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IMPLEMENTATION OF BEST MANAGEMENT PRACTICES TO MITIGATE ORGANOPHOSPHATE (OP) PESTICIDE RUNOFF

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I1. Executive Summary:

The 319h project was complementary to a larger project funded by several sources and known as the Integrated Prune Farming Practices (IPFP) project. The IPFP was initiated 2 years before the 319h project started. The results reported here include data collected within the IPFP and 319 projects.

Due to the impending loss of many pesticides, stricter use regulations, and concerns over contaminating natural resources, the IPFP project was initiated to develop research, demonstrate, and implement alternative practices that reduce pesticide use and conserve natural resources.

Treatment threshold is the basis for reducing pesticide usage which may be discharged into the environment which is a 319 objective. Within IPFP, plant nutrition, and irrigation needs were researched and demonstrated but are not included in this report. Target pests germane to 319 include: San Jose scale, European fruit lecanium**,** leaf curl plum aphid, mealy plum aphid, peach twig borer, and oblique banded leaf-roller.

The past five years' results show that by monitoring and using treatment thresholds developed by this project, many pounds of pesticides and application costs could have been saved because either treatments were not needed, lower rates of insecticides could have been used, or non-organophosphate materials were effective. Within the five years, we estimate a total of 7,356,708 pounds of pesticide a.i. could have been saved. The growers directly participating in this project saved approximately 90,468 pounds of pesticide i.e. during the five years of this project.

Over the past five years, 113 educational meetings, which discussed progress and implementation of data being developed, were held for an audience of over 3,886 individuals interested in dried plum production. Thirteen newsletters were published and distributed to all 1,114 prune growers and about 500 related industry members in California about the project's progress. Electronic media was used in at least two counties to advise dried plum growers of pest status and "reduced risk" treatment options.

In 1999 Pest Control Advisors (PCAs) began evaluating the monitoring techniques used in this project. The PCAs generally agreed with the treatment thresholds but felt that many of the monitoring techniques took too long. Efforts were made to streamline the monitoring techniques for wider acceptance.

In 2004 additional grant support was provided by the State Water Resources Control Board and Cal-Fed that allowed PCAs and growers the opportunity to try the monitoring techniques developed and validated in this project. In all, project monitoring techniques were used on 1,200 dried plum acres by five PCAs, four growers and one irrigation consultant. An, end of season, survey filled out by those that used the various monitoring techniques indicated that they were all useful and acceptable.

The ultimate goal of this project was to get growers to make treatment decisions based on some type of monitoring system with the belief that this would reduce the amount of pesticides used in prune production. According to published records the pounds of pesticides used in prune production have been reduced during the course of this project.

A part of the project was initiated during the winters of 2002-03, 2003-04, and 2004-05 developing “Best Management Practice” (BMP) efficacy research in Butte County, California. This research was conducted by the California Dried Plum Board and the BMP studies are products of a DPR contract with the University of California at Davis.

The objectives of the studies were to 1) evaluate the efficacy of different widths of buffering vegetation strips in reducing the concentration of diazinon in surface runoff from orchards dormant sprayed with diazinon, 2) determine the efficacy of following pesticide application with a relatively small amount of sprinkler irrigation as a means of reducing the concentration of diazinon in surface runoff from orchards dormant sprayed with diazinon, and 3) determine if a relationship exists between the area of orchard being drained across a vegetated buffer strip and the resulting reduction in diazinon.

The storm pattern during the winter of 2002-03 was atypical and resulted in long periods of dryness between significant storm events. This, combined with the low clay content of the soil in the study orchard and well-established resident vegetation, resulted in no runoff being generated and no samples being collected that were of any scientific value.

The primary conclusion of the first study was that the uncertainties of natural rainfall and corresponding runoff events can potentially be avoided by utilizing sprinkler irrigation systems to simulate rainfall.

In Year 2, a sprinkler irrigation system was installed for the purpose of simulating a rainfall event that was sufficient to produce runoff. Data that resulted from the Year 2 samples strongly suggested that vegetated buffer strips do afford a measurable reduction of diazinon concentration in orchard runoff, that 10 m, 20 m, and 30m buffer strip widths were not significantly different from one another in terms of diazinon concentration in stormwater runoff, that post application sprinkler irrigation reduces diazinon concentration in orchard runoff although the difference was not statistically significant, and that there was no difference in diazinon concentration in orchard runoff flowing over a 20 m buffer strip that drained either 50 m or 100 m of orchard row sprayed with diazinon.

In year 3, the similar treatments were evaluated as in Year 2, but a number of changes were made. A different study site was selected wherein the orchard soil had a higher clay content and was therefore judged to offer greater runoff potential, and the length of the study plots and corresponding buffer strips were scaled down to half the size of those used in Year 2.

Data resulting from the Year 3 study elevated our understanding of Year 2 data that suggested that vegetated buffer strips do afford a measurable reduction of diazinon concentration in orchard runoff regardless of the width of the buffer zone. However, unlike Year 2 data that only accounted for diazinon concentrations in the initial 400 gallons of runoff from treated plots, Year 3 accounted for both concentration in the initial period of runoff and the total volume and concentration of diazinon in runoff from the treated areas. Diazinon concentration measured in the initial runoff were similar between treatments in both years, but this more complete accounting suggests that buffer zones of a given width are likely to become overwhelmed in their mitigation capacity as the size of their associated treated areas becomes larger. Therefore, implementing buffer zones of sufficient width to significantly mitigate diazinon in runoff from large orchards may not be practical, and would primarily be effective only when rainfall events would not produce excessive runoff. In orchards that have the capability of applying a sprinkler irrigation soon after diazinon has been sprayed are likely to realize sizeable reductions in the diazinon concentration in the runoff from subsequent runoff-producing storm events particularly if the pre-existing soil moisture is not high at the time diazinon is applied and predictably if the soil is a lighter leaching type soil rather than a heavy runoff type. The efficacy of this BMP would likely not be influenced by the size of the treated area. The results of this light sprinkling is also indicative of what might occur when a rainfall event not resulting in runoff occurs soon after the diazinon application. Light rainfall, sufficient to result in infiltration but not sufficient to produce rainfall, may well be beneficial in reducing subsequent load.

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IV. Project Goals:

- **Elevate grower awareness and appreciation of the problem of pesticide runoff from Prune Orchards.**
- **Demonstrate effective alternatives and management practices for grower implementation.**
- **Encourage implementation of currently available technologies that prevent OP runoff.**

V. Background

Introduction

Economics and regulations are creating change in the way dried plums are farmed. Cost of farming is going up, the industry is experiencing problems with over production and the industry will no longer pay for small, poor quality fruit. Federal acts, such as the Federal Clean Air Act, Federal Food Quality Protection Act and California's Proposition 65, Safe Drinking Water and Toxics Enforcement Act of 1986, dealing with water quality, establish pesticide expiration dates and/or threaten continued use of many pesticides. Regulations established by California Department of Pesticide Regulation (DPR) have created new requirements and certification for application of pesticides. Misuse of natural resources is becoming a common environmental concern.

Alternative low environmental risk pest control and cultural practices need to be researched and results demonstrated to encourage implementation. Treatment thresholds and monitoring techniques need to be discovered so that pesticide use and other cultural practices can be safely reduced, or at least used in a timely fashion when needed.

Project objectives:

1. **Demonstrate effectiveness of in-season pest monitoring to assess need for annual diazinon applications.**
2. **Demonstrate site management and in-season pest and cultural management practices that mitigate surface runoff from tree fruit orchards.**
3. **Provide widespread awareness of project results to the dried plum industry.**
4. **Determine changes in pesticide use as a result of goals 1, 2, and 3.**

Project design:

IPFP

The "Integrated Prune Farming Practices" (IPFP) project is a research/demonstration effort begun in 1998 where University of California (U.C.) Cooperative Extension dried plum farm advisors, U.C. Cooperative Extension IPM advisors, U.C. faculty members, U.C. Cooperative Extension specialists and industry representatives participated to advance economically and environmentally sound approaches to dried plum production. Support was initially provided by the California Dried Plum Board (CDPB). Additional support was provided by the Biologically Integrated Farming Systems (BIFS) program to expand the scope of this project became available in 2000. This project's accomplishments are reported here as they provided our basis for practices germane to the 319 project's objectives.

The IPFP project was conducted in Tulare, Madera, Fresno, Yolo, Sutter, Yuba, Butte, Glenn and Tehama counties. In most of these counties the project was conducted from 2000 through 2004. The project included 23 orchards designated as either research, demonstration, or implementation orchards chosen to best represent the dried plum industry in California. Research orchards were those where a specific research trial supporting IPFP goals was conducted. For example research controlling aphids with Zinc sprays was conducted in such an orchard. Demonstration orchards are those where two dried plum farming systems were compared: 1) the “conventional” system (a grower’s normal practices with Asana/oil used for a dormant spray) and 2) a “reduced risk” system where pest control and cultural decisions were made based upon monitoring protocols developed during the project. In 2000, 2001 and 2002 a small, untreated “check” area was also present at each site to help validate various components of the low-risk dried plum farming system. Implementation orchards are those project orchards that have converted totally to a “reduced risk” status. In 2003 and 2004 most cooperating demonstration orchards (19) became implementation orchards because the growers saw the “reduced risk” program was working and they no longer wanted to make the comparison. For this reason, there are very little comparison data available for 2003 and/or 2004. Demonstration and implementation orchards numbered 22 in 2000, 26 in 2001, and 26 in 2002.

There were additional sites monitored by pest control advisors (PCAs). The sites monitored by PCAs followed the “reduced risk” program only. The PCAs monitored the orchard using pest protocols developed specifically for PCAs. This was done to see if the monitoring techniques developed in this project would be acceptable to PCAs. PCAs evaluated the following IPFP protocols: dormant spur sampling, pheromone traps for peach twig borer, spring aphid monitoring, and the mite monitoring.

IPFP objectives germane to the 319 project:

1. Develop economic treatment thresholds, monitoring techniques and implement alternative pest control strategies that reduce use of “conventional” biocides.

2. Evaluate more effective use of fertilizers and natural resources.

3. Demonstrate a cover crop and hedgerow program.

4. Encourage adoption of “reduced risk” practices through outreach and extension efforts.

IPFP procedures germane to the 319 project:

Monitoring: Field scouts (6) monitored each project site for San Jose scale, European fruit lecanium, European red mite eggs, prune aphids, peach twig borer, oblique banded leaf roller, beneficial insects. These pests are normally controlled with OP’s some of which could wind up in water ways. . Reduced risk recommendations were made base upon the monitoring data. The cooperator agreed to apply these recommendations to the “reduced risk” part of the orchard. As new pest monitoring techniques and recommendations became available they were incorporated into the project. These new monitoring techniques and recommendations came from “satellite” research projects listed later and reported separately.

Evaluation: Evaluation of the two farming systems was carried out using data collected throughout each season, at final evaluations in July and at harvest. Final evaluations were made before any damaged fruit would fall from the tree. During the final evaluation 1000 fruit from each site was examined for the presence of scale and worm damage. Harvest evaluations were also made. In 1999 and 2000, P-1 grade sheets of the growers' entire harvest were used in the harvest evaluation and in 2001 and 2002; the Dried Fruit Association of California (DFA of California) evaluated dried fruit samples submitted from each orchard. In 2003 and 2004 project members evaluated 1000 fruit from each site at harvest for presence of scales and worms.

Education/outreach: A major effort was devoted to production of the "Integrated Prune Farming Practices Decision Guide". This publication is now in its third edition and includes sections describing orchard floor management and mitigation of pesticide runoff. In 2003 the material in this guide was presented to clientele at six, one day, "Prune Pest and Orchard Management Short Course" meetings. The six meetings were held around the state (Gridley, Yuba City, Woodland, Orland, Red Bluff and at the UC Kearney Agricultural Center in Parlier). Registrants received the Decision Guide binder, UCIPM Tree Fruit Pest Identification Monitoring Cards, a hand lens, a CD database for recording field monitoring information. A meeting evaluation was conducted.

Other meetings: Each year of the project information was extended at dried plum commodity days, field meetings and at other industry and academic meetings held throughout the state

Funding: We recognized the CDPB could not support this project to the extent needed to attract rapid, wide adoption of "reduced risk" practices by clientele. To this end, additional grant support from other agencies was sought to expand the project beyond the capabilities of the CDPB. However; securing other grant funding has been contingent upon prune industry support provided by the CDPB.

Industry survey: The degree industry implements orchard monitoring in the cultural decision process measures the IPFP project success – demonstrating the importance of monitoring when making pest management or other cultural decisions is the cornerstone of the IPFP project. Although we have no objective baseline data when IPFP began in 1999, the basis for initiating such a program was the common knowledge that dried plum growers' pest control decision process was indeed subjective often resulting in excess treatment. This created a growing concern for both economic and environmental consequences. For example, economic or treatment threshold levels that should "trigger" a decision process were essentially non-existent resulting in practices often being applied by: calendar, because the neighbor does it or, simply due to tradition. At the onset of IPFP, such management strategies, combined with burgeoning dried plum supplies, had reduced profitability margins. In order to have dried plums return an acceptable level of profit, new monitoring-based management strategies for careful and efficient use of inputs, including organophosphate pesticides, were required to reduce costs and environmental contamination. Through education/demonstration of appropriate pest monitoring, IPFP has replaced many conventional treatment strategies and provided grower access to an economically viable, environmentally sensitive decision process. Was the project successful?

In winter of 2003/2004 the CDPB, in cooperation with the U.C.'s Sustainable Agriculture Research and Education Program (SAREP), prepared and sent a survey to all dried plum growers (1114) in California, to determine the extent monitoring practices developed and promoted within the IPFP program were used in the 2002 season – presumably as a result of extensive educational and demonstration efforts.

Satellite projects: “Reduced risk” concepts needed to be researched before being demonstrated for implementation on a wide scale. Satellite projects, supported by IPFP to evaluate single aspects of “reduced risk”, (e.g. evaluating aphid control with soft chemicals) were established in one or more areas. Satellite projects germane to this 319 project are listed below but results reported separately.

2004

- Fall aphid control with low or below label rates of certain insecticides applied by air blast sprayer – Butte County.
- Fall aphid control with low or below label rates of certain insecticides applied by hand gun – Sutter County.
- Phytotoxicity of dormant oil sprays applied at different timings – Sutter County.
- Fall aphid control with low or below label rates of certain insecticides applied by air blast sprayer – Glenn County.
- Spring aphid control with oil – Butte County.

2003

- Fall prune-tree defoliation for aphid control – Butte County.
-
- Use of pheromone traps to measure oblique-banded leaf roller (OBLR) populations and predict fruit damage – Butte County.
-
- Evaluating Imidan and fall “dormant” applications for aphid control – Butte and Sutter Counties.
- Cost comparison of “reduced risk” or “conventional” approaches to pest monitoring and control – Statewide.

2002

- Controlling mealy plum and leaf curl plum aphids using reduced rates of diazinon and Asana with oil, in a dormant spray – Butte and Sutter Counties.
- Controlling mealy plum and leaf curl plum aphids by using zinc to induce early fall defoliation – Butte and Sutter Counties.
- Using pheromone traps to predict oblique banded leaf roller populations and fruit damage – Butte and Sutter Counties.
- Using water traps to catch fall returning aphids to determine exactly when they return to lay their over-wintering eggs - Statewide.

2001

- Controlling mealy plum and leaf curl plum aphids using reduced rates of diazinon and Asana with oil, in a dormant spray – Butte and Sutter Counties.
- Controlling mealy plum and leaf curl plum aphids by using zinc to induce early fall defoliation – Butte and Sutter Counties.
- Using pheromone traps to predict oblique banded leaf roller populations and fruit damage - Statewide.
- Literature and research review of prune aphid control using oils over the past ten

years - Statewide.
- Using water traps to catch fall returning aphids to determine exactly when they return to lay their over-wintering eggs - Statewide.

2000
- Biological control of mealy plum aphids using *Harmonia axyridis* lady beetles - Statewide.
- Pesticide efficacy trial using two types of oil and one type of pesticide for aphid control - Butte, Sutter, Glenn and Tehama Counties.
- Alternate year dormant insecticide program evaluation- Tulare County.
- A new aphid infestation-predicting model - Statewide.

1999
- Material efficacy for control of prune aphids using soft materials including a number of novel products not yet registered - statewide.

Prior to 1999:
- An alternate year dormant spray program to cut pesticide use in half - Tulare County.
- Aphid control using soft chemicals – Statewide.

VI. IPFP accomplishments germane to the 319 project:

Objective 1. Demonstrate effectiveness of in-season pest monitoring to assess need for annual diazinon applications.

1. Dormant Treatment Decision Guide

Situation: The dormant spray (usually and OP plus oil) has been in wide use because growers have been taught for many years this is the most efficacious spray they can apply. It: 1) kills a number of pests including: San Jose scale (SJS), peach twig borer (PTB), European red mite (ERM), mealy plum aphid (MPA) and leaf curl plum aphid (LCPA), and 2) is least harmful to beneficials. Also many dried plum growers apply a dormant spray because there is no good "reduced risk" alternative for control of MPA and LCPA.

Recently the dormant spray has been implicated in polluting natural resources. These findings suggested the dormant insecticide spray is being over used. A monitoring technique was needed to help growers decide if they required a dormant insecticide treatment.

We developed a dormant treatment decision guide:

Evaluation:

Aphids: During this project's course, various techniques were attempted to monitor and predict whether MPA and/or LCPA might occur in an orchard in the spring to determine need for a dormant spray. The following were researched:

1. Correlation between fall aphid abundance with spring aphid abundance.
2. Correlation between appearance of aphids in the fall and appearance of aphids in the spring.
3. The "Prather Model" that considered geographic regions and tried to account for

aphids flying to and from their alternate hosts in late summer/early fall. It also assumed that if an orchard had a high population of aphids in the spring, the grower would spray for them and there would a lesser population returning in fall resulting in fewer aphids the following spring.

4. Correlation of spring aphid counts in one year vs spring aphid counts the next.

No technique was totally reliable.

Scales: A sequential sampling, dormant spur monitoring technique involving sampling spurs in winter for the presence of SJS or EFL crawlers was developed by a statistician and is the other part of the "Dormant Treatment Decision Guide". This monitoring technique was evaluated for three years before implementation. The treatment threshold is based on the number of fruit spurs that can have scale before scale become present on the fruit. It is believed that presence of scale on fruit is an early sign of a growing scale population that might eventually damage the trees. The monitoring technique involves collecting 100 spurs in winter, examining 20 of them at a time for presence of SJS and EFL. If, after evaluating the first 20 spurs, a decision cannot be made, another 20 are evaluated and so on until a decision is made or all one hundred have been evaluated. In most cases the decision could be made after only looking at the first 20 spurs. The sequential sampling treatment threshold was based on 10 percent of the spurs out of 100 having live scale (see Tables 1 and 2).

Based on aphid monitoring techniques that had fairly high correlations (techniques 2 and 4) and dormant spur monitoring, two treatment guides were developed and used through 2003 (see Tables 1 and 2). Table 1 was intended for orchards that had been receiving annual dormant insecticide sprays. Table 2 was for orchards that had not been receiving dormant insecticide sprays. For the latter, the aphid treatment threshold was based on orchard history. If 10% or more of the trees had aphids during the last growing season, then a dormant treatment for aphids would be recommended.

Table 1. "Dormant Treatment Decision Guide" used until 2004 for orchards that had been receiving dormant sprays.

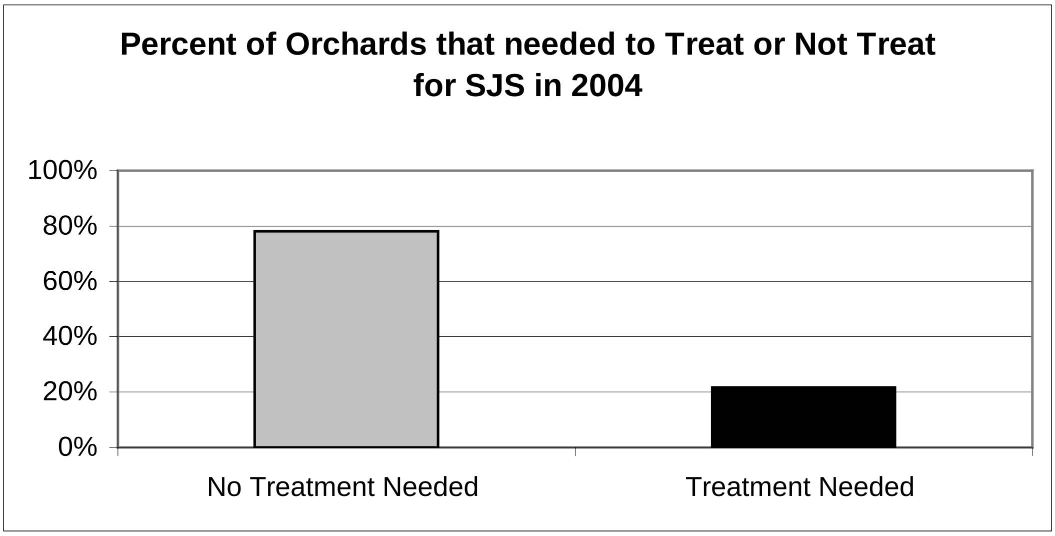
Dormant Treatment Decision Guide For Orchards That Have Been Receiving Dormant Insecticide Sprays in The Past			
Aphids present using methods 1, 2 or 3 (Y,N)	**Scale above Threshold**	**Reduced Risk Treatment Reccomendation**	**Conventional Treatment Recommendation**
N	N	Nothing	Nothing
N	Y	Dormant Oil	Dormant Insecticide + Oil
Y	N	Oil at Green Tip or Growing season Insecticide or Growing season Oil*	Dormant Insecticide + Oil
Y	Y		Dormant Insecticide + Oil
* Oil alone is not effective for Leaf Curl Plum Aphid once the leaves are			
1) One tree out of the 40 trees monitored in the fall has prune aphids.			
2) Orchard history indicates at least one tree had aphids last season			
3) One or more aphid eggs are found in the dormant spur samples.			

Table 2. "Dormant Treatment Decision Guide" used until 2004 for orchards that had not been receiving dormant sprays.

Dormant Treatment Decision Guide for Orchards That Have Not Been Receiving Dormant Insecticide Sprays in The Past				
Orchard History Indicates:		**Scale above Threshold**	**Reduced Risk Treatment Recomendation**	**Conventional Treatment Recommendation**
Below 10% of Trees Infested w/aphids	**Above 10% of Trees Infested w/aphids**			
x		N	Nothing	Nothing
x		Y	Dormant Oil	Dormant Insecticide + Oil
	x	N	Oil at Green Tip or Growing season Insecticide or Growing season Oil*	Dormant Insecticide + Oil
	x	Y		Dormant Insecticide + Oil
*Oil alone is not effective for Leaf Curl Plum Aphid once the leaves are curled.				

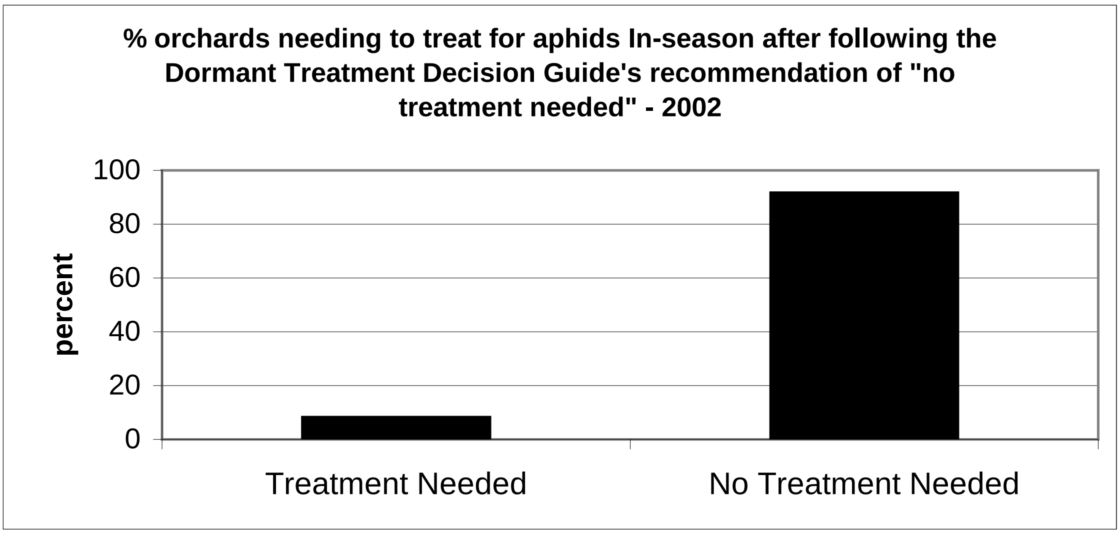
Results: 1) By following these guides, very few orchards needed to treat for SJS (Figure 1) and no orchard had an outbreak of SJS during the course of the project.

Figure 1. The percent of orchards that needed to be treated for SJS during the course of the project.



2) In 2002 the two guides failed to accurately predict the need to control aphids in many cases. Two orchards needed to treat for aphids in the spring that were not recommended to do so in the dormant season. Both orchards had not been applying dormant sprays and had no aphid history over the past three years but, never the less, aphids became a problem. Other growers that had no history of aphids in their orchards were also beginning to report aphid problems. Also, the use of these guides did not predict aphid outbreaks or the need to treat in any orchard that had previously used a dormant pesticide treatment (Figure 2).

Figure 2. In 2002 nearly 10 percent of the orchards had to treat for aphids after being advised there was no aphid problem.



Conclusions: This Dormant Treatment Decision Guide was not reliable in forecasting aphid outbreaks; there is no good way of knowing long-term history of aphid populations in those orchards. As a result of problems predicting aphid outbreaks, all cooperating growers were advised to control aphids in the dormant period or with oil during the bloom period in 2004 unless they had long term history of knowing their orchard was not frequented by aphids. This program was totally successful in 2004.

Dormant Treatment Decision Guide Revision

As a result of problems predicting aphid outbreaks, more work needed to be done with reduced rates of insecticides and/or alternative timings before significant fall rain and saturated soil; alternative pesticides have been tried in the past by several project members with little success. Focus for 2003-04 was a “satellite project” testing reduced rates of insecticides at an early treatment timing. A trial was set up and treated with an orchard sprayer on November 14th 2003 with the lowest label rates of the OP’s “Diazinon” or “Imidan” and below label rates of the pyrethroid “Asana”. These were compared to untreated plots for aphid control. Field data collected the following spring indicated 100 percent control of leaf curl plum aphid and mealy plum aphid, while in the untreated plots, 14% of the trees had colonies of leaf curl plum aphid and 49% of the trees had colonies of mealy plum aphid.

This early timing, before significant fall rain and saturated soil, with very low rates of insecticides may completely mitigate dormant spray runoff into surface waterways from dried plum growers orchards. Project farm advisors have been informing growers about these exciting results and encouraging growers to try this method of controlling aphids and these results will soon be incorporated into the “UC IPM Pest Management Guidelines for Dried Plums”.

As a result of problems predicting aphid outbreaks and the success of the November spray trials with low rates of insecticides a revised guide for all orchards was developed and is presented in Table 3.

Table 3. The "Dormant Treatment Decision Guide" developed in 2004.

"Dormant" Treatment Decision Guide for Prune Orchards				
Aphid Pressure Unknown Due to Past Dormant Sprays?[1]	**Long Term[1] Orchard History or Spur Sample Indicates Aphids? (No or Yes)**	**Scale Above Threshold**	**"Reduced Risk" Treatment Options**	**"Conventional" Treatment**
Yes		**No**	Low rates of insecticides without oil in Nov. **OR** 2X oil* (once at green tip and 10 days later). **OR**	Insecticide + oil
Yes		**Yes**	Low rates of insecticides + oil	Insecticide + oil
	No	**No**	Nothing	Insecticide + oil
	No	**Yes**	Oil (low pop[2]) **OR** Insecticide + oil (high pop[2])	Insecticide + oil
	Yes	**No**	Low rates of insecticides without oil in Nov. **OR** 2X oil* (once at green tip and 10 days later). **OR**	Insecticide + oil
	Yes	**Yes**	Low rates of insecticides + oil	Insecticide + oil
*** Oil alone is not effective for leaf curl plum aphid once the leaves are curled and will only suppress mealy plum aphid populations**				

[1] Long term is more than three years. To determine history of aphids in a dormant treated orchard:

1) Carefully observe trees throughout the orchard during growing season for the presence of any aphids. OR
2) Leave a few edge rows untreated and observe trees during the growing season for the presence of aphids.

[2] Low scale populations are when 10 – 15 percent of the spurs have live scale.
High scale population is when more than 15 percent of the spurs have live scale.

2. Pheromone Traps to Aid with Treatment Decisions

Situation: Pheromone traps have long been available but are generally underutilized by dried plum growers for treatment decisions. Pheromone traps are most commonly used to help determine treatment timing by calculating degree-days from a biofix and, in the case of SJS traps, are also used to assess the presence of beneficial insects. Rarely have they shown utility or have they been used to help determine if a treatment was needed. This information would be useful to dried plum growers who may need to treat for PTB, OBLR or SJS. This would also minimize un-needed OP sprays that may contaminate waterways.

A. San jose scale and beneficials

Evaluation: By monitoring SJS pheromone traps in spring, beneficial insects (*Encarsia (Prospatella)* and *Aphytis melinus)* and SJS males, were documented in each orchard each year of the IPFP project. For each "conventional", "reduced risk" and "check" orchard one SJS scale trap was monitored and 1000 fruit were examined in July and near harvest for evidence of SJS crawlers.

Results: Average numbers of male SJS and parasites caught in the "conventional", "reduced risk" and "check" orchards during the course of this project are presented in Figure 3. No significant difference in pheromone trap catches was ever found for male SJS between the "conventional", "reduced risk", and "check" orchards. Significant differences in beneficial insects did occur in some years. *Encarsia (Prospatella)* was caught in significantly larger numbers in "reduced risk" and "check" orchards than in "conventional" orchards in 2000. No live or parasitized SJS were found on fruit during pre-harvest fruit evaluation in 2004, 2003, 2002 or 2001. However, a few live SJS were found on fruit in the 2000 and 1999 crops. The average number of live and parasitized SJS found on fruit during this project is shown in Table 4.

Figure 3. Mean number of male SJS and SJS parasitoids caught each year during the project.

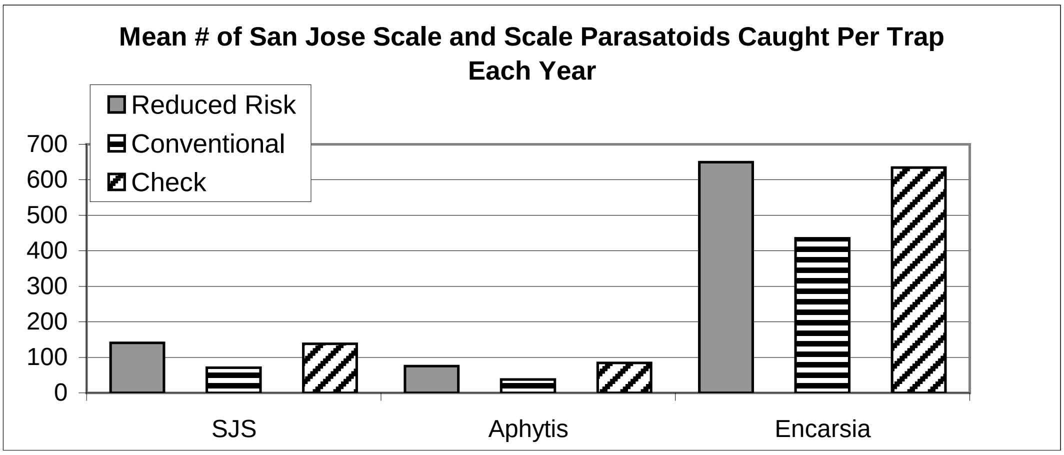


Table 4. Average number of live or parasitized SJS found on fruit each year of the project.

TREATMENT	% Fruit w/Live SJS	% Fruit w/ Parasitized Scale
“REDUCED RISK”	3	1
“CONVENTIONAL”	7	0
CHECK	.5	.5

Conclusion: Presence of more parasitoids in “reduced risk” and “check” orchards, where dormant insecticides had not been applied, indicates the dormant insecticide with oil treatment suppressed populations of these beneficial insects. Clearly, parasites can keep SJS in check after a few years of no dormant insecticide applications. The data also suggest that less than 150 male scales trapped during late winter-spring are low populations and should not require treatment since SJS crawler presence was not significant on the fruit. Although there were a few SJS on the fruit the first two years of the project, albeit of no economic consequence, in the last four years no SJS were found on the fruit. No SJS buildup was seen on the trees’ branches in any of the orchards during the course of this project.

Using SJS traps occasionally (not necessarily every year) can gave a good indication of SJS and scale parasite populations in the orchard and is a practice growers should follow. It appears however, from this project’s results, that SJS control is rarely required for dried plums.

B. Peach Twig Borer

Situation: Although research conducted during this project revealed a high correlation between total PTB trap catch in an orchard and damaged fruit at harvest, and a high correlation between live PTB larvae and PTB damage during the season, PCAs and growers said the monitoring techniques were too costly and time consuming. A new, less time consuming, PTB monitoring technique had to be discovered.

Currently PCAs and growers use PTB pheromone traps to obtain a biofix and then base their spray timing on degree-day accumulation. Project members took advantage of this and, over the past three years, developed and evaluated a one-time fruit monitoring technique that could tell the PCA if a PTB treatment was actually needed.

Evaluation: PTB pheromone traps were used to obtain a biofix and 400 degree-days after biofix, 1200 fruit were evaluated in each “conventional”, “reduced risk” and “check” orchard for presence of PTB larvae or PTB damage. Based on this fruit evaluation, a treatment decision was made based on a threshold of 1 percent of fruit having larvae and/or larvae damage. After the 2002 season, the threshold of 1 percent was found to be too conservative and was changed to 2 percent. This treatment, if needed, would lessen the chance of more worm or brown rot damage (associated with worms) later in the season. Alternatively, if the orchard history indicated that last year’s crop had significant worm damage then, two-bloom time *B.t.* sprays (one pre-bloom, at “popcorn”, and again ten days later) would be recommended. For each site, 1000 fruit were examined in July and near harvest for evidence of PTB larvae or damage in order to validate this monitoring technique.

Results: When the treatment threshold for PTB was set at one percent of the fruit with PTB larva and/or PTB damage at 400 degree-days from biofix, only one of the project orchards reached that level and was recommended for treatment. Of those orchards that did not reach the treatment thresholds only one orchard had any PTB larva and/or PTB fruit damage with 1.3 percent damage being detected in July. At harvest only one orchard, a different one, had any PTB larva and/or PTB fruit damage with 1.4 percent damage being detected. None of these orchards were treated and there was no significant difference in PTB damaged fruit between the "conventional" and "reduced risk" plots at harvest.

The one project orchard that was recommended for treatment had a previous history of over four percent fruit damage due to PTB larvae. The grower followed the projects recommendation of applying two bloom-time B.t. sprays (one at popcorn and again ten days later). Since the 400 degree-day fruit evaluation revealed 2.29 percent PTB damage in the "check" orchard, an additional PTB spray was recommended. This strategy was completely successful. The "conventional" and "reduced risk" plots had very low levels of PTB damage in the July and harvest evaluations while the "untreated check" had considerably more damage (Table 5). The Dried Fruit Associations grade sheet revealed no PTB damage in the "conventional" or reduced risk" orchards but the untreated "check" orchard had 1.3 percent PTB damage (Table 5). However statistically, there were no significant differences in the PTB damage between the three orchard programs.

Table 5. Control strategies and incidence of PTB damage in the only orchard during the course of this project that indicated a need for a 400 degree-day PTB treatment.

% Fruit with PTB Damage (Butte County Orchard) 2001			
Evaluation Timing	"Reduced Risk" Bt + Inseason Insecticide	"Conventional"Dormant Insecticide + Inseason Insecticide	Untreated Check
400 Degree-Days	0.8	0.3	2.9
July Evaluation	0.2	0.0	1.8
Harvest Evaluation	0.7	1.4	2.3
DFA Disease/Insect Offgrade	0	0	1.3

After the treatment threshold was changed to two percent of the fruit containing PTB larva and/or PTB damage at 400 degree-days from biofix, none of the orchards in this project needed to apply a growing season PTB treatment for dried fruit. The July and harvest samples found that no project orchards had PTB larva and/or damage over 1 percent. There was no significant difference between the "conventional" and "reduced risk" plots in the amount of PTB damaged fruit found at harvest in 2003 (Table 6). There was virtually no PTB damage in the "reduced risk" orchards in 2004 (data not shown).

Table 6. Mean percent fruit with PTB larvae and/or damage present (2003).

Treatment	400 Degree-Days	July	Harvest
Reduced Risk	0.02	0.17	0.06
Conventional	0	0.01	0.02

Conclusions:

- Fruit monitoring, 400 degree-days after PTB biofix, can be a useful tool in determining treatment necessity and timing.
- A 2 percent treatment threshold is very conservative because there was nearly no visible damage to the fruit at harvest in any year of the project.
- PTB is rarely an economic problem in dried plum orchards regardless of dormant treatment

C. Oblique Banded Leaf Roller (OBLR):

Situation: Prior to investigations undertaken in this project, it was unknown how OBLR pheromone traps and fruit monitoring might be used to determine need for an OBLR treatment.

Evaluation: Research, using OBLR trap catches and fruit monitoring, was conducted and evaluated each year like the PTB research described above. A one-time sample could not be used because exact degree-days for evaluating presence of OBLR or OBLR damage in dried plums were unknown. To determine best single evaluation timing for presence of OBLR larva and/or damage, 1200 fruit were monitored each week in each orchard for three weeks starting at 690 degree-days after biofix. OBLR were monitored for five weeks in 2003. At the best evaluation timing a treatment decision was made based on 1 percent (later raised to 2 percent) of fruit with OBLR larvae or OBLR larval damage. Alternatively, if the orchard history indicated that last year's crop had significant worm damage (more than 2 percent) then, two-bloom time *B.t.* sprays (one pre-bloom at "popcorn" and again ten days later) were recommended. For each site, 1000 fruit were examined in July and near harvest for evidence of OBLR larvae and/or damage to validate this monitoring technique.

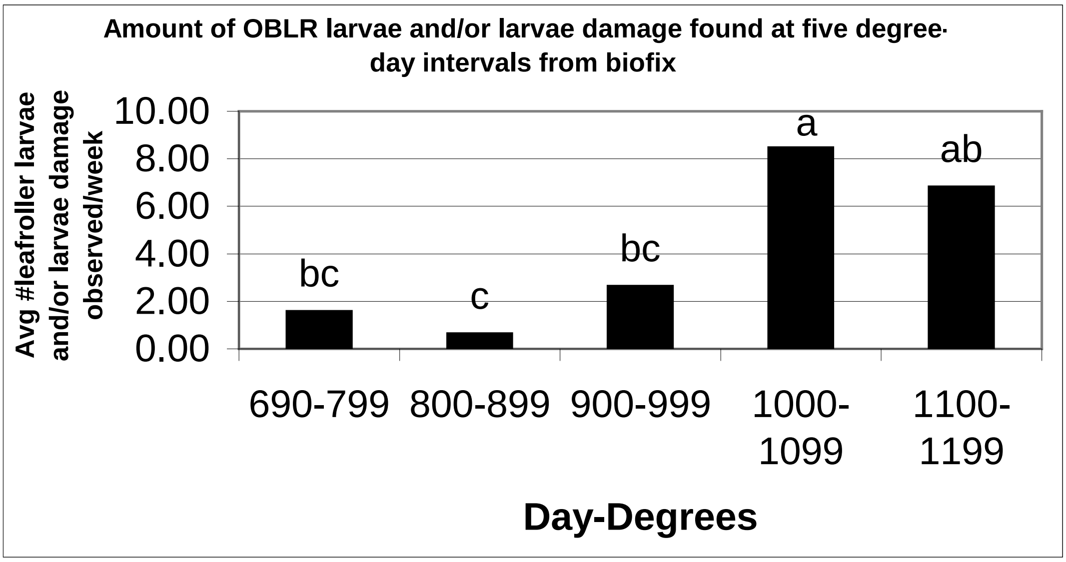
Results: When fruit were evaluated for three weeks, beginning at 690 degree-days after biofix, none of the project orchards reached the 1 percent treatment threshold so none needed to apply a growing season OBLR treatment. In the July sample, six orchards had OBLR larva and/or damage over 1 percent with 2.5 percent being the highest and at harvest five orchards had OBLR larva and/or damage of over 1 percent with 2.5 percent being the highest. However, there were no significant differences between "conventional", "reduced risk" or "check" orchards in amount of OBLR damaged fruit found at harvest. Table 7 shows average percent of fruit with OBLR damage or larva present from all project orchards.

Table 7. Mean percent fruit with OBLR damage present (690 Degree-Days + 2 weeks, July and Harvest Final Evaluations).

Treatment	690 Degree-Days + 2 weeks	July OBLR Damage	Harvest OBLR Damage
Reduced Risk	0.43	0.57	0.52
Conventional	0.31	0.32	0.42
CHECK	0.43	0.57	0.52

When fruit were evaluated for five weeks, beginning at 690 day-degrees after biofix, 900-999 day-degrees from biofix was found to be the best time to evaluate for presence of OBLR larvae and/or damage (see Figure 4). This timing was the beginning of the population rise.

Figure 4. Amount of OBLR larvae and/or larvae damage found at five degree-day intervals from biofix.



Using the 900-999 degree-day monitoring timing in 2003 and 2004, no treatments were recommended since no orchard exceeded 2 percent larvae and/or damage. The July and harvest samples found no orchards with OBLR larvae and/or damage over 1 percent. There were no significant differences between “conventional” and “reduced risk” orchards in the amount of OBLR damaged fruit found at harvest, July or at 900-999 DD (see Tables 8 and 9).

Table 8. Mean percent fruit with OBLR larvae and/or damage present (2003).

Treatment	936 DD	July	Harvest
Reduced Risk	0.77	0.20	0.14
Conventional	0.70	0.02	0.07

Table 9. Mean percent fruit with OBLR Larvae and/or damage present (2004).

Treatment	900-999 DD	July	Harvest
Reduced Risk	0.22	0.36	0

Conclusion:

- Fruit monitoring at 690 degree-days after biofix using pheromone traps is too early to get an accurate reading of OBLR damage. Fruit monitoring at 900-999 degree-days after biofix is the best time to evaluate for OBLR. This monitoring technique can be a useful tool in determining treatment necessity and timing.
- The 2 percent treatment threshold is considered conservative since worm damage at harvest was negligible.
- It appears OBLR is rarely an economic problem in dried plums.

3. Spring Prune Aphid Monitoring

Situation: Without a dormant insecticide and oil treatment it would be important to be able to assess MPA and LCPA populations' during the growing season to determine if treatments would be needed.

Although it has been reported MPA causes fruit cracking, there is no documented evidence to support this. Knowing damage these aphids cause would be important in determining need for control measures.

Evaluation: Beginning in April, a random sample of 80 trees per project site was observed weekly to determine presence of LCPA and MPA. The treatment threshold was 10 percent or more of the trees having aphids in 2000 but in 2001, the treatment threshold was changed based on research done by Dr. Nick Mills to more than 20 percent of trees with "significant" aphid infestations. Significant was defined as trees with aphids covering 10 percent or more of the tree surface. Treatment recommendations ranged from an oil treatment to suppress MPA, to an insecticide treatment to eliminate MPA or LCPA.

A statistician developed a sequential observation technique for aphids from project data. Sequential observation allows for a small number of trees (20) to be observed. From this small sample if the treatment threshold was reached and a decision to treat was made, then sampling could stop. If MPA and/or LCPA aphid levels were determined to be very low, sampling can also stop. If MPA and/or LCPA levels were moderate (more than very low, but not enough to call for a treatment) then additional trees (10) needed to be observed until a decision could be made or 80 trees had been observed.

After a few years of using the sequential observation technique, it was discovered that project scouts and PCAs were taking too long to complete the sequential aphid sampling. To correct this, the sequential observation technique was improved in 2003 and 2004 by introducing a "timed" search. The initial search was for 10 minutes, the approximate amount of time it should take to monitor 40 trees. If a decision couldn't be a made an additional five minutes would be spent looking at more trees. The total time allowed for monitoring was 20 minutes.

To determine to what extent MPA caused fruit cracking, 40 fruit (from up to 25 trees) were examined in August from trees infested by MPA, and 40 fruit (from up to 25 trees) from trees not infested by MPA. For example: if only 10 trees in the orchard had MPA, then only 10 trees not having MPA would be evaluated.

Results: During this project, eight orchards were correctly identified as having growing season aphid populations that exceeded the treatment threshold. Treatment recommendations were made in all eight orchards. However aphid control was varied due to the course of action that each grower took. One orchard, with LCPA, was being farmed "organically" and a new organically approved insecticide that was used did not work. Another orchard had a MPA problem and an oil treatment gave satisfactory control. An oil treatment failed to control LCPA in a third orchard. Five other orchards also exceeded the growing season treatment threshold for aphids; however these growers chose not to apply a treatment.

Average incidence of aphids among cooperators through the course of the project is shown in Table 10.

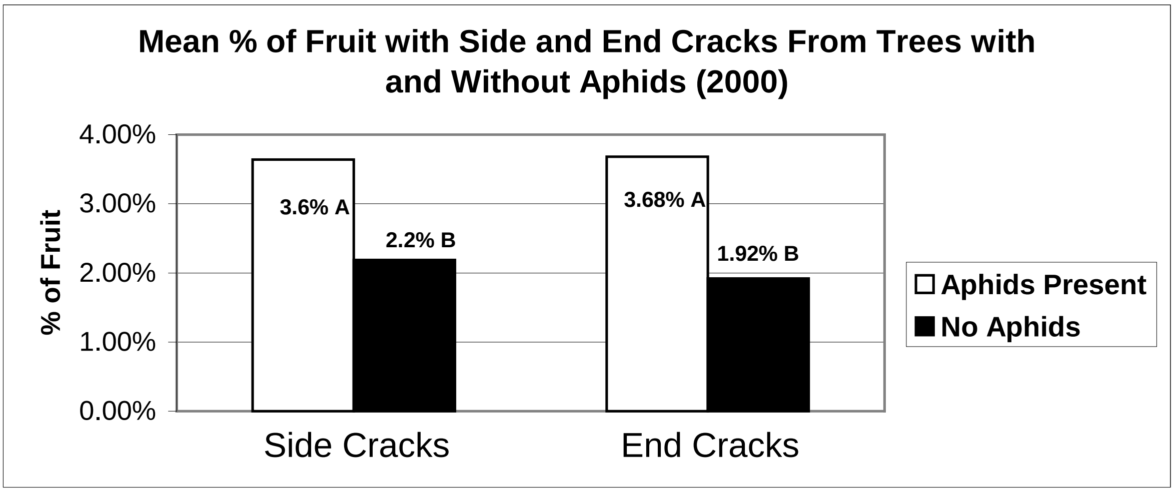
Table 10. Average incidence of aphids among cooperators.

Aphid control program	% of orchards with few aphids	% of orchards with significant aphids above treatment threshold
No program for aphids	0	100
"Reduced Risk" program for aphids	62.8	12.2
Applied traditional dormant spray	30.8	0

The timed search aphid sampling technique was compared to the sequential sampling method of looking at all 80 trees and produced the same results.

Although every year there was a numerical trend for more cracked fruit on trees that had aphids, 2000 was the only year that showed a statistically significant difference in the amount of fruit with side cracks and end cracks. Trees with MPA present had significantly higher levels of side cracks and end cracks than did trees without aphids (see Figure 5). That year also had the highest MPA populations at project sites.

Figure 5. Cracked fruit associated with aphids.



Means not followed by a common letter are significantly different from each other at the 95 percent level of significance according to Duncan's Multiple Range Test for Mean Separation.

Conclusion:

- The new sequential observation and timed search techniques for presence of aphids gave a good indication of aphid population levels and if a treatment was needed.
- All orchards that did not apply a dormant, delayed dormant or bloom treatment for aphids in 2003 and 2004, had a treatable level of aphids during the growing season. Of the orchards that used the original "Dormant Treatment Decision Guide," 12.2 percent had a treatable level during the growing season. This prompted the 2004 revision of the "Dormant Treatment Decision Guide" as described earlier in this report (see page 14).
- The growing season treatment threshold (based on 20 percent significantly infested trees) appears to be fairly accurate.
- Even though there was not always a scientifically statistical difference, trees with MPA always had more cracked fruit than trees without MPA.

4. Quality and Harvest Evaluation:

Situation: In order to evaluate the "reduced risk" program, fruit quality and harvest data were compared to sites farmed "conventionally" to see if there were any negative or positive effects.

Evaluation: In the project's first year, quality data were obtained from growers' P-1 grade sheets. However, these grade sheets were difficult to obtain from the grower, made harvesting more complicated, and processors began charging growers for delivering small lots of fruit. Additionally, it was impossible to separate disease and insect damage; it was combined on the P-1 grade sheets. In 2001 and 2002, the Dried Fruit Association of California (DFA) provided quality analyses of harvest samples submitted from each plot. This was an improvement but in 2003, DFA required a fee be paid for grading project samples. In 2003 and 2004, project scouts gathered fruit quality data at harvest by examining 1000 fruit per site and recording the number of fruit with scale (live or damage), cracks (side or end), and worm damage. Three 100-fruit samples were also taken from each site and evaluated for fresh to dry ratio, dry fruit count per pound, soluble solids and fresh fruit flesh pressure. Beginning in 2001 the only yield data gathered were average dry tons per acre production from the project orchards reported to project scouts by cooperating growers.

Results: Regardless of how fruit quality was evaluated, there were no significant differences between means of any treatments ("reduced risk", "conventional", and/or "check") in soluble solids, fresh to dry ratio, fresh fruit flesh pressure, presence of worm damage, or presence of fruit cracks in any year of the project except 1999 where "reduced risk" plots averaged slightly larger dried fruit. Fruit quality data for 2004 and 2003 is shown in Tables 11 and 12.

Table 11. Average fruit quality from all "reduced risk" sites in 2004.

Mean 2004 Dried Fruit Quality Data							
	Soluble Solids	Dry Away Ratio	Pressure (PSI)	% of Fruit with Brown Rot	% of Fruit with Worm Damage	% of Fruit with SJS Damage	% of Fruit with Cracks
Reduced Risk	23.95	2.90	4.22	0.44	0.44	0	0.28

Table 12. Average fruit quality from all "reduced risk" and "conventional" sites in 2003.

Mean 2003 Harvest and Quality Data								
	Soluble Solids	Dry Count/Lb	Dry Away Ratio	Pressure (PSI)	% of Fruit with Brown Rot	% of Fruit with Worm Damage	% of Fruit with SJS Damage	% of Fruit with Cracks
Conventional	22.17	68.41	3.14	3.92	0.24	0.09	0	1.93
Reduced Risk	21.69	65.66	2.99	3.64	0.69	0.20	0	1.66

Conclusion: Based on the pest management data obtained throughout the course of this project no adverse fruit quality or yield affects have occurred using the "reduced risk" program.

<u>5) Demonstrate a cover crop and hedgerow program</u>

At the onset of IPFP, many dried plum farmers were experienced with cover crops. The CDPB was an initial sponsor of The Nature Conservancy's (TNC) Biological Prune Systems (BPS) project that included cover crops and wildlife development. With the inclusion of the BPS project in the formation of the IPFP project through the SAREP BIFS Grant, ten of the initial growers were already using cover crops on their initial IPFP acres.

Starting in 1998 the USDA Natural Resources Conservation Service (NRCS) awarded the CDPB an Environmental Quality Incentives Program (EQIP) grant, the first of three. The three years of EQIP funding allowed IPFP to have a robust cover crop, filter strip, hedgerow, and wildlife friendly program statewide. During this time, these environmental practices were the primary feature at 28 meetings all of which were sponsored or cosponsored by the CDPB. These meetings drew in excess of 1,000 farmers, landowners, agencies, and reporters. In addition to the meetings, there was television coverage by Channel 12 News, multiple press releases announcing the meetings, 14 follow up articles in regional and statewide newspapers and magazines, including the front-page story by *California Farmer*, January 2000.

A new chapter titled "Orchard floor Management" with a section called "Dried Plum Cover Crop Selection Guide" has been included in the third edition of the "Integrated Prune Farming Practices Decision Guide"

Cover Crop/Buffer Strip Program

A third of IPFP growers use cover crops (native or planted) on their IPFP orchards as part of a normal floor management program. Their reasons include: improving water infiltration, nitrogen fixation, beneficial insect habitat, weed suppression, and establishing a durable floor for orchard operations. In spite of low prices received for their crop, as a farm group, approximately 10 % of prune growers in the state have perennial or annual cover crops as a normal orchard floor practice.

The EQIP program was the ideal program for the CDPB to expand breadth of practices to include buffer strips and hedgerow plantings. EQIP selected eight farmers who allowed the IPFP project to plant 10 different demonstration cover crops at their prune orchards. These cover crop demonstration sites were then used as the focus of meetings over the next three years, allowing other growers to view them and the farmers who farmed them to evaluate how they performed under their management, irrigation, and soil type.

The following cover crops were demonstrated, with the first being planted outside the orchard and then the next four no tillage types being planted in order. The last five were covers that required disking and incorporation. By allowing us to plant these 10 covers, each participating grower had a mixture in their orchard that was difficult to manage and mow, and their contribution to the project was commendable.

1. Hard Fescue: Used as a filter strips and vegetated road.
2. 'Beneficial Blend': A filter strip and insectary reservoir.
3. N. Z. White Clover/Trefoil: A nitrogen fixing sod/insectary.
4. 'Perennial Sod': A durable, low maintenance orchard floor and water infiltration.
5. 'NonTillage Clover': A nitrogen fixing, mow able insectary floor.

6. ‘Plowdown Legumes’: A nitrogen fixing incorporated mixture of bell beans, peas and vetch.
7. ‘Max Organic Builder’: A soil improving incorporated mixture of oats, bell beans, peas and vetch.
8. Juan Triticale: A soil improving, weed suppressing grain.
9. Common Barley: A soil improving, weed suppressing grain.
10. Resident Vegetation: The comparison or check of what would be in the orchard.

The CDPB partnered with one of this project’s “conventional” and “reduced risk” orchard sites at the California State University (CSU)-Chico Farm and with the EQIP grant, planted a long-term cover crop trial as a regional demonstration. Forty perennial and 60 annual cover crops were planted in 2000 and again in 2001. These 5 by 30 foot demonstration plots have been marked and are an open walking tour for any group that wishes to view, cover crops, filter strips, CA native grasses, insectaries, vetch, peas, annual clovers, fenoeugreek, brassicas, phacelia, erosion grasses, cereals, and mixtures. This planting has been the site of 5 walking tour meetings and was the site of a regional NRCS and RCD training workshop held April 25, 2002.

Insectary Hedgerows

The use of insectary hedgerows has been promoted by the IPFP at 6 different meetings. As part of the NRCS Cover Crop grant, a hedgerow project was also implemented with the cover crop cooperators. A total of 8 different dried plum ranches planted hedgerow habitat with signs for demonstration. Two particularly extensive plantings included a replicated planting at this project’s CSU-Chico dried plum site where permanent, laminated signs informed all visitors to CSU Farm tours about hedgerow species, insects attracted and pests controlled. The second planting at Billiou Ranches in Hamilton City (another original site of this project) is a 20 acre planting of hedgerow species; Coyote Brush, Coffee Berry, Yarrow, and Deergrass with the species placed in clumps in place of missing trees. Many groups have visited this innovative planting over the past four years as an insectary plantings interspersed in the orchard. During the first year of the NRCS grant, Mary Kimball, previously of the Yolo County RCD was the featured speaker at four of our meetings.

Wildlife Friendly Farming

The IPFP program has supported wildlife friendly farming through cover crop and hedgerow plantings. Four of our hedgerow plantings were specifically planted next to waterways including Deer Creek and Gilsizer Slough to provide diversity, cover, and food for bird species. As part of the BPS project, funding was also provided by the Point Reyes Bird Observatory (PRBO) to monitor bird species richness and diversity in a dried plum orchard in Sutter County. The results were presented at the 1999 CDPB Research Conference, Anne M. King; *Avian Monitoring on the Heier Ranch: Progress Report of the 1999 Field Work.*

In addition to field plantings and demonstrations, the CDPB’s IPFP program hosted, along with our cosponsors, The Nature Conservancy and the Colusa County NRCS, three ‘Wildlife Workshops’ at the Colusa Farm and Equipment Show in 1999, 2000, and 2001. The attendance at the 2000 show exceeded 100 participants including; farmers, wildlife biologists, and Future Farmer of America students.

<u>Objective II. Demonstrate site management practices, in-season pest and cultural management that mitigate surface runoff from tree fruit orchards.</u>

Here we include the "FINAL REPORT ON THE 2002-05 BMP EVALUATION STUDIES FOR THE CALIFORNIA DRIED PLUM BOARD 319(H) PROJECT IN BUTTE COUNTY", prepared for the California Department of Pesticide Regulation by *Dr. Frank Zalom, Department of Entomology U.C. Davis, Contract Agreement # 01-0223C*

YEAR 1 STUDY

Introduction

This project was intended to develop a better understanding of the effectiveness of dormant spray management practices being considered for implementation in the Sacramento and San Joaquin River Watersheds. DPR is coordinating closely with the Sacramento River Watershed Program's (SRWP) Organophosphate Focus Group (OPFG) in developing a list of management practices intended to reduce the runoff of diazinon from dormant spray-applied orchards. Specifically, DPR is interested in focusing on "edge-of-field" level monitoring that will allow the evaluation of the effectiveness of various management practices on a site-specific basis.

Within the proposed study area of this agreement, the California Dried Plum Board has received a 319h grant from the State Water Quality Control Board to demonstrate and promote management practices aimed at reducing winter runoff of organophosphates (OPs) from prune orchards. DPR intends to measure the effectiveness of some of these demonstrations in reducing OP levels in orchard runoff, particularly diazinon.

The objectives of the Year 1study were as follows:

1. To evaluate efficacy of different widths of buffering vegetation strips in reducing the concentration of diazinon in surface runoff from orchards dormant sprayed with diazinon. Vegetated filter strips are a proposed management practice for reducing off-site movement of pesticides.
2. To determine efficacy of post-spray sprinkler irrigation in reducing the concentration of diazinon in surface runoff from orchards dormant sprayed with diazinon. Irrigation is hypothesized to cause residual OP on soils to infiltrate into the soil and thereby reduce its availability to move off-site with rainfall runoff.

MATERIALS AND METHODS, YEAR 1 STUDY

The study design incorporated five treatments including a control treatment and four treatments that correlate with the two objectives stated above. Plots representing the five treatments were established in 4 non-randomized fully replicated blocks in a mature dormant prune orchard where trees are planted on berms 20 feet apart. A study site was identified and owner cooperation was secured within the Butte County CWA 319 Project area. The proposed study treatments included:

For each of the following five treatments, a typical dormant spray with diazinon (15.1 l active ingredient plus 363.4 l of water per acre) was simulated in order to control the size of the area sprayed and the total active ingredient and concentration applied within the replicated plots. Simulated spraying involved the use of a CO_2-charged backpack sprayer to apply the diazinon spray directly to the ground within the target area of each plot. The amount of active ingredient and dilution of the spray that would typically be applied to an acre of orchard was reduced by the fraction realized from dividing the square meters in the target areas of the plots by the square meters in one acre. The rationale for spraying diazinon only on the ground instead of applying it to the trees and, by default to the ground, with a conventional air-blast sprayer is to 1) reduce the variance of volume and total active ingredient applied in the plots, 2) eliminate the potential for drift from one plot to the next, and 3) ensure that equal areas of ground are treated in all plots. In contrast, conventional spraying with an air-blast sprayer is much more difficult to control in terms of when spray is initiated and suspended, and the amount of material that adheres to the trees and/or drifts off-site are uncontrollable variables. It is fully recognized that applying all of the material to the ground will result in a higher than normal ground residue, but no data exists to allow for calculating how much material would "typically" remain on the trees from conventional spraying. Therefore, the simulated spray can be viewed as representing a worse case scenario where all of the pesticide applied would miss the trees, not volatilize or otherwise leave the orchard as drift, and be deposited under the trees on the ground.

Treatment #1. Control
A 50-meter long section of orchard floor was sprayed between two berms with diazinon during the dormant season. Subsequent rainfall runoff from the 50-meter section was to drain into an autosampling unit. All of the plots contained relatively equal resident vegetative cover that was classified as to species composition and relative density.

Rationale: The concentration of diazinon monitored in the 50-meter sections of Treatment #1 would serve to demonstrate the concentrations of diazinon from a typical dormant application situation (a treated control). In contrast, measuring diazinon in runoff from sections that are not treated with diazinon would not elucidate potential differences achieved from the other treatments.

Treatment #2. Sprinkler Irrigation
A 50-meter long section of orchard floor was sprayed between two berms with diazinon during the dormant season. Following diazinon application and prior to onset of significant rainfall, the area received 1/4 inch of sprinkler irrigation without causing runoff. Subsequent rainfall runoff from the 50-meter section was to drain into an autosampling unit. The plots contained resident vegetative cover comparable to that of Treatment #1.

Rationale: Our previous work suggests that the diazinon concentration of runoff can be reduced significantly by applying dormant sprays earlier in the dormant season. One reason is that residual diazinon on the ground is transported into the soil by rains occurring earlier in the dormant season when soils are not yet saturated and runoff is less likely to occur. By applying a sprinkler irrigation (simulated rainfall) soon after dormant spraying, it is hypothesized that infiltration of residual diazinon, rather than runoff, would be the result. The post diazinon application sprinkler irrigation also simulates a light rainfall that might occur after an organophosphate application.

Treatment 3: 10-Meter Buffer Strip
A 50-meter long section of orchard floor was sprayed between two berms with diazinon during the dormant season. Subsequent rainfall runoff from the 50-meter section was to flow across an additional 10-meter length of unsprayed vegetated orchard floor and then drain into an autosampling unit. The plots contained resident vegetative cover comparable

to that of Treatment #1.

Rationale: Information was to be developed on the ability of a given width of vegetated filter strip to promote infiltration (reduce runoff) of orchard runoff containing diazinon as compared to the treated control treatment (#1).

Treatment 4: 20-Meter Buffer Strip
A 50-meter long section of orchard floor was sprayed between two berms with diazinon during the dormant season. Subsequent rainfall runoff from the 50-meter section was to flow across an additional 20-meter length of unsprayed vegetated orchard floor and then drain into an autosampling unit. The plots contained resident vegetative cover comparable to that of Treatment #1.

Rationale: Information was to be developed on the ability of a given width of vegetated filter strip to promote infiltration (reduce runoff) of orchard runoff containing diazinon as compared to the treated control treatment (#1).

Treatment 5: 30-Meter Buffer Strip
A 50-meter long section of orchard floor was sprayed between two berms with diazinon during the dormant season. Subsequent rainfall runoff from the 50-meter section was to flow across an additional 30-meter length of unsprayed vegetated orchard floor and then drain into an autosampling unit. The plots contained resident vegetative cover comparable to that of Treatment #1.

Rationale: Information was to be developed on the ability of a given width of vegetated filter strip to promote infiltration (reduce runoff) of orchard runoff containing diazinon as compared to the treated control treatment (#1).

Following each of two (or more) significant storm events (at least one inch of rain per episode):
1. Runoff volume measurements were to be taken at each sampler unit.
2. Composite water samples were to be collected at each sampler unit for diazinon analysis.

Resulting data was to be described using descriptive statistics, ANOVA, and regression analysis with the intent of determining efficacy potentials of the vegetated buffer and post-application management practices.

The University of California was prepared to analyze all study samples by a GC or GC-MS method to achieve a detection limit that is at or below 5 μg/L (parts per billion) for diazinon. Dr. Barry Wilson's lab worked with the Department of Pesticide Regulation's (DPR) Analytical Lab to validate procedures that were to be performed to analyze the runoff samples collected. Analytical tests were performed on control water supplied by DPR and on spiked samples. The procedures established for the trial were approved prior to the start of the winter rainfall season.

Analytical data generated in this study would include the following fields:

1. Identification of the laboratory
2. Sampling party
3. Date and time of sample
4. Location of sampling site
5. Method of collection
6. Chemical analyzed
7. Analytical method
8. Dates of extraction and analysis
9. Quantitative detection limits
10. Individual sample concentration
11. QA/QC statement

RESULTS, YEAR 1 STUDY

Rainfall events that occurred after the diazinon application in January, 2003, were insufficient to produce runoff within the study area. As a result of the lack of runoff , no samples were collected that yielded useful analytical data. Refer to the discussion section for more detail on the rainfall situation and the attempts that were made following the diazinon application to produce runoff artificially via flood irrigation of the study area.

DISCUSSION, YEAR 1 STUDY

In spite of total rainfall approximating "normal" for the winter period, the dry periods between significant storm events were long enough to allow for soil moisture to decline enough to preclude their becoming saturated by subsequent storm events. Through March 2003, rainfall totals were far below normal, and it wasn't until a very large unseasonal storm occurred in April that the annual rainfall total approached normal.

Recognizing that runoff was unlikely to occur from storm events and concerned that residual diazinon was likely approaching non-detect levels due to normal degradation, a late-season effort was made to produce runoff via flood irrigation. Runoff was indeed produced, unfortunately, insignificant levels of diazinon were detected in the runoff and no conclusions could be drawn with regard to the project objectives.

SUMMARY AND CONCLUSION, YEAR 1 STUDY

The storm pattern during the winter of 2002-03 was atypical and resulted in long periods of dryness between significant storm events. This, combined with the low clay content of the soil in the study orchard and well established resident vegetation cover, resulted in no runoff being generated and no samples being collected from natural rainfall events. A late season attempt to produce runoff resulted in sample collection, but residue analysis indicated this effort was likely too late as only very low levels of diazinon were detected in any of the samples.

Our primary conclusion was that the uncertainties of rainfall and corresponding runoff events can potentially be avoided by utilizing common irrigation technology wherein sprinkler systems could be installed to simulate rainfall. It was our intention to utilize this technology in future studies that require runoff samples for evaluating the efficacy of various BMPs.

YEAR 2 STUDY

INTRODUCTION, YEAR 2 STUDY

Within-field water quality runoff studies for the winter of 2003-2004 had the following objectives:

1. To evaluate efficacy of different widths of buffering vegetation strips in reducing the concentration of diazinon in surface water runoff from orchards dormant sprayed with diazinon. Vegetated filter strips are a proposed management practice for reducing off-site movement of pesticides. (Treatments 1, 3, 4, and 5)
2. To determine efficacy of post-spray sprinkler irrigation in reducing the concentration of diazinon in surface runoff from orchards dormant sprayed with diazinon. Irrigation is hypothesized to cause residual OP on soils to infiltrate into the soil and thereby reduce its availability to move off-site with rainfall runoff. (Treatments 1 and 2)
3. Determine if a relationship exists between the surface area of diazinon treated orchard being drained across a vegetated buffer strip and the resulting reduction in diazinon. (Treatments 4 and 6)

MATERIALS AND METHODS, YEAR 2 STUDY

The study design incorporated six treatments including a control treatment and five treatments that correlated with the three objectives stated above. The six treatments, each replicated three times were randomly assigned within three blocks in a mature dormant prune orchard where trees are planted on berms approximately 20 feet apart. A permanent cover was established at the site. The study site was the same as the one used in the Year 1 study.

For each of the following six treatments, a typical dormant spray with diazinon (15.1 l active ingredient plus 363.4 l of water per acre) was simulated in order to control the size of the area sprayed and the total active ingredient and concentration applied within the replicated plots. Simulated spraying involved the use of a CO_2-charged backpack sprayer to apply the diazinon spray directly to the ground within the target area of each plot. The amount of active ingredient and dilution of the spray that would typically be applied to an acre of orchard was reduced by the fraction realized from dividing the square meters in the target areas of the plots by the square meters in one acre. The rationale for applying diazinon to the ground instead of applying it to the trees and, by default to the ground, with a conventional air-blast sprayer was the same as that stated for the Year 1 study.

The rainfall/runoff event for this study was simulated by using a sprinkler irrigation system that drew water from a neighboring water district supply canal. At the time of simulated rainfall, samples of the canal water were collected and analyzed for diazinon, and were found to be below detection limits.

Treatment #1. Control

Three replicates of a 50-meter long section of orchard floor was sprayed with diazinon between the two tree berms during the dormant season (12/8/03 AM). During the evening of 12/9/03, one inch of natural rainfall fell on the study site. The following day (12/10/03), simulated rainfall was applied (approx. 1.75 inches of rain equivalent) and runoff from the 50-meter sections drained into the respective autosampling units. All of the plots contained relatively equal resident vegetative cover.

Rationale: The concentration of diazinon monitored in the 50-meter sections of Treatment #1 served to demonstrate the concentrations of diazinon from a typical dormant application situation and served as a treated control. In contrast, measuring diazinon in runoff from sections that are not treated with diazinon would not elucidate potential differences achieved from the other treatments.

Treatment #2. Sprinkler Irrigation
Three replicates of a 50-meter long section of orchard floor was sprayed with diazinon between the two tree berms during the dormant season (12/8/03 AM). The day following diazinon application (12/9/03), the area received a light sprinkler irrigation (approx. 0.42 inch of rain equivalent) without causing runoff. Later that same night, one inch of natural rainfall fell on the study site. The following day (12/10/03), simulated rainfall occurred (approx. 1.75 inches of rain equivalent), and runoff from the 50-meter section drained into the autosampler unit of each plot. The plots contained resident vegetative cover comparable to that of Treatment #1.

Rationale: Our previous work suggests that the diazinon concentration of runoff can be reduced significantly by applying dormant sprays earlier in the dormant season. One reason is that residual diazinon on the ground is transported into the soil by rains occurring earlier in the dormant season when soils are not yet saturated and runoff is less likely to occur. By applying a sprinkler irrigation (simulated rainfall) soon after dormant spraying, it is hypothesized that infiltration of residual diazinon, rather than runoff, will be the result.

Treatment 3: 10-Meter Buffer Strip
Three replicates of a 50-meter long section of orchard floor was sprayed with diazinon between the two tree berms during the dormant season (12/8/03 AM). During the evening of 12/9/03, one inch of natural rainfall fell on the study site. The following day (12/10/03), simulated rainfall occurred (approx. 1.75 inches of rain equivalent), and runoff from each 50-meter section flowed across an additional 10-meter length of unsprayed vegetated orchard floor and then drained into an autosampler unit. The plots contained resident vegetative cover comparable to that of Treatment #1.

Rationale: Information can be developed on the ability of a given width of vegetated filter strip to promote infiltration (reduce runoff) of orchard runoff containing diazinon as compared to the control treatment (#1).

Treatment 4: 20-Meter Buffer Strip
Three replicates of a 50-meter long section of orchard floor was sprayed with diazinon between the two tree berms during the dormant season (12/8/03 AM). During the evening of 12/9/03, one inch of natural rainfall fell on the study site. The following day (12/10/03), simulated rainfall occurred (approx. 1.75 inches of rain equivalent), and runoff from each 50-meter section flowed across an additional 20-meter length of unsprayed vegetated orchard floor and then drained into an autosampler unit. The plots contained resident vegetative cover comparable to that of Treatment #1.

Rationale: Information can be developed on the ability of a given width of vegetated filter strip to promote infiltration (reduce runoff) of orchard runoff containing diazinon as compared to the control treatment (#1).

Treatment 5: 30-Meter Buffer Strip
Three replicates of a 50-meter long section of orchard floor was sprayed with diazinon between the two tree berms during the dormant season (12/8/03 AM). During the evening of 12/9/03, one inch of natural rainfall fell on the study site. The following day (12/10/03), simulated rainfall occurred (approx. 1.75 inches of rain equivalent), and runoff from the 50-meter section flowed across an additional 30-meter length of unsprayed vegetated orchard floor and then drained into each autosampler unit. The plots contained resident vegetative cover comparable to that of Treatment #1.

Rationale: Information can be developed on the ability of a given width of vegetated filter strip to promote infiltration (reduce runoff) of orchard runoff containing diazinon as compared to the control treatment (#1).

Treatment 6: 100-Meter Section Sprayed with Diazinon Plus a 20-Meter Buffer Strip
Three replicates of a 100-meter long section of orchard floor was sprayed with diazinon between the two tree berms during the dormant season (12/8/03 AM). During the evening of 12/9/03, one inch of natural rainfall fell on the study site. The following day (12/10/03), simulated rainfall occurred (approx. 1.75 inches of rain equivalent), and runoff from the 100-meter section flowed across an additional 20-meter length of unsprayed vegetated orchard floor and then drained into an autosampler unit. The plots contained resident vegetative cover comparable to that of Treatment #1.

Rationale: Information can be developed on the ability of a given width of vegetated filter strip to promote infiltration (reduce runoff) from a larger area of orchard runoff containing diazinon as compared to the treatment with half the treated area draining into the same width of buffer area (Treatment #4).

Methods Common to All Plots
Runoff volume measurements were taken at each sampler unit. Simulated rainfall, runoff collections ceased after 2271 liters of runoff had been pumped through each autosampler unit and composite water samples were collected at each sampler unit at the time for diazinon analysis. Diazinon runoff hydrographs developed by Dr. Wes Wallender, Department of Land, Air and Water Resources, UC Davis, during previous research by our group showed that most diazinon leaving the orchard in runoff occurred during this early phase of a runoff event (Angermann, T., W. W. Wallender, B. W. Wilson, I. Werner, D. E. Hinton, M. N. Oliver, F. G. Zalom, J.D. Henderson, G. H. Oliveira, L. A. Deanovic, P. Osterli, and W. Krueger. 2002. Runoff from orchard floors - micro-plot field experiments and modeling. J. Hydrology 265(2002):178-194.). The composite water samples we collected were labeled and returned immediately in ice chests too Dr. Wilson's lab at UC Davis where they were frozen until the GC analysis could be run. Chain of custody records were maintained for the samples.

Chemical residue analysis was conducted by Mr. Jack Henderson in Dr. Wilson's lab according to analytical methods approved by agreement with the DPR Analytical Chemistry Lab. The analysis measurements were controlled using diazinon spiked samples analyzed at the same time as the field collected runoff samples, and at a range of concentrations expected in the field collections.

Diazinon residue concentrations determined from the runoff samples collected from each of the six treatments were normalized within each of the three replicates by converting ppm measurements to the proportion of ppm in the control which was set to 1.00. The formula used for this calculations was:

$P_c = C_{tn}/C_{cn}$

where:
P_c = proportion of control ppm present in sample
C_{tn} = diazinon concentration in ppm for a given treatment (t) and replicate (n)
C_{cn} = diazinon concentration in ppm for control plot of the same replicate (n)

Data were analyzed by one way ANOV following arcsine transformation for the proportional data.

RESULTS, YEAR 2 STUDY

Diazinon spike recovery samples indicated that the methodology used was most efficient for those samples in the range of 5 ppm to 250 ppm, corresponding well to the range of diazinon concentrations ultimately observed in our field collected runoff samples (Figure 1). Those samples ranged from a low of 17.9 ppm in one of the replicate plots with a 100 m treated area and 20 m buffer zone, to high of 519.5 ppm in one of the replicate plots with no buffer strip. Diazinon recovery averaged 97.6% for four spiked water samples analyzed during the chemical analysis of the field samples (Table 1).

Analysis of variance results indicate that the vegetated buffer strips provided a measurable reduction of diazinon concentration in orchard runoff (ANOV results following arcsine transformation F=4.819; df=4,10; p=0.0200). Table 2 provides the mean levels of diazinon (ppm) detected in samples collected from the 3 buffer strip widths, the no buffer strip control and the larger versus smaller plot area with the same buffer strip width as well as the proportion of each buffer strip treatment as a proportion of the no buffer strip control. Surprisingly, there was considerable variability in ppm between the 3 replicates even though the groundcover present and soils appeared to be similar, so analysis using the actual mean ppm values did not indicate statistically significant differences (ANOV results F=1.034; df=4,10; p=0.4364). However, when the treatments within each replicated were transformed to proportion of the no buffer treatment, treatment differences became apparent. Analysis using t-tests indicated that the 10 m, 20 m and 30m buffer strip widths were not significantly different from one another (Table 2), and that there was no difference in diazinon concentration between the 330 m^2 (50 m row length) and 660 m^2 (100 m row length) areas drained over a 20 m buffer strip. In each buffer strip scenario, the diazinon concentration was reduced by at least 50%.

Post application sprinkler irrigation reduced diazinon concentration in orchard runoff by 45% (Table 3), although the difference was not statistically significant even when diazinon concentration (ppm) for this treatment in each replicate was transformed to proportion of no sprinkler application ppm for the same replicate (ANOV results following arcsine transformation; F=3.982; df=1,4; p=0.1167). The reduction in diazinon concentration might have been greater and the difference between sprinkled and non-sprinkled plots statistically significant had not one inch of natural rainfall fallen on the study site the evening after the post sprinkler irrigation was applied. Because both the sprinkled and non-sprinkled plots received this rainfall (without runoff occurring), the effect of the post application sprinkling might have been masked.

DISCUSSION, YEAR 2 STUDY

Vegetated buffer strips reduced diazinon concentration in the first 2271 l of orchard runoff by at least 50%. Previous research by Dr. Wallender and his students to develop a chemical hydrograph indicated that most diazinon runoff occurs in this initial period. It was our hypothesis that vegetated buffer strips might not work as well in the California orchard system for stormwater runoff because the buffer areas would receive that same amount of rainfall as the treated areas so water infiltration might not be increased by the presence of an untreated vegetated buffer.

A logical question growers might ask concerns the effective width of a vegetated buffer. A wider buffer is more costly for a grower to establish and maintain, and potentially takes useable orchard area out of production if it must be dedicated to the buffer strip area. Our data suggest that there is no significant difference in efficacy between 10 m, 20 m and 30m buffer strip widths in terms of diazinon concentration in stormwater runoff. This is encouraging as it suggests that growers could devote a relatively small area of vegetated buffer and still have an impact on diazinon runoff. It would be instructive to conduct an additional study using an even narrower width of vegetated buffer.

In addition to effective buffer strip width, the treated orchard area drained over the buffer strip could logically affect the ability of the vegetated buffer to reduce diazinon concentration in the stormwater runoff. This concern was tested by comparing diazinon concentrations in 330 m^2 and 660 m^2 orchard areas drained over the same width (20 m) of vegetated buffer. No significant difference was observed in relation to orchard area drained, suggesting that a similar width of vegetated buffer would be effective independent of orchard area being drained.

Previous research by Dr. Wallender and his students suggested that post dormant spray application sprinkler irrigation could reduce diazinon concentration in orchard runoff. The mechanism for this is infiltration of the diazinon residue present on the soil surface into the soil where it can be reduced by the action of soil microbes. Our study provided a 45% reduction in diazinon concentration attributable to post application sprinkling. However, this difference was not statistically significant possibly due to the occurrence of a natural rainfall event soon after the post application sprinkling was made which, in effect, made the sprinkled and non-sprinkled plots more similar than intended. Further evaluations of this potential BMP seem warranted given these promising results. It should be noted that we are unaware of any data generated by surveys of Central Valley groundwater that shows any consistent detections of diazinon or any diazinon concentrations that would indicate a potential problem.

One of the most promising aspects of this study was the use for the first time of simulated rainfall on our large-scale field plots. This approach had been successfully used in the microplot experiments that were conducted by Dr. Wallender and his students in our prior collaborations. Simulated rainfall gives us more control over the timing of rainfall events relative to pesticide application, soil moisture and other variables than is possible with the occurrence of natural rainfall, as well as the amount of rainfall.

SUMMARY AND CONCLUSION, YEAR 2 STUDY

Data resulting from the Year 2 study strongly suggests that vegetated buffer strips do afford a measurable reduction of diazinon concentration in orchard runoff, that 10 m, 20 m, and 30 m buffer strip widths were not significantly different from one another in terms of diazinon concentration in stormwater runoff, that post application sprinkler irrigation reduces diazinon concentration in orchard runoff (although the difference was not statistically significant possibly due to timing of a natural rainfall event relative to the time when the sprinkling occurred), and that there was no significant difference in diazinon concentration in orchard runoff flowing over a 20 m buffer strip that drained either 50 m or 100 m of orchard row that had been sprayed with diazinon.

Figure 1. Year 2 Study, diazinon spike recovery (ppm) measurements of water samples at a range of values anticipated from the analysis of field water runoff collections.

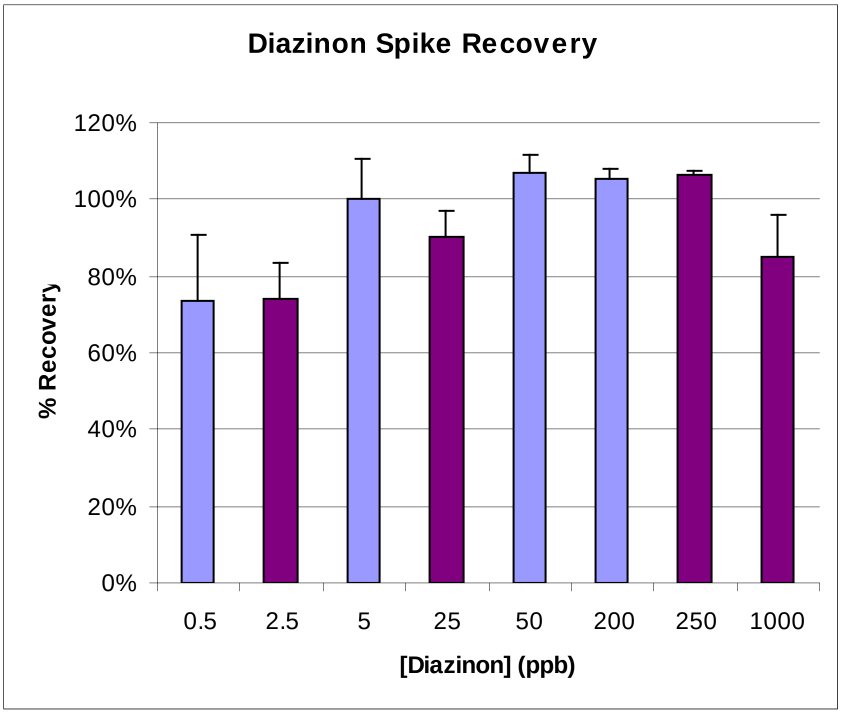


Figure 2. Year 2 Study, average diazinon concentration of runoff presented as a proportion of the no buffer strip control (n = 3 replicates).

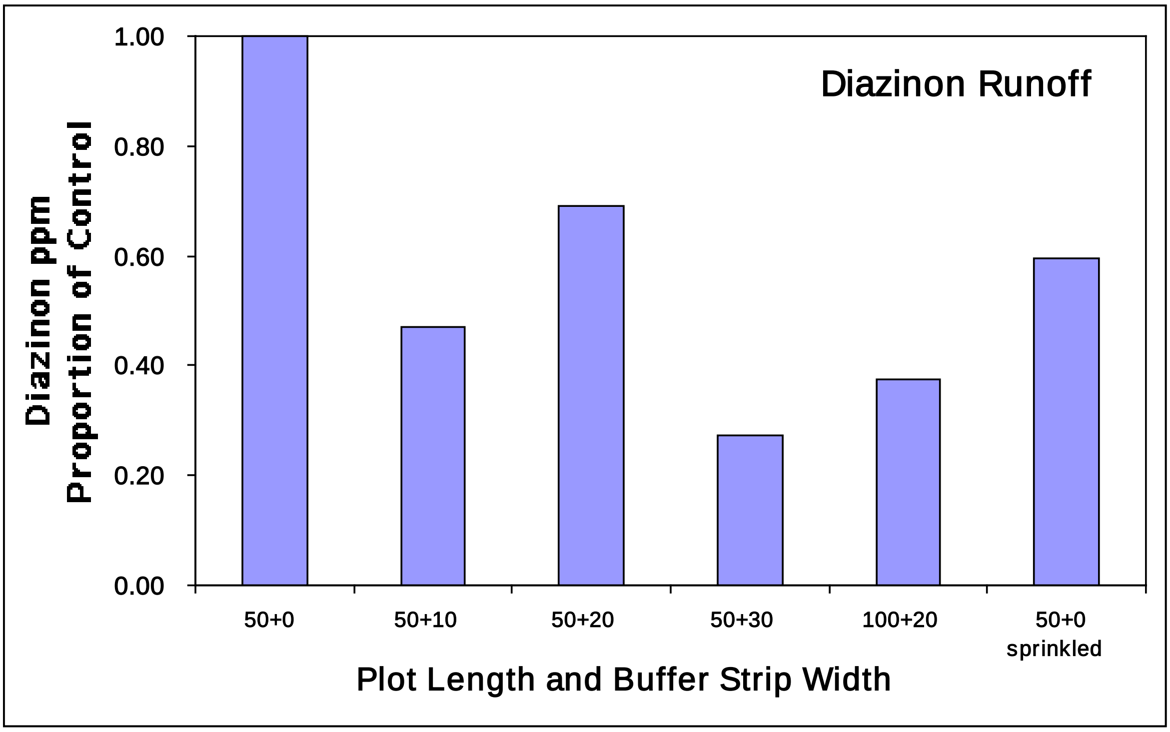


Table 13. Year 2 Study, diazinon recovery (ppm) measured from chemical analysis of spiked water samples conducted in concert with analysis of field water runoff collections.

Sample ID	Measured ppm	Sample volume (ml)	Concentration correction	Dilution correction	Series recovery correction	Sample ppm	Recovery percentage
Spike 1 20 ppb	363.4	100	0.05	1.00	1.000	18.2	90.9%
Spike 2 20 pbb	357.2	100	0.05	1.00	1.000	17.9	89.3%
Spike 3 20 ppb	442.1	100	0.05	1.00	1.000	22.1	110.5%
Spike 4 20 ppb	398.1	100	0.05	1.00	1.000	19.9	99.5%
Blank - 0 ppb	nd	100	0.05	1.00	1.000	nd	nd
Blank - 0 ppb	nd	100	0.05	1.00	1.015	nd	nd

Table 14. Year 2 study, mean concentration (ppb) of diazinon in first 2271 liters of runoff and mean diazinon concentration of runoff from each treatment as a proportion of the no buffer strip control.

Treatment	Mean $\pm$ SE ppb [1]	Mean $\pm$ SE proportion [2]
No buffer	332.100 $\pm$ 99.641	1.000 $\pm$ 0.000
50 m + 10 m buffer	178.133 $\pm$ 101.309	0.470 $\pm$ 0.136 **
50 m + 20 m buffer	229.500 $\pm$ 129.907	0.500 $\pm$ 0.261 ** and ***
50 m + 30 m buffer	67.933 $\pm$ 13.763	0.273 $\pm$ 0.119 **
100 m + 20 m buffer	143.633 $\pm$ 99.151	0.373 $\pm$ 0.171 **

[1]ANOV results; F=1.034; df=4,10; p=0.4364
[2]ANOV results following arcsin transformation; F=4.819; df=4,10; p=0.0200;
** mean is significantly different p<0.05 from no buffer treatment by t-test.
*** the reason(s) for results for this treatment not fitting a pattern with the other two treatments is unclear.

Table 15. Year 2 Study, mean concentration (ppb) of diazinon in first 2271 liters of runoff and mean diazinon concentration of runoff from each treatment as a proportion of the not sprinkled control.

Treatment	Mean $\pm$ SE ppb [1]	Mean $\pm$ SE proportion [2]
Not sprinkled	332.100 $\pm$ 99.641	1.000 $\pm$ 0.000
Sprinkled	250.500 $\pm$ 171.225	0.550 $\pm$ 0.226

[1]ANOV results; F=0.170; df=1,4; p=0.7015
[2]ANOV results following arcsine transformation; F=3.982; df=1,4; p=0.1167

YEAR 3 STUDY

INTRODUCTION, YEAR 3 STUDY

Within-field water quality runoff studies for the winter of 2004-2005 had the following objectives:

1. To evaluate efficacy of different widths of buffering vegetation strips in reducing the concentration of diazinon in surface water runoff from areas of a given size that are dormant sprayed with diazinon (Treatments 1, 3, and 4).
2. To determine efficacy of post-spray sprinkler irrigation in reducing the concentration of diazinon in surface runoff from orchards dormant sprayed with diazinon. Irrigation is hypothesized to cause residual OP on soils to infiltrate into the soil and thereby reduce its availability to move off-site with subsequent rainfall runoff (Treatments 1 and 2).
3. Determine if a proportional relationship exists between the size of the orchard area treated with diazinon and the width of the buffer zone in its ability to reduce the concentration of diazinon in runoff (Treatments 3 versus 5, and treatments 4 versus 5).

MATERIALS AND METHODS, YEAR 3 STUDY

The study design incorporated five treatments including a control treatment and four treatments that addressed the three objectives stated above. The five treatments, each replicated four times were randomly assigned within four blocks in a mature dormant prune orchard where trees are planted on berms approximately 18 feet apart (Figure 3). A permanent orchard floor cover of native vegetation exists at the site.

For each of the following five treatments, a typical dormant spray with diazinon (15.1 l active ingredient plus 363.4 l of water per acre) was simulated in order to control the size of the area sprayed and the total active ingredient and concentration applied within the replicated plots. Simulated spraying involved the use of a CO_2-charged backpack sprayer to apply the diazinon spray directly to the ground within the target area of each plot. The amount of active ingredient and dilution of the spray that would typically be applied to an acre of orchard was reduced by the fraction realized from dividing the square meters in the target areas of the plots by the square meters in one acre. The rationale for applying diazinon to the ground instead of applying it to the trees and, by default to the ground, with a conventional air-blast sprayer was the same as that stated for the Years 1 and 2 studies.

The rainfall/runoff event for this study was simulated by using a sprinkler irrigation system that drew water from a neighboring water district supply canal. At the time of simulated rainfall, samples of the canal water were collected for diazinon analysis.

Treatment #1. Control

Four replicates of a 25-meter long section of orchard floor were sprayed with diazinon between the two tree berms during the dormant season (12/14/04). Two days later (12/16/04), simulated rainfall was applied (approx. 0.8 inches of rain equivalent) and runoff from the 25-meter sections drained into their respective autosampling units. All of the plots contained relatively equal resident vegetative cover.

Rationale: The concentration of diazinon monitored in the 25-meter sections of Treatment #1 served to demonstrate the concentrations of diazinon from a typical dormant application situation and served as a treated control. In contrast, measuring diazinon in runoff from sections that are not treated with diazinon would not elucidate potential differences achieved from the other treatments.

Treatment #2. Post Treatment Sprinkler Irrigation

Four replicates of a 25-meter long section of orchard floor were sprayed with diazinon between the two tree berms during the dormant season (12/14/04). The day following diazinon application (12/15/04), the area received a light sprinkler irrigation (approx. 0.135 inch of rain equivalent) without causing runoff. On 12/16/04, simulated rainfall was applied (approx. 0.8 inches of rain equivalent) and runoff from the 25-meter sections drained into their respective autosampling units. The plots contained resident vegetative cover comparable to that of Treatment #1.

Rationale: Our previous work suggests that the diazinon concentration of runoff can be reduced significantly by applying dormant sprays earlier in the dormant season. One reason is that residual diazinon on the ground is transported into the soil by rains occurring earlier in the dormant season when soils are not yet saturated and runoff is less likely to occur. By applying a sprinkler irrigation (simulated rainfall) soon after dormant spraying, it is hypothesized that infiltration of residual diazinon, rather than runoff, will be the result.

Treatment 3: 5-Meter Buffer Strip

Four replicates of a 25-meter long section of orchard floor were sprayed with diazinon between the two tree berms during the dormant season (12/14/04). Two days later (12/16/04), simulated rainfall was applied (approx. 0.8 inches of rain equivalent) and runoff from the 25-meter sections flowed across an additional 5-meter length of unsprayed vegetated orchard floor and then drained into an autosampler unit. The plots contained resident vegetative cover comparable to that of Treatment #1.

Rationale: Information can be developed on the ability of a given width (5m vs 10m, treatments #3 and #4, respectively) of vegetated filter strip to promote infiltration (reduce runoff) and reduce concentration of orchard runoff containing diazinon as compared to the control treatment (#1).

Treatment 4: 10-Meter Buffer Strip

Four replicates of a 25-meter long section of orchard floor were sprayed with diazinon between the two tree berms during the dormant season (12/14/04). Two days later (12/16/04), simulated rainfall was applied (approx. 0.8 inches of rain equivalent) and runoff from the 25-meter sections flowed across an additional 10-meter length of unsprayed vegetated orchard floor and then drained into an autosampler unit. The plots contained resident vegetative cover comparable to that of Treatment #1.

Rationale: Information can be developed on the ability of a given width (5m vs 10m, treatments #3 and #4, respectively) of vegetated filter strip to promote infiltration (reduce runoff) and reduce concentration of orchard runoff containing diazinon as compared to the control treatment (#1).

Treatment 5: 50-Meter Section Sprayed with Diazinon Plus a 10-Meter Buffer Strip
Four replicates of a 50-meter long section of orchard floor were sprayed with diazinon between the two tree berms during the dormant season (12/14/04). Two days later (12/16/04), simulated rainfall was applied (approx. 0.8 inches of rain equivalent) and runoff from the 50-meter sections flowed across an additional 10-meter length of unsprayed vegetated orchard floor and then drained into an autosampler unit. The plots contained resident vegetative cover comparable to that of Treatment #1.

Rationale: Information can be developed on the ability of the same width of vegetated filter strip to promote infiltration (reduce runoff) and reduce concentration of orchard runoff containing diazinon from a larger area as compared to the treatment with half the treated area (Treatment #4).

Methods Common to All Plots
Runoff volume measurements were taken and recorded at each sampler unit each time a sample was collected from the composite holding tank. Immediately following the collection of a sample, the composite tank was emptied and allowed to begin filling once more. Samples were collected at approximately 300, 600, 1,000, and 1,500 gallons of runoff and/or until all runoff from each plot had ceased in order to account for the total volume and concentration of diazinon in the runoff samples. The composite water samples were labeled and returned immediately in ice chests to Dr. Wilson's lab at UC Davis where they were frozen until the GC analysis could be run. Chain of custody records were maintained for the samples.

Chemical residue analysis was conducted by Mr. Jack Henderson in Dr. Wilson's lab according to analytical methods approved by agreement with the DPR Analytical Chemistry Lab. The analysis measurements were controlled using diazinon spiked samples analyzed at the same time as the field collected runoff samples, and at a range of concentrations expected in the field collections.

Data were analyzed by one way ANOV to determine if there were significant treatment differences.

RESULTS, YEAR 3 STUDY

The sample residues were calculated based on the 101.5% recovery determined in the spike recovery profile requested by DPR as part of the laboratory QA. This was the same value used in the calculations for the Year 2 study. The spikes during these analyses had an average recovery of 92.8 $\pm$ 6.6 %.

There were no significant differences between mean total runoff volumes for any of the 5 treatments. For treatments 2 and 4, there were 3 samples instead of 4 due to breakage and loss while samples were stored in the freezer. Results of one-way ANOV are shown in Tables 4 through 7.

Table 4 and Figure 3 show the differences in mean diazinon concentration (ppb) for 25-meter treated areas with 0, 5, and 10-meter buffer zones. With a 10-meter buffer zone (40% of the width of the treated area) there was a significant difference, but with a 5-meter buffer zone (20% of the width of the treated zone) the difference was not significant.

Table 5 shows the differences in mean diazinon concentration (ppb) for 25-meter treated areas with and without post-spray sprinkler irrigation. Sprinkler irrigation reduced the diazinon concentration in runoff by 34%, but this was not significantly different from the treated control.

Table 6 shows the differences in mean diazinon concentration (ppb) for 25-meter treated areas with 5-meter buffer zones versus 50-meter treated areas with 10-meter buffer zones. Because there is no significant difference between these treatments, it appears that there is a proportional relationship for size of treated area and size of buffer zone relative to mitigating diazinon in runoff.

Table 7 shows the differences in mean diazinon concentration (ppb) for 25-meter treated areas with 10-meter buffer zones versus 50-meter treated areas with 10-meter buffer zones. Maintaining the same buffer zone while doubling the size of the treated area resulted in a 43% increase in diazinon concentration. This result did not quite reach the level of significance.

DISCUSSION, YEAR 2 STUDY

The data from Year 3 point to many important considerations that weren't as evident from Year 2 data. In Year 3, sampling accounted for the total volume of runoff and associated diazinon concentration rather than looking only at the initial runoff as was done in Year 2. As in Year 2, this year's data suggests that buffer strips can be effective in reducing diazinon concentrations in runoff. There was a 38% reduction with 5-meter buffer zones and a 52% reduction with 10-meter buffer zones when the treated areas were 25 meters in length. However, of potentially greater importance, Year 3 data show that in order to maintain the same degree of mitigation capability, buffer zones might need to become larger as the size of the treated area becomes larger. Looking at treatment 3 versus treatment 5, no significant difference was seen in diazinon concentrations when both treated areas and buffer zones were doubled in size, but when size of treated area was doubled while maintaining the same size buffer zone (treatment 4 versus treatment 5), there is a 43% increase in the diazinon concentration of the runoff from the larger treated area, and this value approached significance. Collectively, these data suggest that a proportional relationship may exist such that buffer zones would have to become increasingly larger as treated areas become larger. If this proportional relationship is real, then it may be impractical to implement buffer zones sufficiently wide enough to mitigate the runoff from orchards that are typically many hundreds of meters in length and width.

In contrast, post-spray sprinkler irrigation reduced the diazinon concentration by 32%. Although this reduction did not achieve statistical significance, it is nonetheless reasonable to assume that the same result may have been achieved regardless of the size of the treated area. This potential BMP reduces the amount of diazinon available to be picked up by runoff by promoting infiltration of diazinon into the soil where it can be broken down by microbial activity. The size of the treated area is not a variable in this case. Furthermore, because the pre-existing soil moisture was relatively high at the time sprinkler irrigation took place in the Year 3 study, infiltration may not have been as high as may have occurred if the pre-existing soil saturation had been lower.

SUMMARY AND CONCLUSION, YEAR 3 STUDY

Data resulting from the Year 3 study improved our interpretation of Year 2 data that suggested that vegetated buffer strips do afford a measurable reduction of diazinon concentration in orchard runoff regardless of the width of the buffer zone.Unlike Year 2 data that only accounted for diazinon concentrations in the initial 400 gallons of runoff from treated plots, Year 3 accounted for the total volume and concentration of diazinon in runoff from the treated areas as well as the concentration in the first 300 gallons of runoff. This more complete accounting suggests that buffer zones of a given width are likely to become overwhelmed in their mitigation capacity as the size of their associated treated areas becomes larger. Therefore, implementing buffer zones of sufficient width to significantly mitigate diazinon in runoff from large orchards may not be practical. However, when the storm event produces only a very small amount of runoff, the buffer strip could have mitigation potential.

In orchards that have the capability of applying a sprinkler irrigation soon after diazinon has been sprayed are likely to realize sizeable reductions in the diazinon concentration in the runoff from subsequent runoff-producing storm events particularly if the pre-existing soil moisture is not high at the time diazinon is applied and predictably if the soil is a lighter leaching type soil rather than a heavy runoff type. The efficacy of this BMP would likely not be influenced by the size of the treated area. The results of this light sprinkling is also indicative of what might occur when a rainfall event not resulting in runoff occurs soon after the diazinon application. Light rainfall, sufficient to result in infiltration but not sufficient to produce rainfall, may well be beneficial in reducing subsequent load.

Table 16. Year 3, one-way ANOV for concentration of diazinon (ppb) in runoff from 25-meter treated areas with 0,5, and 10-meter buffer zones.

Treatment	N	Mean	Std Err Mean	Significant from control	
1 25+0	4	935.934	147.81		a
3 25+5	4	585.545	69	N	ab
4 25+10	3	451.212	68.67	Y	b

ANOV results; F=5.2311; df=2, 8; p=0.0353
Means followed by the same letter are not significantly different from one another.

Figure 6. Year 3 Study, average diazinon concentration of runoff from 25-meter treated areas with 0,5, and 10-meter buffer zones. Treatments 1 and 4 are significantly different.

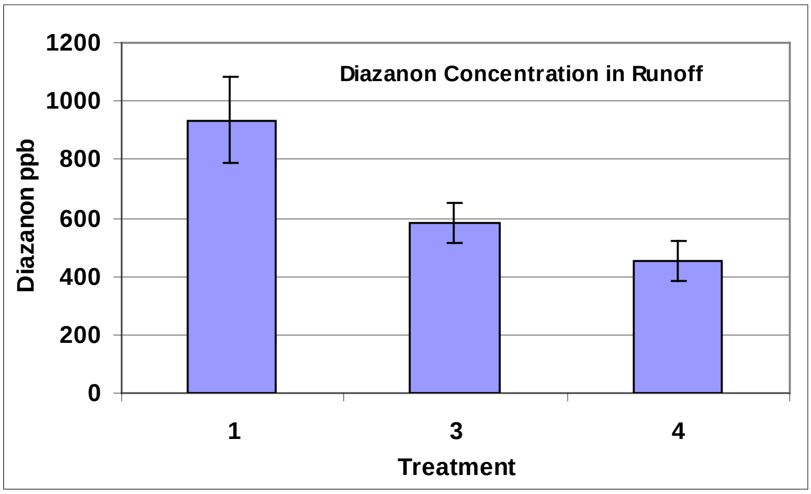


Table 17. Year 3, one-way ANOV for concentration of diazinon (ppb) in runoff from 25-meter treated areas with and without post-spray sprinkler irrigation. No buffer zones.

Treatment	N	Mean	Std Err Mean
1 25+0	4	935.934	147.81
2 25+0+sprinkled	3	616.388	274.88

ANOV results; F=1.2232; df=1, 5; p=0.3191

Table 18. Year 3, one-way ANOV for concentration of diazinon (ppb) in runoff from 25-meter treated areas with 5-meter buffer zones versus 50-meter treated areas with 10-meter buffer zones.

Treatment	N	Mean	Std Err Mean
3 25+5	4	585.545	68.998
5 50+10	4	643.697	50.867

ANOV results; F=0.4602; df=1, 6; p=0.5228

Table 19. Year 3, one-way ANOV for concentration of diazinon (ppb) in runoff from 25-meter treated areas with 10-meter buffer zones versus 50-meter treated areas with 10-meter buffer zones.

Treatment	N	Mean	Std Err Mean
4 25+10	3	451.212	68.673
5 50+10	4	643.697	50.867

ANOV results; F=5.3513; df=1, 5; p=0.0686

Objective III. Provide widespread awareness of project results to the dried plum industry.

Starting at petal fall, scouts and cooperating PCAs visited each project orchard at least once a week until harvest. Orchard information such as insect counts, disease findings, etc. was reported to the grower at least once per week.

In 2004, a program was introduced to growers and PCAs in the Butte and Sutter County areas that offered to pay them for using monitoring techniques researched and validated through this project. They were paid on a per acre basis, based on what monitoring techniques were actually followed. Funding was provided by the "State Water Resources Control Board" and "Cal-Fed". The goal was to allow people in the industry to try the various monitoring programs out and realize that there were no detrimental effects from using them. Over 1,200 acres were monitored using the IPFP program by five PCAs, four growers and one irrigation consultant. At the end of the season a survey was filled out by all who participated in the program. The survey asked how they thought each of the monitoring techniques they used worked for them. All of the participants had very positive responses to the questions.

Thirteen newsletters were published and distributed to all ~1,400 prune growers and about 500 related industry members in California about the progress of the project. Meetings to share information were numerous and well attended. During the five years of this project over 3,886 people attended 113 meetings focused on this project. . In 2004, 14 meetings relative to this project were held and attended by 424 people. In Sutter County the following meetings were held: Statewide Dried Plum Day, March 3rd; Spring Field Day, April 29th; Fall Field Day, September 23rd; Sutter County Agricultural Commissioners Meeting, December 7th and 9th; Winter Field Meeting, December 14th. Other meetings across the state included: Glenn County's Spring Prune Meeting on May 18th; Madera County's Prune Day on May 19th; Merced County's Prune meeting on May 19th; Tulare County's Prune meeting on May 20th; Tehama County's Prune Day on February 26th; Sacramento County's meeting on the Dormant Spray Decision Guide on January 29th and two meetings one on March 9th and the other on April 16th for the California Dried Plum Board. In addition, the Tehama County advisor provided insect day degree accumulation to clientele via e-mail on a regular basis. Advisors also wrote several newsletters. A list of news articles is attached (IPFP News Articles). One advisor created a "loaner program" in which he loaned out pressure chambers so growers could become familiar with how they worked and how to schedule irrigations using stem water potential information.

Industry survey results: Here we provide that survey's results (36% response) germane to IPFP program objectives.

Outreach efforts of IPFP resulted in approximately 71% of dried plum growers being aware of the IPFP project, according to survey results. Further, approximately 54% had attended field days within the previous 4 years; essentially all of these targeted IPFP concepts, especially monitoring.

Orchard monitoring: Orchard monitoring is the key component of the IPFP project and is essential to economic and efficient use of IPFP demonstrated inputs.

General:

	Yes	Sometimes	No
Is the orchard monitored 2-3 times per month during the active season?	67.9%		32.1%

Pest Management:

	Yes	Sometimes	No
Do you monitor dormant spurs for aphid eggs and scales? (3.9% didn't recall)	39.5%		56.6%
Do you monitor for prune rust? (2.2% didn't recall)	76.7%		21.1%
Did you monitor in spring for live aphids?	65.6%		34.4%
Did you monitor beneficials?	58.4%		41.6%
Did you monitor spider mites?	76.7%		23.3%

Monitoring-based practices: There were decisions made based upon monitoring. Below are changed practices we believe resulted from monitoring techniques developed and demonstrated within IPFP:

Pest Management: A substantial portion of orchard monitoring was devoted to pest management and the subsequent management decision process. Because one option, when using monitoring for pest control decisions is "no treatment", which was not recorded in the survey, the dormant and in-season insecticide/fungicide pest management changes could not be determined with the following exception.

	Yes	Sometimes	No
Used a miticide spray (3% didn't recall)	25.5%		58.4%

We believe, due to extent pest monitoring was conducted in dried plum orchards (~68% of grower respondents), and that 53.7% of those that monitored sometimes or always recorded their findings (according to that same survey), the findings were used to make more sensible pest control decisions by a significant number of dried plum growers.

Pest Control Advisor Involvement

During the course of this project approximately 15 Pest Control Advisors (PCAs) were asked to review and if possible, try using monitoring techniques under evaluation during the 2000 and 2001 seasons. At meetings held in October 2000 and spring 2001, the PCAs and the project team met and discussed the monitoring techniques. Following are highlight points made at those meetings:

1) Many monitoring techniques took too long to implement. Many PCAs reported they could not spend more than one-hour per week in an orchard. One PCA said he could not spend more than 30 minutes in an orchard. Suggestions made to speed up the monitoring procedure included: using a timed search rather than looking at a certain number of trees, look at one side of tree only rather than walking around tree, rather than recording data, just keep a mental note of abundance of the pest being monitored.
2) Several PCAs reported they use a more subjective monitoring technique. The quantitative monitoring under evaluation takes too long.
3) The PCAs all agreed that treatment thresholds were about right and about the same as those they have been using.
4) Most PCAs found the dormant spur sampling technique was useful and even though it took some time; winter is when they have more time and it required monitoring only once per season.

5) The PCAs found the tree and fruit monitoring techniques were useful but agreed that it took too long and too many trees had to be looked at before a decision could be made.
6) PCAs felt springtime aphid monitoring was useful but preferred quickly covering the entire orchard rather than the quantitative approach as stated in the monitoring technique.
7) PCAs found pheromone traps provided little if any useful information and recommended discontinuing their use.

Overall, the PCAs were pleased to be involved in the project. As stated in the highlighted points of the meeting, PCAs favor more subjective methods of monitoring. However, for this project, quantitative methods must be used in order to determine what treatment thresholds and/or monitoring techniques are most accurate. When techniques and thresholds are finally presented to those involved in the dried plum industry, it is understood many will use subjective techniques and shortcuts in order to save time and money.

Objective IV. Evaluate changes in pesticide use due to project's goals.

Pesticide Use Reporting:

One of the main goals of the IPFP project was to reduce amounts of pesticides applied. Table 17 presents pounds of active ingredient of the major pesticides applied to dried plums from 1997 to 2002 (2003 data are not currently available). Diazinon, oil, and Sulfur show significant reductions beginning in 1999, the first year results from this research project were presented. Asana has only shown a slight reduction. This decrease is not because of the acreage reduction, but because growers are now using less material per acre (Figures 9 and 10).

The trend is clearly reduced use of pesticides in dried plum production. To this end, project members believe the project was a complete success.

Table 16. Total pound of pesticides used in dried plum production two years before and five years during the project.

Total Pounds of a.i. Applied							
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
DIAZINON	57,335	57,139	40,068	48,877	28,587	38,585	32,781
ESFENVALERATE (Asana)	1,525	1,474	1,235	1,685	1,212	1,268	1,382
OIL	1,074,785	837,120	654,158	714,634	413,779	464,562	386,470
SULFUR	534,039	700,360	355,420	323,653	111,945	205,670	189,846

Figure 9. Total pounds of Asana, diazinon, sulfur and oil used in dried plum production two years before and five years during the project.

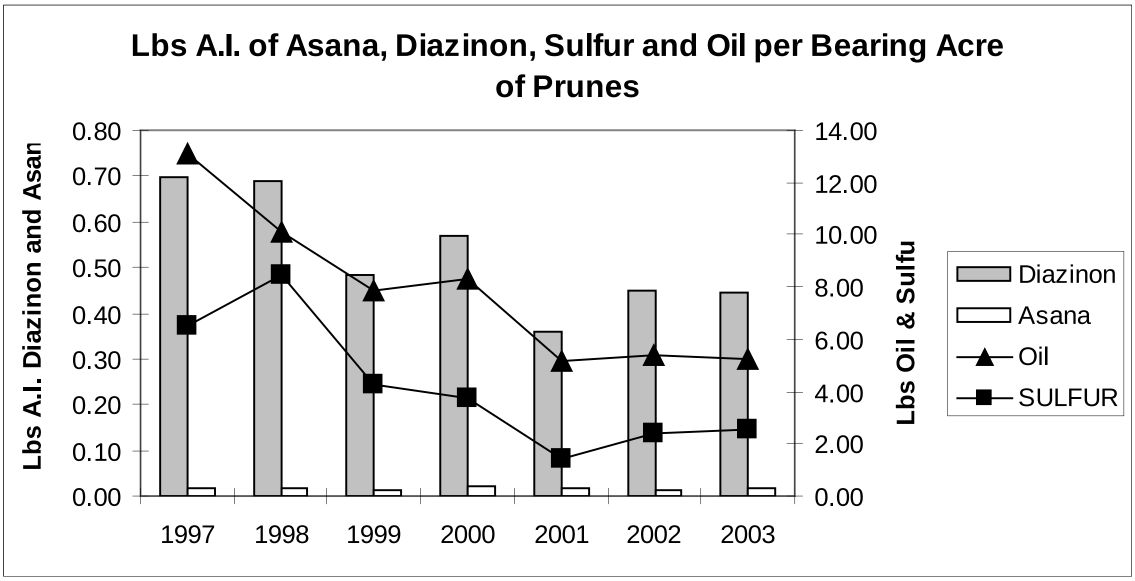
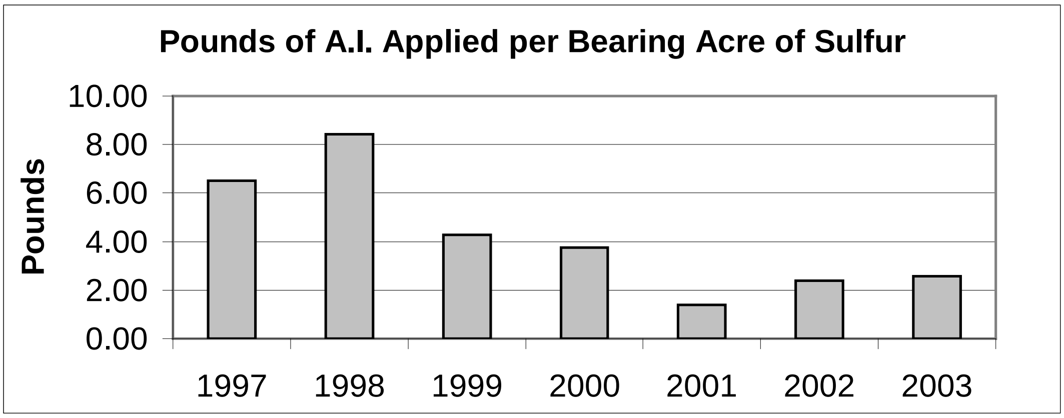


Figure 10. Total pounds of Sulfur used in dried plum production two years before and five years during the project.



PUR data for the 319h project, Butte County showed one growers in 2001 used Diazinon, three in 2002 and one in 2003. The Butte County totals pounds of Diazinon used 2001-2003 were 3,825, 3,727 and 3227 respectively.

VII. Other Funding Sources:

Additional grant support was solicited and secured from several sources. Listed below are sources of each additional grant that was used to support this project:

California Environmental Protection Agency/Department of Pesticide Regulation/Pest Management Alliance (CalEPA/DPR/PMA)
University of California/Sustainable Agriculture Research and Extension Program/Biologically Integrated Farming Systems (UC/SAREP/BIFS)
United States Department of Agriculture/Cooperative States Research, Education and Extension Services (USDA/CSREES)

United States Department of Agriculture/Natural Resources Conservation Service (USDA/NRCS)
United States Environmental Protection Agency (USEPA/Region 9)
State Water Resources Control Board (SWRCB)
CALFED Bay-Delta Program (Cal-Fed)

VIII. Future Plans:

Future plans include continued efforts to implement the monitoring, treatment thresholds and reduced rates of pesticides researched and validated by the IPFP project. Efforts will also be made to encourage clientele to use the November timing for their dormant aphid control program. These plans also include finishing the third edition of the "Integrated Prune Farming System Decision Guide" and disseminating new sections to farm advisors that have copies of the guide's second edition for sale in their office. The new sections will be placed in the guide to bring them up to date. This will be done in time for two spring meetings where topics relative to IPFP will be discussed. Those that already have the guide will be able to pick up the new sections to include in their existing guide.

IX. Matching Funds:

Matching funds were:

Task	Support
1.2	$2,400
1.3	$5,700
3.3	$2,050
4.1	$6,100
4.2	$150,000
4.3	$12,000
5.1	$13,385
5.2	$50,000
6.1	$150,000
6.2	$289,505
Total	$681,140

X. Literature Cited/Reports complementing the project:

1. 2002 Prune Research Reports
    a. Reducing Input of Dormant Sprays/Barry Wilson
    b. Prune Aphids: Fall Migration, Biological Control and Impact on Prune Production/Nick Mills
    c. Environmentally Sound Prune Systems/Bill Olson
    d. Prediction on Model of Blossom Blight Brown Rot in Prunes/Themis Michailides
    e. Mealy Plum Aphid and Leaf Curl Plum Aphid Pheromone Development/Barry Wilks
2. 2003 Prune Research Report
    a. Reducing Input of Dormant Sprays/Barry Wilson
    b. Prune Aphids: Fall Migration, Biological Control and Impact on Prune Production/Nick Mills
    c. Environmentally Sound Prune Systems/Bill Olson

3. 2004 Prune Research Report
    a. Reducing Input of Dormant Sprays/Barry Wilson
    b. Prune Aphids: Fall Migration, Biological Control and Impact on Prune Production/Nick Mills
    c. Environmentally Sound Prune Systems/Bill Olson

4. Implementation of Best Management Practices to Mitigate OP Pesticide Runoff, California Bay-Delta Watershed Program, Contract # 4600001690, June 2005

a. Summary of Work Completed

Reporting Period: 4-1-02 to 3-31-05

Contract No. 01-108-255-0
Project Name: Implementation of Best Management Practices to Mitigate OP Pesticides Runoff
Contractor Name: California Dried Plum Board
Project Director: Richard L. Peterson

Summary of Work Completed

Task	Deliverable by Subtask No. *	Due Date	% of Work Complete	Date Submitted
1. Project Management and Administration	1.2 Quarterly Progress Report	10/10/04	100%	1/10/05
	1.5 Contract Summary Form	04/10/02	100%	04/10/02
	1.6 MBE/WBE Documentation (319(h) only)	04/10/02	100%	04/10/02
	1.7 Contractor Documentation/ Solicitation Documentation	01/07/05		
	1.8 Project Survey Form	03/31/05		
2. CEQANEPA/Permits	2.1 CEQA/NEPA Documents	04/10/02	100%	04/10/02
	2.2 Permits	04/10/02	100%	04/10/02
3. Management Team	3.1 Establish Management Team	02/15/02	100%	02/15/02
	3.2 Initial Management Team Meeting	02/15/02	100%	02/15/02
	3.3 Regular Management Team Meetings	Ongoing: Final 01/09/05	100%	07/05/04
4. Demonstration Orchards	4.1 Landowner Agreements	03/04/04	100%	10/10/04
	4.2 Establish Demonstration Orchards	07/10/04	100%	03/04/04
	4.3 Annual Evaluation and Update to Demonstration Plans	February	100%	02/10/04
5. Public Outreach and Education**	5.1 Outreach	01/07/05	100%	10/10/04
	5.2 Education	01/07/05	100%	10/10/04
6. Monitoring and Tracking***	6.1 Chemical Monitoring	Annual Summary	100%	10/10/04
	6.2 Pest Monitoring	Annual Summary	100%	10/10/04
	6.3 Tabulate PUR Data	Annual Summary	100%	
	6.4 Tracking Management Changes	Beginning and End	100%	
7. Draft and Final Reports	7.2 Draft Report	02/01/05	100%	2/10/05
	7.3 Final Report	03/31/05	100%	3/31/05

* All deliverables were sent to the RWQCB contract manager with the quarterly report or separately.

** Contract Modification 5.3 occurred January 2005. We received funding through a separate CALFED grant project since the execution of this 319(h) contract. The CALFED project is closely coordinated with this 319(h) project and will continue to report on the progress of this subtask. The previously projected funds for this subtask are no longer required from this project and will not be included in subsequent invoices. The $10,000 budgeted for the UCCE Farm Advisor Assistant position, Subtask 5.3, be transferred to the Subtask 6.1.1 to allow for an additional season of pesticide runoff studies measuring the effectiveness of "Best Management Practices" recommended by the SRWP OPFG. Following a July 1, 2004 meeting with the researchers from UC and DPR concerning the pesticide runoff studies, it was decided that we should repeat the studies of last year concerning the effectiveness of filter strips and the width necessary for effective reduction in pesticide runoff. DPR feels that the 2003 data needs to be confirmed a second year, and it is hopeful that changes to the experiments will show a higher level of significance. Filter strips have the potential to be a major management strategy to reduce pesticide runoff and thus improve surface water quality. The additional studies should give DPR the data it needs to recommend the practice to growers.

*** Contract Modification to 6.2.2 occurred October 2002. After the project was began, we realized it would be prudent to develop a database that could be adapted to help facilitate the collection and dissemination of pest monitoring data under this project. There was a lot of pest monitoring data collected at each grower's orchard. When you multiply this times the 10 different orchards over the three years you have a tremendous amount of data to manage. The database helped with quality control of the data, and provided a summary to give to growers weekly, made it easier to more accurately summarize data for report the results of the project.