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:

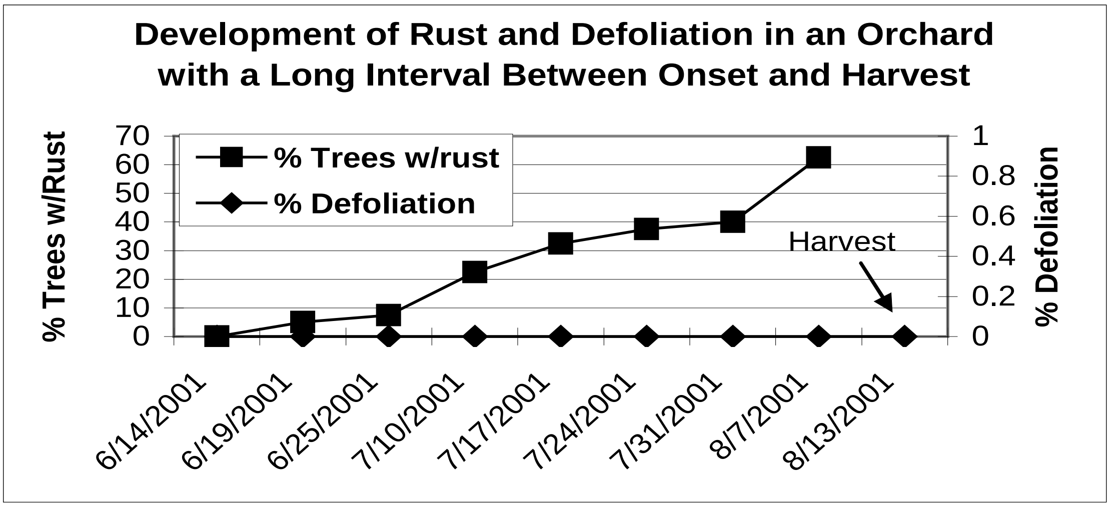
Situation: Prune rust is the most common pest treated during the growing season. Previously, growers had no way of knowing if they needed to treat for rust. Most growers simply applied one or more protective wettable sulfur treatments in May, June and/or July.

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:

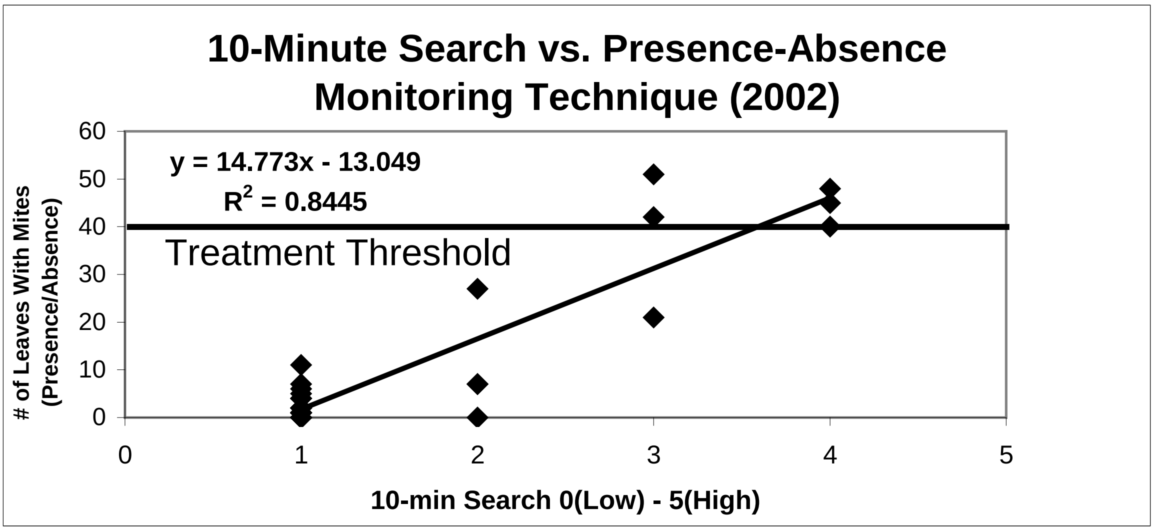
1. Low – Hard to find. Example: less than one predator per six leaves.

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).

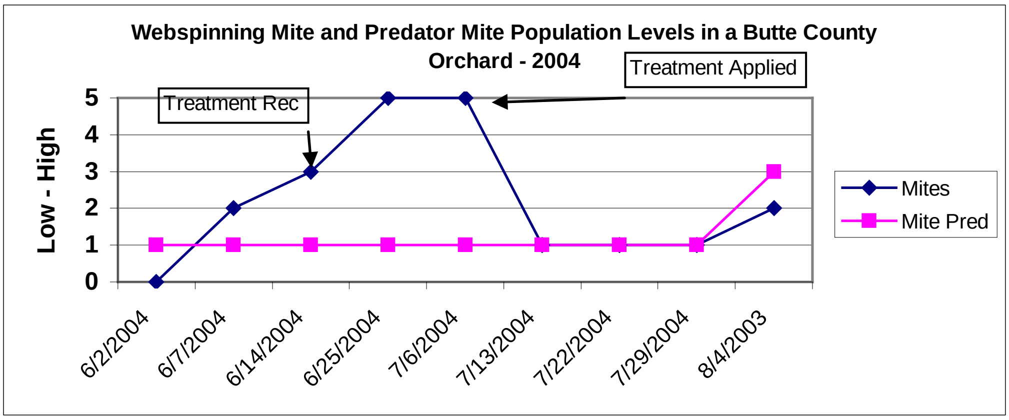
Figure 7. Correlation between "10 minute search" and presence/absence mite sampling in 28 orchard sites in 2002.



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
Fl - 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.

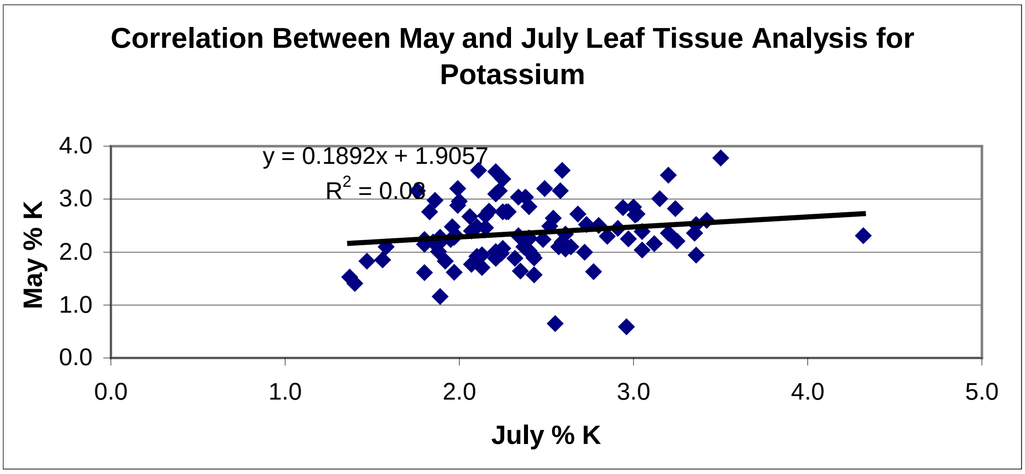
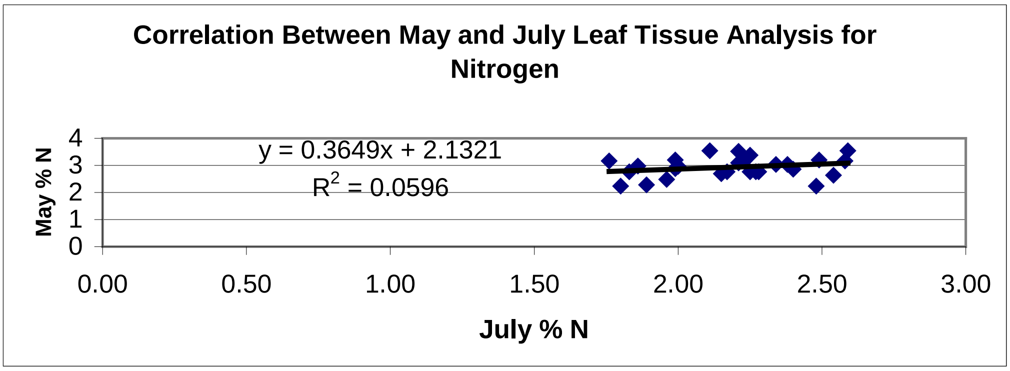


Figure 10. Correlation between May and July leaf Nitrogen.



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

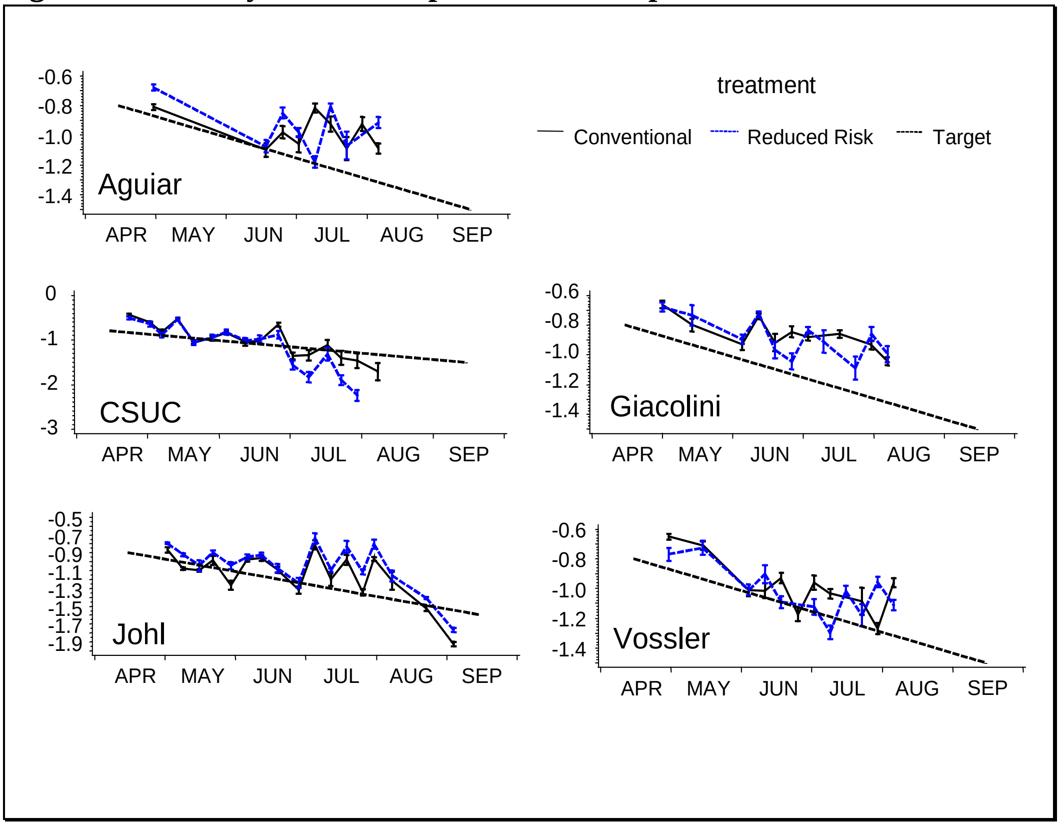
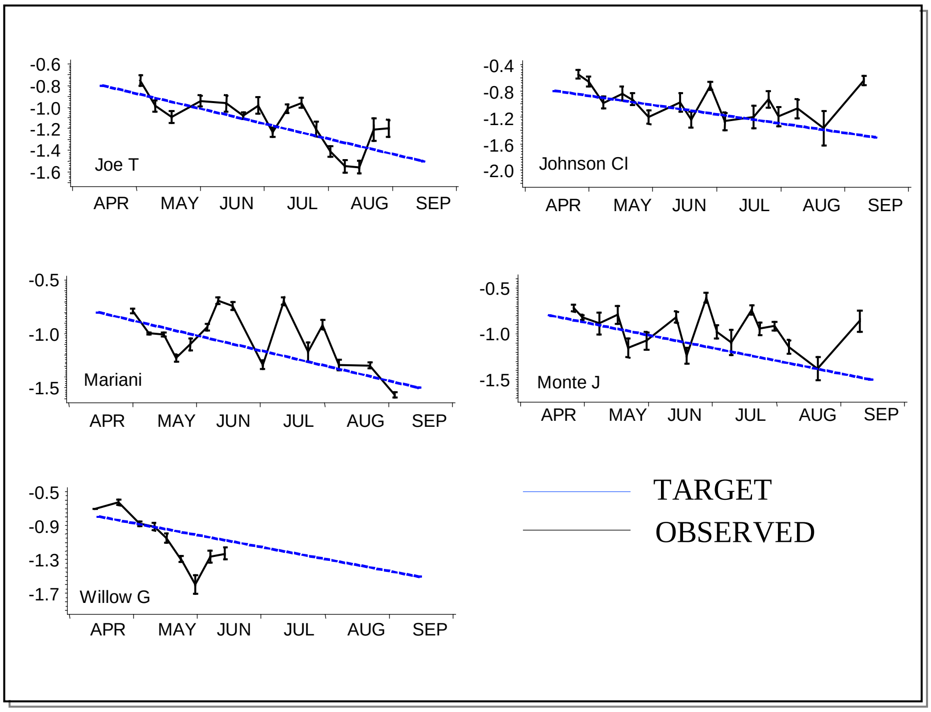


Figure 12. Observed midday stem water potential compared to target.



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.

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

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.

	Yes	No
General:		
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.

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.

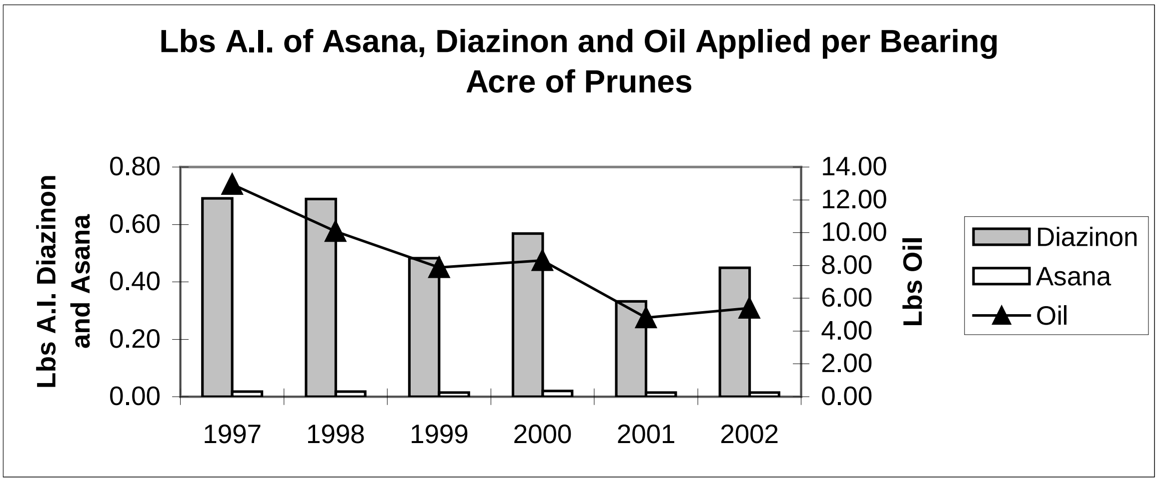
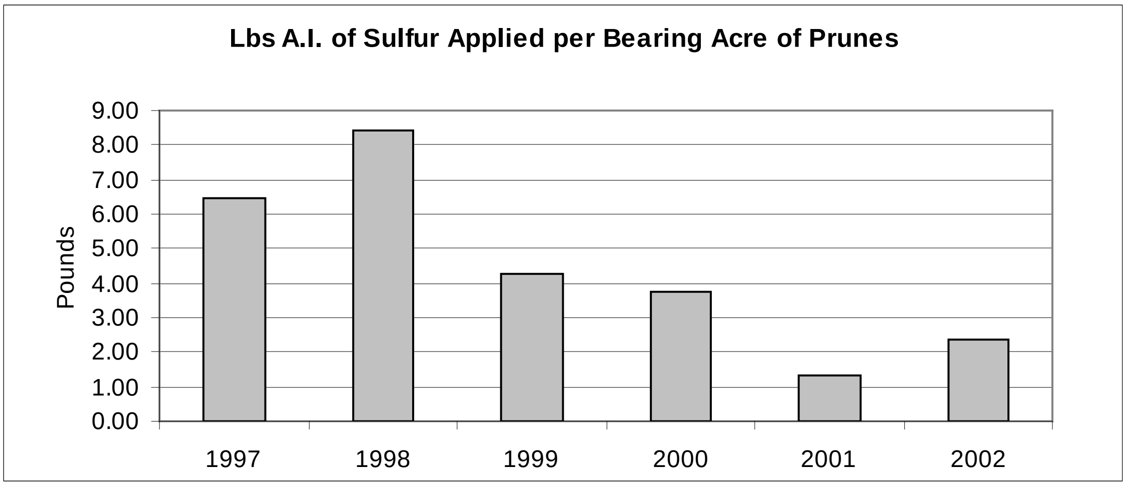


Figure 14. Total pounds of Sulfur used in prune production two years before and four years during the project.



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.

IX. Literature Cited/Publications

Fulton, A., R. Buchner, B. Olson, L. Schwankl, C. Gillis, N. Bertagna, J. Walton, K. Shackel. 2001. Rapid equilibration of leaf and stem water potential under field conditions in almonds, walnuts and prunes. Hort Technology 11(4); 609-615.
Glozer, K., S. Southwick, B. Olson, R. Buchner, B. Krueger, S. Sibbett, W. Reil, J. Yeager. 2000. Summary of leaf potassium status in "French "prune suggests overfertilization. Hort Science Abstracts 35 (3).

Klassen, P.N., B.L. Bret, R.C. Ehn, S. Gill, J.M. Lee, G.L. Obenauf, M.N. Oliver, W.H. Olson, I. Werner, F.G. Zalom. 2002. Stakeholder development of agricultural management practices in orchards to reduce pesticides in surface water following dormant applications in winter. Published in the proceedings of the Watershed Management to Meet Emerging TMDL Environmental Regulations Conference and Exhibition. Fort Worth Texas.

Lampinen, B., K.A. Shackel, S. Southwick, D. Goldhamer, B. Olson. 1991. Sensitivity of French Prune production to water deprivation at different stages of fruit growth. Hort Science Abstracts 27 (6):656.

Lampinen, B.D., K.A. Shackel, S.M. Southwick, B. Olson, J.T. Yeager, and D. Goldhamer. 1995. Sensitivity of yield and fruit quality of French Prune to water deprivation at different fruit growth stages. J. Amer. Soc. Hort. Sci. 120:139-147.

Michailides, Themis J., David P. Morgan, Liqun Hou, Steve Sibbett, William Olson, John Edstrom, William Krueger, and Richard Buchner. 1994. Population dynamics of Brown Rot Fungi (Monolinia species) in prune orchards in California in 1993. U.C. Kearney Plant Protection Group. Plant Protection Quarterly 4 (2):7.

Michailides, Themis, D.P. Morgan, L. Hou, Steve Sibbett, William Olson, John Edstrom, William Krueger, and Richard Buchner. 1994. Population dynamics of Brown Rot Fungi (Monolinia species) in prune orchards in California. California Prune News Research Reports. No. 91:3

Michailides, Themis J., David P. Morgan, William Olson, Steve Sibbett, Beth Teviotdale, and Richard Buchner. 1994. Fruit contact surfaces as infective sites for brown rot development in French Prune and disease control by early summer fungicide sprays. California Prune News Research Report. No. 91:2.

Olson, B., N. Shawareb. 1999. Predicting prune aphid populations. Tree Fruit 31(8).

Olson, B. 2001. Many prune orchards can skip dormant sprays. Western Farm Press, February 2001.

Olson, B., S. Southwick, R. Buchner, B. Krueger, M. Norton, C. Pickel, J. Walton. 2001. 10 years of oil use to control aphids reviewed. Tree Fruit 33(3).

Pickel, C., B. Olson, W. Bentley. 1995. Alternatives to dormant spray treatments. Proceedings, 1995. Prune Production: A University of California Pomology Workshop Series: February, April and November, 1995.

Pickel, C., W.H. Olson. 2001. Testing oblique banded leaf roller (*Choristoneura rosaceana*) pheromone load rates for monitoring and predicting damage in French prunes. Abstract in the proceedings of the Pacific Branch of the Entomology Society of America meeting. Park City, Utah. 2001.

Shackel, K.A., H. Ahmadi, W. Brasi, R. Buchner, D. Goldhamer, S. Guwsinghe, J. Hasey, D. Kester, B. Krueger, B. Lampinen, G. McGourty, W. Micke, E. Mitcham, B. Olson, K. Pelletrau, H. Philips, D. Ramos, L. Schwankl, S. Sibbett, R. Snyder, S. Southwick, M. Stevenson, M. Thorpe, S. Weinbaum, J. Yeager. 1997. Plant water status as an index of irrigation needs in deciduous fruit trees. Hort Technology 7 (1): 23-29.

Shackel, K., B. Lampinen, S. Sibbett, W. Olson. 2000. The relation of midday stem water potential to the growth and physiology of fruit trees under water limited conditions. Acta Horticulturae No. 537: 425-430.

Shackel, K.A., B. Lampinen, S. Southwick, W. Olson, S. Sibbett, W. Krueger, J. Yeager. 2000. Deficit irrigation in prunes: maintaining productivity with less water. Hort Science 35 (6):1063-1066.

Shackel, K.A., B. Lampinen, S. Southwick, D. Goldhamer, W. Olson, S. Sibbett, W. Krueger, J. Yeager. 1997. Deficit irrigation in prunes: getting more with less water. Hort Science Abstracts: 32(3).

Shackel, K., A. Fulton, R. Buchner, B. Olson, L. Schwankl, C. Gillis, N. Bertagna, J. Walton. 2001. Rapid equilibration of leaf and stem water potential under field conditions. Hort Science Abstracts 36 (3).

Teviotdale, B.L., B. Krueger, B. Olson, and S. Sibbett. 1997. Prune rust control in 1997. Sun-Diamond Grower 16(2).

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,

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

Internet websites

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