ucdavis.edu

Bill Krueger
Glenn County Farm Advisor
P.O. Box 697
Orland, CA 95963
(530) 865-1107
Fax: (530) 865-1109
Email: whkrueger@ucdavis.edu

Rick Buchner
Tehama/Shasta County Farm Advisor
1754 Walnut St.
Red Bluff, CA 96080
(530) 527-3101
Fax: (530) 527-0917
Email: rpbuchner@ucdavis.edu

Wes Asai
Pomology Consulting
14113 Harding Rd.
Turlock, CA 95380
Cell phone: (209) 531-3735
Pager: (209) 990-3735
Office/fax: (209) 669-6123

Mark Looker
Project Administrator
717 El Vecino Ave.
Modesto, CA 95350
(209) 549-8262 ext. 108
Fax: (209) 549-8267
Email: mllooker@ainet.com

http://www.lookercomm.com/AlmondPMA/almondpma.htm

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Executive Summary

The Almond Pest Management Alliance (PMA) was initiated by the Almond Board of California in 1998 to evaluate the possibility of managing economic pests by implementing reduced risk pesticides. Working closely with the Almond Hullers and Processors Association, the Community Alliance with Family Farmers, the University of California Statewide IPM Project, and University of California Cooperative Extension, the Almond Board formed an alliance to study reduced risk practices in California almonds. This collaborative approach grew out of two major concerns. Those two concerns are: 1) the implementation of the Food Quality Protection Act (FQPA) with possible loss of some traditional crop protection tools, and 2) growing public concern over water quality standards in the San Joaquin River and Sacramento River watersheds, with possible links to runoff of dormant sprays of pesticides used by almond growers.

Because of the enormous scope of the California almond industry, which encompasses 595,000 acres, ranging from Bakersfield to Chico, and the wide range of pests and regional variables, the PMA set up three regional projects and continues to study those sites. These projects are located in the Northern Sacramento Valley (Butte County), the Central San Joaquin Valley (Stanislaus County) and the Southern San Joaquin Valley (Kern County). Each project consists of an orchard that is divided into a conventional practice treatment and a reduced risk treatment. There are variations to the treatment blocks with various degrees of reduced risk practices. Each project is directed by the local UCCE farm advisor who establishes the plot that best addresses local pest concerns and growing conditions that would be relevant to the local growers of the region. The advisors employ a field scout who performs the extensive monitoring required.

The target pests addressed across all three projects continue to be navel orangeworm (NOW), peach twig borer (PTB), San Jose scale (SJS), mites, and ants. Diseases, cover crops, and fertilizer applications are studied on a regional basis. Smaller satellite projects complement the PMA orchard demonstration sites by providing research about regional issues.

Other aspects of the Almond PMA are to continue to work closely with the Advisory Team, share the results of pest monitoring with area PCA's, growers, and Farm Advisors, research pesticide use reports, continue to outreach, educate and extend the most current information through meetings and mailings, and lastly to evaluate the project.

Extending information and outreach is critical regarding use and acceptance of reduced risk practices. The University of California involvement is important to ensure scientific credibility of the project. The success of the PMA project essentially rests on the proactive growers who are willing to be innovative and accept possible economic risks in order to give reduced risk practices validity and be a positive example for other growers. Finally, we can conclude that we are building a foundation of pest management information that will result in a better understanding of the management of economic pests with less risk to farm workers and the environment.

Based on what we have learned after three years of this project, it is suggested future improvements of the Almond PMA would include:

1. Increase monitoring through the dormant season,

2. Implement smaller, more frequent, more regionally based field meetings regarding reduced risk practices,

3. Add an untreated control plot to all regional sites (if the grower/cooperator would agree) to assess the impact of a no-spray regime.

A summary of the third year accomplishments of the Almond PMA demonstrates the following important points:

- Reduced risk practices appear to be controlling the pests below economic damage levels
- Growers are interested in reduced risk practices and continue to be proactive in their experimentation with, and adoption of, reduced risk practices
- Extensive orchard monitoring is the key to the success of this approach
- Other pests may begin to build populations due to the altering of spray programs
- Growers in the Almond PMA have made an unselfish commitment to continue to study reduced risk programs by remaining in the PMA for a continuous third year
- PMA field days coinciding with the traditional pesticide spray seasons (dormant and in-season) are very successful in an outreach campaign to growers
- The important elements of successful PMA field days are 1) a thorough and scientific evaluation of alternative vs. conventional methods of pest control, 2) proper pest identification, and 3) timing crop protection activities using weather and monitoring data
- Multiyear funding is necessary to obtain scientifically valid data on which growers and PCA's can make sound economic and environmental decisions regarding reduced risk programs.

Almond Pest Management Alliance Final Report

INTRODUCTION

The Almond Pest Management Alliance (PMA) started with a $99,000 grant awarded by the California Department of Pesticide Regulation (CDPR) for the crop year Aug. 1, 1998 to July 31, 1999. The PMA again received funding for the crop years 1999 - 2000 and 2000 - 2001. This report is the product of the third year of funding. A fourth year of funding has been awarded for this project entitled "To Promote a Reduced-Risk System of Almond Production Through Alternative Practices". .

The Almond Board of California, the Almond Hullers and Processors Association, the Community Alliance with Family Farmers, the University of California Statewide IPM Project, and University of California Cooperative Extension (UCCE) almond farm advisors are members of the Pest Management Alliance.

Structurally, the Almond PMA is managed by a team composed of representatives from each of the identified organizations, as well as a private Pest Control Advisor (PCA.) The team meets on a regular [sp] basis to review the project's progress and make decisions about its future course. The administrative functions are overseen by the Almond Board of California.

The Almond PMA set these basic objectives at the beginning and continues to implement them. These objectives continue to be relevant.

- Establish orchard sites in three different almond-growing regions to collect data regarding almond pest management practices that reduce risks associated with pesticide use.
- Conduct extensive orchard monitoring and specific research activities that address localized pest control and almond production practices.
- Provide almond growers with updated information on available reduced risk pest control products and practices so they can make informed choices about alternatives.
- Promote and extend information to growers and PCA's to ensure California almond growers understand the need for a farming system that has the ability to reduce pesticides and sustain profitability.
- Evaluate the risk reduction achieved as a result of this project by producing a final report that includes not only a projection of the risk reduced, but a discussion of the costs and benefits of the solution and the practicality of adoption.

The implementation of the federal Food Quality Protection Act (FQPA) and the increase of public and regulatory concern about water quality in the San Joaquin River and Sacramento River watersheds was the catalyst for the formation of the Pest Management Alliance. The project objectives were decided upon by the Almond PMA team and were adopted to provide an opportunity to successfully address FQPA, pesticide use, and water quality issues. These objectives assist to: 1) encourage the adoption of reduced risk pesticides by demonstration, outreach, and reporting, 2) expand current knowledge and research when applicable, and 3) research and demonstrate reduced risk practices statewide. In order to successfully fulfill these objectives, the PMA team has formed a positive relationship with the growers involved, remains abreast of the latest developments in farming techniques and in the regulatory arena, researches pesticide use trends, generates interest among growers by extending information in field meetings and newsletters, and finally, draws conclusions in reports.

To complement the objectives involved in the Almond PMA, tasks were designed to accomplish the goal of reducing pesticide use. Task 1 is to assemble an Advisory Team that meets and keep the project moving forward. Tasks 2 through 4 consist of the individual orchards in each region. Task 5 is to research pesticide use over time in California and in each of the regional PMA sites. Outreach and education to the growers and the public comprise Task 6. Task 6 includes field meetings, newsletters, and news articles relating to the Almond PMA. Finally, Task 7 is the project evaluation.

The target pests addressed across all three regional projects continue to be navel orangeworm (NOW), peach twig borer (PTB,) San Jose scale, mites and ants. These pests, in general, pose the greatest economic challenge to California almond growers.

The almond industry views the Almond PMA as an efficient way to apply the many years of research and demonstration projects invested in by the industry on alternative and reduced risk management techniques. By applying the vast body of knowledge accumulated over the years by the University of California the PMA's goal is to study reduced risk practices side-by-side with traditional practices in regionally targeted areas of the almond growing region.

The Almond Board of California has been supporting an Integrated Pest Management (IPM) system for more than 25 years. These projects have helped reduce the use of pesticides. Several landmark studies have included: Navel Orangeworm Orchard Sanitation and Early Harvest, Reducing Dormant Spray Hazards, Pheromones for Peach Twig Borer, and Alternatives for Soil Fumigation with Methyl Bromide. Results of these research projects are available from the Almond Board of California. The Board has also received an "IPM Innovator Award" from CDPR for its innovative leadership role in the field of IPM.

The UC Statewide IPM Project is well recognized for its national leadership on IPM. The IPM Project has recently published a second edition of the well-respected *IPM for Almonds Manual.* This publication states, "A good IPM program coordinates pest management activities with cultural operations to achieve economical and long-lasting solutions to pest problems." The PMA has taken this quote directly from the literature right to the field to study reduced risk farming practices in the context of a long-lasting cultural solution.

Reduced risk strategies such as CAFF's Biologically Integrated Orchard Systems (BIOS) program seek to demonstrate that a small, but growing number of almond producers have been successfully reducing their insecticide, herbicide, and fertilizer inputs without affecting yield or quality. Most program growers have experience with individual components of the system, such as Bt sprays and insect releases. By combining these with seeded cover crops, modified mowers, increased monitoring, and habitat enhancement, BIOS growers have replaced the broad-spectrum chemical control on their farms with biological processes and selective insecticides.

RESULTS

Task 1:

Task 1 is the formation, cooperation, and planning by the Advisory Team. The Advisory Team is responsible for implementing and designing new ways to approach reduced risk practices. Communication between groups is important and the results from this task have been very successful. The PMA Advisory Team conducted two meetings this year. The first meeting was held in Modesto on March 7, 2001, and the second held on September 6 at UC Davis. Almond Pest Management Alliance Advisory Team members meet to discuss current commodity issues and options for reduced risk pest management in the coming year(s). Data collection and monitoring methods are compared and reduced risk practices are examined. These timely meetings provide a forum for discussion of issues, concerns, successes, and overall updates of the Almond PMA. Field meetings are planned and topics discussed at these meetings. Discussions regarding improvements to the project are held. Noteworthy discussions also occur on pesticide use trends in relation to regional differences, pest pressure, weather, economic conditions and grower outlook. The Advisory Team is essential for the success of the Almond PMA by providing communication, leadership, direction, and expertise.

Tasks 2 – 4:

The Almond PMA is designed to be a demonstration project, with grower-cooperators in three regional areas. In these orchards, the data collected can enable the almond growing community to witness a reduced risk system in action. With the information provided by the Alliance, growers and their Pest Control Advisors (PCA's) can see first-hand the monitoring techniques, economics, yields, practices used and have the opportunity to talk with the grower/cooperator himself about how the project works. It is not feasible to directly compare the numbers and results of each individual orchard. Due to differences in farming practices, pest pressures, and treatments, directly comparing the figures may lead to incorrect conclusions. In addition to the information regarding each of the three regional orchards, there will be a pesticide use summary for those three regions. Each will be specific and show organophosphate, carbamate, pyrethroid, and Bt use for each county.

Almond PMA 2001

Butte County

Joe Connell, Carolyn Pickel, Sara G Smith

Objectives:

1. To scientifically evaluate the success and profitability of managing arthropod pests with less broadly toxic pesticides in a commercial almond orchard.
2. To demonstrate and facilitate adoption of integrated pest management monitoring techniques and decision making processes to growers and pest control advisors.

This report summarizes our progress as we approach the end of the third year of the project. The Butte County site is an orchard of 49 acres and contains four different treatment blocks plus an untreated check of ½ acre added in 2001. The entire orchard, all treatments, was treated with fungicide on every other row and weed control was the same for all treatments. The PMA II block is a "typical" soft treatment with *Bacillus thuringiensis* used for lepidopteran control, the OP Dorm block is treated with Diazinon plus oil during dormancy, and the OP Dorm/HS block is treated with Diazinon plus oil during hullsplit as well as during dormancy, which is a typical grower standard practice. The PMA I block is this particular growers standard practice which did not include any additional sprays in the 2001 season, so can be considered the same as the untreated check. Treatment details are as follows:

PMA I, 27 acres (growers standard practices):

- (3-01-2001) Vangard fungicide @ 5 oz/acre, sprayed every other row.
- (Not used.) Abamectin bait (Clinch) @ 1.5 pounds/acre for ant control if shown necessary through monitoring.

PMA II, 12 acres (This program utilizes Bt in lieu of traditional in-season sprays):

- (3-01-2001) Vangard fungicide @ 5 oz/acre, sprayed every other row.
- (3-22-2001) Dipel DF (Bt), one lb./acre
- (Not used.) Abamectin bait (Clinch) @ 1.5 pounds/acre for ant control if shown necessary through monitoring.

OP Dorm, 5 acres (Organophosphate used during dormancy)

- (1-20-2001) Diazinon @ 4 pts/acre plus oil.
- (3-01-2001) Vangard fungicide @ 5 oz/acre, sprayed every other row.
- (Not used.) Abamectin bait (Clinch) @ 1.5 pounds/acre for ant control if shown necessary through monitoring.

Op Dorm/HS, 5 acres (Organophosphate used during dormancy and at hullsplit)

- (1-20-2001) Diazinon @ 4 pts/acre plus oil.
- (3-01-2001) Vangard fungicide @ 5 oz/acre, sprayed every other row.
- (7-15-2001) Diazinon @ 4 pts/acre plus oil.
- (Not used.) Abamectin bait (Clinch) @ 1.5 pounds/acre for ant control if shown necessary through monitoring.

In addition, weed control was the same in all treatment blocks. The weed control consisted of four sprays with mowing in between as needed. The applications were as follows:

- (1-22-2001) Strips only treated with Roundup @ 3 pints/acre plus Goal @ 6 ounces/acre.
- (6-5-2001) Strips only treated with Roundup @ 2 pints/acre.
- (7-13-2001) Whole floor of orchard treated with Roundup @ 2 pints/acre.
- (8-9-2001) Whole floor treated, Roundup @ 2 pints/acre.

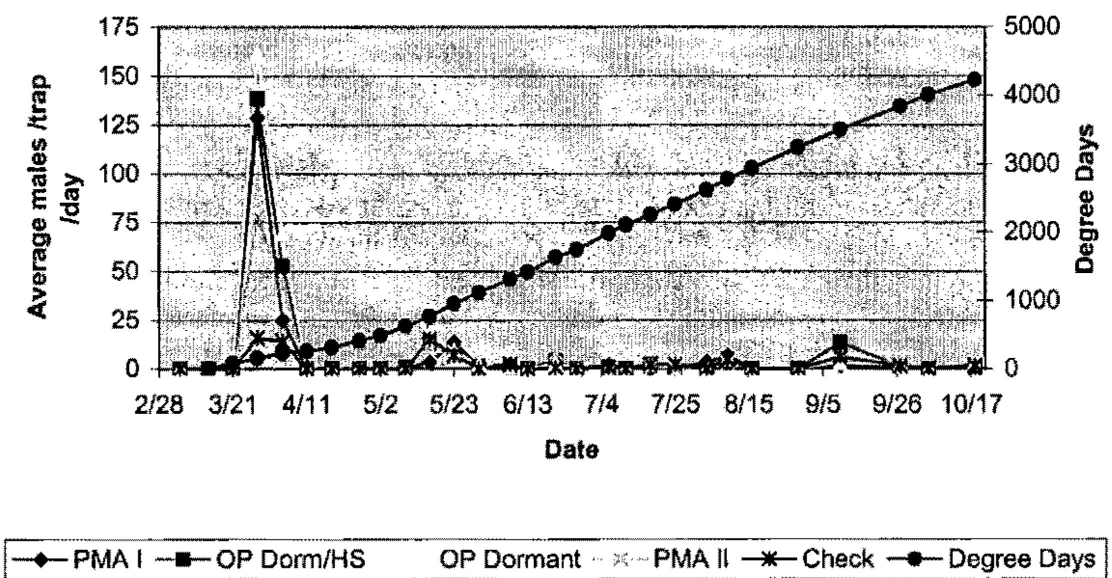
Mummy counts averaged 0.8 mummies per tree across all treatments. This falls below the established UC threshold of less than two mummies per tree.

Monitoring:

This trial is monitored for PTB, NOW, web spinning mites, SJS adult males, and SJS parasitoids (*Encarsia* and *Aphytis*) from late winter through October. In each treatment pheromone traps were placed in the center of the block and monitored weekly for PTB, SJS, and NOW. Lures were changed as recommended by the manufacturer. Weekly trap counts were shared with growers, Farm Advisors, and PCA's. Degree-days for each of these pests were calculated to determine biofixes and to provide treatment timing for those in areas where needed. Beginning in July, plots were monitored weekly for mites using the presence / absence sampling technique. Ants were also monitored and identified just before harvest using the hot dog baiting method.

SJS pheromone traps were placed in the orchard on February 26 and checked weekly for the presence of male scales. The SJS traps were also checked for parasites of the scale, *Encarsia perniciosi* and *Aphytis species.* The first scales were found in the traps March 14 and populations grew until April 11. After this date, the male scale reappeared sporadically in low numbers on May 16th, June 21st, August 9th, and Sept. 10th as can be seen in Figure 2.1. Parasites were also detected on the traps beginning March 14th and were most always present when the scales were caught on the traps, Figure 2.2. The OP Dorm block had the highest number of scale but it also had the highest number of parasites. The PMA I block had the fewest parasites with the number of *Encarsia* being only slightly more than double that of the SJS.

Figure 2.1 Almond PMA 2001
San Jose Scale



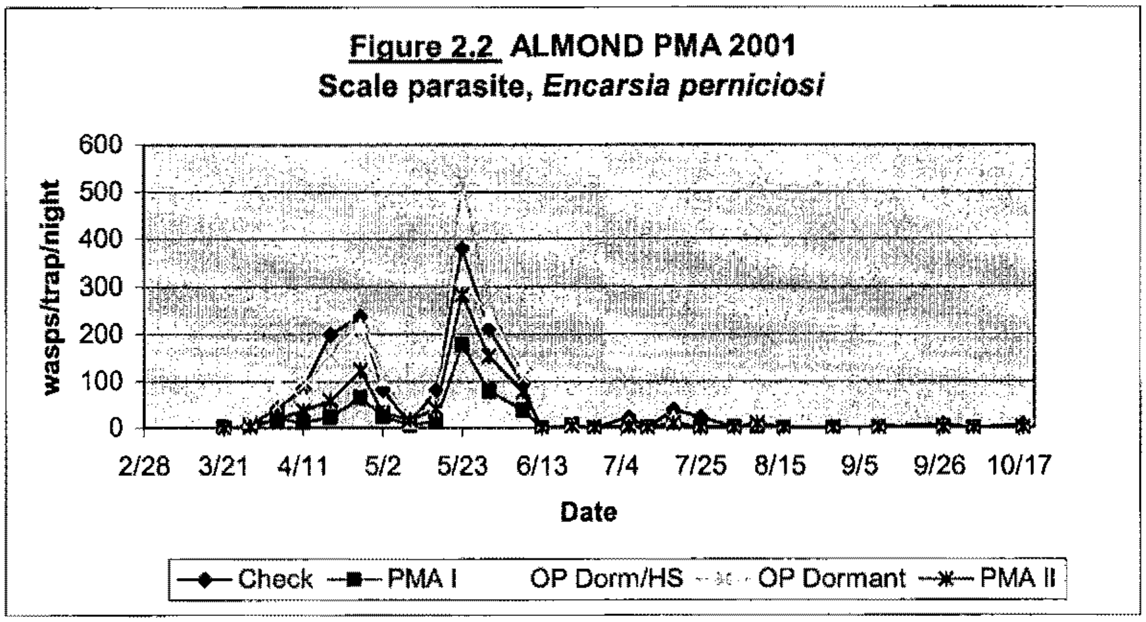
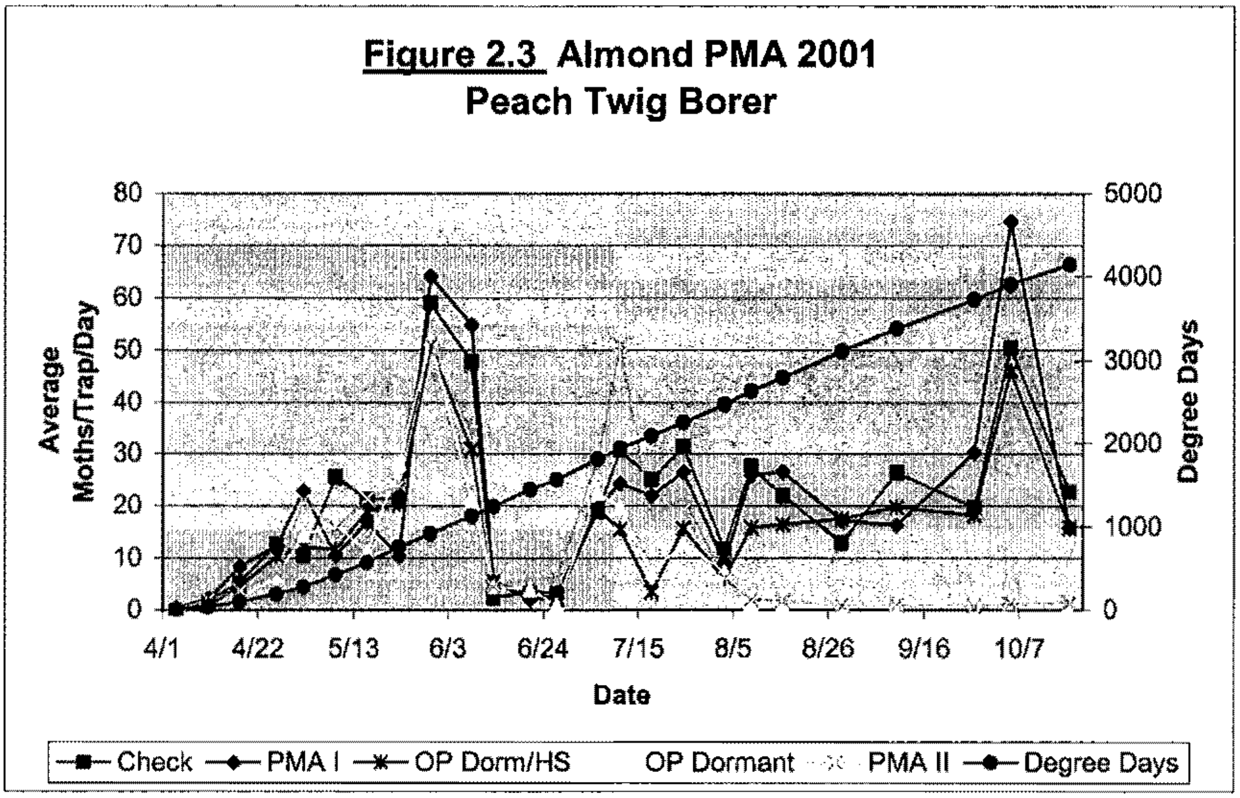


Figure 2.2 ALMOND PMA 2001
Scale parasite, *Encarsia perniciosi*

PTB pheromone traps were hung March 14 and checked twice a week to establish the first biofix. Biofix for the overwintering generation of PTB was established on April 4. By comparing trap catches and degree-days, the PTB also had biofixes on May 23 and July 6, as shown in Figure 2.3. The upper portion of the canopy was inspected for shoot strikes at the beginning of PTB generations. Five trees per treatment block were examined. Shoots with damage were clipped with pole pruners and split down the center to verify presence and identification of larvae.



The NOW egg traps were filled with ground almond bait and also placed in the orchard on March 14. The first NOW egg was detected on April 11. Eggs were cleaned off the trap whenever they were found in order to determine the weekly number of eggs. After that, there were no more NOW eggs found until the beginning of June. After the June peak, egg-laying was sporadic until the end of August when number started to increase dramatically. Cumulative trap catches through October 18, 2001 for PTB, SJS males, *Encarsia, Aphytis* and NOW eggs for the four treatments are listed below in Table 2.1. It is worth noting that all the treatments show similar numbers of PTB, and, to a certain extent, SJS, whether zero, one or two sprays of organophosphates were used.

	Table 2.1 Cumulative number of arthropods per trap through October 18, 2001.				
	PTB	**S.J. Scale**	**Encarsia**	**Aphytis**	**NOW**
PMA I	4380	1542	3685	70	179

PMA II	4070	1215	6420	70	206
OP Dorm	3578	2030	12355	50	95
OP Dorm/HS	3247	1695	10595	90	43
Check	4265	512	11338	65	92

Beginning in July, mites were monitored weekly using the presence / absence sampling method. Differentiation between two-spotted mites and red mites were not recorded. When using the presence / absence method, leaves are examined for the presence of web spinning mites. If a leaf has one or more mites or mite eggs, it is rated as a (+). If no mites or eggs are present, then it is given a (–) rating. Mite predators and other beneficial insects are also noted. If mite predators are not present, a treatment threshold is reached if approximately 1/3 of examined leaves have mites or eggs. If predators are present, then the treatment threshold is increased to approximately 50% or more of sampled leaves with mites or eggs.

In this trial, fifteen leaves from five trees in each block (75 leaves per block) were examined for mites. At the start of mite sampling, trees in possible hot spots were monitored, and as the populations increased, trees were chosen more randomly. The two blocks not treated with organophosphates had higher numbers of web spinning mites; they also had greater numbers of predatory mites and beneficials, mostly six-spotted thrips as shown in Table 2.2. The high number of mites in the PMA II block is probably due in part to the old, partially removed almond orchard directly to the north. The remaining trees in this orchard seemed to be very old and not in the best condition. No treatment was applied to control mites.

	Table 2.2 ***Percent of Leaves with Mites***	
	Web spinning Mites	Predators/Beneficials
PMA I	42	6
PMA II	113	7
OP Dorm	3	1
OP Dorm/HS	3	1

Ants were monitored in the orchard in August to determine whether a treatment was necessary. Baited ant traps were placed in all treatment blocks. The ant species at each bait station were identified because not all species are damaging to almonds. We found Southern Fire ants in the PMA block and pavement ants in all the other treatments. We made no attempt to quantify the ant populations. No treatment was applied to control ants, and damage at harvest was very low.

European fruit lecanium, *Lecanium corni*, populations have been building in this orchard. The scale was not detected in the first year of the project, but a population was first detected during the dormant spur sample inspection at the beginning of the second year. European fruit lecanium (EFL) was on 8% of the dormant spurs in the PMA I and in 15% of the spurs in the PMA II soft treatments. Populations were not detected in the two treatments receiving a dormant spray, the organophosphate dormant treatment and the organophosphate dormant and hullsplit treatment. No monitoring protocol exists but a satellite project studying in-season oil sprays for the control of EFL was conducted in Butte County with treatments as follows: An untreated check, and an oil spray at two different dates, treated during summer of 2000. Ten spurs were collected from each of five trees on Jan. 31, 2001, and the number of live scale on each was counted on Feb. 9, 2001. Trees were inspected again this spring, all treatments had good control of scale, and naturally occurring parasites had provided additional control.

Another type of monitoring, dormant spur sampling, is conducted before the growing season begins, most recently on December 8, 2000. Spurs were taken from each treatment block and inspected for mites, SJS, PTB, and EFL. Counts were tabulated and compared to the two previous years of the PMA project to determine if levels are increasing or decreasing. As shown in Table 2.3, there is no increase in mites or SJS in the PMA treatments and there are more SJS parasites.

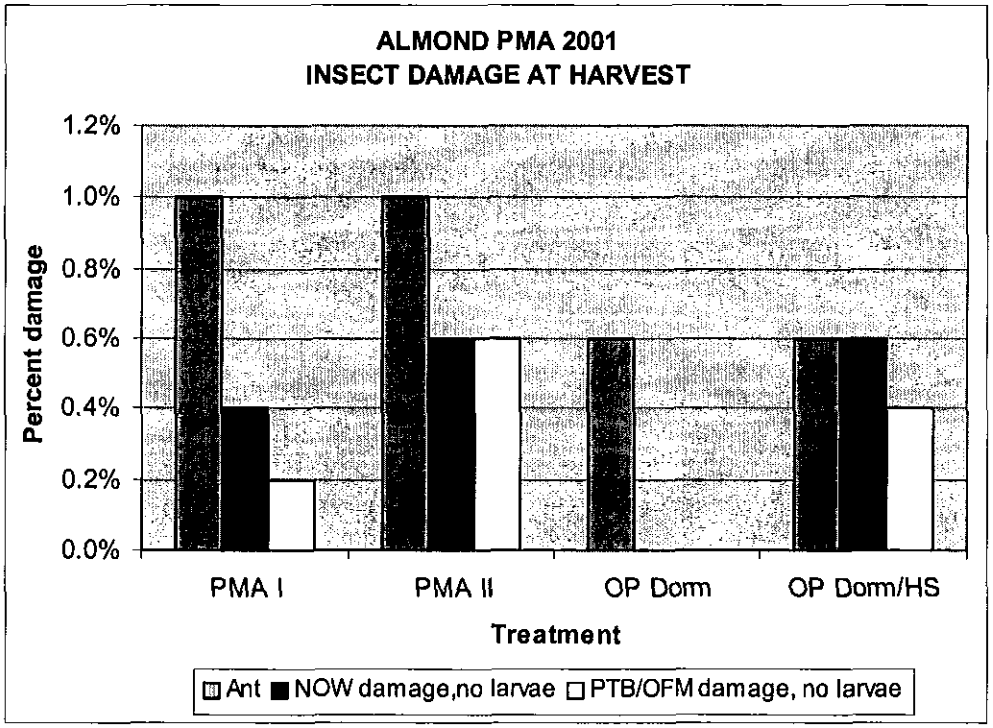
Table 2.3 Counts from Dormant Spurs for Three Consecutive Years

	Date	**PMA I**	**PMA II**	**OP Dorm.**	**OP Dorm/HS**
Mite Eggs	12/7/1998	68	69	54	53
	12/3/1999	17	18	8	8
	12/8/2000	4	2	3	7
Live SJS	**Date**				
	12/7/1998	5	2	0	6
	12/3/1999	15	11	3	3
	12/8/2000	5	1	1	2
PTB	**Date**				
	12/7/1998	0	0	0	0
	12/3/1999	0	0	0	0
	12/8/2000	0	0	0	0
SJS parasites	**Date**				
	12/7/1998	0	0	0	0
	12/3/1999	5	6	0	1

	12/8/2000	2	1	0	0
EFL	**Date**				
	12/7/1998	N/A	N/A	N/A	N/A
	12/3/1999	8	15	0	0
	12/8/1999	10	0	0	0

Harvest Reject Levels

At harvest, 100 almonds were randomly collected from each of 5 trees in each treatment block for a total of 500 per treatment. Nuts were inspected for damage, and the damaging insect identified. Percent damage to each treatment block was calculated. This year, there were very low damage levels from all insect pests. The two PMA blocks reached 1% damage from ants. Damage from all other insect pests was 0.6% or less, Figure 2.4.



Costs Associated with Three Pest Management Programs

Those costs that are the same in all treatments are not compared in Table 2.4 (fungicide sprays and weed control). As mentioned above, the PMA I, the grower standard, does not appear in the table because there were no insecticide sprays. Product costs are taken from the UC IPM website, http://www.ipm.ucdavis.edu/ and would be similar for growers in the area.

Table 2.4 Treatment Costs

Block	Date	Product	Product	Application	Total

			cost/acre	cost/acre	cost/acre
PMA II	Mar 22	Dipel	$ 13.75	$ 18.00	$ 31.75
OP Dorm	Jan 20	Diazinon	$ 18.60		
		Oil	$ 11.80	$ 18.00	$ 48.40
OP Dorm/HS	Jan 20	Diazinon	$ 18.60		
		Oil	$ 11.80	$ 18.00	
	July 15	Diazinon	$ 18.60	$ 18.00	$ 85.00

Conclusions

We had another successful season with the Butte County Almond Pest Management Alliance. Our spring meeting was well attended and interest in adopting reduced risk practices remains in the forefront for growers. We were able to monitor using the same techniques as the first year, thus helping to ensure that the effects of reduced risk practices are being documented. The key to successful reduced risk practices is intensive monitoring. We will continue to monitor to follow insect populations and to ensure that the potential for economic damage is minimized.

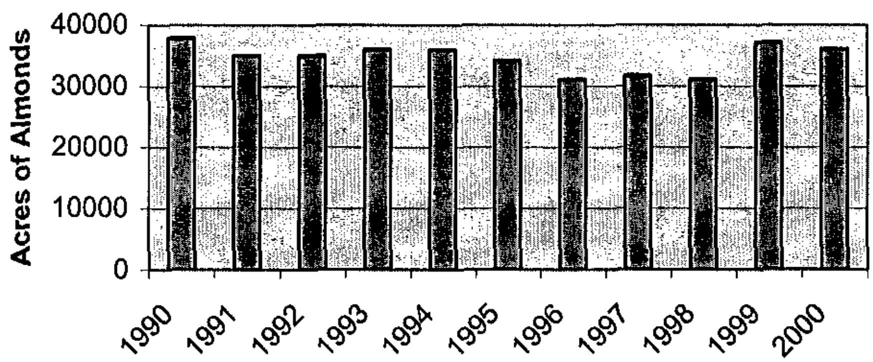
The Almond Pest Management Alliance has been active for three years in California. Interest in reduced risk farming practices has increased as the economic viability of the methods has been demonstrated. The PMA has been beneficial for growers, industry, and the environmental and regulatory community.

The Butte County Almond PMA has been quite successful in showing that there is no more pest damage in the PMA blocks which had one or zero pesticide applications, than there is in the treatments with two sprays. Also, the PMA II cost the grower almost three times less in pesticide costs per acre.

Butte County Pesticide Summary 2001

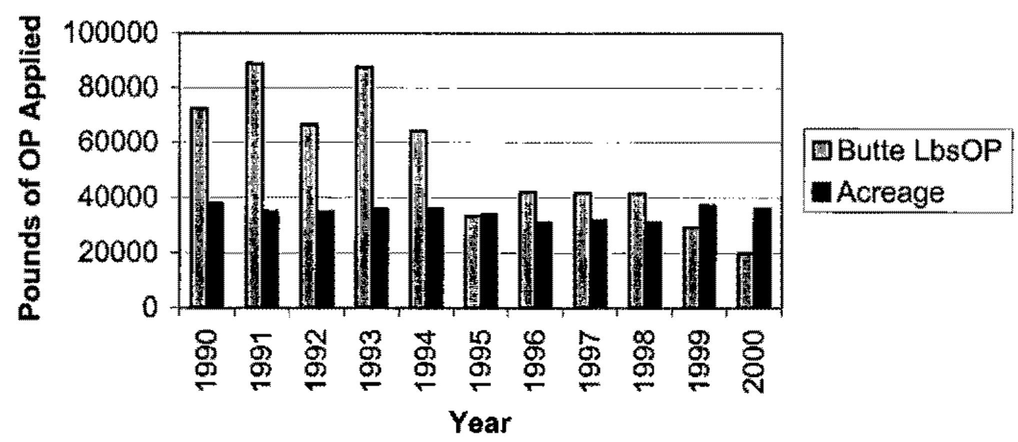
Butte County almond acreage has remained relatively stable over the past eleven years. This trend is seen in Figure 2.6. The information regarding harvested acreage was accessed via the World Wide Web at the California Agricultural Statistical Service (CASS). All pesticide use information was accessed via the World Wide Web on www.ipm.ucdavis.edu and the California Department of Pesticide Regulation, www.cdpr.gov.

Figure 2.6 Harvested Almond Acres Butte County 1990-2000



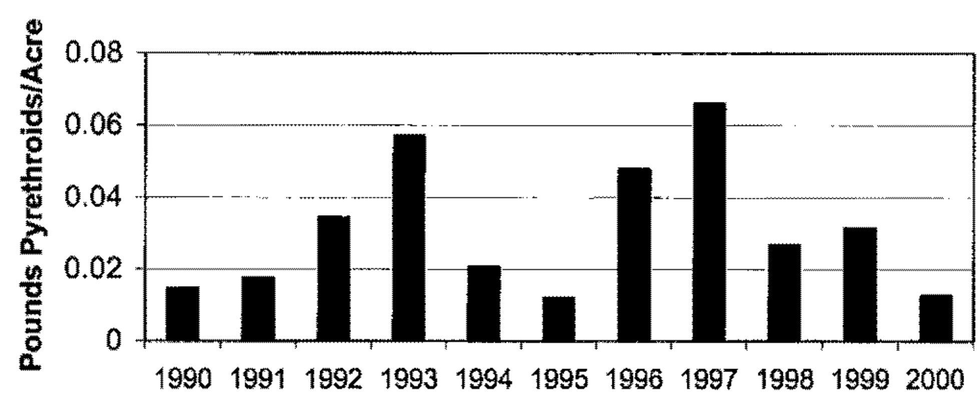
Organophosphate use in Butte County compared to almond acreage in Butte County is noted in Figure 2.7 below. There has been substantial proactive drive to limit the amount of organophosphates in Butte County and the Figure 2.7 reflects this marked decrease in the use of OP's. Organophosphates used in this calculation are azinphos-methyl, diazinon, chlorpyrifos, methidathion, parathion, naled, phosmidion, and phosmet.

Figure 2.7 Organophosphate Use Butte County 1990-2000

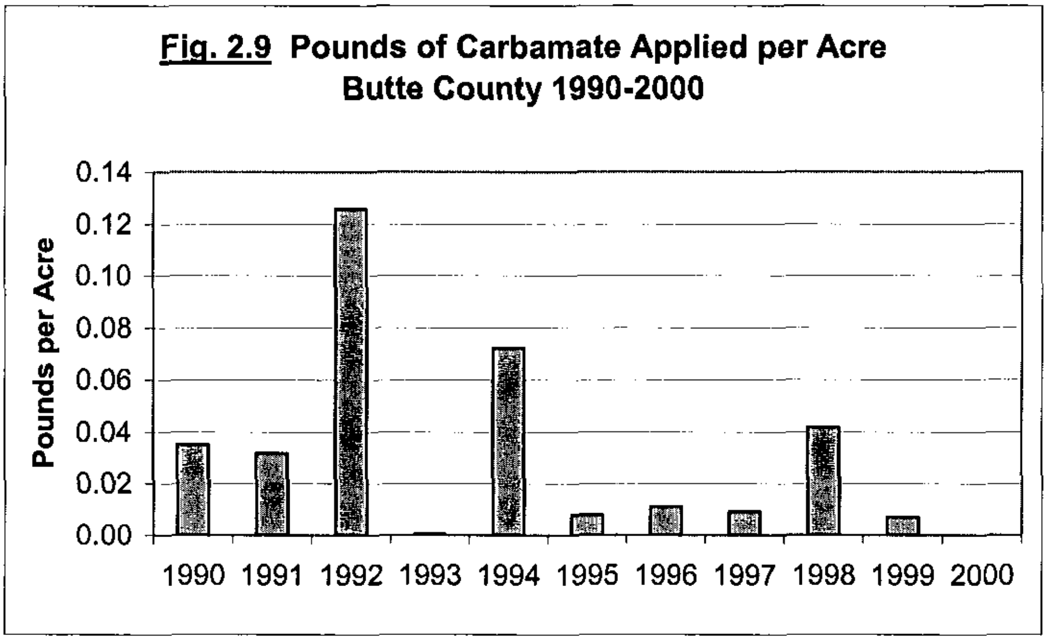


Pyrethroid use in Butte County shows a steep decline since the peak usage in 1997. The trend of pyrethroid use is noted in Figure 2.8. Pyrethroids compiled for this report were esfenvalerate, permethrin, and pyrethrin.

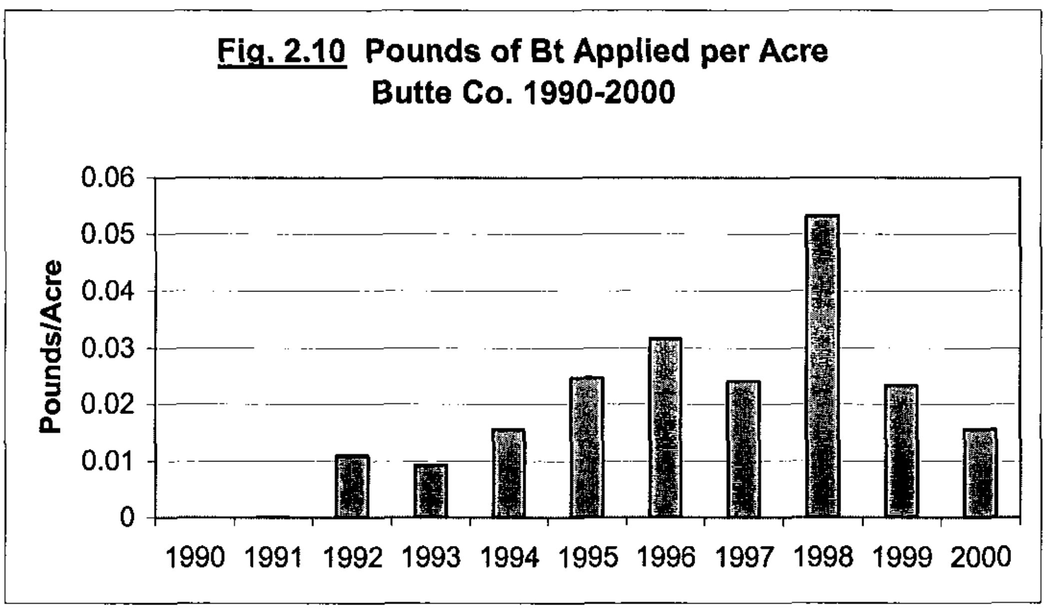
Fig. 2.8 Pounds of Pyrethroids Applied per Acre Butte County 1990-2000



Carbamate use in Butte County from 1990-2000 is noted in Figure 2.9. Carbamates compiled for this chart were carbaryl and methomyl. In 2000, zero pounds of carbamates were applied in Butte County!



For this report all strains of Baccilus thuringiensis (Bt) were used. The amount of pounds per acre applied to almonds in Butte County are noted in Figure 2.10. In 1990 and 1991, virtually no Bt was applied to Butte County almonds, however, in 1998, over 1,500 pounds were applied which shows an increase in use from 1992 to 1998, but usage has declined since 1998.



Pest Management Alliance Project, Kern County

Mario Viveros, Walt Bentley,
Peggy Schrader and Minerva Gonzalez

Introduction:

The purpose of this project was to demonstrate a reduced pesticide input versus a conventional pesticide management program in young orchards for the Southern end of the San Joaquin Valley. This project was established three years ago in a 160-acre block, which was made up of 80 acres of "hard shells" (Butte – Mission – Padre) and 80 acres of "soft shells" (Nonpareil – Fritz – Sonora). Both "hard and soft" shell varieties were divided into two (20 acres each) conventional and two (20 acres each) reduced input management plots. For the 2001 season each of the plots in both conventional and reduced input was divided into dormant and non-dormant spray subplots to better assess the impact of dormant sprays. Thus, there are now the following treatments: 1) conventional dormant, 2) conventional non-dormant, 3) reduced dormant, and 4) reduced non-dormant.

This report is for data obtained in the 2001 season. It doesn't include information from 1999 and 2000 seasons.

Cover Crops:

A barley cover crop has been selected because of the saline-alkali and poor drainage conditions of the PMA orchard soil. The barley was seeded in every middle on both "soft" and "hard" shell blocks, at a rate of 80 lbs. per acre. The seeding was done in December. In previous years, insectary mixes were also planted at this time. However, this has been discontinued. Lack of success was attributed to poor germination and plants that bloomed too late to be of benefit for the control of key pests.

Pest Monitoring:

The setup for pest monitoring was modified for 2001 because each conventional and reduced input management treatment was subdivided into dormant and non-dormant subplots.

San Jose Scale (SJS). This pest was monitored using twig samples, pheromone lures and double-sided sticky tape. The over-wintering SJS population in the orchard was monitored by randomly selecting 20 spurs from each plot. These spurs were sampled in early December. The adult population was monitored by placing one sticky trap with a pheromone lure in each plot. The trap was placed on the tenth tree in from the end, and six or seven feet high in the northeast quadrant of each tree. The trap was placed on February 28 and was monitored weekly until the end of November. Pheromone lures were replaced every four weeks. Adult SJS moths were counted as well as the *Encarsia* and *Aphytis* adults. The crawlers were monitored by using double-sided sticky tape, which was placed in four trees surrounding the tree that contained the pheromone traps. Tape was placed April 4, 2001 and was monitored weekly for presence-absence until the biofix occurred.

Peach Twig Border (PTB). PTB was monitored by the placement of pheromone traps and by larva emergence from hibernacula. The traps were used for monitoring the adult population. They were placed in the tenth tree in from the end, six or seven feet high in the northeast quadrant of the tree. The traps were placed April 4, 2001 and their pheromone lure were replaced every eight weeks.

The PTB larvae emergence was determined by collecting rust-colored hibernacula (minute chimney-like piles of frass and sawdust) from crotches (branch angles) of two-year-old trees. With a grafting knife, a pie-shaped wedge containing the hibernacula was cut from tree crotches and placed into a vial. Ten hibernacula were collected from 10 different areas of an orchard located a few miles from the PMA orchard. Under the microscope, the hibernacula was opened with a probe and the presence or absence of the larvae was noted. Absent larvae meant it had emerged. Therefore emergence was determined by the number of absent larvae. Samples were taken, twice a week, from early February through mid-March.

Navel Orangeworm (NOW). NOW was monitored using egg traps and an evaluation of winter sanitation practices. One NOW egg trap was placed in each plot on April 4, 2001. It was placed in the tenth tree in from the end in the north side of the tree and six or seven feet high. The traps were black and contained an almond meal mixture.

Winter sanitation was evaluated on February 7, 2001 by counting the number of mummies, the nuts left from harvest. Forty-five trees in each plot were selected and the number of mummies was counted in each tree.

Mites. Mites were monitored with soil and leaf samples. The soil samples were taken in the winter and leaves were sampled during growing season. Soil monitoring to determine the overwintering female web-spinning mite began February 2, 2001 and continued with weekly samples until April 11, 2001. Soil samples were taken from the base of the trees and placed in eight ounce Styrofoam cups, filled to the rim with the soil. Then, they were placed on a sticky card and left at room temperature for two weeks. After two weeks, the overwintering female mites emerged from the soil and became stuck to the cards. The sticky cards were then read and the overwintering female mites were recorded.

Leaf monitoring for mites on Nonpareil and Butte varieties began on April 11, 2001. Leaf samples were taken at random from five trees in each plot. The tree location changed every week. One week the trees were located at the extreme ends of the orchard, but on the following week, they were located through the middle of the two blocks. Ten leaves were selected from each tree. Initially, only interior leaves were selected, however, by mid-May, half of the leaves were selected from the interior and half from the exterior of the tree. Leaves were brought back to the lab in an ice chest, and examined under a microscope. The presence-absence method was used. Only web spinning mites were considered. European red, predatory mites and sixspotted thrips were noted.

Ants. Ants were monitored by the "hot dogging" method on May 26 and June 25, 2001. Half-inch hot dog slice (Bar-S brand containing beef, pork, and chicken) was placed in a snap-cap vial; 10 vials were distributed in a diagonal pattern across each block. Vials were distributed in the orchard during early morning ant activity for duration of two hours, then picked up and stored in the freezer until counting. Sample processing involved removing ants from the hot dog and vial by washing them into a petri dish for counting. All ants per vial were individually separated and counted.

Nutrients. The nutrient levels were monitored by June-July leaf samples. The samples were washed in distilled water. They were allowed to dry and then ground through a Wiley mill. The samples were then sent to the ANR Laboratory at U.C. Davis for analysis.

Production. Yields of Nonpareil and Butte from both conventional and reduced input systems were taken at harvest. In addition, yields were taken from dormant and non-dormant sprayed plots from both conventional and reduced input systems.

Treatments:

Dormant Sprays. For the 2001 season, the conventional and reduced input systems were subdivided be dormant spray, i.e., sprayed and non-sprayed. The conventional sprayed treatment was sprayed with five pints of Diazinon® plus six gallons of oil mixed with 250 gallons of water per acre. The reduced input treatment received six gallons of oil in 250 gallons of water per acre. The spray was applied January 23, 2001.

Winter Sanitation. By February 7, both conventional and reduced input treatment were mechanically shaken for mummy removal.

May Spray. A May spray was done for control of SJS. The biofix for male adult moths occurred March 21, 2001 and for crawlers it occurred March 26, 2001. Degree-day calculations indicated that the optimum time for spraying was during the second week of May (from the 7th to the 15th.)

The orchard was sprayed May 8. The conventional dormant treatment plots were sprayed with Esteem® at a rate of 14 oz. In 200 gallons of water per acre. The non-dormant conventional treatment plots were left unsprayed. The reduced input treatment (dormant oil only) was sprayed with two gallons of oil in 200 gallons of water per acre.

Hull Split Spray. This spray was done June 27 before hull split took place. It was timed for the control of PTB in the soft shell plots. The conventional plots were sprayed with Imidan® at a rate of four pounds in 200 gallons of water per acre. The reduced input was sprayed with 16 oz. of Confirm® in 200 gallons of water per acre. The hard shell blocks were left unsprayed.

Mite Sprays. The conventional (dormant spray) plots were sprayed with Omite® at a rate of 4 pts. in 200 gallons of water per acre on May 30. The conventional (non-dormant spray) plots were sprayed with 12 oz. Agri-Mek® plus 2 gallons of summer oil in 200 gallons of water. This spray was also applied to the non-dormant spray reduced input plots. The Agri-Mek® spray on both of these plots was applied May 31. Predatory mites were released in the reduced input (dormant oil) plot June 1. There were two predatory mite releases in the reduced input (non-dormant) plot, one May 16 and the second, June 1. Each release was 2500 mites per acre.

There were additional mite sprays in June-July. Three out of the four Omite® plots (conventional dormant-spray) and one reduced input plot (where mites were released June 1) were sprayed using 2 gallons of oil in 200 gallons of water per acre.

Ant Sprays. Clinch® was applied to the reduced input plots at a rate of one pound per acre. There was no spray on the conventional plots.

Results:

San Jose Scale. Shoot samples have been showing an increase in infestation. Table 1 shows that shoots from reduced input plots were more infected than shoots from the conventional plots. For this reason, the crawlers in half of the reduced and half of the conventional were treated with oil and Esteem® respectively.

Table 1. Percent of infested shoots from conventional and reduced input treatments.

Treatment/replicate	Variety	% Infestation 2000	% Infestation 2001
Conventional 1	Sonora	0	0
Reduced Input 1	Sonora	45	0
Conventional 2	Butte/Padre	0	25
Reduced Input 2	Butte/Padre	0	10
Conventional 3	Butte	0	10
Reduced Input 3	Butte	0	40
Conventional 4	Sonora	0	5
Reduced Input 4	Sonora	10	0

Figure 1 and 2 show the number of SJS male from February to November. The number of males was higher in the no-dormant than on the dormant plots. The population was higher on the conventional than on the reduced input plots (Figure 1). However, this was not the case for the dormant spray plots. Both conventional and reduced plots show no differences in SJS (Figure 2). Figure 1 and 2 show no male SJS population after April 14. This was before a crawler spray was applied.

Figure 1. Average number of male SJS per trap, where no dormant spray was applied, from February to November.

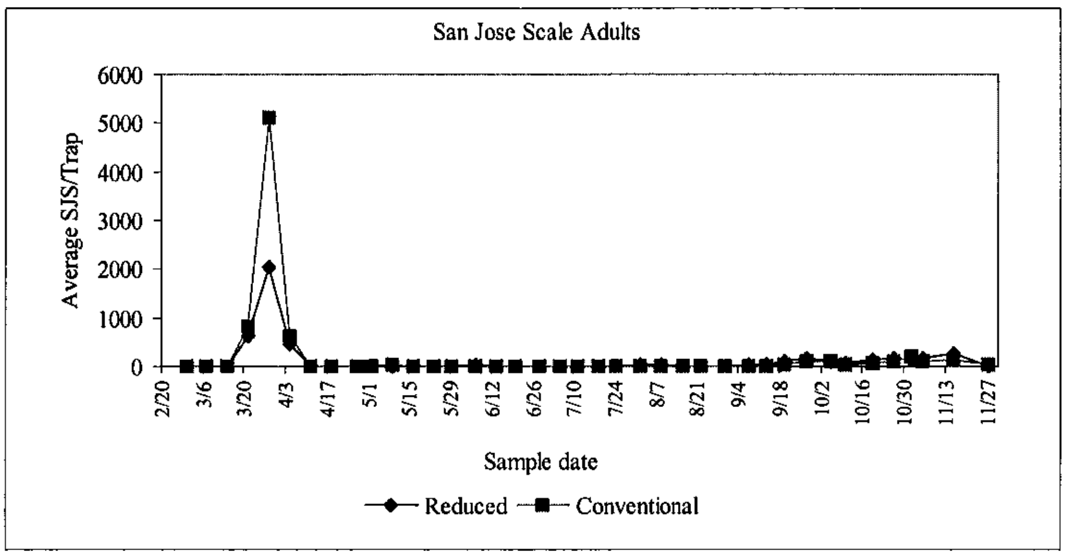
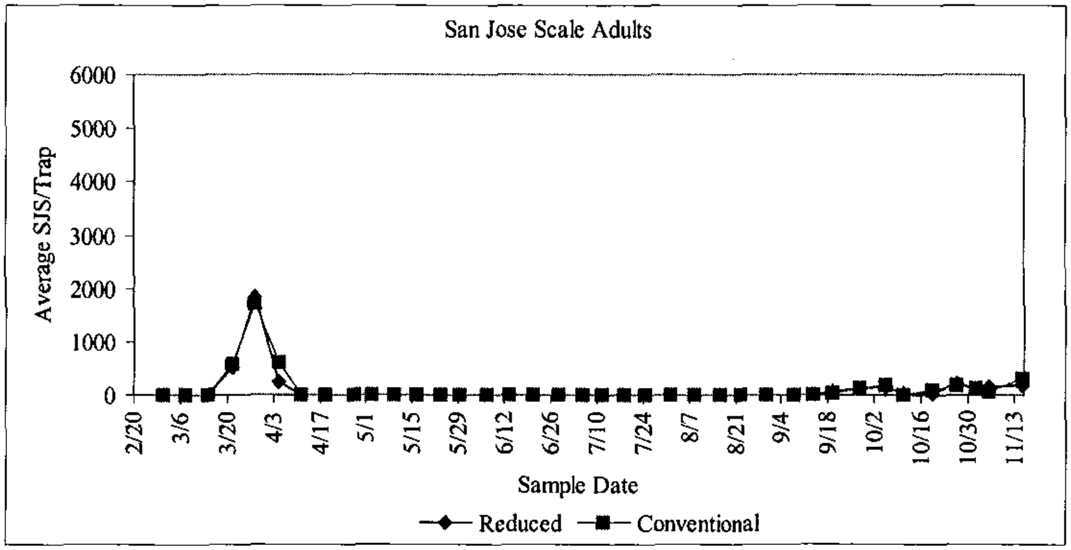
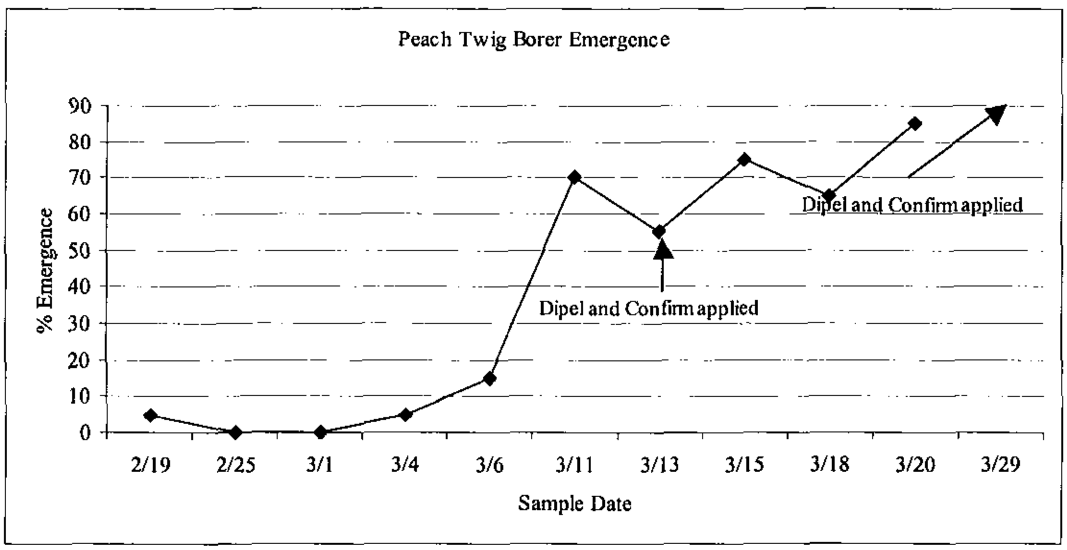


Figure 2. Average number of male SJS per trap, where dormant spray was applied, from February to November.



Peach Twig Borer. Figure 3 shows the PTB emergence for 2001. PTB emergence doesn't correspond to bloom development. Full bloom of Nonpareil occurred February 26. At this time there were no PTB emergence. The treatment level occurred March 8 or 12 days after full bloom (Figure 3).

Figure 3. Percent of PTB emergence for 2001.



The number of shoot strikes in both May and June readings were not large. In the May reading, shoot strikes were greater in the reduced input (dormant oil treatment) than conventional dormant treatment (Diazinon® and oil). The same relationship can be seen in the July readings (Table 2).

Table 2. Average number of PTB strikes per tree in conventional and reduced input plots treated and non-treated with dormant sprays.

Management	Dormant Treatment	Strikes / Tree	
		May 5	June 4
Conventional	Diazinon® & Oil	0.10	1.3
Reduced Input	Oil only	0.50	2.75
Conventional	Nontreated	0.20	1.55
Reduced Input	Nontreated	0.45	2.43

Figure 4 shows the adult population of PTB from February to November in the no dormant spray for both conventional and reduced input treatments. The adult population for the conventional and reduced input plots differs at the beginning of the third flight and continue in this manner until the end of October. There were no sprays on these plots. This was not the case in Figure 5, which shows the PTB adult population from the dormant spray of both conventional and reduced input. The dormant spray received an Imidan® and Confirm® spray on June 27.

Figure 4. Average number of PTB per trap, where no dormant spray was applied, from February to November.

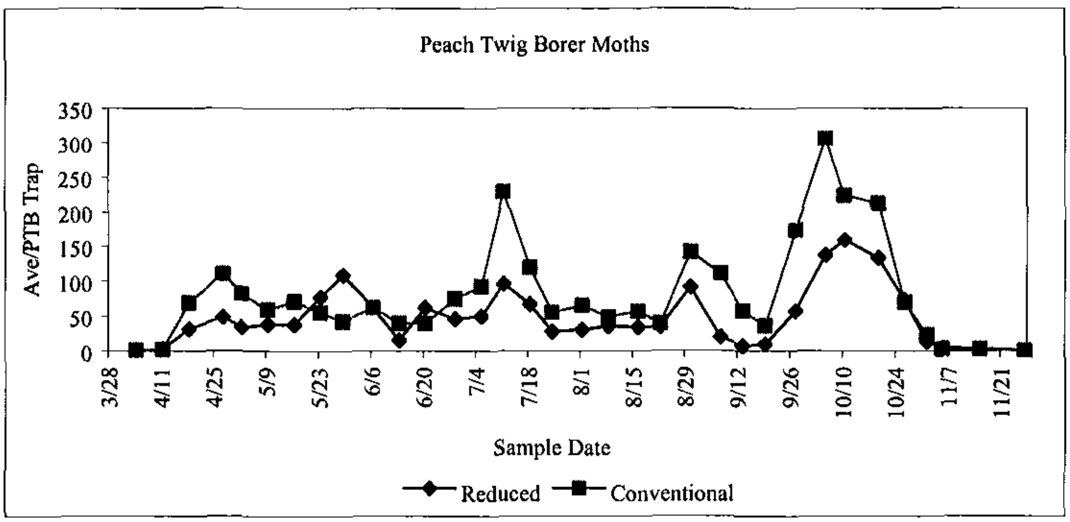
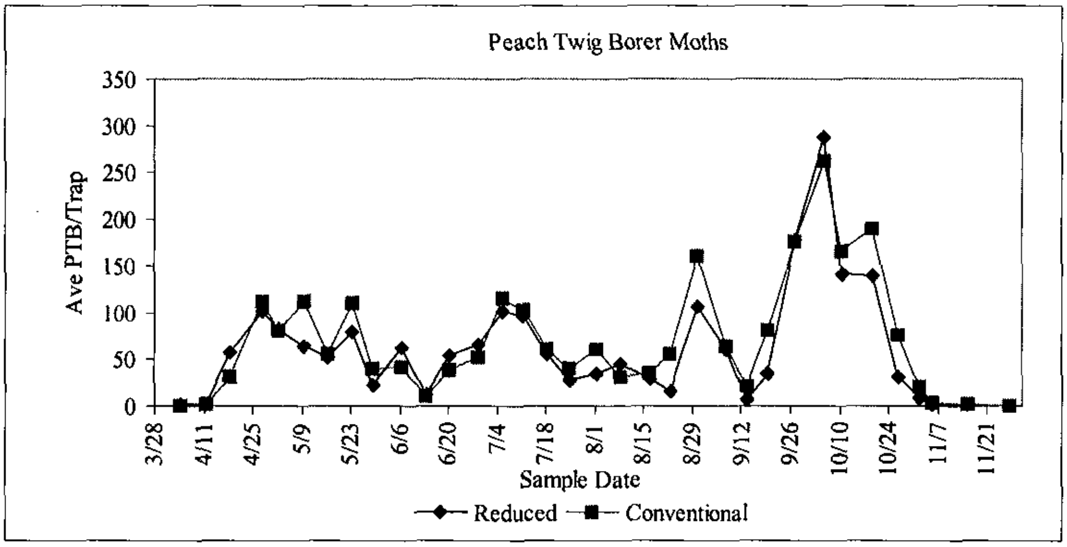


Figure 5. Average number of PTB per trap, where dormant spray was applied, from February to November.



The percent rejects due to PTB is shown in Table 3. The rejects were very low in 2001 in both Nonpareil and Butte. Either spray, Confirm® or Imidan®, had little effect in reducing reject levels in the Nonpareil.

Table 3. Percent of reject levels due to PTB from conventional dormant and non-dormant also from reduced dormant and non-dormant sprays.

Management	Dormant Treatment	Percent Reject	
		Nonpareil	Butte
Conventional	Diazinon® & Oil	0.00	1.00
Reduced Input	Oil only	0.69	0.19
Conventional	Nontreated	0.25	0.00
Reduced Input	Nontreated	0.13	0.00

Navel Orangeworm (NOW). Mummy counts showed that all conventional and reduced input management plots had less than one mummy per tree by February 15.

Figure 6 shows number of eggs per trap of NOW where no dormant spray was applied for both conventional and reduced input management treatment. There were no differences between conventional and reduced. This is expected since no spray was applied. In contrast, there was a marked difference in the number of eggs between conventional and reduced input plots when they were dormant sprayed (Figure 7). There were more eggs in the reduced input dormant-sprayed plot than the conventional dormant-sprayed treatment.

Figure 6. Average number of NOW eggs per trap, where no dormant spray was applied, from February to November.

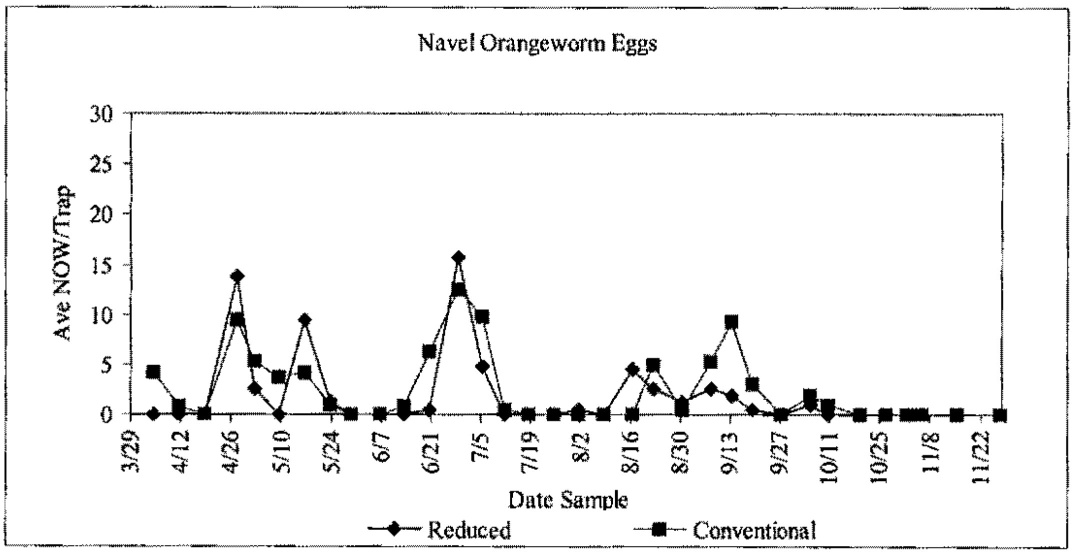
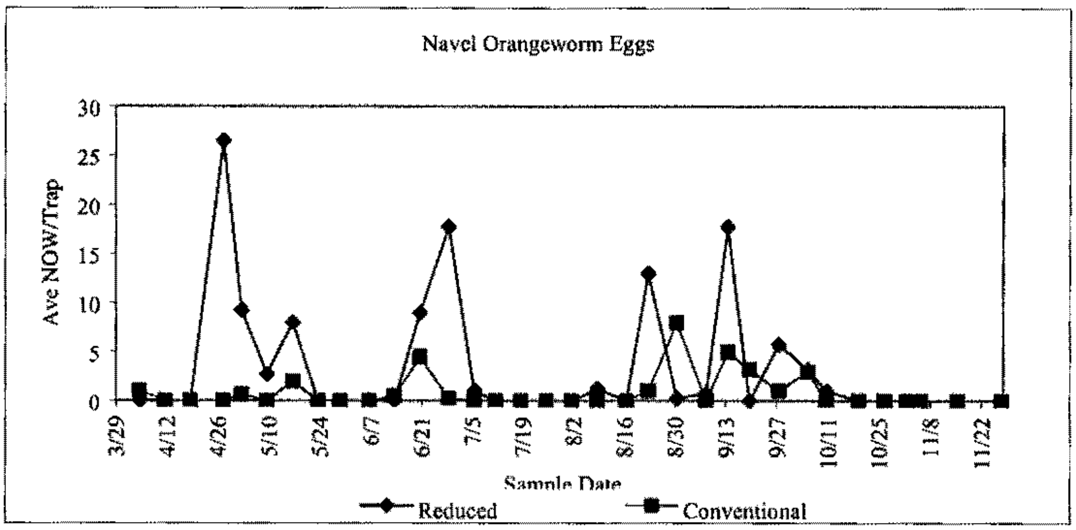


Figure 7. Average number of NOW eggs per trap, where dormant spray was applied, from February to November.



The reject levels for NOW are found in Table 4. The rejects for Nonpareil are less than one percent. The rejects from reduced input both from the dormant and non-dormant spray were larger than the conventional dormant and non-dormant. Please note that both reduced input dormant and conventional dormant received a hullsplit spray on June 27. Table 4 also shows the reject levels for Butte. The reject levels for this variety were about one percent. All treatments were about the same except for the conventional plot, which had less than one percent.

Table 4. Percent of reject levels due to NOW from conventional dormant and non-dormant also from reduced dormant and non-dormant treatments.

Management	Dormant Hullsplit Treatments	Percent Reject Nonpareil	Percent Reject Butte
Conventional	Diazinon® & Oil/Imidan®	0.14	1.19
Reduced Input	Oil only/Confirm®	0.94	1.00
Conventional	Nontreated	0.44	0.88
Reduced Input	Nontreated	0.50	1.19

Ants. Figure 8 shows ant population at May 29 and June 25 from the conventional plots which received no treatment and reduced input plots which received Clinch®. The population was higher in May 29 and by June 25 had decreased. There was no marked difference in the population between conventional and reduced input plots.

Figure 8. Average number of ants per sample on two sampling dates.

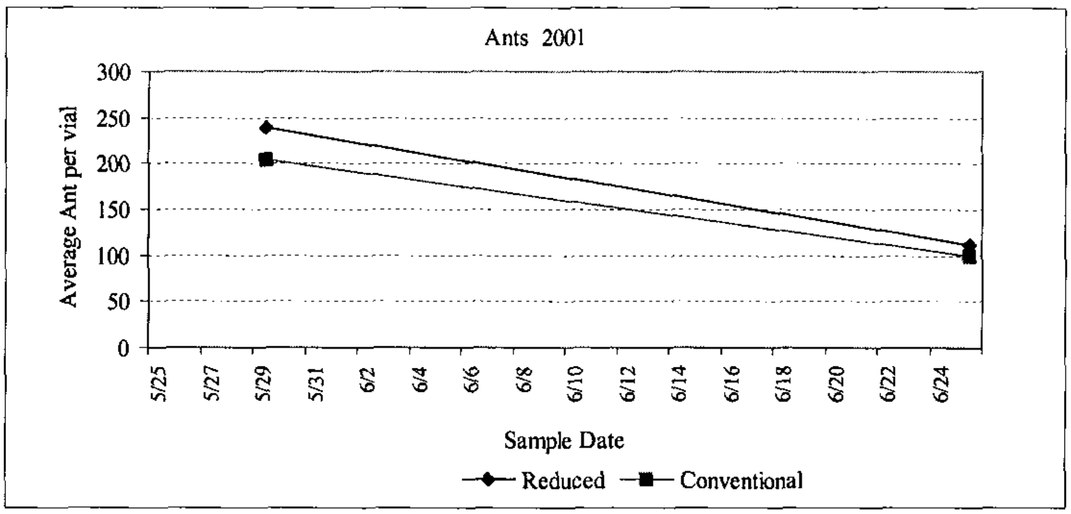


Table 5 shows percent rejects due to ants from the conventional and reduced input plots. The conventional plots were not treated for ants however the reject level is less with the conventional compared to the reduced input treatment. From the reject level, it appears that the application of Clinch® offered little protection against damage by ants.

Table 5. Percent rejects due to ants.

Treatment	Percent of Rejects	
	Nonpareil	Butte
Conventional	0.27	0.00
Reduced Input	1.40	0.26

Mites. The 2001 season was a particularly prone to mite infestation this year due to 100 F days during the summer. The mites were kept under control and none of the trees webbed over or were defoliated during the summer.

Predatory mite releases were unsuccessful in five out of eight plots. These plots were sprayed with Agri-Mek® or one percent oil when the infestation of the leaves increased to 70%. These sprays were applied 2 weeks after the predatory mite releases.

Omite® sprays were unsuccessful in two out of four plots. These plots were re-sprayed with Omite® or one percent oil.

Agri-Mek® worked well in every plot where applied. One spray done on May 31, 2001.

The female emergence from the soil can be found in Table 6. There were no statistical differences in the number of females emerging from the soil. However, when the totals are considered, we can see that there were more female mites emerging from the conventional than from the reduced treatments.

Table 6. Average number of overwintering female

Treatment	2/2/01	2/14/01	3/2/01	3/14/01	3/22/01	3/28/01	4/4/01	4/11/01	Total
Reduced Input	0.25a	0.10a	0.05a	0.10a	0.05a	0.00a	0.00a	0.05a	.075a*
Conventional	0.00a	2.25a	1.50a	2.75a	4.25a	0.00a	0.00a	0.00a	1.344b

*value followed by different letters are significantly different at P=0.05.

Yields. Yields are found in Table 7. There was a significant difference in yields among in the Nonpareil variety. The conventional nontreated plot produced more almonds than the reduced nontreated treatment. There are no significant differences among the treatments in the Butte.

Table 7. Yields in meat pound per acre for Nonpareil and Butte under different management systems.

Management	Dormant Treatment	Nonpareil	Butte
Conventional	Diazinon® & Oil	1814ab*	2747a*
Reduced Input	Oil only	1737ab	2562a
Conventional	Nontreated	2116b	2603a
Reduced Input	Nontreated	1422a	2368a

*value with same letters are not significantly different from each other.

Reject Levels. The total reject levels are shown in Table 8. The reject levels for ants, NOW and PTB are very low and within acceptable levels for growers.

Table 8. Insect damage (percent) in Nonpareil and Butte due to Ants, NOW and PTB from different management systems.

Management	Dormant Treatment	Nonpareil			Butte		
		Ants	NOW	PTB	Ants	NOW	PTB
Conventional	Diazinon® & Oil/Imidan®	0.29	0.14	0.00	0.00	1.19	0.00
Reduced Input	Oil only/Confirm®	1.31	0.94	0.69	0.38	1.00	0.19
Conventional	Nontreated	0.25	0.44	0.13	0.00	0.88	0.06
Reduced Input	Nontreated	1.50	0.50	0.25	0.13	1.19	0.00

Orchard Nutrition. There is no difference in orchard nutrition between conventional and reduced input treatment, as would be expected because there were no differing nutrient applications (Table 9).

Table 9. Tree nutrition levels from the conventional and reduced management systems.

Nutrient Element	Reduced Input	Conventional
N – Total (%)	2.71	2.85
P – Total (%)	0.14	0.14
K – Total (%)	1.99	1.88
Na (ppm)	244	277
Cl (%)	.11	.12
B (ppm)	35	35

Summary and Conclusions:

Monitoring. Monitoring is a necessity to gain knowledge of pests and diseases in an orchard. Studies have shown that knowing pest and disease pressures allows the grower to reduce pesticide usage. Less pesticide use reduces production costs to a grower.

Cover Crops. The greatest benefit of a cover crop such as barley is an increase in water penetration. This finding has solid support in literature.

Dormant Sprays. Dormant sprays control SJS and ants while not controlling PTB. Esteem® and Oil were effective in SJS control.

Winter Sanitation. Research has shown that winter sanitation and early harvest reduces NOW nut infestation. The sanitation was excellent this year, less than one mummy per tree. The reject levels were less than one percent in all plots.

In Season Sprays. With reject levels of less than one percent for both NOW and PTB, it is questionable whether in-season sprays are needed. Also, in season sprays can have a detrimental effect to beneficial insects.

Mite Control. Mites were controlled by intense monitoring in the orchard, even though more than one spray was applied to some of the plots. This year predatory mite releases were not always successful, nor was the application of Omite®. However, Agri-Mek® worked in every plot it was applied.

Shell Seal. We are expecting a better shell seal this year. The reject levels were very low in both Nonpareil and Butte.

Acknowledgements

We wish to thank Thomas Vetsch of Vetsch Farms of California, Inc. for providing and maintaining the study site in Kern Co., and for providing labor when needed. We appreciate the donation of predatory mites by Matt Billings of Sterling Nursery, and Clinch® ant bait by Roger Williams of Novartis. This study was supported by a grant from the California Almond Board Pest Management Alliance. Thank you for your support.

Disclaimer

Discussion of research findings necessitates using trade names. This does not constitute product endorsement, nor does it suggest products not listed would not be suitable for use. Some research results included involve use of chemicals which are not currently registered for use, or may involve use which would be considered out of label. These results are reported but are not a recommendation from the University of California for use. Consult the label and use it as the basis of all recommendations.

Kern County Pesticide Summary 2001

Kern County is one of the largest almond producing counties in California. Since 1990, approximately 10,000 new acres have come into bearing, increasing Kern County to more than 82,000 harvested acres. This information is available through the California Agricultural Statistical Service (CASS) via the World Wide Web. Figure 3.1 depicts the amount of harvested almond acreage in Kern County 1990-1998.

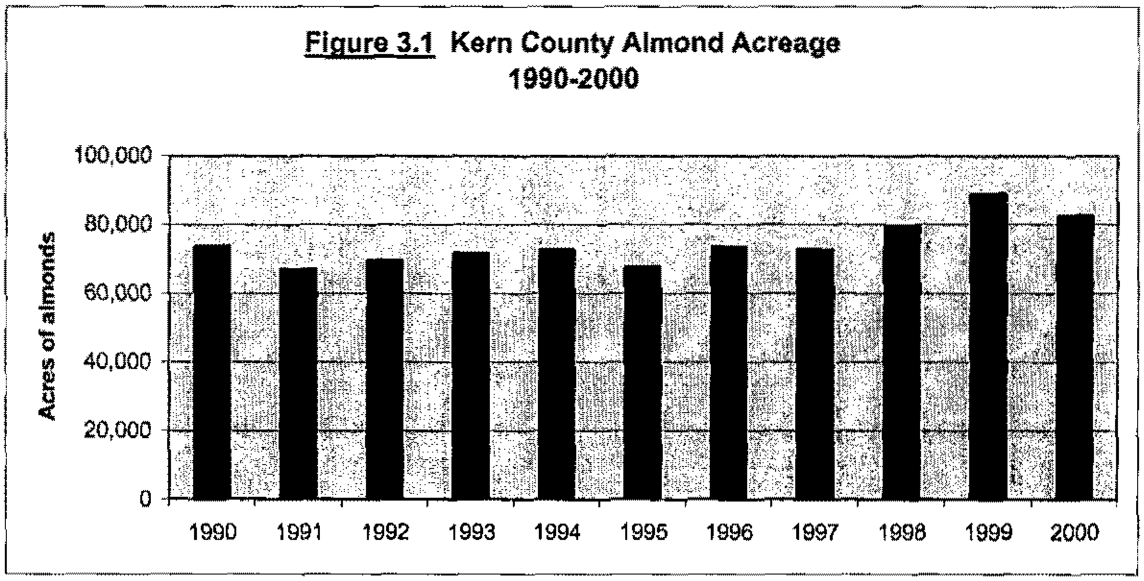
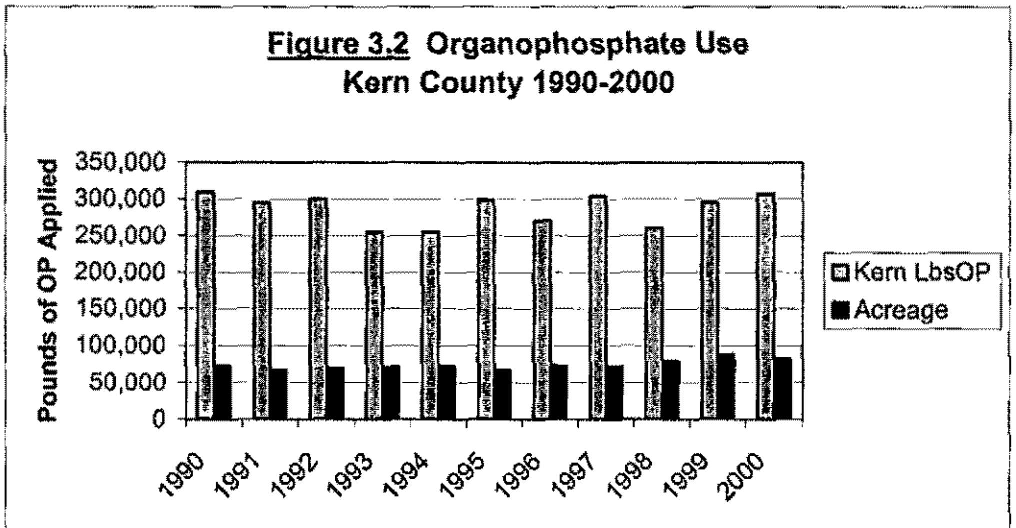
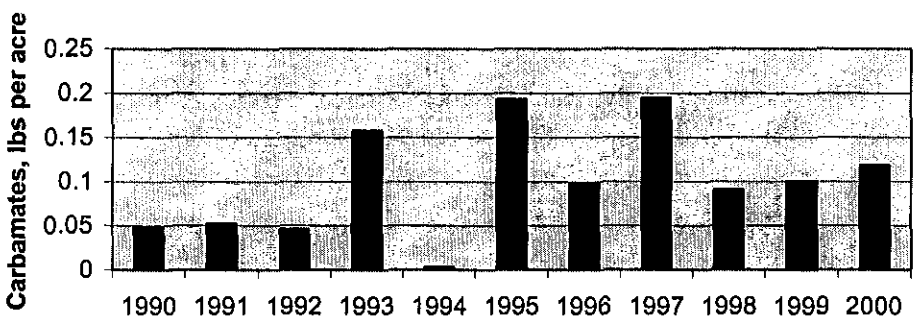


Figure 3.2 depicts the amount of harvested acreage and the pounds of organophosphates applied per acre. Despite the amount of harvested acreage increasing, the amount of organophosphates applied has reduced - this is a positive trend. The organophosphates used in this report are azinphos-methyl, diazinon, chlorpyrifos, methidathion, parathion, naled, phosmidion, and phosmet.



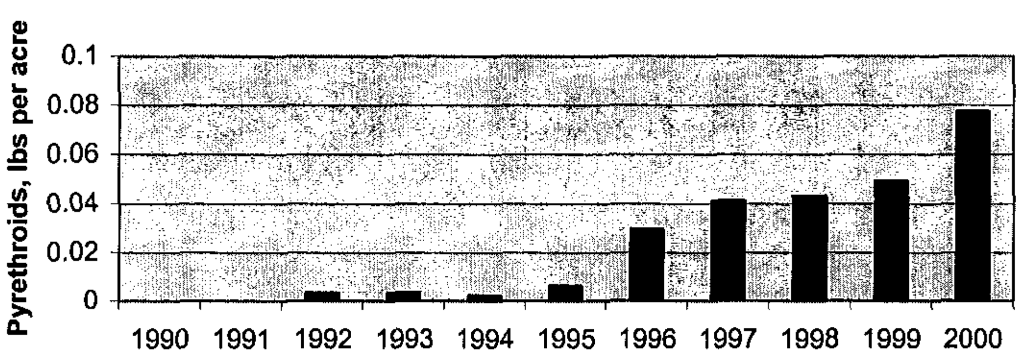
Carbamate use in Kern county has fluctuated over the past eleven years. Figure 3.3 shows the pounds of carbamates applied per acre in Kern County. With the total amount of acres increasing and the amount of carbamate much lower than the peaks of 1995 and 1997, carbamate use per acre has decreased in Kern County.

Figure 3.3 Carbamates Applied to Almonds in Kern County 1990-2000

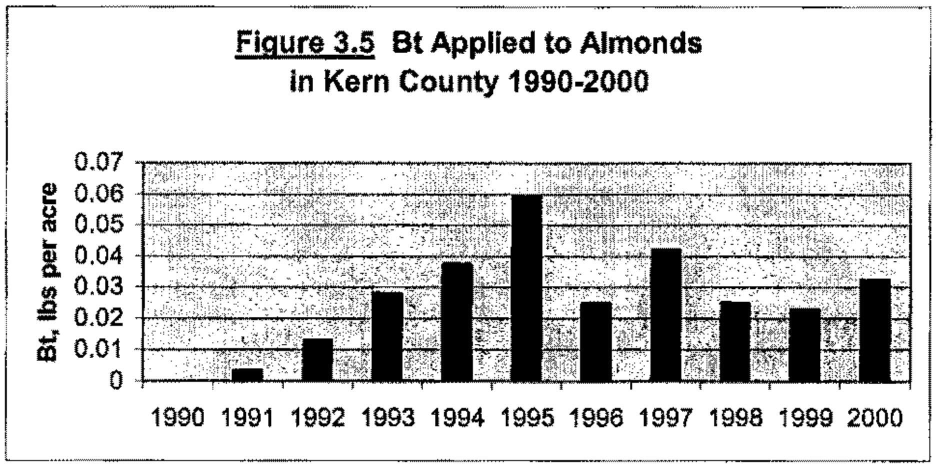


Pyrethroids applied increase from virtually none in 1990 to approximately 0.08 pounds per acre in 2000. However, the amount of harvested acreage rose by approximately 10,000 acres in this time period. Figure 3.4 shows the pounds of pyrethroids per acre in Kern County from 1990-2000.

Figure 3.4 Pyrethroids Applied to Almonds in Kern County 1990-2000



Pounds of Bacillus thuringiensis applied in Kern County rose steadily from 1990-1995 but then began to fluctuate. Figure 3.5 shows the pounds of Bt applied in Kern County from 1990 to 2000.



Despite the fluctuations in the use of organophosphates and carbamates and the steady increase in pyrethroid applications, the amount of acreage has also risen steadily in Kern County. The rise in acres must be addressed in viewing these pesticide use reports. This remains to be the case when viewing the fluctuations of Bt use.

Stanislaus County Almond Pest Management Alliance Project
2001 Final Report

Roger Duncan, UCCE Farm Advisor, Stanislaus County; Walt Bentley, IPM Advisor, UC Kearney Agricultural Center, Parlier; Cara Cross & Clinton Bowman, Field Technicians, Stanislaus County UCCE; Merlyn Garber, grower; Art Bowman, pest control advisor, Salida Ag Chem

Objectives of the Stanislaus County Almond Pest Management Alliance project:

- To scientifically evaluate the long-term effectiveness and economic viability of less broadly toxic pest management programs.
- To extend gained information to the almond industry.
- To demonstrate IPM monitoring techniques and decision-making processes.

We have completed our third season in the Stanislaus County PMA trial. The original three pest management regimes were maintained similar to the first two years (grower's standard practice and two "reduced risk" ***treatments***). Because reject levels have been very low for all three pest management regimes during the first two years, a fourth, "untreated" program was added in 2001. Each pest management program is replicated three times within a 120 acre Nonpareil: Carmel orchard west of Modesto. Each plot is approximately 13.5 acres in size. The treatments are:

1) Grower's Standard Practice: (fairly common in the Northern San Joaquin Valley).

- A dormant application of Asana® (a pyrethroid), 6 gallons of oil, & 8 lb. Kocide®.
- A May spray with an organophosphate (Lorsban).
- Omite® if needed for mites.
- Lorsban for ant control.

2) Soft Program #1:

- A dormant application of copper & oil (no insecticide).
- A "bloom" spray of Success® at ~ 30% PTB emergence (piggy-backed with fungicides).
- A May spray of Confirm®.
- Savey® for mites if monitoring deems necessary.
- Clinch® (Abamectin) bait for ants if monitoring deems necessary.

3) Soft program #2:

- A dormant application with oil only.
- Two "bloom" applications of Bt (@ ~20% PTB emergence & ~ 80% emergence).
- Two May sprays of Bt (300-350 & 450-500 DD after biofix).
- Potassium nitrate & oil for mites if monitoring deems necessary.
- Esteem® bait for ants if monitoring deems necessary.

4) "Untreated": only mites and ants are controlled if necessary.

- No dormant copper, oil, or insecticide application.
- No bloom Bt applications.
- No May or hull split sprays.
- Potassium nitrate & oil for mites if monitoring deems necessary.
- Esteem® bait for ants if monitoring deems necessary.

Overwintering nuts ("mummies") were removed and destroyed in all treatments to reduce overwintering naval orangeworm. Cover crop management, fertilization, and fungicide treatments were the same for all treatments other than no dormant copper was applied in "soft program #2" and the "untreated" areas.

Monitoring:

Each plot had two PTB pheromone traps, two SJS pheromone traps, four sticky tape traps for SJS crawlers, and two NOW egg traps for a total of 120 traps in the trial. PTB and NOW traps were checked twice weekly while SJS pheromone and sticky traps were monitored weekly throughout the season (March through October). In addition, mites and mite predators were monitored bi-weekly with the presence / absence leaf sampling technique. Ants were monitored periodically using hotdog bait traps. In the dormant period, spurs were sampled to monitor SJS populations.

Results:

Peach Twig Borer. Early in the season, PTB moth catches were roughly half as high in areas treated with Asana or Success compared to "untreated" or Bt treated areas. Most of the difference was due to a peak of moths caught May 9 in the Bt treated and untreated areas. After May, PTB moth catches were very similar for all treatments (Fig. 1). By the end of the season, cumulative moth catches were also very similar for all treatments and showed no clear advantage to dormant and in-season spraying (Fig. 2).

Fig. 1. Peach Twig Borer Populations as Related to Pesticide Program - 2001

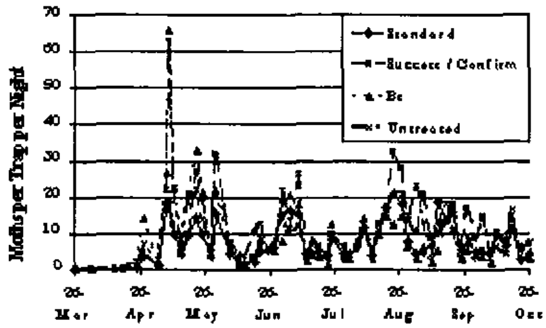


Fig. 2. Season Total of Peach Twig Borer Moths Stanislaus County PMA Trial, 2001

Mites. Brown almond mite (BAM) feeding damage was most severe early in the year and mostly restricted to individual trees within the orchard. In this trial, BAM numbers were highest in untreated areas (Fig. 3). On the first date of mite monitoring using the presence / absence method (May 22), about 15% of leaves sampled from untreated trees had BAM. The dormant oil and Bt treated trees had approximately 7% infestation while the dormant oil & Success or Asana treatments each had approximately 2% infestation. By mid-July, BAM numbers were similar for all programs. By the end of August, no BAM were found on sampled leaves. Very few European red mites were found in the trial.

It is very difficult to draw conclusions from the spider mite data. Due to lengthy pre-harvest interval and re-entry restrictions, miticides can be applied no later than about one month before harvest. Even though two-spotted mite numbers in 2001 were higher than the previous two years, none of the treatment areas had reached economic thresholds by the time mite sprays had to be applied. Despite leaf infestation levels of only about 12%, all areas were treated for mites on July 19 & 20 (treatment threshold is approximately 33% infestation). The "untreated" areas were sprayed a second time with potassium nitrate and oil on August 3. Despite spraying, spider mite levels exceeded the treatment threshold on August 21in all but "Soft" program #1 (Fig. 4). Areas treated with a dormant applied pyrethroid did not develop higher mite numbers than areas that did not receive dormant or in-season insecticide sprays. However, each area was treated with different in-season miticides with differing efficacies and residual effectiveness, making it difficult to draw sound conclusions. In the future, all areas will be treated with the same in-season miticide to alleviate this problem.

Fig. 3. Brown Almond Mite Populations as Related to Pest Management Program

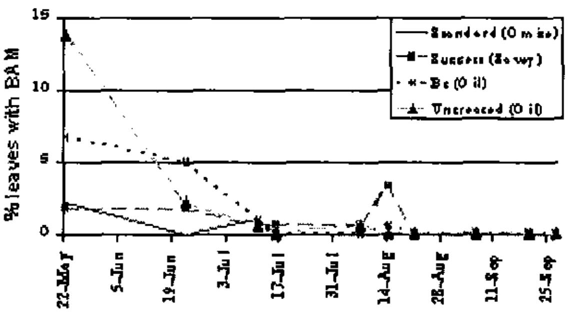
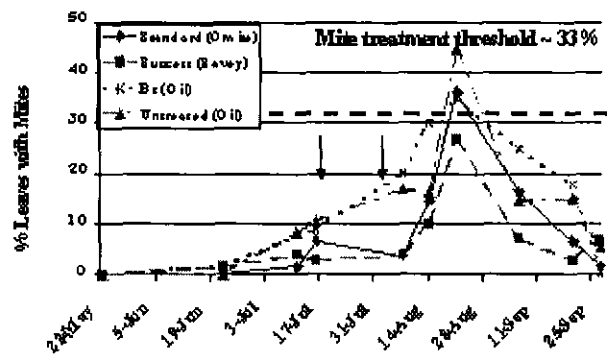
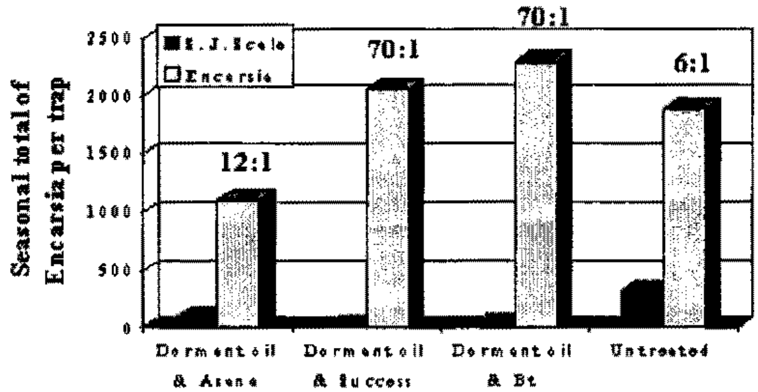


Fig. 4. Spider Mite Populations as Related to Pesticide Program



San Jose scale and scale parasitoids. In general, SJS numbers were very low in this trial. Untreated areas (areas not sprayed with oil or an insecticide) had higher pheromone trap catches than areas sprayed with dormant oil. Cumulative season totals for the grower's standard, soft program #1, soft program #2, and "untreated" areas were 92, 30, 33, and 320 scale caught per trap. As in previous seasons, approximately twice the number of scale parasitoids were caught in areas that were not sprayed with dormant Asana and in-season Lorsban (Fig. 5). The vast majority of parasitoids caught were Encarsia *sp. although* Aphytis *sp. were also present in the orchard. Ratios of parasitoids to scale were very high (70:1) in the two treatments that received dormant oil sprays but no dormant or in-season insecticides. Although the "untreated" areas had high numbers* of parasitoids, these areas also had the highest scale numbers resulting in a less favorable parasitoid to scale ratio (6:1). Observations over future seasons will determine if high parasitoid numbers in untreated areas can maintain scale levels below economic thresholds without the use of oils.

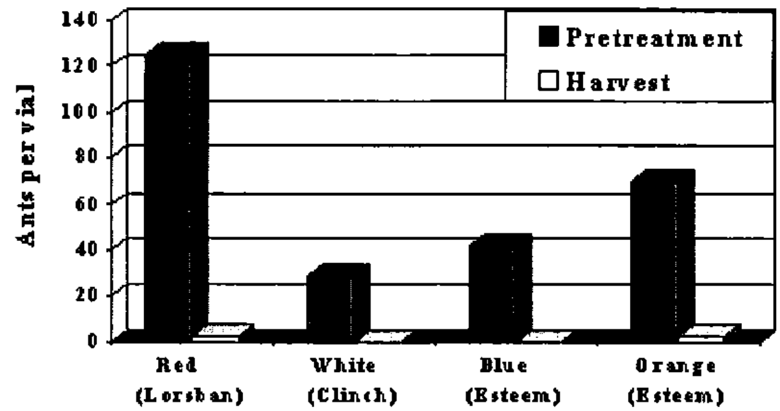
Fig. 5. San Jose Scale & Scale Parasitoid Numbers as Related to Treatment



Spur samples collected after the 1999 and 2000 growing seasons showed almost no SJS present in any of the treatments. Samples will be collected in January 2002 to determine scale numbers overwintering from the 2001 season.

Ants. Bait materials (Esteem and Clinch) were applied approximately five weeks prior to harvest (July 19) in the two "soft" treatments and in "untreated" areas. No ant treatment was applied in the grower's standard treatment. Ants were monitored on July 17 (prior to treatment) and again just after harvest. Twenty vials containing pieces of hot dog were placed throughout each replication in early morning and collected after 3-4 hours. Vials were transported back to the lab and put into a freezer. After 24 hours, frozen ants were identified and counted under a dissecting microscope. Almost all ants collected were identified as black pavement ants with only an occasional southern fire ant captured. Just after Nonpareil harvest, ants were again collected and counted. Fewer ants were caught in the reduced risk program areas in the pretreatment samples (Fig. 6). This may have been due to a carry over effect from bait materials used the previous season. By harvest, there were very few ants in any of the treatments.

Fig. 6. Ant Counts Before and After Treatment.
Stanislaus County PMA trial, 2001



Test areas were treated in 2000 with the same materials.

Harvest Evaluation:

At harvest, 500 almonds were randomly collected from each replication (1500 per treatment) and examined for insect damage. Reject levels for all treatments were very low. There were no differences between treatments from damage due to NOW or PTB (Table 2). The grower's standard treatment had high ant damage in one of the three replications, resulting in an average of 1.8% ant damage over all. Areas treated with Clinch or Esteem baits had 0.1 – 0.2% ant damage.

Table 2. Harvest Evaluation of Nonpareil Almonds Farmed Under Four Pest Management Programs.

Stanislaus County Almond PMA Trial, 2001

Treatment	% NOW	%PTB	% Ant	Total % Rejects
Standard	0.1	0.1	1.8	1.9
Success	0	0	0.1	0.1
Bt	0.1	0.1	0.2	0.4
Untreated	0.2	0.1	0.1	0.4

Costs Associated with Four Almond Pest Management Programs*

Stanislaus County Almond PMA Trial, 2001

TREATMENT	APPLICATION		COST PER

T			PLANTED ACRE
Grower's Practice **(RED)**	**Dormant Spray** **(1-20-01)**	Asana XL @ 8 oz	$8.00
		Kocide DF @ 8 lb.	$18.58
		Gavicide Super 90 @ 6 gal	$16.73
		Application costs:	$13.65
		Subtotal:	**$56.96**
	May Spray **(5-14-01)**	Lorsban 4E @ 4 pints	$23.89
		Nu-Film 17 @ 12.8 oz	$3.36
		Application costs:	$13.65
		Subtotal:	**$40.90**
	Mite Spray **(7-20-01)**	Omite 6E @ 2.5 pints	$16.47
		Nu-Film 17 @ 12.8 oz	$1.51
	-spot sprays to 17.9 acres (45% of plot acreage)	Application costs @ $13.65 per treated acre	$6.14
		Subtotal:	**$24.12**
		TOTAL PROGRAM COSTS	**$121.98**
"Soft" Program #1 **(WHITE)**	**Dormant Oil & Copper Spray** **(1-22-01)**	Kocide DF @ 8 lb.	$18.58
		Gavicide Super 90 @ 6 gal	$16.73
		Application costs	$13.65
		Subtotal	**$48.96**
	Bloom Spray **(3-12-01)** **(piggy-backed with fungicide spray)**	Success @ 4 oz	$23.46
		Application costs	$0.00
		Subtotal	**$23.46**
	May Spray **(5-9-01)**	Confirm 2F @ 1 pt	$25.16
		Application costs	$13.65
		Subtotal	**$38.81**

	Mite Spray **(7-20-01)** -spot sprays to 17.2 acres (43% of plot acreage)	Savey @ 4 oz Nu-Film P @ 6 oz Application costs @ $13.65 per treated acre Subtotal	$31.21 $0.57 $5.87 **$37.65**
		TOTAL PROGRAM COSTS	**$148.88**
"Soft" **Program #2** **(BLUE)**	**Dormant Oil Spray** **(1-22-01)**	Gavicide Super 90 @ 6 gal Application costs Subtotal	$16.73 $13.65 **$30.38**
	Bloom PTB Sprays (piggy-backed with one fungicide spray) **(3-13-01)** **(3-22-01)**	Dipel DF @ 1 lb. (3-13-01) Application costs Dipel DF @ 1 lb. (3-22-01) Application costs Subtotal	$10.78 $0.00 $10.78 $13.65 **$35.21**
	May PTB Sprays **(5-10-01)** **(5-18-01)**	Dipel DF @ 1 lb. (5-10-01) Nu-Film P @ 6 oz Application costs Identical second application (5-18-01)) Subtotal	$10.78 $1.32 $13.65 $25.75 **$51.50**
	Spot Mite Sprays 7-19-01 – 30% of area **8-3-01 – 28% of area**	Potassium nitrate @ 10 lb / 100 applied @ 200 gpa Super 90 oil @ 1.5 gal / 100 applied @ 200 gpa Application costs Potassium nitrate @ 10 lb / 100 applied @ 200 gpa Super 90 oil @ 1.5 gal / 100 applied @ 200 gpa	$1.80 $2.51 $4.10 **$1.57** $2.19 $3.82 **$15.99**

		Application costs Subtotal	
		TOTAL PROGRAM COSTS	**$133.08**
Costs Associated with Four Almond Pest Management Programs* Stanislaus County Almond PMA Trial, 2001 (Continued)			
TREATMENT	**APPLICATION**		**COST PER PLANTED ACRE**
"Untreated" **(ORANGE)**	**Dormant Spray**	(none)	**$0.00**
	Bloom PTB Sprays	(none)	**$0.00**
	May PTB Sprays	(none)	**$0.00**
	Spot Mite Sprays 7-19-01 – 30% of area **8-3-01 – 28% of area**	Potassium nitrate @ 10 lb / 100 applied @ 200 gpa Super 90 oil @ 1.5 gal / 100 applied @ 200 gpa Application costs Potassium nitrate @ 10 lb / 100 applied @ 200 gpa Super 90 oil @ 1.5 gal / 100 applied @ 200 gpa Application costs Subtotal	$1.80 $2.51 $4.10 $1.57 $2.19 $3.82 **$15.99**
		TOTAL PROGRAM COSTS	**$15.99**

*Costs do not include ant treatments because the grower's standard treatment was not treated for ants.

Conclusions:
After 3 years of intensive monitoring, we have not seen an increase in any pest in the two "soft" treatment programs compared to the standard grower's practices. There also have not been any differences in rejects due to PTB, NOW or ants at harvest. In 2001 we added an "untreated" program where no sprays are applied to control NOW, PTB or SJS.

This program does allow for mite management with potassium nitrate and oil and for ant control with bait. After one year, there is no indication of increased populations of NOW, PTB or ants in these untreated areas. Harvest reject levels were also very low and similar to treated areas.

It is clear SJS parasitoids are significantly reduced in areas where a pyrethroid is applied in the dormant period and an organophosphate is applied in-season. In the two "soft" programs where oil was applied in the dormant period, extremely low levels of scale were caught in-season and very high numbers of Encarsia scale parasitoids were present. In these areas, 70 Encarsia parasitoids were caught for every 1 SJS, a very high ratio of parasitoids to the pest. In the grower's standard practice treatment, SJS numbers were also low but parasitoid numbers were only half as high as in the other three programs, leading to a ratio of 12 parasitoids to 1 scale. In the northern San Joaquin Valley, almond and stone fruit orchards rarely have significant damage from SJS whether orchards are treated with insecticides or not. However, in areas where SJS is a serious threat, growers should understand that the use of some insecticides could exacerbate their scale problems. In the untreated program where no dormant oil was applied, high parasitoid numbers were present but SJS numbers were significantly higher than the other treatment programs (a ratio of only 6:1). Although scale numbers were still too low to cause concern, these areas will need to be watched closely in the future to determine if natural predation will be enough to keep SJS under control.

Brown almond mite numbers were highest in the "untreated" areas. This could be expected because dormant oil can kill mite eggs. However, BAM numbers were not serious and obvious feeding injury was limited to a few isolated trees. Even this amount of feeding could not be expected to cause economic levels of damage.

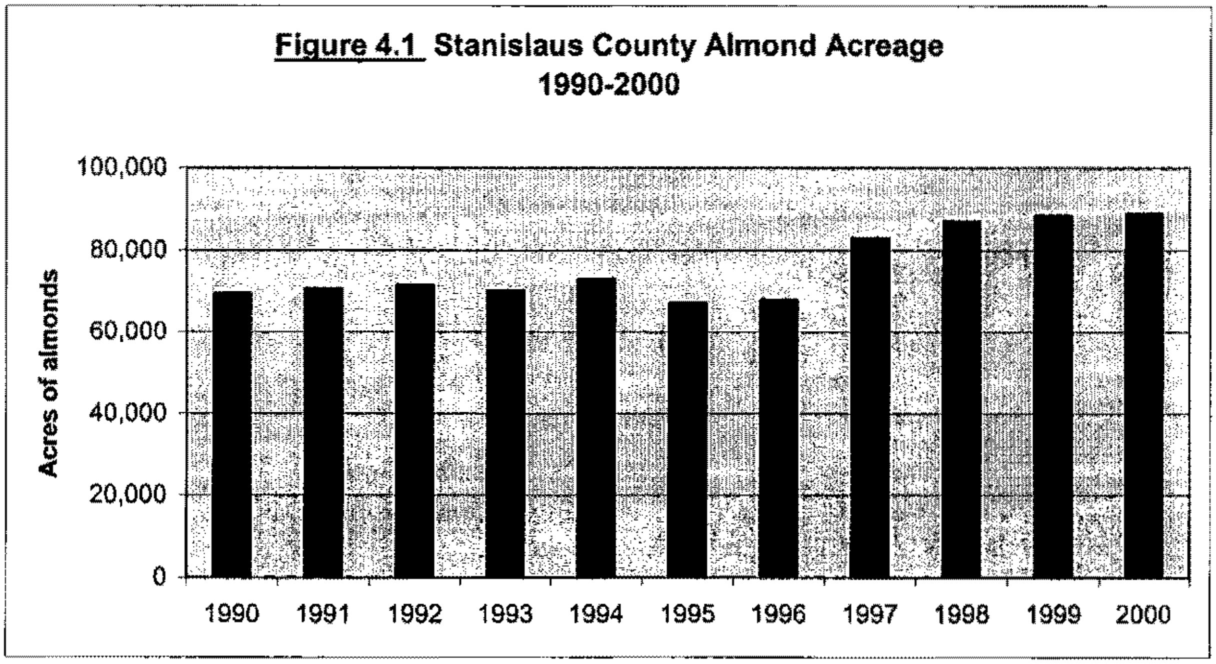
There was no clear relationship between pest management program and spider mite numbers. It has been shown in other experiments that the use of broad-spectrum insecticides, primarily pyrethroids, can lead to large increases in spider mites. This has not been observed in the three-year duration of this trial. However, miticides have been applied each year before mite levels have reached established threshold levels. This is largely because conventional miticides have lengthy re-entry and pre-harvest intervals (Omite is 28 days). This leads many growers to apply these materials for "insurance" even when mites are present in low levels. If a miticide is not applied and then mites build shortly before harvest, growers are unable to treat and thus risk defoliation. In addition, the use of different miticide materials with different efficacies and residual levels makes it even more difficult to interpret the effects of dormant and in-season sprays on mites. Beginning in 2002, one miticide with the shortest pre-harvest interval will be used in all treatment programs.

Very few ants were captured on the harvest sampling date even though no treatment for ant control was applied in the grower's standard program. This orchard had a moderate infestation of Fuller's rose beetle, which lays its eggs in micro sprinklers and clogs them. The entire trial area was sprayed with Lorsban shortly before harvest to control this pest. It is certain that this spray substantially reduced ant numbers in all treatments. It will be valuable to observe if the bait products hold ant populations down into the 2002 season.

In the spring, areas treated with and without dormant copper were examined for brown rot and shot hole diseases. No brown rot strikes were observed in any treatment. In addition, very few shot hole lesions were observed on the fruit and no treatment differences were detected. It is doubtful that dormant applied copper has a significant effect on brown rot or shot hole if a strong bloom-time fungicide program is maintained. We have shown over the past three years that almonds can be farmed without some of the more traditional broad-spectrum insecticides and still have very low damage to the crop, at least in cases where pest pressure is low. In addition, using only dormant oil and in-season sprays that do not harm scale parasitoids may better control SJS than a "conventional" program. However, programs that utilize newer reduced risk materials are often more expensive than using pyrethroids and organophosphate insecticides. In our trial, the "soft" program #1 using Success, Confirm and Savey was the most expensive program, a cost increase of 22% over the grower's normal practice. Soft program #2 utilizing Bt and Savey cost 9% more than the grower's normal practice. The cost increase in the Bt program was largely due to increased labor and equipment costs where two applications at bloom and in May were required instead of the normal single application required with more conventional insecticides. Under present economic conditions, almond growers cannot afford to adopt practices that increase their costs. The "untreated" program was the least expensive by far in this trial (only 13% of the grower's standard program). However, leaving orchards completely untreated increases the risk of experiencing periodic economic damage. Although there was very little insect feeding in the untreated areas in 2001, more years of observation are necessary to evaluate the long-term consequences of this practice. Better monitoring techniques to determine treatment thresholds for PTB and SJS need to be developed before almond growers can reduce pesticide usage with confidence.

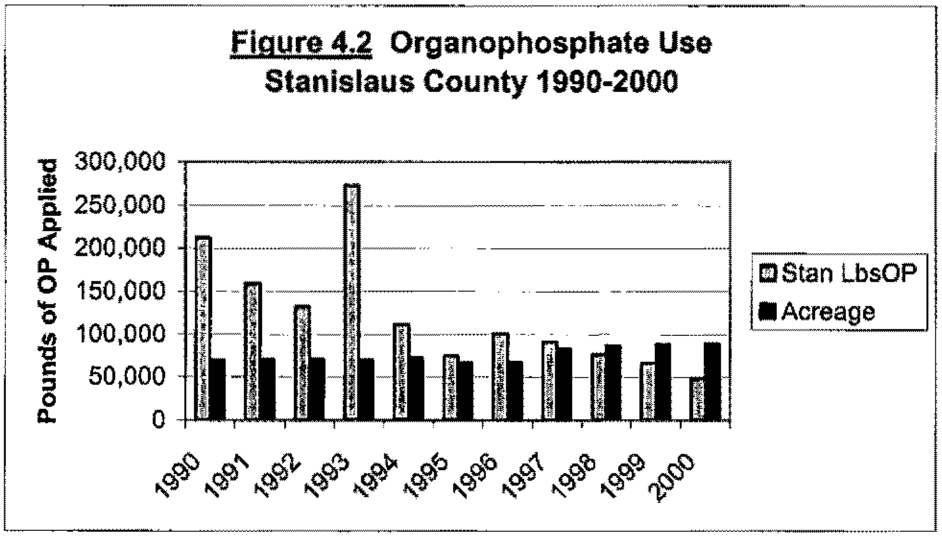
Stanislaus County Pesticide Summary 2001

Despite rapid growth in population in Stanislaus County throughout the past 11 years, the amount of harvested almond acreage has slowly increased. Figure 4.1 shows the trend of harvested acreage in Stanislaus County.



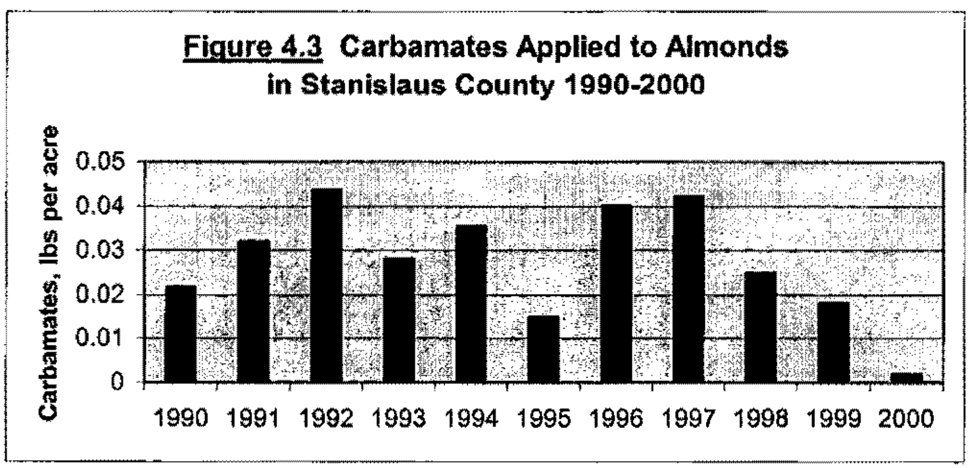
Organophosphates

Organophosphate use in Stanislaus County has decreased substantially from 1990 to 2000. OP use has decreased by a factor of five since the high of 1993 despite the steady increase in almond acreage. As stated above, the information regarding pesticide use was accessed via the California Department of Pesticide Regulation's website at www.cdpr.ca.gov. Figure 4.2 shows the trend of organophosphate use as compared to the harvested acreage in the county.



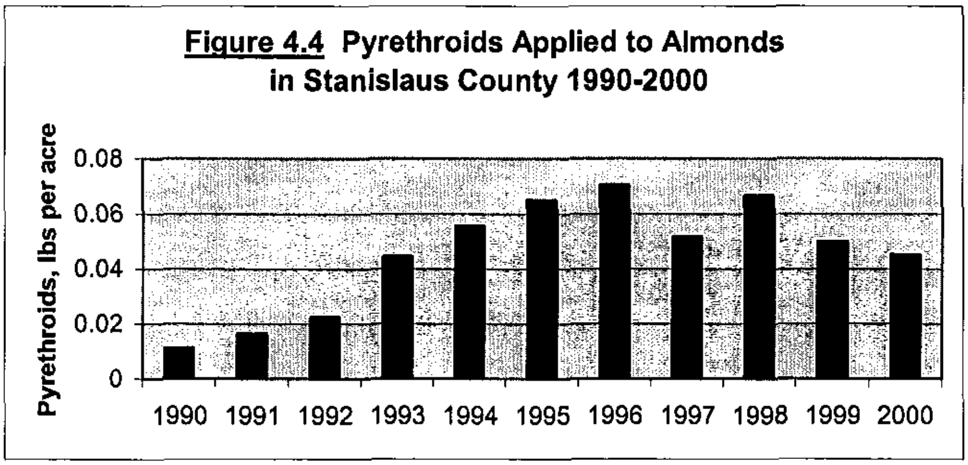
Carbamates

Pounds of carbamates applied per acre in Stanislaus County have fluctuated throughout the years but have shown a steep decline since 1997, with almost none used in 2000. Figure 4.3 shows the trend of carbamates in Stanislaus County from 1990-2000.



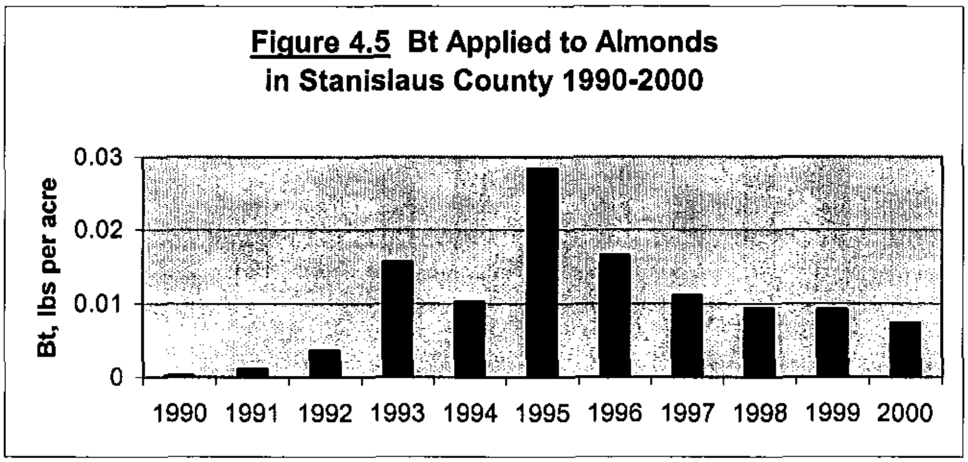
Pyrethroid

Pyrethroid applications in Stanislaus County have risen since 1990, but have decreased since 1998. Figure 4.4 shows the pyrethroids used in pounds per acre in Stanislaus County.



Bt

Bt use per acre in Stanislaus County appears to have peaked in 1995 and then has shown a steady decline in use. Figure 4.5 shows the trend of Bt use per acre in Stanislaus County.



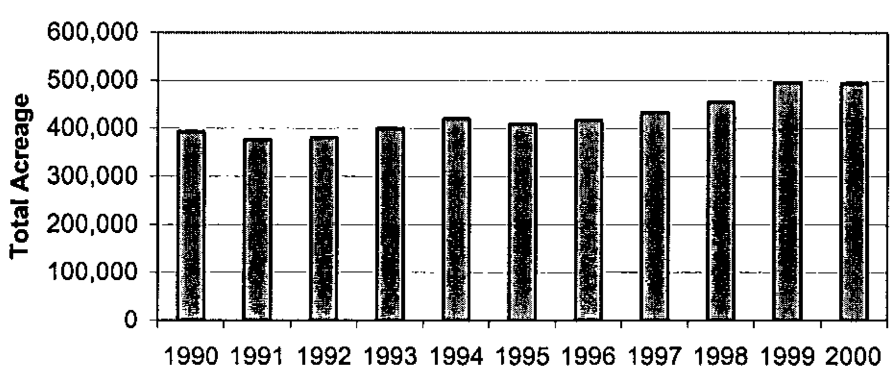
Task 5: Pesticide Use Reports

In a report written for the Almond Board of California by Susan Bassein and Lynn Epstein both from the University of California Davis, titled "Reduction in Use of Organophosphates in Almond Orchards During the Rainy Season in California" shows that the amount of organophosphates are being applied with much more discretion today than in the early 1990's. By accessing the Pesticide Use Reports from 1990 to 2000, they have shown a reduction of growers using organophosphate dormant sprays. The researchers also show the mass of organophosphates applied during the dormant season was reduced 22 to 57% depending on the region. Furthermore, they reported a significant increase in use of Bt. The results are promising, indicating the positive and proactive response the almond industry has adopted in order to curb organophosphate use.

The results reported here in Year 3 of the Almond PMA show a trend even more positive than the report submitted by Bassein and Epstein. According to the Department of Pesticide Regulation, 2000 was the second consecutive year of reduction in pesticide use statewide. The report highlights almonds as having reduced pesticide use more than any other crop, with a decrease of more than 3 million pounds from 1999 to 2000. With the increasing amount of commercial almond acreage, the amount of organophosphates applied per acre are decreasing and the use of Bt is remaining fairly steady across the state in commercial almond orchards. Figure 5.1 shows the increase in commercial almond acreage in the ten major almond growing counties in California: Butte, Kern, Stanislaus, Colusa, Fresno, Glenn, Madera, Merced, San Joaquin, and Tulare.

Organophosphates, carbamates, pyrethroids and Bt use were tracked in almonds using the Pesticide Use Reports from 1995-2000 and reported here as pounds per acre.

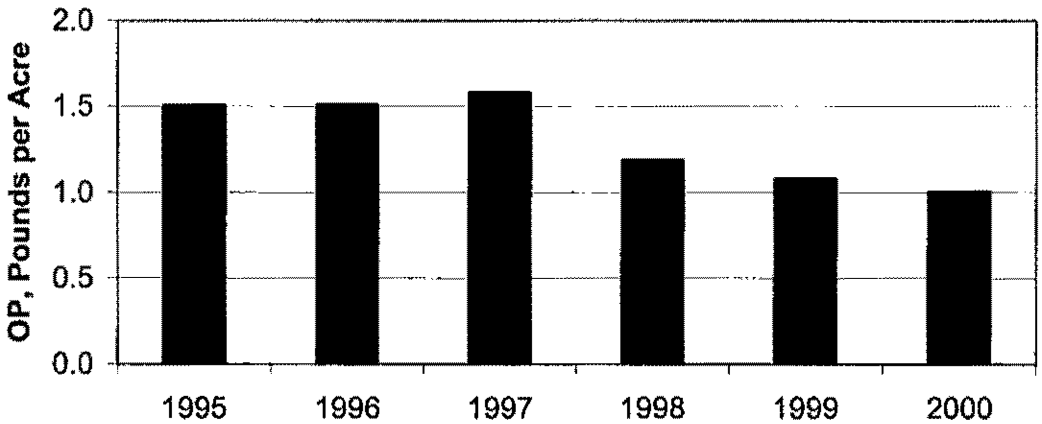
Figure 5.1 Almond Acreage in Ten Almond Producing Counties



Organophosphates:

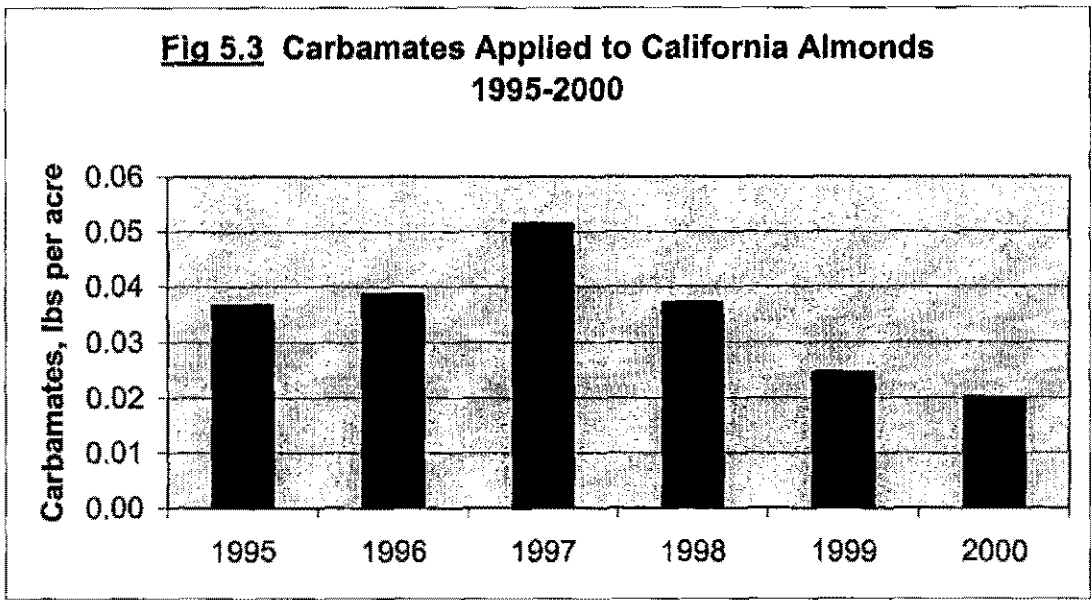
Organophosphates used in these results are: azinphos-methyl, chlorpyrifos, ddvp, diazinon, disulfoton, fenamiphos, malathion, methidathion, naled, parathion, and phosmet. Since each county has various amounts of almond acreage, pounds per acre were analyzed. Figure 5.2 shows the use of organophosphates on California almonds from 1995-2000. Most organophosphate use occurs in January and July, corresponding to the dormant and hullsplit sprays. Total organophosphate use has dropped due in part to growers realizing that a dormant spray of organophosphate is not always needed.

Figure 5.2 Organophosphates Applied to California Almonds 1995-2000



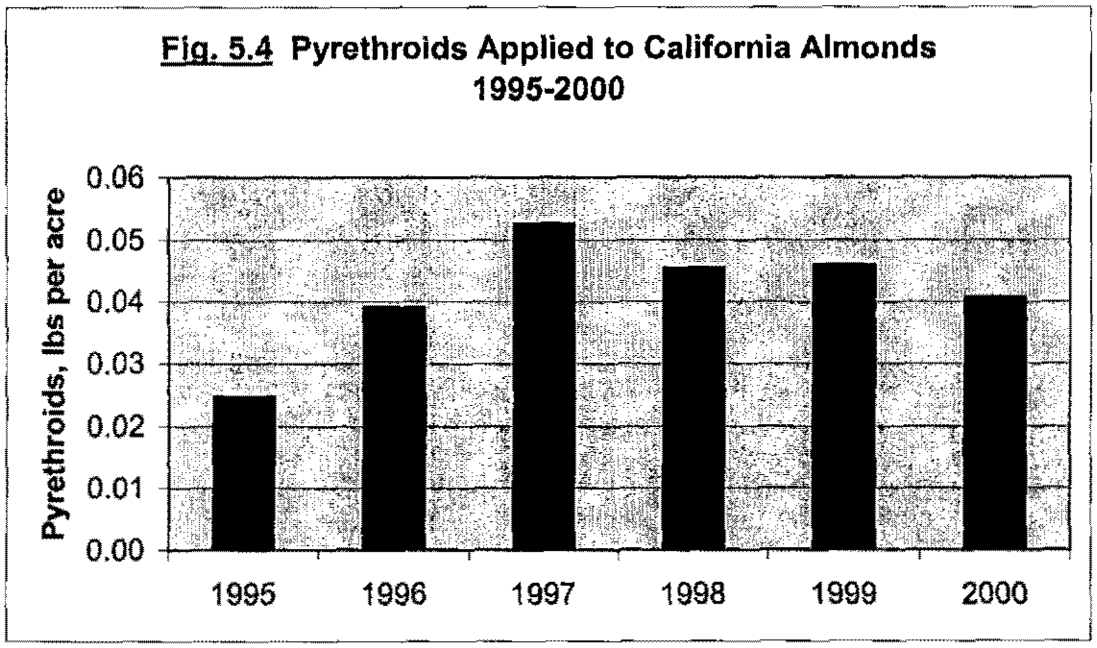
Carbamates:

Carbamates used in these results are methomyl and carbaryl. Carbamate use in California has been reduced by more than half since 1997, Figure 5.3. January and July have significantly more carbamate applications than any other month. Again, these two months correspond to dormant and hullsplit sprays.



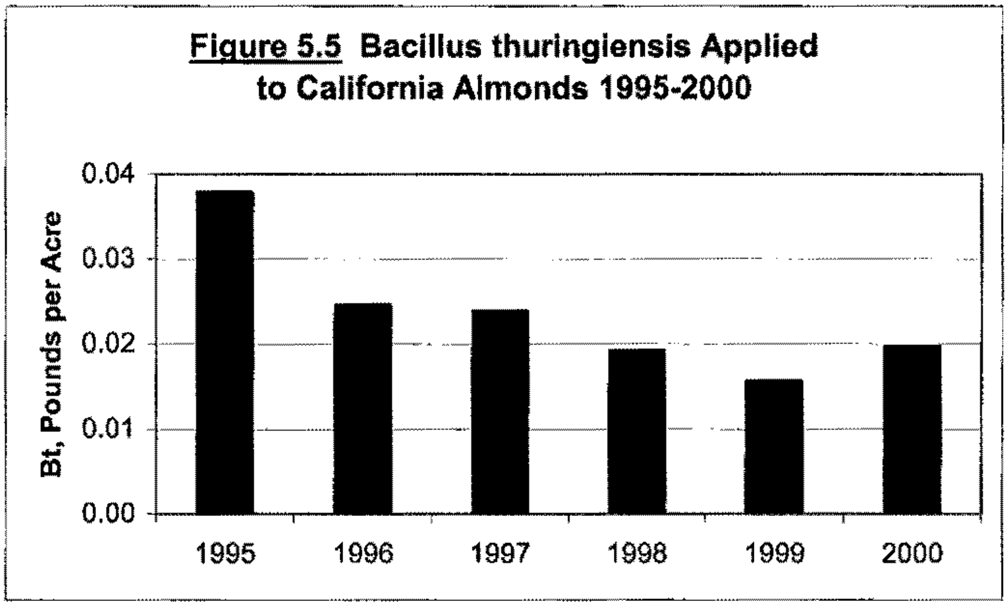
Pyrethroids:

Pyrethroids used in these calculations are esfenvalerate, permethrin and pyrethrin. The pounds per acre used in 1995 to 2000 are shown in Figure 5.4



Bacillus thuringiensis:

There has been a significant increase in the use of Bt in commercial almonds since 1990 when there were no applications of Bt to almonds in the state. The pounds of Bt applied per acre have risen steadily from 1990 to 1995 when virtually no Bt was applied statewide and after 1995 remains fairly steady, given the increase in new plantings, Figure 5.5. Bt is applied mainly in February and March. Bt use spikes again in July.



Task 6: Outreach and Extension

Outreach and the extension of information are the basis for California almond growers to gain confidence in reduced risk practices. Conducting PMA Advisory Team meetings, field meetings, and providing information via newsletters, status reports, and articles play an important role in the Almond PMA outreach activities.

Attendance at field day meetings reflects the optimism and success of the PMA program. Each region organizes at least two meetings per year. One meeting is conducted in the spring and the other is a dormant/winter meeting. The winter meetings coincide with the seasons where insecticidal sprays are being applied and therefore are relevant for discussing the interaction of reduced risk pest management and the reduction of pesticide runoff into the state's waterways.

Each PMA site holds a field meeting during the late spring/early summer with pest management demonstrations and hands-on displays. These meetings are valuable because attendees can see the successes of the reduced risk treatments and talk to the PMA grower/cooperator about his experiences in the project. Reduced risk alternatives to traditional in-season insecticides are thoroughly explained. Emphasis is placed on proper insect identification and using weather and monitoring data to properly time sprays. The Kern site held a meeting on May 1, 2001, the Stanislaus site on May 10, and the Butte site's meeting was June 7.

Two dormant season field meetings were held for the Sacramento Valley almond growing area. Two-hour meetings were conducted at Live Oak and at Hamilton City on Nov. 14th and on Nov. 17th, 2000, respectively, each attracting about 50 growers. On November 22, Kern County had a dormant spray meeting in Bakersfield, which was attended by 42 growers and 23 PCA's. Stanislaus held a dormant meeting on December 14 with about 80 attendees. These meetings also emphasized monitoring of pest populations and included demonstrations affecting dormant spray decisions. In all meetings, the organization, successes and lessons learned from the statewide Almond PMA was described. Participants were interested in the regional differences among the three statewide PMA sites. Newsletters are an important component for relaying updates and informing growers, some who may not be active in the PMA, on issues regarding almonds in California. Many of these newsletters are regional, thereby relaying pertinent information to local growers. Some newsletters are sent via mail, others are status reports or quarterly reports reported by the Almond PMA to the Department of Pesticide Regulation that can be accessed via the World Wide Web. News articles and news coverage relating to the Almond Pest Management Alliance benefit the program by reaching a large audience in popular agricultural periodicals.

Many growers and those involved with the almond industry subscribe to or have access to agricultural periodicals. The Almond PMA makes good use of this medium for educating and updating many of those growers who do not actively participate in the Almond PMA. Through this extensive outreach effort, we hope to gain interest in the program, thereby increasing the numbers of growers voluntarily adopting reduced risk techniques in some capacity.

An article in Ag Alert, January 2001, the California Farm Bureau's newsletter, and an article in February's California Farmer, highlighted the two dormant season field meetings that were held in the Sacramento Valley in the year 2000. The successes of the Almond PMA in helping to educate the need to reduce winter pesticide runoff was mentioned as well as detailed instructions on how to decrease fertilizer costs. Also in February, the Modesto Bee printed an article about the Almond PMA helping to reduce pesticide use without impacting farmers economically. In Rohm and Haas's spring newsletter PCA Pipeline, information about the upcoming approval of their product, Confirm, for use on almonds, was associated with the move away from organophosphates touted by the Almond PMA. The Almond Board of California's spring newsletter included a page detailing the structure and funding of the PMA and noted some successes of the program's innovative approaches to reducing conventional broad-spectrum pesticides used in almonds. The Department of Pesticide Regulation released a report on October 23, 2001 detailing a second consecutive year of reduction in pesticide use statewide. The report highlight almonds as having reduced pesticide use more than any other crop, with a decrease of more than 3 million pounds from 1999 to 2000. Pesticide use reduction was also the topic of an article in the Modesto Bee on October 25. This article also points out that California almond growers are especially aggressive in their efforts to reduce the use of potentially harmful chemicals. It also detailed local pesticide reduction in Stanislaus County, as well as describing reduced risk methods of crop protection and the use of monitoring and timing information to make spray decisions.

DISCUSSION

The third year of the Almond Pest Management Alliance has clearly shown that the Almond PMA continues to be an effective demonstration and education resource for almond growers and Pest Control Advisors interested in learning about reduced risk systems for crop protection. The impending loss of traditional crop protection tools due to FQPA implementation, the possible risks to water quality from some dormant sprays, and a growing interest in farming with more sustainable practices all indicate that the PMA project is important to farming California almonds.

The Almond PMA in its first year demonstrated the power of pooling resources to educate growers about reduced risk approaches. By working together, the various partners were able to reach more growers and Pest Control Advisors than any one individual organization could have reached on its own. UC farm advisors were able to have their limited resources expanded by the talents offered by PMA partners, whether it be in mailing out field day flyers, staffing sign-in booths, arranging for field day lunches or paying the salaries of field scouts performing the critical monitoring work.

The Almond PMA website provides a convenient and easily accessible location for all information related to the project. Web site usage statistics show that the site is accessed hundreds of time each month. The website provides information 24 hours a day, seven days a week to anyone with access to the Internet.

The Almond PMA in its second year built upon the alliance formed from the various partners involved. The management team continues to discuss and be proactive in the goal for reducing pesticide use in almonds. Each of the original regional demonstration orchards remained in the program demonstrating that growers are committed to reducing pesticide use. Each of the regional orchards kept the same overall program including some additions, which made the program better. For statistical purposes, the trapping performed in each region remained similar.

In the third year of the PMA, the regional demonstrations were continued, creating an extensive database of information about reduced risk scenarios that will be very valuable to almond growers. With three years of research, the PMA sites are an excellent demonstration that reduced risk programs in these particular geographic locations using lower inputs of organophosphate pesticides in many cases may result in levels of insect and pest damage that compare favorably with the conventional methods of growing almonds when sometimes use two or more pesticide sprays are used. By speaking with one voice on the critical issue of pesticide use, the Almond PMA has done much during the past three years to raise awareness of reduced risk farming practices among growers.

The Almond Board continues to support the Almond PMA program as one of its key high-profile activities that allows the industry to prepare growers toward a future of farming as some of the best land stewards in the State of California. The Almond Board continues to increase its own financial support of the Almond PMA project as the project costs increase and DPR's contribution remains stable or decreases.

The collective voice of the Almond PMA and its partners has been valuable in helping educate governmental regulatory agencies regarding the many complex issues involved in almond production. The PMA has proven to be a valuable platform from which the industry can educate such agencies as the Environmental Protection Agency, the State Water Resources Control Board, the regional Water Quality Control Boards, the USDA, the California Department of Food and Agriculture, and the California Department of Pesticide Regulation pertaining to almond production practices and the importance of controlling pests and diseases.

Project Summary Form

1) Proposal Title

To Promote a Reduced Risk System of Almond Production Through Alternative Practices

2) Principal Investigator

Chris Heintz

3) Alternative Practices

Pheromone traps and degree-day models to time sprays. Bt and insect growth regulators instead of OP pesticides. Predatory mites and oil sprays instead of miticide sprays. Cover crops planted to decrease runoff and increase water penetration. Winter sanitation to reduce need to spray for navel orangeworm.

4) Summary of Project Successes

California almonds had the largest pesticide reduction of all crops in 1999-2000. The Almond PMA has shown that growers, under certain conditions, and with low pest pressure and careful monitoring, can harvest economically successful crops with minimal pesticide use while incorporating reduced risk fungicide control.

5) Number of Participating Growers: 3
6) Total Acreage in Project: 329
7) Project Acreage Under Reduced Risk: 160
8) Total Acres of Project Crop: 329
9) Non-Project Reduced Risk Acres: 0
10) Number of Participating PCA's: 5
11) Cost Assessment

The average cost for the grower standard treatment blocks was $96/acre and the average costs for the reduced risk treatment blocks was $101.25/acre. Similar costs, but no more damage seen to the crop in reduced risk.

12) Number of Field Days: 5
13) Attendance at Field Days: about 400
14) Number of Workshops & Meetings: 2
15) Workshop Attendance: 123 total
16) Number of Newsletters: 2
17) Number of Articles: 7
18) Number of Presentations: 15, mostly by the Almond Board
19) Other Outreach Activities

Telephone and mail survey of almond growers to measure use of OP's and pyrethroids.

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Contract Number
Project ID
DPR ID#
Contract Manager
25th June 2001 Version