I. Cover Page

SAREP Final Report
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A Biologically Integrated Production System for Prunes
Final Report 1999-2004

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II. Table of Contents

III. Project goals:

Long-term: Implement monitoring techniques and use treatment thresholds for pest control and nutritional and water requirements in dried plum production.
Short term:

1. Develop and validate several monitoring systems useful to California dried plum growers and pest control advisors.
2. Research reduced use of pesticides by monitoring, making treatments only when needed, and use of lower pesticide rates to mitigate natural resource pollution.

IV. Executive Summary:

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. Irrigation scheduling help several participants in the project reduce water use. Monitoring of tree and well water nutrition status allowed most growers in the project to better supply fertilizers only as needed.

The IPFP/BIFS project covers the 1999-2004 seasons. We started with 25 growers (6,409 acres – 8% of the industry) in 1999, increased to 37 growers (9,311 acres – 11% of the industry) in 2001 and finished with 11 growers (1,696 acres – 2% of the industry) in 2004, see attached annual summary of growers and practices by year. There were 13 active U.C. and 45 industry participants during the project.

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

The core project focuses on monitoring and developing treatment thresholds for pests, plant nutrition, and irrigation needs. Pests being studied include: European red and web-spinning mites, San Jose scale, European fruit lecanium**,** leaf curl plum aphid, mealy plum aphid, peach twig borer, oblique banded leaf-roller, prune rust, and fruit brown rot.

The past six years', 1999-2004, results show that by using monitoring protocols and using treatment thresholds (developed by this project) substantial pesticide and coincident application costs could have been saved. Growers directly participating in this project saved approximately 111,928 pounds of pesticides annually during the six years of the project (see pages 17 and 27).

Monitoring tree-water status indicated some growers participating in this project were applying water more frequently than needed for best production; both water and cost savings occurred when tree water status was monitored and irrigation applied as needed (see pages 38, 39 and 40).

Some project growers had well water containing high levels of nitrate nitrogen. By using well-water analyses, this available nitrogen source could be used to supplement topically applied N fertilizer. Although not a requirement to participate in the project some growers annually used this information and reduced their topically applied N applications, saving both fertilizer and cost. Some project orchards were found to be N deficient every year of the project and most

orchards were N deficient during the final year of this project (see Table 15 page 36).

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 total attendance of individuals interested in dried plum production, several individuals attended more than one meeting. 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.

V. Justification/Background

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 and 204 dealing with water quality establish 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, to "conventional" ways dried plums have been farmed, need to be researched and results demonstrated and implemented to adjust to current economics and approaching and/or existing regulations. Economic 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.

The "Integrated Prune Farming Practices" (IPFP) project is a research/demonstration/implementation effort where eight University of California (U.C.) Prune Farm Advisors, one U.C. IPM Advisor, three U.C. Faculty Members, two U.C. Specialist and four industry representatives participate to advance economically and environmentally sound approaches to dried plum production. Although the focus of the project was redirected in 1999 the overall project was begun in 1998 with support from the California Dried Plum Board. Support from BIFS to expand the scope of this project became available in 1999.

VI. Project Design, Objectives and Procedures:

A. Project Design:

The 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 1999 through 2004. The project included research, demonstration, and implementation orchards. The sites were chosen, based on their location, to best represent the dried plum industry in California Research orchards are those where a specific research trial was conducted and their numbers were low and varied each year. For example research on controlling aphids with Zinc sprays was conducted in a research orchard. For 2003 and 2004 there were 23 orchards in the project, four demonstration and 19 implementation orchards. Demonstration orchards are those where two dried plum farming systems were compared: 1) a "conventional" system and 2) a "reduced risk" system. Each system consisted of at least 5 acres. The "conventional" system consisted of the grower's normal practices, but always included an Asana/oil dormant spray. Pest control and cultural decisions for the "reduced risk" system 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 orchards in this project that have converted totally to a "reduced risk" status. In 2003 and 2004 most cooperating growers orchards (19) converted totally to implementation orchards because they saw that the "reduced risk" program was working and they no longer wanted to make the comparison between "conventional" and "reduced risk". For this reason there are very little comparison data available for 2003 and/or 2004.

For 2000 there were 22, for 2001 there were 26, and for 2002 there were 26 demonstration and implementation orchards. The orchards were monitored by field scouts hired and trained by the IPFP team. There were six field scouts hired during this project. In past years, 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 that were 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 dormant spur sampling, using pheromone traps for peach twig borer, spring aphid monitoring and the mite monitoring protocols.

B. Objectives:

I. Secure additional funding
II. Develop economic treatment thresholds and monitoring techniques through "satellite" research projects.
III. Demonstrate alternative pest control strategies that reduce use of "conventional" biocides.
IV. Evaluate more effective use of fertilizers and natural resources (water).
V. Evaluate fruit quality from the "conventional" and "reduced risk" project sites.
VI. Demonstrate benefits of a cover crop/buffer strip, insectary hedgerow and wildlife friendly program.
VII. Encourage adoption of "reduced risk" practices through outreach and extension efforts.
VIII. Evaluate awareness, satisfaction and adoption of "reduced risk" practices through an industry survey, Pest Control Advisor involvement and changes in pesticide use.

C. Procedures:

Objective I. Secure additional funding.

The IPFP project team recognized the California Dried Plum Board could not support this project to the extent needed to conduct all the research and 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 California Dried Plum Board. However; securing other grant funding has been contingent upon prune industry support provided by the California Dried Plum Board.

Objective II. Develop economic treatment thresholds and monitoring techniques through "satellite" research projects.

"Reduced risk" concepts needed to be researched and developed before being demonstrated on a wide scale. Satellite projects, supported by IPFP to evaluate aspects of "reduced risk", (e.g. evaluating aphid control with soft chemicals) were established in one or more areas. The objectives and locations of "satellite" projects germane to IPFP are listed below but results reported separately.

2004

- Evaluate fall aphid control with low or below label rates of certain insecticides applied by air blast sprayer – Butte County.
- Evaluate fall aphid control with low or below label rates of certain insecticides applied by hand gun – Sutter County.
- Determine phytotoxicity of dormant oil sprays applied at different timings – Sutter County.
- Evaluate fall aphid control with low or below label rates of certain insecticides applied by air blast sprayer – Glenn County.
- Evaluate spring aphid control with oil – Butte County.
- Determine the allowable time interval between leaf removal and taking pressure chamber readings before readings become unreliable – Butte County.
- Produce and dissemination of the second edition of the "Integrated Prune Farming Practices Decision Guide".

2003

- Evaluate fall prune-tree defoliation for aphid control – Butte County.
- Determine the allowable time interval between leaf removal and taking pressure chamber readings before readings become unreliable – Butte County.
- Evaluate the use of pheromone traps to measure oblique-banded leaf roller (OBLR) populations and predict fruit damage – Butte County.
- Predict hail damage – Tehama County.
- Evaluate Imidan and fall "dormant" applications for aphid control – Butte and Sutter Counties.
- Determine cost comparison of "reduced risk" or "conventional" approaches to pest monitoring and control – Statewide.
- Produce and dissemination of the "Integrated Prune Farming Practices Decision Guide" – Statewide.

2002

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

2001

- Evaluate control of mealy plum and leaf curl plum aphids using reduced rates of diazinon and Asana with oil, in a dormant spray – Butte and Sutter Counties.
- Evaluate control of mealy plum and leaf curl plum aphids by using zinc to induce early fall defoliation – Butte and Sutter Counties.
- Evaluate adjustments to the pressure chamber use protocol - Statewide
- Evaluate the use of pheromone traps to predict oblique banded leaf roller populations and fruit damage - Statewide.
- Provide a literature and research review of prune aphid control using oils over the past ten years - Statewide.
- Determine exactly when aphids return to prune orchards to lay their over-wintering eggs by using water traps to catch returning aphids in the fall - Statewide.

2000

- Evaluate biological control of mealy plum aphids using *Harmonia axyridis* lady beetles - Statewide.
- Determine pesticide efficacy of two types of oil and one type of pesticide for aphid control - Butte, Sutter, Glenn and Tehama Counties.
- Evaluate of an alternate year dormant insecticide program evaluation- Tulare County.
- Evaluate a new aphid infestation-predicting model - Statewide.

1999

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

Prior to 1999:

- Evaluate an alternate year dormant spray program to cut pesticide use in half – Tulare County.
- Evaluate a predictive model for forecasting scab off-grade at harvest – Butte and Tehama Counties.
- Determine aphid control using soft chemicals – Statewide.
- Demonstrate a “mow and throw” technique for weed control by either using cover crop residue following mowing or rice straw (ag-waste) as mulch for weed control down the tree row – Butte County.

Objective III. Demonstrate economic treatment thresholds, monitoring techniques and implement alternative pest control strategies that reduce use of "conventional" biocides.

Monitoring: Field scouts monitored each site for San Jose scale, European fruit lecanium, European red mite eggs, prune aphids, peach twig borer, oblique banded leaf roller, beneficial insects, prune rust, fruit brown rot, and spider mites.
Field monitoring data were conveyed to grower-cooperators about pest's status. Subsequent reduced risk pest control recommendations were made based upon the monitoring data. The cooperator agreed to apply these recommendations to the "reduced risk" part of the orchard. As new pests monitoring techniques and recommendations became available they were incorporated into the project. These new pests monitoring techniques and recommendations came from "satellite" research projects listed earlier and reported on separately.

Evaluation: Evaluation of pest's populations, monitoring techniques and treatment requirements was made throughout the season.

Objective IV. Evaluate more effective use of fertilizers and natural resources (water).

Monitoring: Tree nutrient and tree-water status were monitored to determine nutritional status of the orchard and to schedule irrigations. Field monitoring data were conveyed to grower-cooperators about the nutritional status of the orchard and tree-water status. The tree nutritional data were provided for information only and grower-cooperators were not required to follow fertilization recommendations that were suggested. In most cases, irrigation schedules could not be applied separately to the "conventional" and "reduced risk" parts of the orchard. In these cases irrigation recommendations were applied to the entire orchard.

Evaluation: Harvest samples were collected to determine fruit dry away ratio, soluble solids and dry count per pound which often reflects tree water status deficiencies.

Objective V. Evaluate fruit quality from the "conventional" and "reduced risk" project sites.

Evaluation of fruit quality from the two farming systems was carried out in July and at harvest. Final evaluations were made before any damaged fruit fell off the tree. During the final evaluation 1000 fruit from each site was examined for the presence of scale, worm damage, cracks and brown rot. 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 the presence of scale, worm damage, cracks and brown rot. Also harvest samples were collected to determine fruit dry away ratio, soluble solids and dry count per pound.

Objective VI. Demonstrate a cover crop/buffer strip, insectary hedgerow and wildlife friendly program

Additional funding allowed for the establishment of cover crop, filter strip, hedgerow and a wildlife friendly program on many of the IPFP cooperators property. This provided sites for many educational meetings.

Objective VII. Encourage adoption of "reduced risk" practices through outreach and extension efforts.

Education/outreach: A major effort was devoted to production of the "Integrated Prune Farming Practices Decision Guide". This publication is now in its second edition and will soon have a third edition with sections on orchard floor management and mitigating pesticide runoff added to it. 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.

Objective VIII. Evaluate awareness, satisfaction and adoption of "reduced risk" practices through an industry survey, Pest Control Advisor involvement and changes in pesticide use.

Industry survey: The degree industry implements orchard monitoring in the cultural decision process measures the Integrated Prune Farming Practices (IPFP) project success – demonstrating the importance of monitoring when making pest management or 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 and cultural management 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 such as pesticides, water, and fertilizers to reduce costs and environmental contamination, were required. Through education/demonstration of appropriate pest, nutrition, and tree-water status 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 2002/2003, the Dried Plum Board 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.

Pest Control Advisor(PCA) involvement: During the course of this project approximately 15 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, these PCAs and the management team met and discussed the monitoring techniques.

Pesticide use reporting: Each year the Department of Pesticide Regulations pesticide use report for prunes (found at www.cdpr.ca.gov) was evaluated to help determine if this project had any impact on pesticide use in prune production.

VII. Accomplishments:

Objective I. Secure additional funding

Additional grant support was solicited and secured from several sources. Listed below are sources of each 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)

The grants secured allowed this project to evolve, provided funds to maintain the field sites and renewed efforts towards technology transfer via newsletters, grower meetings, working with PCAs and measurements of impact of the project on the industry. With the support of the California Plum Board and other sources of grant support, this work can continue to produce "Reduced risk" pesticide and cultural options for prune producers.

Objective II. Develop economic treatment thresholds and monitoring techniques through "satellite" research projects.

Results of "satellite" research projects provided information needed to proceed with developing and demonstrating reliable monitoring techniques and treatment recommendations. Here is a listing of such accomplishments – complete reports of these projects can be found in the "literature cited" section of this report and are included in the 1999-2004 Prune Research Reports.

- Develop a "dormant spur" monitoring technique for detection of scale insects.
- Establish treatment thresholds for scale insects found from using dormant spur monitoring technique.
- Develop a dormant treatment guide.
- Investigate several methods of evaluating potential aphid pressure prior to application of dormant treatments.
- Develop an "in-season" monitoring technique for aphids.
- Establish treatment thresholds for "in-season" aphids.
- Develop a fruit monitoring technique for detection of peach twig borer (PTB).
- Establish a treatment threshold for PTB found from using fruit monitoring technique.
- Develop a fruit monitoring technique for detection of oblique banded leaf roller (OBLR).

- Establish a treatment threshold for OBLR found from using fruit monitoring technique.
- Validate the "presence-absence" almond mite monitoring technique in prunes.
- Develop a "10 minute search" monitoring technique for web-spinning mites.
- Establish a treatment threshold for web-spinning mites using the "10 minute search" monitoring technique.
- Develop a prune rust monitoring technique.
- Establish a treatment threshold for prune rust using the prune rust monitoring technique.
- Develop a dormant spray program that would mitigate environmental concerns associated with dormant sprays.
- Create and distribute the "Integrated Prune Farming Practices Decision Guide" binder.

Objective III. Demonstrate alternative pest control strategies that reduce use of "conventional" biocides.

1. Dormant Treatment Decision Guide

Situation: Dried plum growers have had no way of knowing if they needed to apply a dormant insecticide and oil spray. The dormant spray has been in wide use because growers have been taught for many years that 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.

Evaluation: 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. Although some techniques were encouraging, the "test of time" showed none to be totally reliable. The techniques evaluated included: 1) A correlation between fall aphid abundance with spring aphid abundance. After three years of research, a correlation of only 46 percent (significant at the 99 percent level of confidence) was the best that could be achieved. 2) A correlation between appearance of aphids in the fall and appearance of aphids in the spring. This correlation proved to be 80 percent accurate (significant at the 99 percent confidence level) in predicting whether or not orchards will have aphids in the spring. These results were encouraging but not being able to predict an aphid population 20 percent of the time was unsatisfactory. In order to try and make the correlation more accurate a model, developed by Tim Prather, U.C. IPM advisor, called the "Prather Model", was developed. 3) The "Prather Model" 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. The "Prather Model" failed to have a significant correlation between predicted percent of trees to have aphids in the spring and the actual percent of trees to have aphids. 4) When spring aphid counts in one year were compared to spring aphid counts in the next it was found that there was 76 percent correlation (significant at the 99 percent confidence level) in

predicting level of aphid infestation. This suggested that aphids return to the same orchards at approximately the same population levels.

Based on monitoring techniques that had fairly high correlations (techniques 2 and 4) two treatment guides were developed and used through 2003. (See Tables 1 and 2). Table 1 was for orchards that had been receiving annual dormant insecticide sprays. The aphid treatment threshold would be reached if: 1) one tree out of 40 trees (2.5%) monitored in the fall had dried plum aphids; or 2) orchard history indicates at least one tree had aphids last season despite application of a dormant insecticide and oil; or 3) at least one aphid egg was found in a dormant spur sample. Table 2 was for orchards that had not been receiving dormant insecticide sprays. Here, 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.

A sequential sampling dormant spur monitoring technique involving sampling spurs in winter for the presence of SJS or EFL crawlers is the other part of the "Dormant Treatment Decision Guides". This monitoring technique was evaluated for three years before implementation. A statistician developed the sequential sampling procedure from data collected from those three years. 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).

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

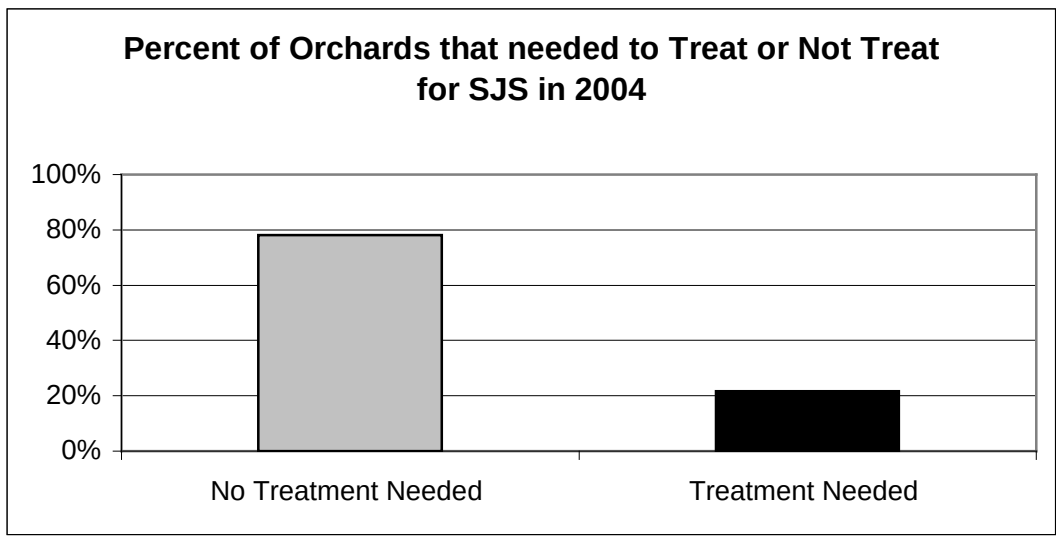
Dormant Treatment Decision Guide For Orchards That Have Been Receiving Dormant Insecticide Sprays in The Past			
Aphids present using methods 1, 2 or 3 (Y,N)	**Scale above Threshold**	**Reduced Risk Treatment Reccomendation**	**Conventional Treatment Recommendation**
N	N	Nothing	Nothing
N	Y	Dormant Oil	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.				

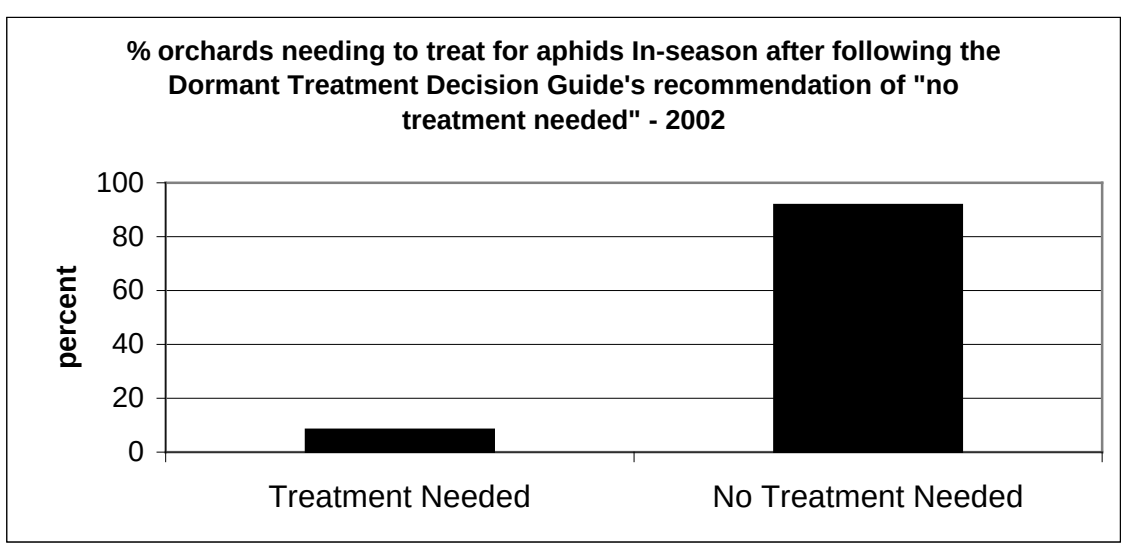
Results: 1) By following these guides, very few orchards needed to treat for SJS (Figure 1) and no orchard had an outbreak of SJS during the course of the project.

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.



As a result of problems predicting aphid outbreaks, for the 2003/04 dormant period, all

cooperating growers were advised to control aphids in the dormant period or with oil during the bloom period unless they had long term history of knowing their orchard was not frequented by aphids. This program was totally successful in 2004.

Conclusions: The Dormant Treatment Decision Guide for orchards that have been receiving dormant insecticide sprays in the past was not reliable in forecasting aphid outbreaks; there is no good way of knowing long-term history of aphid populations in those orchards. The Guide for orchards that had not been receiving dormant insecticide sprays in the past was fairly reliable but there were still problems with two orchards that required aphid control after predicting aphids would not be a problem. The SJS part of both guides was reliable and useful.

Dormant Treatment Decision Guide Revision

As a result of problems predicting aphid outbreaks, more work needed to be done on dormant aphid control with alternative pesticides and/or reduced rates of insecticides. Alternative pesticides have been tried in the past by several project members with little success so the 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 rate of diazinon or Imidan or below label rates of Asana and 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 percent 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 created by dried plum growers. Project farm advisors have been informing growers about these exciting results and encouraging growers to try this method of controlling aphids.

These results will soon be incorporated into the "UC IPM Pest Management Guidelines for Dried Plums" with specific reference to the low rates and November timing for aphid control.

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.

Since aphids are the only routine pest that needs to be controlled with dormant treatments and since low rates of materials without addition of oil are effective, this new information will dramatically reduce the amount of dormant pesticides applied. For example in 2004, among cooperating growers (1,696 acres total) these new recommendations emanating from the project's work, saved 5,088 pounds of pesticides and 67,840 pounds of oil. Based on the current bearing acreage of 65,175 acres and projecting in the future, following this treatment recommendation developed from this project, would save approximately 132,300 pounds of pesticides and 2,800,000 pounds of oil annually. (Based on all bearing acreage receiving a dormant treatment using 63 % less pesticide and no oil).

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. Information of this type could be useful to dried plum growers who may need to treat for PTB, OBLR or SJS.

A. San Jose Scale (SJS)

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 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.

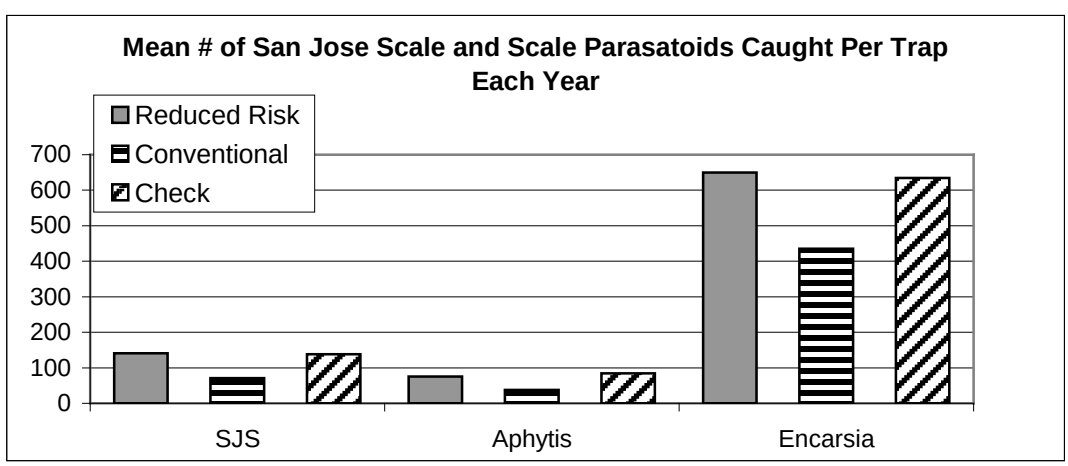


Table 4. Average number of live or parasitized SJS found on 1000 fruit each year of the project.

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 was a few SJS on the fruit the first two years of the project, albeit it was minor and of no economic consequence, in the last four years no SJS was 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.

B. Peach Twig Borer (PTB)

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 do 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. However, 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 at "popcorn" bloom 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). In 2001 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 four "conventional" and nineteen "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 in 19 "reduced risk" and 4 "conventional" orchard sites in 2003.

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

Conclusion: 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.

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 was 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 2002. 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 at popcorn bloom 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.

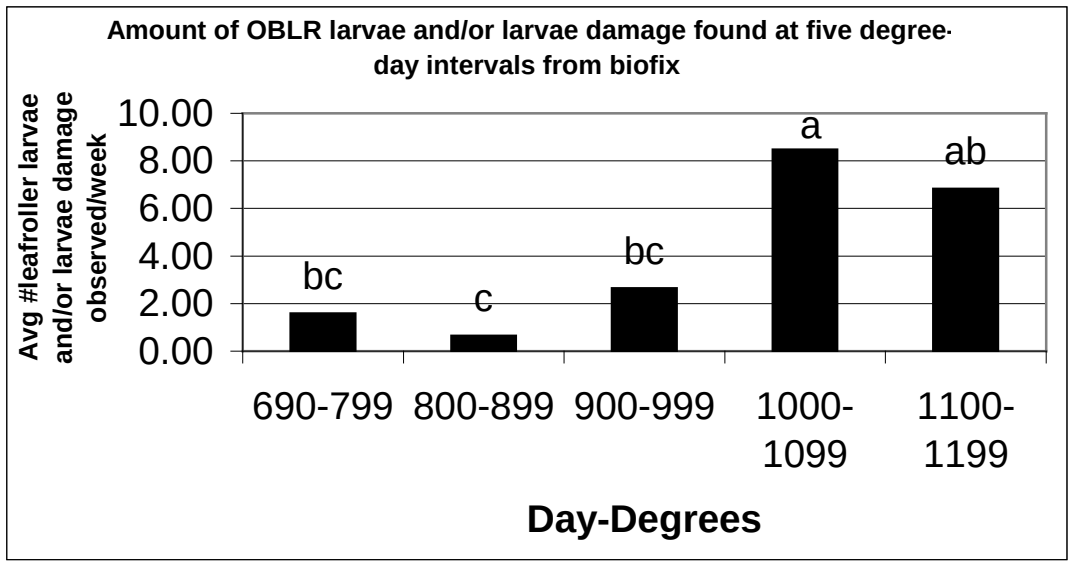
Results: When fruit were evaluated for three weeks, beginning at 690 degree-days after biofix, none of the project orchards reached the 1 percent treatment threshold so none needed to apply a growing season OBLR treatment. In the July sample, six orchards had OBLR larva and/or damage over 1 percent with 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 32 project orchards in 2002.

Table 7. Mean percent fruit with OBLR damage present from 32 orchard sites (690 Degree-Days + 2 weeks, July and Harvest Final Evaluations) in 2002.

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 in 32 orchards for five weeks in 2002, 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 in 2002 in 32 orchard sites



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 four "conventional" and 19 "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 in 19 "reduced risk" and 4 "conventional" orchard sites in 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 in 19 "reduced risk" orchard sites in 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.

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 which 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 found in 29 cooperators orchards through the course of the project is shown in Table 10.

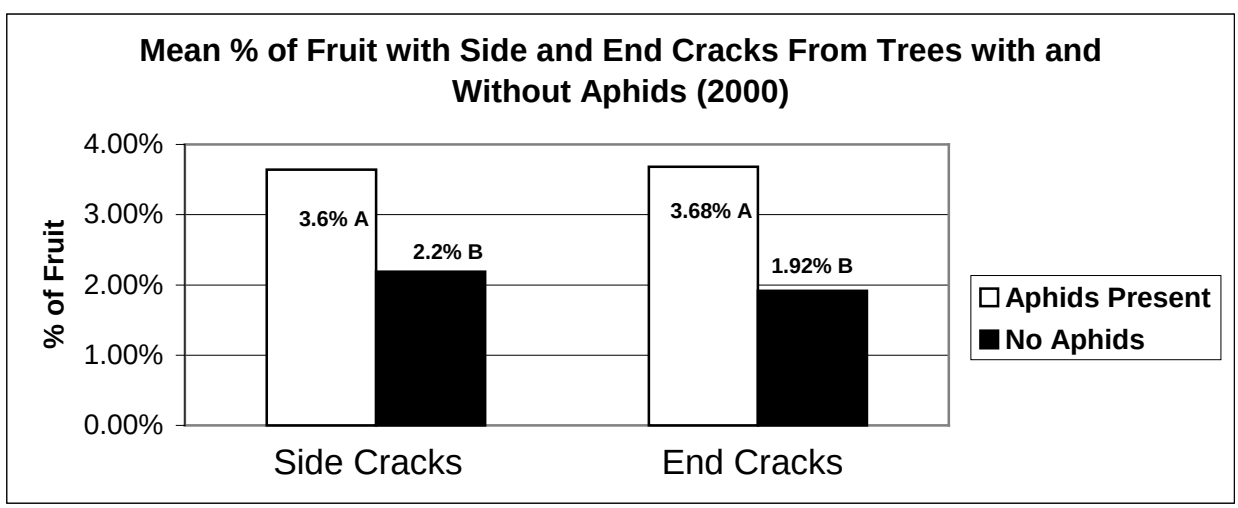
Table 10. Average incidence of aphids in 29 orchard sites from 1999 through 2004.

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. In 17 orchards evaluated 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 in 17 orchard sites in 2000



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. Prune Rust Monitoring and Treatment Timing Recommendations:

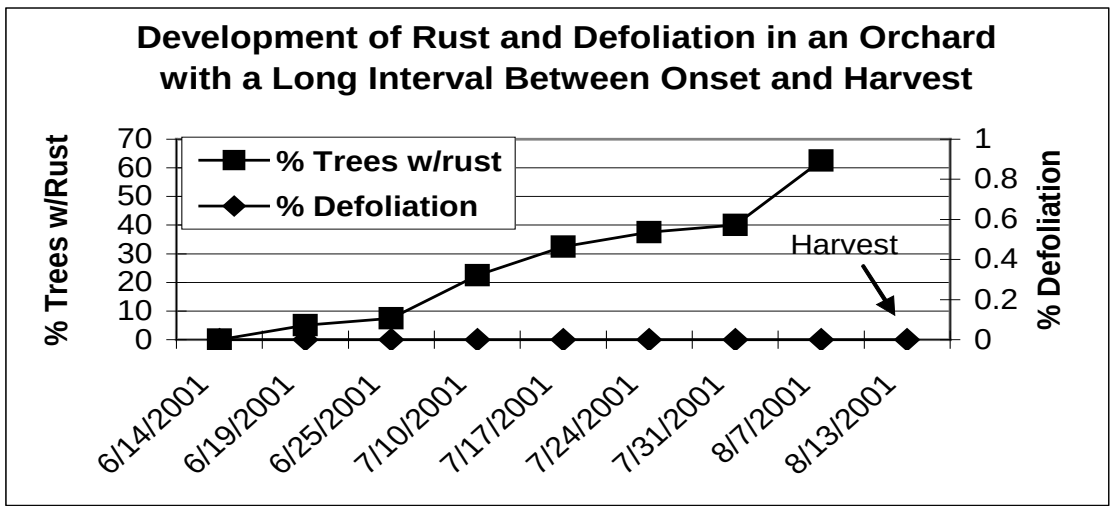
Situation: Prune rust is the most common pest treated during the growing season. Previously, growers had no way of knowing if they needed to treat for rust. Most growers simply applied one or more protective wettable sulfur treatments in May, June and/or July.

Previous research has shown rust treatments applied close to the onset of rust infection were the most beneficial and provided protection for about two weeks. Teviotdale and Sibbett demonstrated that post harvest defoliation from rust had no influence on subsequent fruit quality or productivity. In 1997, Krueger, Olson and Teviotdale reported that appearance of rust infection on leaves has no influence on fruit soluble solids, fruit dry away ratio or fruit size However, according to the French, fruit soluble solids, dry away ratio and/or fruit size can be affected if rust causes defoliation prior to harvest

Evaluation: From this project, a technique was developed to monitor the same 40 trees on each visit to each project site for onset of prune rust infection. Monitoring for rust was initiated May 1st and conducted weekly in the Sacramento Valley and every other week in the San Joaquin Valley to mid-July if no rust was found. If rust was detected, monitoring continued until approximately 4 weeks prior to harvest. The treatment threshold was the first sign of rust in the orchard. Once rust was detected, a treatment was recommended. After a rust treatment was applied, if continued monitoring indicated an increase in rust, additional treatments were recommended. In 2002 the monitoring switched to a random 40 tree search. This led to a broader search area and a faster detection method. Any tree defoliation that occurred prior to harvest in the project orchards was documented to help validate the treatment threshold and treatment cutoff timing.

Results: Prune rust was found in some of the project orchards every year. Growers that followed the project's recommendations and treated when rust first occurred had no defoliation prior to harvest. Slight defoliation only occurred in two years of the project and in only four orchards. The growers at these four orchards decided not to treat for rust even though they had reached the rust treatment threshold. In 2000, 2001 and 2004 at untreated sites, no defoliation from rust occurred when rust was first detected 6, 7, and 6 weeks before harvest respectively. In 2003, rust was found as early as eight weeks before harvest, resulting in minimal defoliation. The earliest prune rust occurred in an orchard was mid June, 2002, about eleven weeks prior to harvest and controlled with one treatment. No defoliation ever occurred when rust first appeared after July 15th. For a graphic example of the prune rust data collected from one representative orchard in 2001, see Figure 6.

Figure 6. The percent of rust and defoliation found in one orchard during the course of the 2001 season.



Conclusion: The data suggest that rust monitoring and rust treatments can be terminated several weeks before harvest. Since 2003 rust treatments have not been recommended within six weeks of harvest.

This prune rust monitoring technique has worked well during the course of this project. The monitoring technique has potential to greatly reduce rust treatments. Sixty-five percent of all orchards monitored in 2004 had either no rust or rust was found only after rust would no longer be a problem (six weeks prior to harvest). The monitoring technique revealed that 76 percent of all orchards monitored in 2003, 84 percent of all orchards monitored in 2002, 91 percent in 2001 and 88 percent in 2000 had either no rust or rust was found only after rust was no longer a potential problem. Based on this data an average of 80 percent of all prune orchards do not need an annual prune rust treatment.

Over the past five year of this project, cooperating prune growers eliminated rust sprays on 1950 acres (20 acres average per grower) this resulted in an estimated 39,000 pounds of sulfur pesticides saved by cooperating growers.

Had all prune growers followed this rust monitoring program during the project years an average savings of approximately 1,325,040 pounds of Sulfur pesticide would have been saved. Based on the current bearing acreage of 65,175 (either here, or previously, identify source of this figure) acres and projecting in the future, following this monitoring program and treatment threshold, would save approximately 1,042,800 pounds of sulfur pesticide annually. (Based on all bearing prune acreage receiving one Sulfur application for rust at 20 lbs/acre.)

Monitoring for prune rust is a fairly simple technique. It takes one person less than 30 minutes to evaluate an orchard. Judging from the recent reduction in the amount of Sulfur used in prune production this or some other decision-making technique is now being utilized by prune growers.

5. Presence–Absence Sequential Sampling for Web-spinning Mites:

Situation: Dried plums are occasionally infested by web-spinning mites and require an in-season treatment. When this project started there were no established monitoring techniques or treatment thresholds for web-spinning mites in dried plums. When growers made treatment decisions it was generally based on visible damage or on calendar date. This was often too late, too early, or unneeded. The presence-absence web-spinning mite monitoring technique developed for almonds was tested and validated for use in prunes from 2000 through 2001.

Evaluation: In 2000, the presence-absence sequential sampling for web-spinning mites consisted of sampling 15 leaves from 10 trees per project site for the presence of web-spinning and beneficial mites/predators. Sampling began around June 1 and continued for 10 weeks. In 2001 the number of trees monitored dropped from 10 to 5 per project site due to length of time it took to complete monitoring. The treatment threshold was when over 53 percent of the leaves had web-spinning mites or eggs with mite predators present, or 32 percent of the leaves having web-spinning mites/eggs with no predators present. Sampling took 30 – 45 minutes (5 trees per site) and was done every other week until 20 percent of leaves had mites. Once that level was reached, sampling was done weekly. Pest control advisors were kept aware of this mite monitoring technique.

Results: This monitoring technique was validated in dried plums and clearly showed population levels of mites, predators and treatment thresholds. Even though PCAs agreed the monitoring system was accurate and provided the information they needed to know, they all agreed they would never use it because of time required.

Conclusion: Although this monitoring technique takes too long for PCAs to implement, the presence-absence monitoring technique for mites is a useful method of determining need for treatment, reducing likelihood of treating without justification. However, another mite monitoring system that that would be acceptable to PCAs had to be discovered and validated.

6. 10-Minute Search for Web-spinning Mites Technique

Situation: To replace the presence-absence mite sampling technique PCAs would not use, work was begun on a “10-minute search” monitoring technique in 2001 and 2002.

Evaluation: The “10-minute search” monitoring technique for web-spinning mites was compared to the presence-absence technique in 28 orchards. Each monitoring technique was performed in the same area of the orchard. The “10-minute search” was conducted first so results would not be influenced by the results of the presence-absence technique. The “10 minute search” technique involved looking for symptoms of web-spinning mites, as well as, looking at individual leaves with a hand lens to evaluate mite predator and web-spinning mite populations. This would be done for approximately five minutes in two different locations in the orchard. After each five-minute search, web-spinning mite and mite predator levels were recorded. The following six categories for web-spinning mites and three categories for mite predators were used:

Web-spinning mite rating:

1. None – No mites present.

2. Low – An occasional web-spinning mite on occasional leaf. Web-spinning mites generally hard to find. Example: less than one web-spinning mite per leaf.

3. Low-moderate – Web-spinning mites easier to find, but no colonies of web-spinning mites, no webbing and few eggs. Example: two to four web-spinning mites per leaf.

4. Moderate – Some leaves with no web-spinning mites others with small colonies of web-spinning mites with eggs easy to find, but very little, if any, webbing**.**

5. Moderate-high – Web-spinning mites on most leaves, colonies with eggs and webbing on some leaves

6. High - Lots of web-spinning mites on most leaves. Colonies of web- spinning mites, eggs and webbing abundant.

Predator rating:

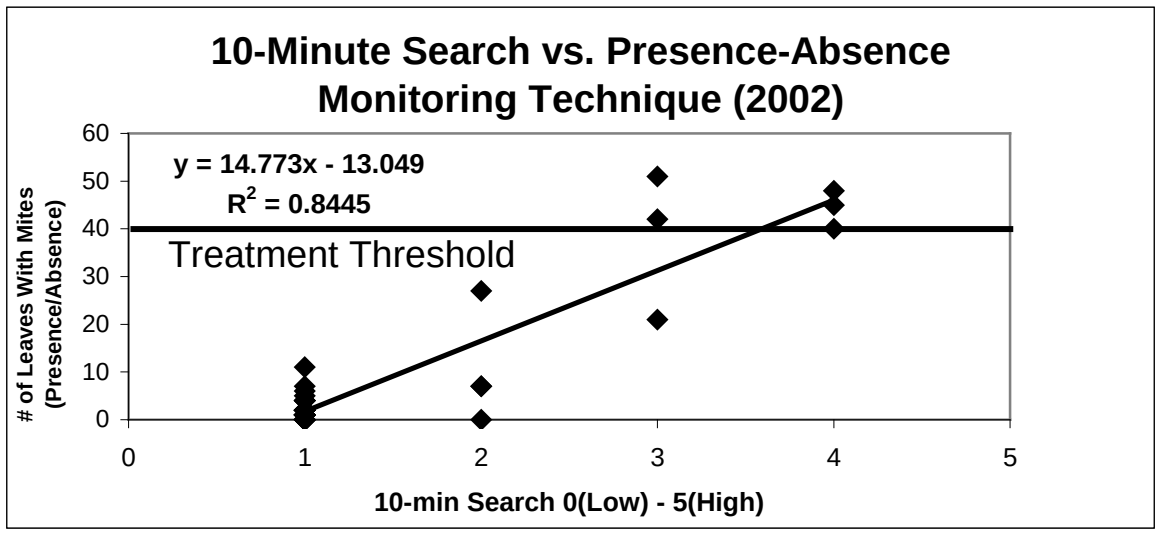
1. Low – Hard to find. Example: less than one predator per six leaves.

2. Moderate – Easier to find. Example: one predator per three leaves.

3. High – One or more predators per leaf.

Results: Results from this technique were compared with presence-absence technique and a strong correlation between the two was found. The "10-minute search" monitoring technique had an 84 percent correlation (significant at the 99 percent confidence level) with the presence-absence sampling technique in 2002 (Figure7).

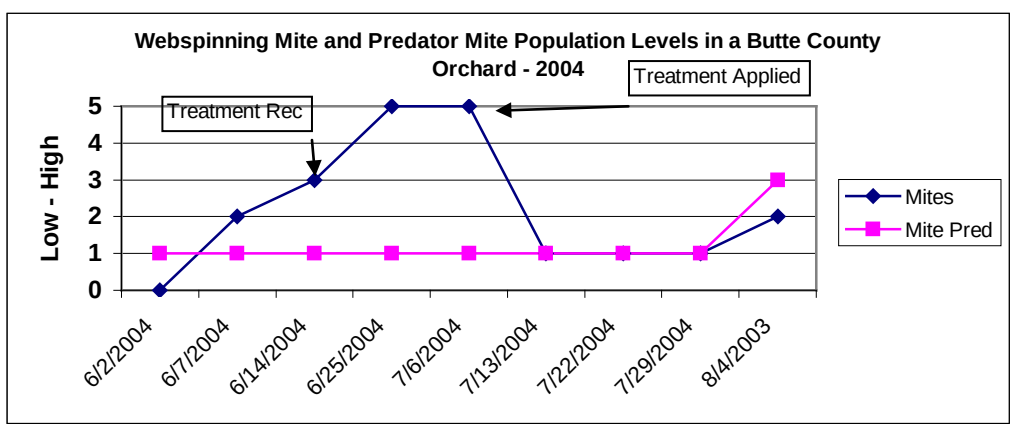
Figure 7. Correlation between "10 minute search" and presence/absence mite sampling in 28 orchard sites in 2002.



In 2004, 22 percent of the orchards reached a treatable level of web-spinning mites before mid July. Four orchards were treated shortly after the population reached the treatment threshold and lowered the population enough to avoid defoliation before harvest. The orchard that did not treat had a low incidence of defoliation prior to harvest.

Figure 8 summarizes data collected in one orchard in 2004 and illustrates the type of information this monitoring system can generate.
In 2003 and 2004, the "10-minute search" technique was the only mite monitoring technique that was used in this project.

Figure 8. Information gathered from using the "10 minute search" for mites in one orchard in 2004.



Conclusion: The "10-minute search" monitoring technique is an accurate, time saving monitoring technique to determine whether or not a treatment is needed for web-spinning mites. Using this technique, the observer can see a problem coming and apply treatments in a timely fashion, often using low rates of miticides or oil. The "10-minute search" technique requires little training or experience to use. Pest control advisors should find this monitoring system acceptable since it takes little time to use.

7. Fruit Brown Rot Predictive Model (ONFIT – Over Night Freezing and Incubation Technique):

Situation: There is currently no way of knowing if fruit brown rot will occur or not. Consequently growers have been applying prophylactic sprays pre-harvest for fruit brown rot based on suspicion it will occur. U.C. Plant Pathologist Themis Michalaides created a technique to determine presence of fruit brown rot from latent infections that needed to be validated.

Evaluation: Evaluating usefulness of ONFIT involves sterilizing and freezing a sample of green fruit from 23 project sites in late May-early June then allowing it to thaw to promote development of latent infections by brown rot fungi *Monilinia fruticola* or *Monilinia laxa*. Levels of latent infection found using this ONFIT technique were correlated to levels of fruit brown rot infection that became visible at the project sites in the field from 1000 fruit samples evaluated in July and again at harvest. These results were compared to a predictive table provided by Dr. Michalaides (see Table 11). This information was used to determine need to protect fruit from brown rot infection with a fungicide application.

Table 11. ONFIT brown rot predictive table.

% infected green fruit from ONFIT	% infected fruit (field)	% infected fruit (post harvest)
0	0	0
1	1	5
2	3	15
5	9	35
8	14	50

Results: The ONFIT technique was evaluated for four years but never during those four years was there enough brown rot in the field to validate the ONFIT technique. An example of 2001 results is presented in Table 12. . That year, ONFIT revealed 12 sites (52 percent) with low levels of latent brown rot present. Final field evaluations at harvest indicted fruit brown rot was present in low levels at 10 sites (43 percent). Eight of the 10 sites having brown rot at harvest were among 12 predicted to have brown rot using ONFIT. In 2001, brown rot levels during July exceeded 1 percent infection in two sites, while at harvest only one site exceeded 1 percent infected fruit. ONFIT over estimated the harvest incidence of brown rot in 80 percent of cases and underestimated the harvest incidence of brown rot in 20 percent of cases.

Table 12. 2001 ONFIT results.

County and Site	ONFIT Prediction (% Brown Rot)	% Brown Rot Present in July	% Brown Rot Present at Harvest
Ag - Tulare	0	0.0	0.0
BR - Glenn	1	0.0	0.2
DB - Butte	2	0.3	0.2
Br - Madera	0	0.0	0.0
GC - Sutter	8	0.0	0.0
CSUC - Butte	0	0.3	0.0
DC - Butte	8	0.2	0.0
FI - Tehama	1	0.0	0.0
EG - Fresno	0	0.0	0.0
BJ - Butte	2	0.5	1.5
JH - Sutter	0	0.0	0.0
JC - Butte	1	0.7	0.5
JT - Yolo	0	0.0	0.0
KJ - Yuba	5	7.0	0.2
LF - Glenn	1	0.2	0.2
MK - Yuba	6	0.7	0.0
AR - Tehama	0	0.0	0.0
MJ - Sutter	2	1.7	0.0
OO - Butte	0	0.0	0.3
RBF - Tehama	0	0.0	0.2
TR - Sutter	0	0.0	0.2
DV - Tulare	0	0.0	0.0
WG - Glenn	1	0.0	0.7

Conclusion: The ONFIT technique needs to be evaluated under more severe conditions before it can be relied upon. Under conditions of little or no fruit brown rot, the ONFIT test was 67 percent accurate in predicting whether or not the orchard would have some level of brown rot in 2001. Although this percent accuracy may seem low, it is surprisingly high for so little brown rot found at harvest. This monitoring technique could provide valuable guidance about the need for a fruit brown rot spray. More research and evaluation of the ONFIT during years of higher brown rot incidence will need to be conducted before any definite conclusions can be made. Due to the low incidence of brown rot no testing of ONFIT was done after 2001 in this project.

Objective IV. Evaluate more effective use of fertilizers and natural resources.

1. Using Tissue and Water Sample Analysis

Situation: Although leaf-tissue analysis has been recommended for many years, it is an underutilized tool determining fertilization needs. Water analyses are also valuable in detecting nitrate nitrogen (NO_3^-N) in well water. Knowledge of nitrate nitrogen (NO_3^-N) content of irrigation water can be useful for growers wishing to supplement standard N fertilizer programs to further reduce costs and potential for polluting underground water supplies. Project growers' well water was sampled to determine levels of NO_3-N in the water. All growers were told of

NO_3^-N in their irrigation water but were not required to reduce their normal N fertilizer program or to report the amount of N actually applied as part of the project even though some NO_3^-N was present in their irrigation water. Some growers did however reduce their N fertilizer programs to take advantage of the NO_3-N in the irrigation water. For adoption of this monitoring tool, its utility still needs to be documented and demonstrated to growers.

Evaluation: Each year, levels of Nitrogen (N), Potassium (K), Zinc (Zn) and Boron (B) were obtained through leaf-tissue analyses. Plant tissue and water samples for each site were collected in July and submitted to a private analytical laboratory for analyses. Results were reported to growers for their consideration when making decisions about fertilizer applications in the "reduced risk" orchard sites. In 2002, water samples were only collected from wells that had high NO_3^-N in the past. In 2003 and 2004, no water samples were tested because no new orchards that irrigated with well water were added to the project

Results: Results of water analyses are shown in Table 13. Multiplying ppm of NO_3^-N by 2.72 results in pounds of Nitrogen applied per acre foot of irrigation water. Sites highlighted in Table 13 have a high amount of NO_3^-N in the water. Over the four years water samples were collected, 40 percent of the growers had significant amounts of NO_3^-N in their irrigation water. The average pounds per year of Nitrogen per acre foot of irrigation water were 12.8. With prune production two to four acre feet of water are applied. This would provide about 25 to 50 pounds of N per acre. It is not known how much of this N is "captured" by the tree but if it was 50 percent efficient an acre of trees would be getting about an extra 12 to 24 pounds of N.

In 2000 one grower (water analysis site 6) took this source of N into consideration and cut his annual N fertilizer program from 100 pounds of N per acre back to 75 pounds of N per acre on his "reduced risk" site. The following year his "reduced risk" site was N deficient. This example and the fact that 35 percent in 2003 and 67 percent of project growers orchards in 2004 were N deficient (Table 14) suggest not enough is known about N requirements in prune production.

Table 13. Water Analyses (1999-2002)

	2002		2001		2000		1999	
Site	NO_3 N - ppm	Lbs N/acre ft water	NO_3 N - ppm	Lbs N/acre ft water	NO_3 N - ppm	Lbs N/acre ft water	NO_3 N - ppm	Lbs N/acre ft water
Site 1	0.0	0.0	2.1	5.8	2.3	6.1	2.4	6.4
Site 2	7.7	20.94	7.2	19.5	10.1	27.4	10.1	27.5
Site 3	5.2	14.14	4.8	13.1	3.2	8.6	5.7	15.5
Site 4	5.4	14.69	8.0	21.8	5.2	14.2	0.0	0.0
Site 5	0.0	0.0	1.7	4.6	1.7	4.5	6.1	16.5
Site 6	0.0	0.0	15.2	41.3	10.4	28.3	10.5	28.6
Site 7	0.0	0.0	25.2	68.5	3.4	9.1	5.9	16.0
Site 8	0.3	0.82	1.2	3.3	1.6	4.4	1.7	4.7
Site 9	0.0	0.0	9.6	26.1	8.5	23.1	8.2	22.2
Site 10	0.0	0.0	2.2	6.0	2.6	7.1	1.8	4.8
Site 11	3	8.16	0.8	2.2	2.7	7.4	2.1	5.7
Site 12	5.5	14.96	3.6	9.7	2.1	5.7	2.1	5.7
Site 13	0.0	0.0	3.9	10.6	8.3	22.6	5.2	14.1
Site 14	0.0	0.0	8.2	22.3	<.05	<.135	<.05	0.0
Site 15	0.0	0.0	2.7	7.3	<.05	<.135	0.1	0.2
Site 16	0.0	0.0	0.0	0.0	1.0	2.8	1.3	3.5
Site 17	0.0	0.0	0.7	1.9	1.5	4.2	0.0	0.0
Site 18	0.0	0.0	0.2	0.5	0.0	0.0	<0.05	0.0
Site 19	0.0	0.0	10.8	29.4	0.0	0.0	11	30
Site 20	0.0	0.0	0.0	0.0	6.1	16.6	6	17

Although tissue analyses were conducted each year, only results for the past two years are shown in Table 14. Deficient levels of the nutrients are as follows: N – less than 2.2 percent, K – less than 1.3 percent, Zn – less than 18 ppm, and B – less than 30 ppm. B is also toxic if the levels in the tissue exceed 100 ppm. Orchards deficient in these nutrients are highlighted in Table 14.

In 2003, based on U.C. established critical mid-summer leaf tissue levels, 35 percent of the sites were considered deficient in N. No cooperator was deficient in K. Eighty-four percent of the cooperators were considered deficient in Zn. High levels of Zn found in two orchards were the result of Zn spray contamination. All cooperators orchards had adequate B levels.

In 2004, 67 percent of the sites that had leaf samples taken were deficient in N, 72 percent were deficient in Zn and none of the sites were deficient in K or B.

Table 14. 2003-2004 Tissue Analyses for Various Nutrients *

	2003				2004			
Site	N - %	K - %	Zn - ppm	B - ppm	N - %	K - %	Zn - ppm	B - ppm
1	2.4	2.35	**12**	51	2.39	2.68	18	66.00
2	**2.17**	2.77	**9**	48	2.37	2.42	**16**	61.00
3	2.25	1.85	70	54	**1.89**	1.85	**11**	46.00
4	2.23	1.47	18	37				
5	2.21	1.97	**15**	52	**1.94**	2.39	**15**	43.00
6	2.38	2.07	**16**	59	**1.88**	2.19	**13**	50.00
7	**1.83**	1.95	**14**	48	**1.68**	2.54	**13**	42.00
8	2.28	2.13	**15**	53	**1.44**	2.18	**15**	42.00
9	**2**	2.15	63	51	**1.54**	2.63	18	43.00
10	2.25	3.35	**11**	63	2.32	2.56	**16**	68.00
11	2.27	3.35	**11**	59	2.24	2.56	**16**	71.00
12	**1.86**	2.1	**15**	52	**2.01**	2.64	18	45.00
13	**1.89**	1.98	**15**	54	**1.87**	2.49	18	48.00
14	2.21	1.40				2.31		
15	2.48	1.37	**15**	54	**1.88**	1.68	**15**	45.00
16	**1.99**	1.88	**15**	49	**1.89**	1.65	**17**	47.00
17	2.49	2.42	**15**	58	**2.01**	2.63	**14**	49.00
18	2.58	2.24				1.68		
19	2.59	2.94				3.2		
20	2.54	1.56				3.72		
21	**1.8**	1.8	**10**	51	**1.81**	1.86	**13**	53.00
22	2.34	2.8	**13**	44	2.26	2.76	18	62.00
23	**2.15**	2.43	**17**	45	2.37	2.42	**16**	61.00

- **Bold** type indicates a deficiency

Conclusion: The N levels found in the well water were told to growers for their consideration when making fertilizer recommendations in the "reduced risk" orchard sites. Some growers reduced their annual N application because of $NO3^-N$ in the well water, others did not and others did not have N in their irrigation water. Regardless of the N program followed most grower's orchards (67 %) were N deficient in 2004. Clearly more needs to be known about N fertilization of prune orchards.

The percentage of orchards deficient in N, K, Zn and/or B in 2003 and 2004 was typical of what was found in other years of this project (see Table 15). No grower was found to have high levels of N indicating growers are not applying too much N. In fact the contrary appears to be the case. Growers also may have reduced their fertilizer programs in recent years due to reduced payments and declining markets for prunes.

Tissue analysis has provided useful information and has proved to be a very valuable tool when making fertilizer decisions. How to take advantage of information about the amount of NO_3^-N in water samples in order to make N fertilizer recommendations needs further investigation.

Table 15. Percentages of orchards with various nutrient deficiencies over the five years of the project.

	Percent of orchards deficient in:			
Year	**N**	**K**	**Zn**	**B**
2004	67	0	72	0
2003	35	0	84	0
2002	20	0	26	0
2001	48	0	24	0
2000	5	5	47	0

2. Early Leaf Analysis to Forecast the Need of Potassium (K) and/or Nitrogen (N) Fertilizer Applications:

Situation: Established guidelines for adequate leaf K levels in prunes are available using July leaf tissue samples. However, if deficiency is present then, detrimental effects to crop production may have already occurred. If an early method of predicting nutrient deficiencies was available it would give growers an early opportunity to make corrective fertilizer applications.
Evaluation: In 2001, 2002 and 2003 the early leaf tissue sampling for K was compared to the July leaf samples at all project sites. In 2002 and 2003 N was also tested and compared along with K. The test involved collecting 100 fully expanded, mature leaves from at least 25 healthy trees per orchard site the first week of May and the first week of July and having them analyzed by a private analytical laboratory for K and N content. If a correlation between the two sampling dates could be made then early fertilizer recommendations could be made. Once in June, July and August, trees in the "reduced risk" and "conventional" sites were visually monitored for presence of K deficiency symptoms. In 2004 no tests were conducted because the prune crop was too light to gain any meaningful information.

Results: Using May leaf K and N nutrient levels to predict a July leaf K and N nutrient levels was unsuccessful. Potassium and N levels in May would generally be predicted to be lower in July. This was not the case in many orchard sites. No correlation between these two leaf sampling times could be found for leaf K or N (see Figures 9 and 10).

Figure 9. Correlation between May and July leaf Potassium.

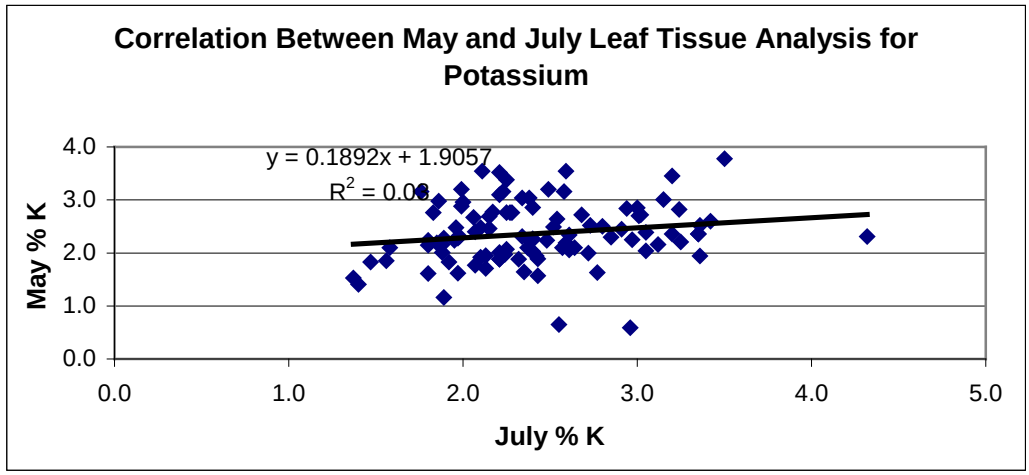
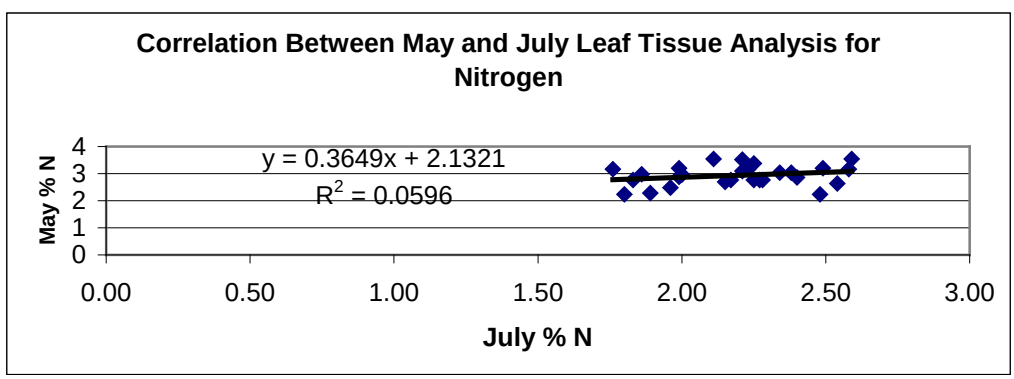


Figure 10. Correlation between May and July leaf Nitrogen.



Orchards that exceeded 2.3 percent leaf K in May generally did not have visual symptoms of K deficiency that year and generally had adequate K levels in the July tissue analysis. Orchards that were below 1.3 percent leaf K in May, and were known not to have applied K for correction, showed deficiency symptoms in July and August.

Conclusion: The poor correlations indicate that knowing K and N status of prune trees in May has little relation to what the K or N status would be in July. This is undoubtedly due to: 1) the influence of any fertilizer applications that may have been recently made, 2) the influence of the crop load, 3) the influence of residual K and N in the soil. However, in general the following recommendations could be made based on the data collected: 1) K levels above 2.3 percent in May suggest that there will be no need for additional K applications that season and deficiency symptoms are highly unlikely and 2) May K levels at or below 1.3 percent suggest a likelihood of visual K symptoms and the need for K treatments. These guidelines are too broad to provide much utility. Other information such as irrigation schedule and quantity, soil type, soil K status, and crop load would be important factors needed to help get a better picture of the need for K applications in these orchards. This information is often difficult to obtain. May leaf sampling for Nitrogen status has little value except in the case where an orchard is near deficiency in May it would surely be deficient in July.

3. Irrigation Scheduling:

Situation: Irrigation requirements of fully canopied orchards have been determined for stone fruits. It is generally assumed these requirements also apply to dried plums. However, previous research has determined that allowing mild stress to occur in mid-season, has no economic effect on production and quality of dried plums. This offers dried plum growers the opportunity to reduce mid-season irrigation, saving money, water, reducing pesticide runoff, and lowering fruit fresh to dry ratio. To expose growers to this new information and to gain adoption, it needed to be demonstrated on a wide scale.

Evaluation: In order to achieve the goal of reduced irrigation and maximum economic productivity, a monitoring technique that determines tree-water status (midday stem water potential or SWP) was utilized. The monitoring technique was carried out on 5 – 10 trees every week from May through harvest in project orchards every year of the project.

The monitoring technique was conducted from 1:00 p.m. to 3 p.m. The midday SWP was determined by using a "pump up" pressure chamber. A plastic/foil envelope was used to cover a lower canopy leaf that was close to the trunk or a main scaffold. The bagged leaf remained on the tree for at least 10 minutes (result of 2001 "satellite project" results). The bagged leaf was then placed in the chamber with only the petiole sticking out. Air was forced into the chamber by pumping the device (similar to a tire pump) until water was forced out of the petiole. The amount of pressure that it took to force the water out of the leaf was measured in bars. The amount of bars it took to force the water out of the leaf was the tree's SWP. Irrigation was only recommended when SWP reached the target values as shown in Table 16.

Table 16. "Reduced risk" irrigation target values over the growing season for midday stem water potential (bars).

Period	Month						
	March	April	May	June	July	August	September
Early-	-6	-8	-9	-10	-12	-13	-14
Mid-	-7	-8	-9	-11	-12	-13	-15
Late-	-7	-9	-10	-11	-12	-14	-15

Results: Initially only five sites were able to have a comparison between "conventional" irrigation management and "reduced risk" irrigation management. At four of the sites, (Aguair, CSUC, Giacolini, and Vossler), benefits of the "reduced risk" program in terms of reduced water use was realized (see Figure 11). Although the actual quantity of water savings was beyond the scope of this project, some of these sites saved applied water as compared to the "conventional" program in terms of SWP (examples: CSUC, Giacolini, Vossler) While others mostly copied the "reduced risk" schedule in their "conventional " orchard sites (examples: Aguair and Johl). Although measuring energy and economic savings from reduced irrigations was beyond the scope of this project it was observed with some growers who scheduled fewer irrigations than in previous years. Scheduling and applying fewer irrigations had no impact on fruit production (only measured in the first year) or on fruit quality at season's end (see Tables 17 and 18). In the last four years all cooperating growers scheduled irrigations in all projects sites based on

pressure chamber readings and following the "reduced risk" recommendation of irrigation scheduling. Monitored sites generally observed a good match between the observed and the target SWP. An example of these comparisons can be seen if Figure 12.

Figure 11. Midday stem water potential in comparison orchards

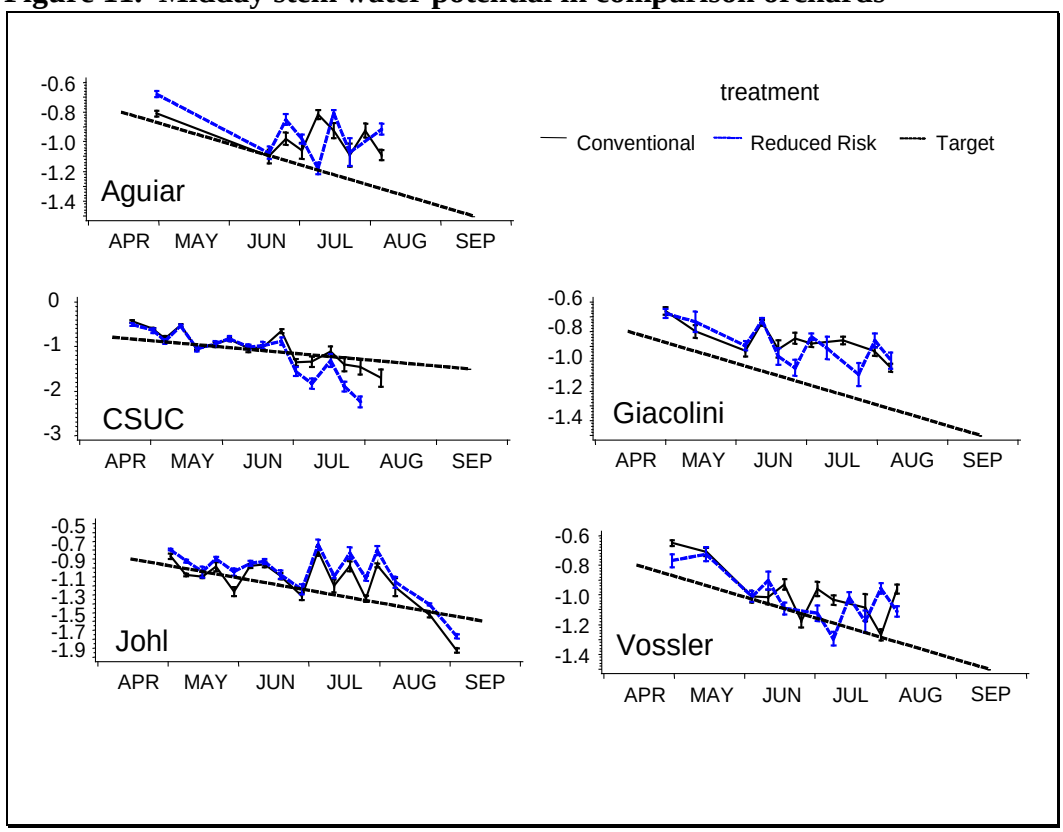
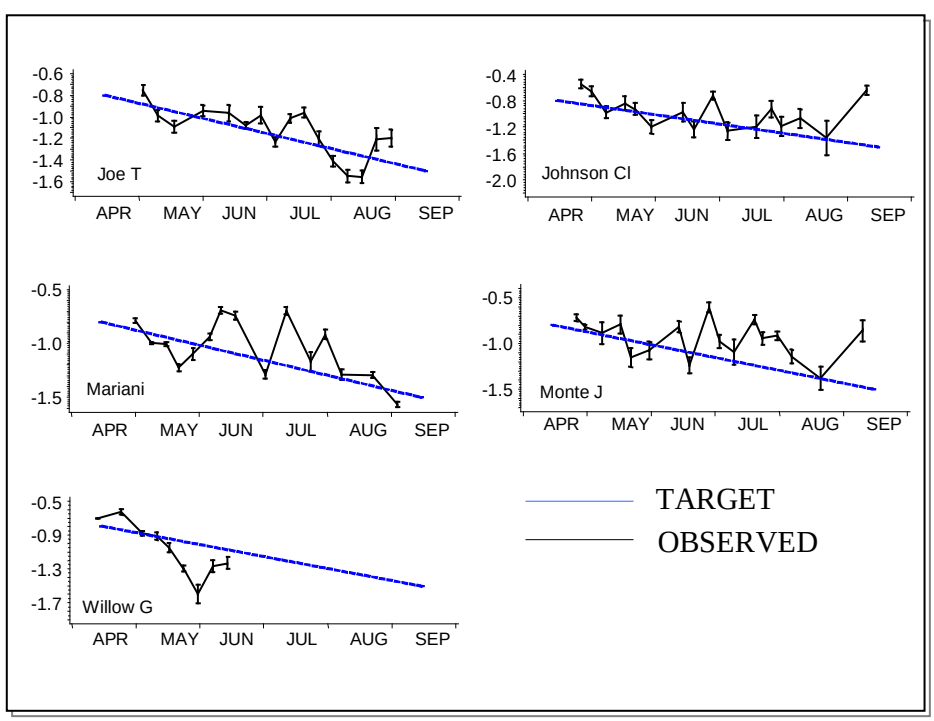


Figure 12. Observed midday stem water potential compared to target.



In 2004 project scouts scheduled irrigations with 15 out of the 23 growers in the project by measuring midday stem water potential using the pressure chamber and scheduling irrigations based on the "reduced risk" target values. No negative effects were observed or reported by scheduling irrigations in this manner.

Note: In 2004 Dr. Schackel was funded separately by the California Dried Plum Board to determine the actual water savings using the "reduced risk" approach in a few dried plum orchards. Results from this study await publication.

Conclusion: All growers that followed the irrigation scheduling recommendations were satisfied. With a few years of experience, most growers were able to manage irrigation to achieve the targets recommended. In most cases this resulted in a substantial savings in energy and water use. Now that many growers have had positive experiences with this strategy, some growers have started scheduling their own irrigations using this technique. Adoption is understandably slow in part due to the expense of the pressure chamber. A pump up pressure chamber costs more than $1300 and gas pressure chambers are nearly double that cost. As dried plum production becomes more economical and growers can afford to invest in this technology greater adoption is anticipated.

Objective V. Evaluate fruit quality from the "conventional" and "reduced risk" project sites.

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), worm damage, and brown rot . 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 brown rot, 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 the 23 orchards evaluated in 2004 and 2003 are shown in Tables 17 and 18.

Table 17. Average fruit quality from 23 "reduced risk" orchard 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 18. Average fruit quality from 23 "reduced risk" and 4 "conventional" orchard 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 data obtained throughout the course of this project no adverse fruit quality or yield affects have occurred using the "reduced risk" program.

Objective VI. Demonstrate a cover crop/buffer strip, insectary hedgerow and wildlife friendly program

Introduction: At the onset of IPFP, many prune farmers were experienced with cover crops. The California Dried Plum Board (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 is 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 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.

Objective VII. Encourage adoption of "reduced risk" practices through outreach and extension efforts.

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.

Objective VIII. Evaluate awareness, satisfaction and adoption of "reduced risk" practices through an industry survey, Pest Control Advisor involvement and changes in pesticide use.

2002/2003 Dried Plum Board/SAREP Industry survey results: Here we provide survey results (36% response rate) germane to IPFP program objectives. There were 361 respondents; however, not every respondent answered every question. Unless otherwise noted, the number of respondents (n) for the following survey questions ranged from 311 - 359.

Outreach efforts of IPFP resulted in approximately 71% of survey respondents 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	No
Is the orchard monitored at least 2-3 times per month during the active season?	68%	32%

Pest Management:

Do you monitor dormant spurs for aphid eggs and scales? (4% didn't recall)	39%	57%
Do you monitor for prune rust? (2% didn't recall)	77%	21%
Did you monitor in spring for live aphids? (3% didn't recall)	64%	33%

Did you monitor beneficials? (2% didn't recall)	58%	41%
Did you monitor spider mites? (2% didn't recall)	75%	23%

Nutrition:

Did you use leaf-tissue analyses? (1% didn't recall)	60%	39%
Did you use well water analysis? (of those who use well water; n = 275) (1% didn't recall)	23%	76%

Irrigation:

Did you use the pressure chamber measurements (monitor) for irrigation scheduling? (1% didn't recall)	6%	94%
Did you measure soil moisture for irrigation?	48%	52%

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

Nutrition:	Yes	No
Adjusted N fertilization based upon water analyses. (of those who had well water analyzed; n = 61) (3 % didn't recall)	49%	48%

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

	Yes	No
Used a miticide spray (4% didn't recall)	29%	67%

We believe, due to the extent that pest monitoring was conducted in dried plum orchards (~68% of grower respondents), and that 59% of those that monitored (n = 225) sometimes or always recorded their findings, that monitoring results were used to make more sensible pest control decisions by a significant number of dried plum growers.

Pest Control Advisor Involvement: At the meetings held in 2000 and 2001 the 15 PCAs made the following highlighted points about the monitoring protocols and use of pheromone traps:

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.

Pesticide Use Reporting: One of the main goals of the IPFP project was to reduce amounts of pesticides applied. Shown below, in Table 17, are 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 13 and 14).

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

Table 17. Total pound of pesticides used in prune production two years before and four years during the project.

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

Figure 13. Total pounds of Asana, diazinon and oil used per bearing acre in prune production two years before and four years during the project.

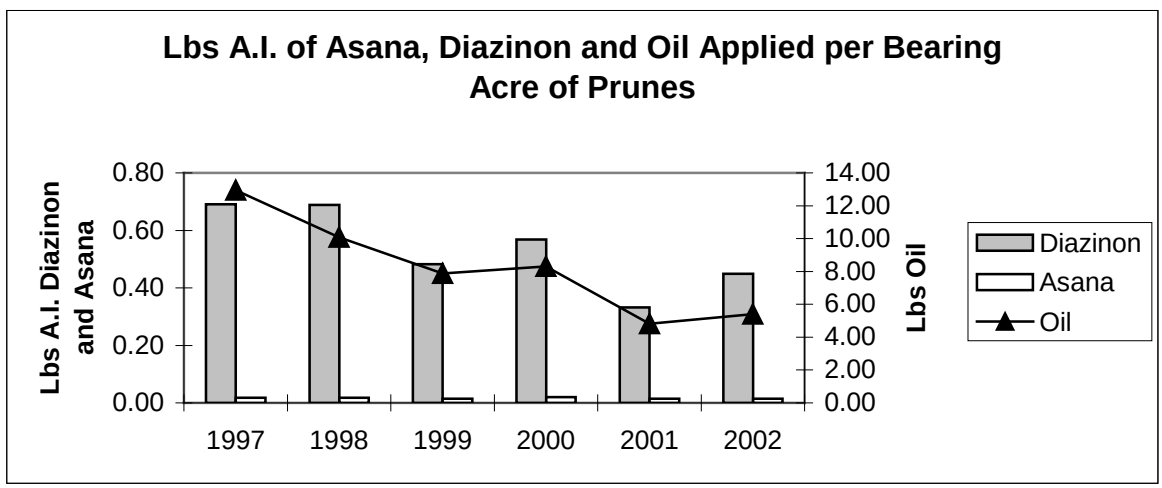
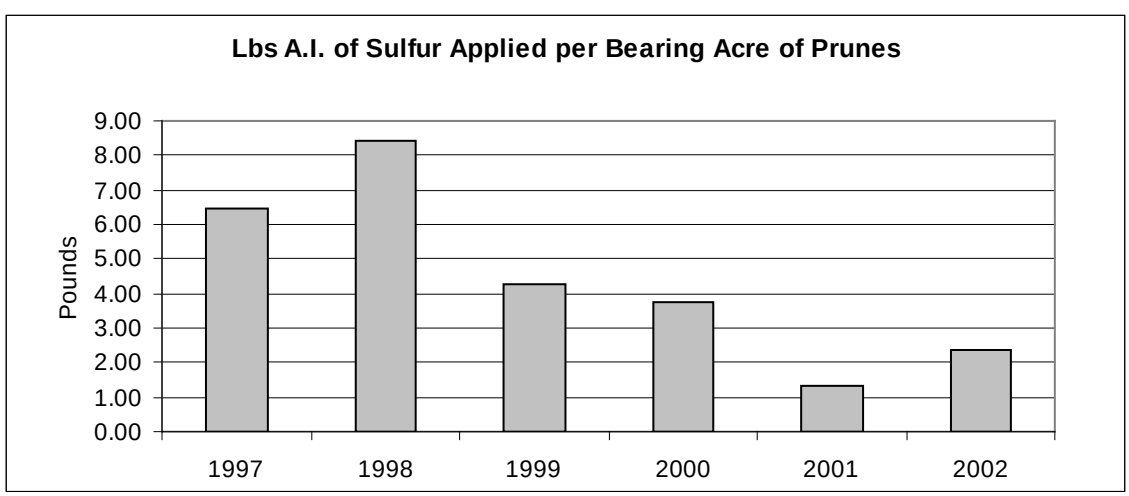


Figure 14. Total pounds of Sulfur used in prune production two years before and four years during the project.



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.

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Research Reports

1. 1999 Prune Research Report
    a. Relationship Among Leaf Potassium Concentration and Fruit Production Characteristics in “French” Prune in 1999/Southwick, Steve, et al
    b. Reducing Input of Dormant Sprays/Barry Wilson
    c. Production, Release and Evaluation of Parasitoids Attacking Prune Aphids/ Mills,

N. J., et al
   d. Efficacy of Omni Oil Plus Breakthru® for Leaf Curl Plum Aphid Control/ Buchner, Richard P. and Cyndi K. Gilles
   e. Efficacy of Esteem® for Italian Pear Scale Control On French Prune/ Buchner, Richard P., Cyndi K. Gilles and Bruce Carroll
   f. Evaluation of Low Toxicity Materials for Control of Mealy Plum Aphid/ Olson, Bill, Nadeem Shawareb and Carolyn Pickel
   g. In Season Control of Mealy Plum Aphids on Prunes/ Kreuger, Bill, Zachary Heath and Brett Mulqueeney
   h. Prediction Model of Blossom Blight Brown Rot in Prunes: Factors Affecting Blossom Blight and Secondary Infection of Fruit by *Monolinafructicila*/ Michailides, Themis J., Yong Luo and Zhongua Ma
   i. Environmentally Sound Prune Systems (E.S.P.S.)/ Olson, Bill
   j. Avian Monitoring on the Heir Ranch: Progress Report of the 1999 Field Work/ King, Anne M

2. 2000 Prune Research Report
   a. Effect of Irrigation on Fruit Cracking for French Prune/ Buchner, Rick and Cyndi Gilles
   b. Correction of Potassium Deficiency in Prunes Using Potassium Chloride and Gypsum./Krueger, William H., Zachary Heath
   c. Reducing Input of Dormant Sprays/Barry Wilson
   d. Production, Release and Evaluation of Parasitoids Attacking Prune Aphids/ Mills, N. J., et al
   e. Pesticide Efficacy Trial on Mealy Plum Aphid/ Olson, Bill, Nick Bertagna and Jed Walton
   f. Evaluation of Aphid Predicting Models and Development of New Dormant Treatment Decision Guides/ Olson, Bill, et. al
   g. Use of Fall Prediction and Oil Sprays at Bloom to Control Plum Aphids/ Krueger, William H. and Zachary R. Heath
   h. Efficacy Trial Using *Harmonia axyridis* Lady Beetles to Control Mealy Plum Aphids on Prunes/ Olson, Bill, et. al
   i. Efficacy of Omni Oil Plus Breakthru® for Leaf Curl Plum Aphid Control/ Buchner, Richard P. and Cyndi K. Gilles
   j. Efficacy of Esteem® for Italian Pear Scale Control On French Prune/ Buchner, Richard P., Cyndi K. Gilles and Bruce Carroll
   k. Testing Oblique Banded Leafroller Pheromone Load Rates for Monitoring/ Pickel, Carolyn, et. al
   l. Alternate Year Dormant Insecticide Spray Program in the Sacramento Valley/ Olson, Bill and Jed Walton
   m. Efficacy of Valero® (cinnamaldehyde) for Mite Control on French Prune/ Buchner, Richard, et. al
   n. Prediction and Risk Assessment Model of Blossom Blight and Latent Infection of Brown Rot in Prunes Caused by *Monilinia fructicola*/ Luo, Yong, Themis J. Michailides and David P. Morgon
   o. Phytotoxicity of Captan Following Oil/Rovral Application on French Prune/Buchner, R. P. and C. K. Gilles
   p. Use of Walnut Hulls for Weed Control/ Heath, Zachary R. and William H. Krueger
   q. Environmentally Sound Prune Systems (E.S.P.S.)/ Olson, Bill

r. Pesticide Usage Survey and Pesticide Use Reporting/ Olson, Bill and Jed Walton

3. 2001 Prune Research Report
    a. Reducing Input of Dormant Sprays/Barry Wilson
    b. Prune Aphids: Fall Migration, Biological Control and Impact on Prune Production/ Mills, N. J., et al
    c. Prune Aphid Pheromone Research Project/ Wilk, Barry
    d. Prediction of Brown Rot of Dried Plum: Spore Inoculum Potential and Threshold Conditions Leading Latent Infection to Fruit Rot Caused by *Monilinia fructicola*/Luo, Yong, et al
    e. Development of Website for Brown Rot of Stone Fruits and a Decision Support System for IPM of Blossom Blight of Dried Plum/ Luo, Young and Themis Michalidies
    f. Mowing Cover Crops and Throwing Residue into Tree Rows for Weed Control (Mow and Throw); USE of rice straw mulch for weed control and beneficial insect Monitoring in Cover Crops/ Olson, Bill, et.al
    g. Integrated Prune Farming Practices (IPFP)/ Olson, Bill, et. al

4. 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

5. 2003 Prune Research Report (reformat to start with a.)
    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

6. 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

Newsletters

IPFP Newsletter
    a. 2000-June
    b. 2001-February, May
    c. 2002-March, May, June, September
    d. 2003-January, June, September, November
    e. 2004-March, June October

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a. Gary Obenauf (http://www.agresearch.nu/)
b. UC IPM (www.ipm.ucdavis.edu)
c. UCCE Sutter/Yuba Counties (http://cesutter.ucdavis.edu)
d. (http://cesutter.ucdavis.edu/newsletterfiles/newsletter656.htm)

X. Attachments

1. Grower Plots 1999-2004