Diazinon Runoff Management Plan
For Orchard Growers
In the Sacramento Valley:

2007 Annual Report

Sacramento Valley Water Quality Coalition

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A INTRODUCTION

In fulfillment of the requirements set forth in the Diazinon Runoff Management Plan for Orchard Growers in the Sacramento Valley, the Sacramento Valley Water Quality Coalition (Coalition) is submitting the 2007 Annual Report summarizing the 2006-2007 monitoring objectives, location and results, outreach efforts, and management practices effectiveness.

There were no exceedances of the concentration or load objectives observed in 2006-2007 TMDL compliance monitoring.

B BACKGROUND

The federal Clean Water Act requires each State to identify waters within its boundaries that are not currently meeting or maintaining water quality standards (33 USC 1313 (d)(1)). Water quality standards consist of the beneficial uses for which waterways are used and water quality objectives set at specified levels to maintain beneficial uses. The Sacramento and Feather Rivers were listed as impaired by diazinon in 1994 for the Sacramento and Feather Rivers by the Central Valley Regional Water Quality Control Board (Regional Board), in part due the an error in the data set used in the calculation of the water quality objective for diazinon.

Due to the 303(d) listing, the Regional Board adopted a total maximum daily load (TMDL) in accordance with the federal Clean Water Act (33 USC 1313 (d)(1)). Loads established in a TMDL are required to implement the applicable water quality standards with seasonal variations and a margin of safety (Id.). In addition to adopting a TMDL, the Regional Board also prepared and adopted a Basin Plan amendment that included new water quality objectives for diazinon and an implementation plan. The Basin Plan amendment was intended to establish an orchard runoff control program that focused on protecting the Sacramento and Feather Rivers from the impacts of diazinon.

More specifically, the Regional Board adopted (and the State Water Resources Control Board and federal EPA approved) diazinon water quality objectives of 0.080 µg/L as a 1-hour average (i.e. acute objective) and 0.050 µg/L as a 4-day average (i.e. chronic objective). At the time of adoption (and subsequently), questions were raised about the validity of the objectives and the studies from which the objectives were derived. As a result of subsequent litigation, the Regional Board committed to reviewing the objectives by July 1, 2007, and potentially amending the objectives by July 1, 2008. The Regional Board has recently adopted new amendments to revise the diazinon objectives of 0.16 µg/L as a 1-hour average and 0.1 µg/L as a 4-day average (*Basin Plan Amendments to the Water Quality Control Plan For the Sacramento River and San Joaquin River Basins For The Control of Diazinon and Chlorpyrifos Runoff into the Sacramento and San Joaquin River Basins)*. The amendments to the Basin Plan are pending approval by the State Water Resources Control Board and USEPA.

The existing approved Basin Plan amendment contains requirements for an Orchard Pesticide Runoff and Diazinon Runoff Control Program. As part of the Control Program, the Regional Board requires dischargers of diazinon to submit a management plan that "describes actions that the discharger will take to reduce diazinon discharges and meet the applicable allocations by the required compliance date." In lieu of individual plans, the Basin Plan amendment allows a discharger group or a coalition to submit management plans. The Coalition submitted a management plan in January 2006.

Monitoring Objectives

The purpose of the monitoring program is to determine whether numeric water quality objectives for diazinon contained in the *Basin Plan Amendment* are being met in the Sacramento and Feather Rivers. Specifically, the *Basin Plan Amendment* identifies the following goals for compliance monitoring for the TMDL:

1. Determine compliance with established water quality objectives for diazinon in the Sacramento and Feather Rivers;
2. Determine compliance with established waste load allocations and load allocations for diazinon;
3. Determine the degree of implementation of management practices to reduce off-site migration of diazinon;
4. Determine the effectiveness of management practices and strategies to reduce off-site migration of diazinon;
5. Determine whether alternatives to diazinon are causing surface water quality impacts;
6. Determine whether the discharge causes or contributes to a toxicity impairment due to additive or synergistic effects of multiple pollutants; and
7. Demonstrate that management practices are achieving the lowest pesticide levels technically and economically achievable.

Water quality monitoring results presented in Section C of this report address goals 1 and 2. Adequate data are not yet available to address goals 5 and 6. Results from the Coalition Irrigated Lands Program monitoring will be used to address these goals in the future. Goals 3, 4, and 7 are addressed in Sections D, and E of this report.

Sampling Site Descriptions

Selection of monitoring sites for the compliance monitoring program is detailed in the *Diazinon Runoff Management Plan for Orchard Growers in the Sacramento Valley* (SVWQC 2006). Monitoring sites for this program are consistent with those proposed in the *Basin Plan Amendment Staff Report* (CVRWQCB 2003) which identifies 6 compliance monitoring locations, and with subsequent monitoring guidance provided to the Coalition by the Regional Board (CVRWQCB letter to SVWQC, May 2, 2005). Five of these sites were selected for compliance monitoring by the Coalition. The sites for the Coalition's compliance monitoring program are Sacramento River at Colusa, Sacramento Slough, Colusa Basin Drain, Feather River at Yuba City, and Feather River at Verona. Compliance was assessed for a sixth site (Sacramento River at Verona) by mass-balance calculations with monitoring results for the other five sites. All six sites and their contributing watersheds (as defined by the *Basin Plan Amendment*) are listed in Table 1 and also illustrated in Figure 1.

Table 1. Compliance Monitoring Sites for Diazinon Runoff Management Plan

Site	Site ID	Subwatershed	Lat	Long
Sacramento River at Colusa	SRCOL	Sacramento River above Colusa	39.2142	-121.9992
Colusa Basin Drain above Knight's Landing	COLDR	Colusa Basin	38.8121	-121.7741
Sacramento Slough	SACSL	Sutter/Butte	38.7833	-121.6338
Feather River above Yuba City	FRYUB	Drainage not defined	39.1384	-121.6058
Feather River near Verona	FRVON	Feather River	38.7903	-121.6266
Sacramento River at Verona	SRVON	Sum of Sacramento River above Colusa, Colusa Basin, Sutter/Butte, and Feather River subwatersheds	38.8875	-121.6097

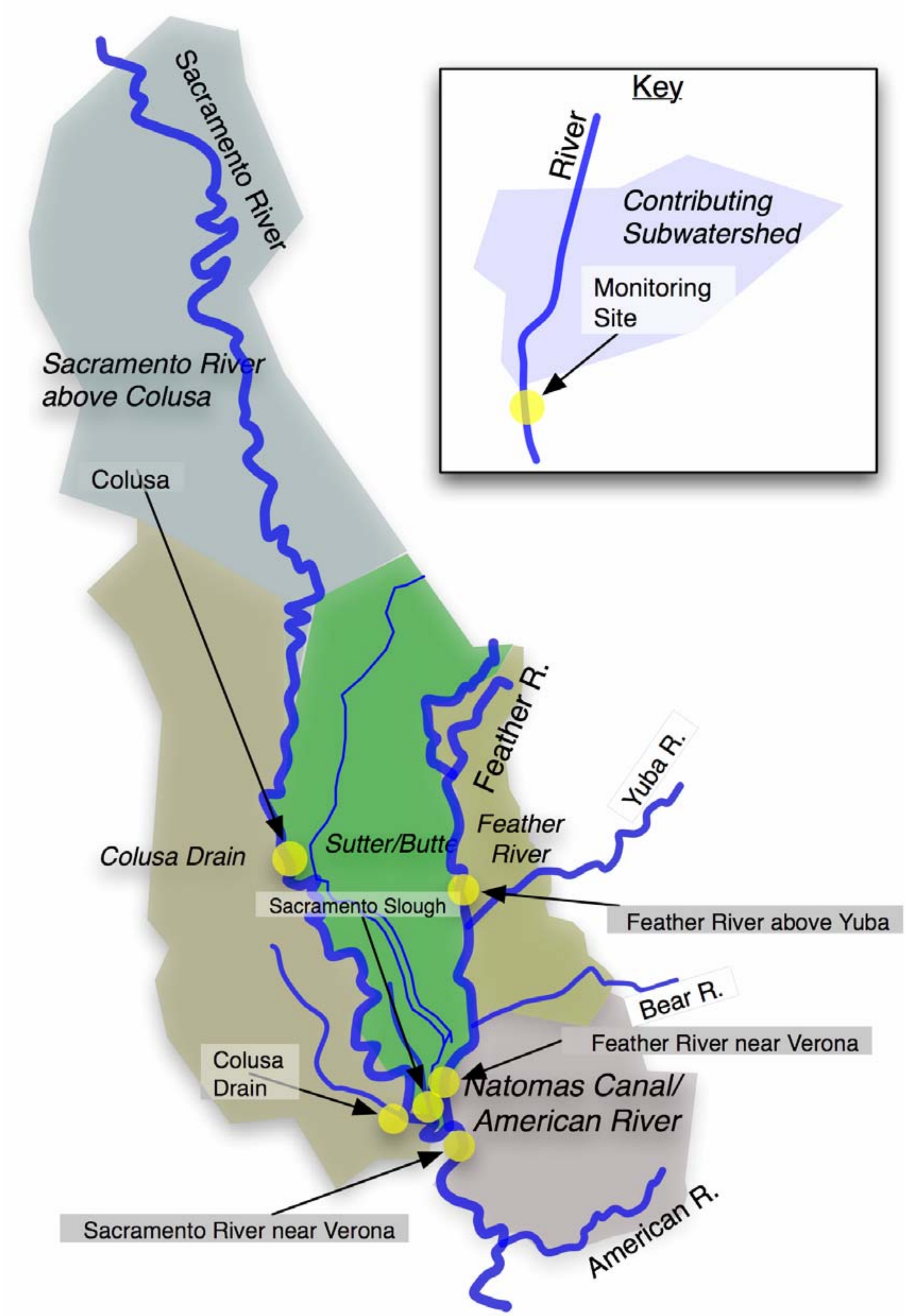

Figure 1. Compliance Monitoring Sites

Descriptions Of Sampling And Methods Used

Samples for each event were analyzed for diazinon, flow, pH, and conductivity (Table 2):

- Diazinon was analyzed in each daily sample to characterize concentrations and allow estimation of daily loads of diazinon from each subwatershed (monitoring goals 1 and 2). The analytical method used for diazinon is a modification of EPA Method 625.
- pH and conductivity were measured in the field for each sample collected and recorded on field log sheets. Flow data were acquired from USGS or DWR flow gauging stations (Sacramento River at Colusa, and Sacramento River at Verona) or measured in the field (all other sites). These parameters were measured to allow load calculation and to evaluate the length of storm impacts for each event.

Analytical methods were selected to provide adequate sensitivity, accuracy, and precision to address the monitoring goals. Sufficient numbers of quality assurance samples were planned and analyzed to ensure validity of the data for addressing the monitoring goals.

Table 2. Constituents Monitored

Parameter	Method Detection Limit	Quantitation Limit	Reporting Unit	Composite or Grab
Diazinon	0.005	0.01	ug/L	Depth-Width Integrated Samples
Flow	NA	NA	CFS (ft^3/sec)	Instream flow measurements or appropriate gauge data
pH	NA	0.1 [(a)]	$-\log[H^+]$	Instream probe
Conductivity	NA	0.1 [(a)]	μmhos/cm	Instream probe

(a) Detection and reporting limits are not strictly defined. Value is required reporting precision.

(b) Limits are different for individual pesticides. Refer to Quantitation and Detection Limits.

C MONITORING RESULTS

Tabulated results of analyses

The results of the analyses of water quality samples collected in 2007 for the compliance monitoring program are presented in Table 3.

Table 3. Results For Field And Laboratory Analyses

Location	Date	Time	Matrix	Diazinon, µg/L	Conductivity, uS/cm	pH, -log[H+]
Colusa Drain at Knights Landing	02/08/07	18:20	Sample	0.0059	650	7.92
Colusa Drain at Knights Landing	02/09/07	17:45	Sample	0.0116	678	7.88
Colusa Drain at Knights Landing	02/10/07	17:00	Sample	0.0106	645	8.04
Colusa Drain at Knights Landing	02/11/07	17:40	Sample	0.0315	586	7.99
Colusa Drain at Knights Landing	02/22/07	18:00	Sample	0.0073	882	8.08
Colusa Drain at Knights Landing	02/23/07	16:50	Sample	0.0141	987	8.06
Feather River at Verona	02/08/07	16:30	Sample	0.0102	99	7.70
Feather River at Verona	02/09/07	15:15	Sample	0.0075	101	7.67
Feather River at Verona	02/10/07	15:30	Sample	0.0156	103	7.44
Feather River at Verona	02/11/07	15:40	Sample	0.0113	97	6.97
Feather River at Verona	02/12/07	09:30	Sample	0.0169	103	6.95
Feather River at Verona	02/22/07	16:20	Sample	0.0068	99	7.35
Feather River at Verona	02/23/07	15:20	Sample	0.0084	105	6.22
Feather River above Yuba City	02/08/07	12:20	Sample	0.0141	99	7.09
Feather River above Yuba City	02/09/07	11:00	Sample	0.0102	98	7.62
Feather River above Yuba City	02/10/07	11:50	Sample	0.0165	104	7.43
Feather River above Yuba City	02/11/07	12:00	Sample	0.0187	87	7.32
Feather River above Yuba City	02/22/07	14:00	Sample	0.0076	100	7.48
Feather River above Yuba City	02/23/07	11:45	Sample	<0.002	109	7.14
Sacramento Slough	02/08/07	15:25	Sample	0.0111	393	7.59
Sacramento Slough	02/09/07	14:40	Sample	0.0121	391	7.67
Sacramento Slough	02/10/07	14:30	Sample	0.0206	396	7.94
Sacramento Slough	02/10/07	14:35	Blank[a]	<0.002	nm[b]	nm
Sacramento Slough	02/11/07	14:50	Sample	J 0.0037	182	7.57
Reclamation Slough[d]	02/12/07	12:45	Sample	<.002	708	7.79
East Canal[d]	02/12/07	12:20	Sample	<.002	301	7.39
Sacramento Slough	02/22/07	15:45	Sample	0.0132	313	7.25
Sacramento Slough	02/23/07	14:20	Sample	0.0132	346	6.48
Sacramento River at Colusa	02/08/07	10:20	Blank[b]	<0.002	nm	nm
Sacramento River at Colusa	02/08/07	10:25	Sample	<0.002	164	7.13
Sacramento River at Colusa	02/09/07	09:15	Sample	<0.002	184	7.63
Sacramento River at Colusa	02/10/07	09:25	Sample	<0.002	154	7.81
Sacramento River at Colusa	02/10/07	09:25	Sample[c]	<0.002	nm	nm
Sacramento River at Colusa	02/11/07	09:45	Sample	0.006	94	7.30
Sacramento River at Colusa	02/22/07	12:00	Blank[a]	<0.002	nm	nm
Sacramento River at Colusa	02/22/07	12:10	Sample	<0.002	232	7.71
Sacramento River at Colusa	02/23/07	09:20	Sample	<0.002	180	7.65

a field blank
b nm = not measured
c field replicate sample, RPD = 0%
d Collected at upstream locations due to inaccessible sampling conditions at Sacramento Slough.

Results Of Laboratory And Field Quality Assurance Analyses

The results of laboratory and field Quality Assurance (QA) analyses are presented in Table 4. Laboratory QA for diazinon analyses included method blanks, matrix spikes and matrix spike duplicates, and surrogate recoveries in samples matrices. All laboratory QA results met program data quality objectives, with the exception of laboratory duplicates performed on samples with low concentrations of diazinon near the quantitation limit. However, the precision of replicate matrix spike analyses were adequate and the analytical precision was accepted as adequate on this basis. The laboratory achieved (and surpassed) the project target method detection limits and quantitation limits. Three field blanks and one set of field replicate samples were also collected and analyzed for the two sample events. Diazinon was below the reported analytical detection limit (0.002 µg/L) in all field blanks, indicating that sample contamination was not adversely affecting sample results. The relative percent difference (RPD) for the single field replicate sample was 0% and met the data quality objective for this QA analysis (<25% RPD).

Table 4. Field and Laboratory QA Results

QA Sample Type	Sample ID	Units	Diazinon	Result Qualifier	Data Quality Objective
Field Blank	SRCOL-WB1P01-003.1	µg/L	<.002	ND	<.005
Field Blank	SACSL-WB1P01-003.3	µg/L	<.002	ND	<.005
Field Blank	SRCOL-WB1P01-004.1	µg/L	<.002	ND	<.005
Field Duplicate	SRCOL-WE1P01-003.3	µg/L	<.002	ND	NA
Field Duplicate	SRCOL-WE2P01-003.3	µg/L	<.002	ND	NA
Field Duplicate		RPD	0%		<25%
Lab duplicate	COLDR-WE1P01-003.2	µg/L	0.0116		NA
Lab duplicate		µg/L	<.002	ND	NA
Lab duplicate		RPD	141%		<25%
Lab duplicate	SACSL-WE1P01-004.2	µg/L	0.0132		NA
Lab duplicate		µg/L	0.0087		NA
Lab duplicate		RPD	41%[a]		<25%
Method Blank	51045-B1	µg/L	<.002	ND	<.005
Method Blank	51045-B2	µg/L	<.002	ND	<.005
Method Blank	51543-B1	µg/L	<.002	ND	<.005
MS/MSD	COLDR-WE1P01-003.2	% Recovery	91%		70-130
MS/MSD		% Recovery	98%		70-130
MS/MSD		RPD	7%		70-130
MS/MSD	SACSL-WE1P01-004.2	% Recovery	102%		70-130
MS/MSD		% Recovery	105%		70-130
MS/MSD		RPD	3%		70-130

a Difference between replicates was less than the target reporting limit of 0.01 µg/L.

Summary Of Precision And Accuracy

Based on the results of field and laboratory QA analyses, precision and accuracy generally met program data quality objectives and were adequate for the monitoring compliance program. The precision of laboratory duplicates performed on samples with low concentrations of diazinon near to the quantitation limit did not meet the data quality objective of <25% RPD. However, the precision of replicate matrix spike analyses were adequate and the analytical batch results were accepted on this basis.

Data interpretation

Summary Of Sampling Conditions

High winds were experienced during the first sample event (February 8 – 12, 2007). Water flows were very low at all sampled locations during the first two days of sampling. Due to low flows at the Sacramento River above Colusa site, launching the boat was not possible near Colusa, and samples were collected from a bridge. On days 3 and 4, water flows increased significantly. Large woody debris was observed at all sites. On day 3 while sampling FRYUB, a drogue had to be used in order to prevent winds from blowing the sampling vessel upstream. Due to the prevailing winds it was difficult to make accurate flow measurements. On day 5 of the event, Sacramento Slough was full of large woody debris making boat access to the sampling location impossible. Samples were collected upstream from bridges crossing East Canal and Reclamation Slough, both near Karnack. Water temperatures ranged from 10°C to 14°C, pH values were generally within one pH unit of 7.00 (6.95 – 8.04), and conductivity values ranged between 87 and 708 µS/cm.

Low flows were observed for the duration of the second event (February 22 – 23, 2007). A small increase in water levels was observed on day 2. Water temperatures ranged from 10°C to 13°C, pH values were generally within one pH unit of 7.00 (6.22 – 8.08), and conductivity values ranged between 99 and 987 µS/cm.

Assessment Of Data Quality Objectives

The data quality objectives for this monitoring effort are described in the QAPP for this program.

Completeness is defined as the percent of planned data that was successfully collected and analyzed. All planned diazinon and field-measured parameters were successfully collected and analyzed. All planned flow data were collected with the exception of one measurement for Feather River at Verona. Completeness for planned diazinon, pH, and conductivity analyses was 100%. Completeness for flow measurements was 100%.

Representativeness of the data collected was assured by selection of appropriate sampling and analytical methods. There was no deviation from the standard operating procedures specified in the QAPP, and the data are considered adequately representative for the purpose of the compliance monitoring program.

Analytical precision is assessed by analyzing laboratory-prepared matrix spike duplicates. Sampling precision is assessed by analyzing field-collected sample replicates. All field replicate results were within project data quality objectives (<25% Relative Percent Difference), and sampling precision is considered adequate for the purpose of the compliance monitoring program. The precision of laboratory replicate analyses performed on samples with low concentrations of diazinon near to the quantitation limit did not meet the data quality objective of <25% RPD. However, the precision of replicate matrix spike analyses were adequate and analytical batch results were accepted on this basis.

Analytical accuracy is assessed by routine calibration and analysis of laboratory-prepared matrix and by addition of surrogate organic compounds to sample matrices. All recoveries of matrix spikes and surrogate compounds were within acceptable limits, and analytical accuracy is considered adequate for the purpose of the compliance monitoring program.

Load Estimates

Mean daily flows for Sacramento River at Colusa, Sacramento River at Verona, and Colusa Basin Drain were acquired from the California Data Exchange Center (CDEC). Mean daily flows for Sacramento Slough, Feather River above Yuba City, and Feather River at Verona were set equal to instantaneous discharges measured instream at the time of sampling.

Daily diazinon loads were calculated for all compliance sites. Daily loads were calculated as:

$$Load = Q \times C \times UCF$$

Where, *Load* is the daily diazinon load in g/day,

Q = mean daily flow in CFS

C = sample diazinon concentration, in µg/L, and

UCF = a unit conversion factor of 2.4446.

Loads for Sacramento River at Verona were calculated as the sum of daily loads for Sacramento River at Colusa, Sacramento Slough, Colusa Basin Drain, and Feather River at Verona. The loads estimated for Sacramento River at Verona were also used to back-calculate estimated diazinon concentrations using the above equation for loads.

Flow data, diazinon concentrations, and calculated loads are presented in Table 5.

Table 5. Flow Data And Calculated Loads

Station[a] Code	Date	Mean daily flow	Diazinon Concentrations And Loads In Samples: sample, ug/L	Est'd 4-day avg.	Load, g/day	Daily TMDL Loading Objectives, g/day: Load Capacity (LC)	Load Allocation (LA)	4-day average TMDL Loading Objectives, g/day: Load Capacity (LC)	Load Allocation (LA)
COLDR	02/08/07	406	0.0059	0.015	6	NA	422	NA	264
COLDR	02/09/07	600	0.0116		17	NA	448	NA	280
COLDR	02/10/07	923	0.0106		24	NA	554	NA	346
COLDR	02/11/07	1175	0.0315		91	NA	975	NA	609
COLDR	02/22/07	77	0.0073	0.011	1.4	NA	561	NA	350
COLDR	02/23/07	49	0.0141		1.7	NA	556	NA	348
FRVON	02/08/07	3532	0.0102	0.011	88	691	298	432	186
FRVON	02/09/07	4133	0.0075	0.013	76	809	316	505	198
FRVON	02/10/07	6316	0.0156		241	1236	391	772	244
FRVON	02/11/07	13936	0.0113		385	2727	688	1704	430
FRVON	02/12/07	12311	0.0169		509	2409	898	1506	561
FRVON	02/22/07	4417	0.0068	0.008	73	864	396	540	247
FRVON	02/23/07	4980	0.0084		102	974	316	609	198
FRYUB	02/08/07	2407	0.0141	0.015	83	NA	NA	NA	NA
FRYUB	02/09/07	3006	0.0102	0.013	75	NA	NA	NA	NA
FRYUB	02/10/07	3935	0.0165		159	NA	NA	NA	NA
FRYUB	02/11/07	7315	0.0187		335	NA	NA	NA	NA
FRYUB	02/22/07	2505	0.0076	0.005	47	NA	NA	NA	NA
FRYUB	02/23/07	3225	<0.002		16	NA	NA	NA	NA
SACSL	02/08/07	1326	0.0111	0.012	36	NA	819	NA	512
SACSL	02/09/07	1208	0.0121	0.010	36	NA	869	NA	543
SACSL	02/10/07	1051	0.0206		53	NA	1075	NA	672
SACSL	02/11/07	1423	J 0.0037		13	NA	1893	NA	1183
SACSL[d]	02/12/07	0	<0.002		0	NA	2470	NA	1544
SACSL	02/22/07	1293	0.0132	0.013	42	NA	1089	NA	680
SACSL	02/23/07	1185	0.0132		38	NA	1080	NA	675
SRCOL	02/08/07	6822	<0.002	0.003	33	1335	670	834	419
SRCOL	02/09/07	7503	<0.002		37	1468	711	918	444
SRCOL	02/10/07	14065	<0.002		69	2752	879	1720	550
SRCOL	02/11/07	31700	0.006		465	6203	1549	3877	968
SRCOL	02/22/07	9377	<0.002	<0.002	46	1835	891	1147	557
SRCOL	02/23/07	12479	<0.002		61	2442	884	1526	552
SRVON[b]	02/08/07	12688	0.0053		163	2483	2483	1552	1552
SRVON	02/09/07	13458	0.0050	0.008	166	2633	2633	1646	1646
SRVON	02/10/07	16646	0.0095		387	3257	3257	2036	2036
SRVON	02/11/07	29313	0.013		954	5736	5736	3585	3585
SRVON[c]	02/12/07	38258	0.011 [c]		1065	7486	7486	4679	4679
SRVON	02/22/07	16858	0.0051	0.018	162	3299	3299	2062	2062
SRVON	02/23/07	16725	0.0063		203	3273	3273	2045	2045

a COLDR = Colusa Basin Drain; FRVON = Feather River at Verona; FRYUB = Feather River above Yuba City; SACSL = Sacramento Slough; SRCOL = Sacramento River at Colusa; SRVON = Sacramento River at Verona

b Sacramento River at Verona Loads are calculated as the sum of loads for SRCOL, FRVON, SACSL and COLDR.
Sacramento River at Verona concentrations are calculated as: *Load ÷ (Flow x 2.446 Unit Conversion Factor)*

c Load calculated using previous day's load for COLDR and SRCOL

d Loads calculated as the sum of RECSL and ECSSL. Flows were backing up into Sacramento Slough from the Sacramento River on this day, and there was no measurable net flow from Sacramento Slough.

Comparison with TMDL Objectives and Discussion of Exceedances

Compliance with Concentration-Based TMDL Objectives

Concentrations were compared to the recently proposed Basin Plan Amendment objectives for the Sacramento and Feather rivers[1] (0.16 µg/L as a 1-hour average, and 0.10 µg/L as a 4-day average), and USEPA's final National Water Quality Criterion[2] (0.17 µg/L as a 1-hour average and as a 4-day average). The newly proposed Basin Plan objectives are based on the same data used to calculate the current TMDL objective, with corrections made to erroneous data used in the original criterion. The USEPA National criterion also incorporates the data correction and additional recently published data. As required for compliance with the current approved TMDL, measured concentrations of diazinon were also compared to the existing concentration objectives (0.05 µg/L as a 1-hour average, and 0.08 µg/L as a 4-day average), although these lower objectives were derived based on erroneous data and are not scientifically valid.

- No samples collected at any of the 5 compliance monitoring locations exceeded the proposed Basin Plan Amendment objectives for diazinon (0.16 µg/L and 0.10 µg/L) or chlorpyrifos (0.025 µg/L and 0.015 µg/L), or the USEPA national criterion for diazinon (0.17 ug/L). Chlorpyrifos was not detected above the analytical detection limit (0.001 ug/L) in any sample.
- No samples collected at any of the 5 compliance monitoring locations exceeded the current TMDL 1-hour concentration objective (0.08 µg/L) or the TMDL 4-day average concentration objective (0.08 µg/L) for diazinon.

The proposed Basin Plan Amendment for Control of Diazinon and Chlorpyrifos Runoff[1] also contains implementation measures designed to address the potentially additive effects of diazinon and chlorpyrifos. No samples exceeded this proposed Load Allocation concentration criterion based on the sum of toxic units of chlorpyrifos and diazinon.

Compliance with Load-Based TMDL Objectives

Daily diazinon loads calculated for each site were compared to the load allocations and loading capacities (Sacramento River at Colusa, and Feather River at Verona) as specified in the currently approved TMDL. Loads for the Sacramento River at Colusa and Feather River at Verona were compared to the lesser of the TMDL load capacities and TMDL load allocation for these sites. Loads for the Colusa Drain and Sacramento Slough were compared only to TMDL load allocations for these sites. All loads and load allocations were calculated as specified in the currently approved TMDL Basin Plan Amendment.

Comparisons of calculated loads to current TMDL load objectives for the two 2007 dormant spray season sample events indicate that all sites were in compliance with their applicable load

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[1] CVRWQCB 2007. *Basin Plan Amendments to the Water Quality Control Plan For the Sacramento River and San Joaquin River Basins For The Control of Diazinon and Chlorpyrifos Runoff into the Sacramento and San Joaquin River Basins.* March 2007 Public Review Draft. Central Valley Region Water Quality Control Board (CVRWQCB), Rancho Cordova, California.

[2] USEPA 2006. *Aquatic Life Ambient Water Quality Criteria: Diazinon. Final.* EPA-822-R-05-006. U.S. Environmental Protection Agency, Office of Water.

allocations and load capacities. Loads and applicable TMDL load allocations and capacities are presented in Table 5.

D OUTREACH EFFORTS

In 2006, Department of Pesticide Regulations (DPR) adopted new dormant orchard spray regulations that resulted from detections in surface waters of pesticide used in orchards during the winter months. The regulations apply to organophosphates (OP) insecticides including diazinon, chlorpyrifos, methiddathion and pyrethroids. To use OP or pyrethroid insecticide in a dormant spray, a grower must:

- Obtain a written recommendation from a licensed pest control advisor;
- Provide a 100-foot buffer zone between the treated area and any sensitive aquatic site; and
- Apply when the wind speed is between 3 and 10 mph.

No dormant applications are allowed if the orchard soil is saturated or if field runoff is likely to occur if rain is forecast within 48 hours after a dormant spray application.

Since adoption of the dormant spray regulations, the agricultural commissioners in Sacramento Valley and throughout California have been informing orchard growers about the new regulations when they apply for pesticide permits. Numerous grower meetings have also included the new regulations as part of presentations by agricultural commissioner staff. These regulations are expected to have a positive impact on reducing runoff of all dormant orchard sprays including diazinon.

Landowner and crop advisor outreach was conducted in winter 2006 prior to the dormant season sprays. These outreach presentations focused on the diazinon label changes and the finalized diazinon TMDL. Also included was information on available Best Management Practice (BMP) options to protect surface waters from potential impacts of dormant season runoff of alternatives to diazinon, specifically pyrethroid insecticides. Presentations were given at the following events (Table 6):

Table 6. Outreach Presentations

Date	Sponsors/Location	Subject
11/02/06	Sutter County Agricultural Department , Yuba City	Growers' Meeting: New field workers safety info, Controlling weeds in your orchard, Why we care about pesticides in our rivers, Fall aphid treatments in prunes, Enforcement response policy, Water quality update, Orchard sprayer demo
11/08/06	Primary: CSU Chico Others: Butte and Yuba Counties UCCE(1) and Ag. Commissioners; Butte Co. RCD/NRCS(2), CURES(3), BYS Subwatershed; CSU Chico farm	5th Annual Field Crop Seminar: Tentative agenda items: BMP review, Filter strip implementation, Smart Sprayer display, sprayer calibration display
11/16/06	Sutter County Agricultural Department, Yuba City	Growers' Meeting: Controlling weeds in your orchard, Controlling squirrels and voles, Why we care about pesticides in our rivers, Water quality update, Orchard sprayer demo
11/16/06	Primary CAPCA; Butte and Yuba Counties: RCD, NRCS, UCCE(1), Ag. Commissioner; CURES(3), BYS Subwatershed, Glenn, CA	PCA Meeting CAPCA Annual Meeting
11/29/06	Primary: Butte County Farm Bureau Others: Butte County Ag. Commissioner, Butte County RCD(2), BYS Subwatershed Group(4), CURES(3), Durham Memorial Hall	Irrigated Lands Meeting: Water quality monitoring results, BMP implementation, Grass filter strip implementation program, Sprayer Calibrations, NRCS-EQIP funding, etc.
12/05/06	Primary: BYS Subwatershed Group(4), Others: Butte County RCD, NRCS(2), Ag. Commissioner; CURES(3); Gridley	Subwatershed Coalition Annual Meeting: Water quality monitoring results, BMP implementation, Grass filter strip implementation program, Sprayer Calibrations, NRCS-EQIP funding, etc.
12/12/06	Primary: BYS Subwatershed Group(4), Others: Sutter County RCD, NRCS(2), Ag. Commissioner; CURES(3), Yuba City	Subwatershed Coalition Annual Meeting: Water quality monitoring results, BMP implementation, Grass filter strip implementation program, Sprayer Calibrations, NRCS-EQIP funding, etc.
12/14/06	Sutter County Agricultural Department, Yuba City	Pheromone use in walnuts & peaches, Prune research review
12/15/06	Primary: CSU Chico Others: Butte County UCCE(1), RCD, NRCS(2), Ag. Commissioner; CURES(3), B-Y-S Subwatershed Group(4)CSU Chico farm	Growers' Meeting: BMP implementation, Grass filter strip implementation program, Smart Sprayer demonstration, sprayer calibration demonstration, etc.
8/17/06, 8/18/06	UCCE - Tehama, Glenn, Colusa, and Shasta Counties, Chico State Farm	Farm Water Quality Field Days - management practices to minimize off-site movement of sediments and pesticides associated with
12/04/06	Ag Commissioner, Colusa	Colusa County Ag Dept growers meeting - results and BMPs for Chlorpyrifos, Diazinon, pyrethroids

Date	Sponsors/Location	Subject
12/05/06	Ag Commissioner, Ordbend	Glenn County Ag Dept growers meeting - results and BMPs for Chlorpyrifos, Diazinon, pyrethroids
2/7/07	Placer Co.: PNSSNS Subwatershed Annual Meeting, Roseville	Water monitoring results; BMP for dormant orchard and in season pesticide applications
2/8/07	PNSSNS Subwatershed Annual Meeting, Grass Valley	Water monitoring results; BMP for dormant orchard and in season pesticide applications

E MANAGEMENT PRACTICES EFFECTIVENESS

Management practices for use in dormant orchards to prevent diazinon runoff were evaluated for effectiveness in studies in 2005 and 2006, funded through grants from the State Water Resources Control Board (State Water Board). These studies examined the impact of vegetation on orchard runoff of pesticides as well as use of tree sensing technology to minimize ground deposition and subsequent orchard runoff.

Orchard Vegetation During Winter Dormant Season

Project title: Implementation of Feather River TMDL for Orchards:

Grant Manager; Sutter County Resource Conservation District.

This State Water Board funded project includes a study to evaluate different types of orchard floor vegetated cover configurations in orchards sprayed with diazinon and esfenvelerate (pyrethroid insecticide). Runoff from simulated rainfall events (flood irrigation) after dormant spray applications were monitored for flow volume and pesticide concentration, and compared to paired companion orchard sections or comparable orchards treated with the same chemical and rate but not using these BMPs. Below is a summary of the study performed by Frank Zalom and Corin Pease, Department of Entomology, University of California, Davis.

The winter 2006 study was conducted in three orchards (almonds, peaches and prune) which drain into Gilsizer Slough in Sutter County. The purpose was to demonstrate orchard floor management practices as they might impact diazinon and esfenvalerate movement from these orchards. Orchards were selected because they a) drained into Gilsizer Slough, b) had different orchard floor management practices, c) had soil types that were as similar as possible given proximity to the slough and groundcover type, and d) had growers who were willing to cooperate in this study and not apply either organophosphates or pyrethroids during the 2005-06 dormant season.

No significant rainfall had occurred prior to February 20; therefore, using water pumped from irrigation wells present at each site, the plots were flooded triggering runoff. Water flow was measured so that an equivalent amount of water was applied to each plot and orchard. The total amount of water was equivalent to a 3-inch rainfall event. The dates of flooding and sample collection were February 22 at the almond orchard, February 24 for the peach orchard and February 25 for the site prune orchard. Samples of the irrigation source water from each orchard were collected at the time of flooding and used for preparation of field blanks.

As expected, the orchard with the planted cover had far less water runoff than did the orchard with bare ground (Table 7). Table 8 presents the concentration of diazinon reported in samples taken from the three orchards. Concentrations in runoff captured in our autosamplers ranged from 19.4 to 104 ppb among individual plots. These results are similar in terms of diazinon concentration in runoff water to those we measured in a prune orchard near Artois, Glenn County, where applications were made with a conventional airblast sprayer and following a natural rainfall event (see Werner et al., 2004). In that study, concentrations measured were 2 to 4 times higher, likely because the rainfall event that produced runoff occurred closer to the time of application than did the flooding in our current study. These results confirm, however, that it is possible to apply the pesticide to the soil and use artificial rainfall – even flood irrigation – to obtain realistic concentrations of diazinon.

In order to assure uniformity of insecticide deposition on each study site, diazinon and esfenvalerate were applied to the orchard floor of each plot at a common concentration that was equivalent to the maximum label rate for peaches. The products and rates applied were Diazinon AG 600 (diazinon) applied at rate of 51 oz. product/acre and Asana (esfenvalerate) applied at 14.5 oz. product/acre. Applications were made with an Echo Duster Mister Air Assist Sprayer in a manner intended to simulate deposition to the soil by a conventional orchard air blast sprayer. A Notice of Intent was filed with the Sutter County Agricultural Commissioner's Office prior to the treatment date. All orchards were treated on January 26.

Ground cover and soil type appeared to affect the load of diazinon and esfenvalerate in runoff from the plots within the orchards that we monitored. As expected, we found that the greatest influence of ground cover and soil type is on the volume of water moving from a site, with bare ground and heavier soil being significantly more conducive to water movement. We also found that the presence of vegetation may also reduce the concentration of esfenvalerate in runoff water. Chemical analysis revealed that vegetative debris present at the time of application may move from the orchard carrying esfenvalerate, although the ultimate fate and potential impact of this source is not known.

Table 7. Liters of runoff collected from the 2200 ft^2 plots.

Calculated on a per hectare basis, n=4.

	liters/ plot [1]			liters/ hectare		
Crop and ground cover	Mean	±	SEM	Mean	±	SEM
Prune, Planted Cover	894.29	±	230.26	43623.47	±	*11232.08*
Almond, Bare Ground	1542.52	±	410.86	75244.13	±	20041.75
Peach, Weeds/Disked	2746.26	±	577.80	133962.56	±	28185.08

[1] ANOVA Statistics - F=4.768; df=2,9; P=0.0387

Table 8. Diazinon concentrations for plots in the three orchards, n=4.

	Diazinon (µg/L) [1]		
Crop and ground cover	Mean	±	SEM
Prune, Planted Cover	37.05	±	8.034
Almond, Bare Ground	47.00	±	10.753
Peach, Weeds/Disked	32.08	±	5.746

[1] ANOVA Statistics - F=0.8127; df=2,9; P=0.4737

Table 9. Total load of diazinon in runoff collected from the 2200 ft^2 plots.

Calculated on a per hectare basis, n=4.

Crop and ground cover	µg diazinon/ plot [1] Mean ± SEM	µg diazinon/ hectare Mean ± SEM
Prune, Planted Cover	30297 ± 6853	1477889 ± 334266
Almond, Bare Ground	80178 ± 35727	3911056 ± 1742787
Peach, Weeds/Disked	87107 ± 25082	4249062 ± 1223505

[1] ANOV Statistics - F=1.4759; df=2,9; P=0.2790

Total runoff per plot and concentration data were used to calculate total load in µg diazinon that was observed to leave the 2200 ft2 plots, and then to calculate the load on a per hectare basis (Table 9). The concentrations found in these runoff samples are much greater than was found in samples from Gilsizer Slough. This is not surprising as the samples represent concentrations in the orchard runoff, and does not represent any filtering that might occur before the runoff reaches the slough or another water body, and it is not diluted by the flow of water through the slough that comes from other land surfaces. Data such as these can, however, be used to determine the effect of the BMPs being tested, and the potential contribution of specific orchards to diazinon runoff.

There are few, if any, studies of the effects of orchard practices on offsite movement of pyrethroids from orchards. Table 10 presents the concentration of esfenvalerate in water collected in glass bottles (a composite of 5 bottles per plot), and in our autosampler tub. Analysis of Variance (ANOVA) revealed no significant difference between treatments at the $P<0.05$ level, but for the glass bottle samples the level of probability of differences between orchards was 0.0608 with the orchard with bare ground having greater esfenvalerate concentration than the orchards with vegetation. The esfenvalerate concentration in samples taken from the autosampler tub are expected to be lower than those taken from the glass bottles because the runoff water enters the plastic bucket, passes through Nalgene tubing and into a Nalgene container, with some esfenvalerate presumably adhering to these surfaces along its journey. Interestingly, although esfenvalerate concentration measured in water taken from the autosampler tub was lower than that measured from the glass bottles, the esfenvalerate ppb trend was similar between orchards.

Table 10. Total esfenvalerate concentrations.

Samples collected in glass bottles and autosampler tubs for plots in three orchards, n=4.

Crop and ground cover	Esfenvalerate in bottles (µg/L) [1] Mean ± SEM	Esfenvalerate in autosampler (µg/L) [2] Mean ± SEM
Prune, Planted Cover	0.074 ± 0.008	0.044 ± 0.006
Almond, Bare Ground	0.116 ± 0.028	0.059 ± 0.013
Peach, Weeds/Disked	0.047 ± 0.009	0.036 ± 0.004

[1] ANOVA Statistics - F=3.8856; df=2,9; P=0.0608

[2] ANOVA Statistics - F=2.0322; df=2,9; P=0.1869

Table 11. Total loads of esfenvalerate in runoff collected from the 2200 ft^2 plots.

Calculated on a per hectare basis using samples collected in the glass bottles, n=4.

	µg esfenvalerate/ plot [1]			µg esfenvalerate / hectare		
Crop and ground cover	Mean	±	SEM	Mean	±	SEM
Prune, Planted Cover	61.818	±	13.626	3015.482	±	664.676
Almond, Bare Ground	150.608	±	32.571	7346.658	±	1588.813
Peach, Weeds/Disked	136.828	±	44.926	6674.470	±	2191.490

[1] ANOVA Statistics - F=2.0981; df=2,9; P=0.1787

Table 11 and Table 12 present the total load in µg esfenvalerate in runoff collected from the 2200 ft^2 plots and calculated on a per hectare basis using samples collected in the glass bottles and in the autosampler units, respectively. Total load of esfenvalerate measured in water samples collected by seems to indicate that as for diazinon, load of esfenvalerate is lower in the prune orchard which had the planted cover and was planted on the lighter soil.

Table 12. Total load of esfenvalerate in runoff collected from the 2200 ft2 plots.

Calculated on a per hectare basis using samples collected the autosampler tubs, n=4.

	µg esfenvalerate/ plot [1]			µg esfenvalerate / hectare		
Crop and ground cover	Mean	±	SEM	Mean	±	SEM
Prune, Planted Cover	38.355	±	9.986	1870.957	±	487.117
Almond, Bare Ground	101.305	±	41.166	4941.658	±	2008.077
Peach, Weeds/Disked	102.223	±	28.968	4986.438	±	1413.059

[1] ANOVA Statistics - F=1.527; df=2,9; P=0.2685

Our hypothesis that vegetative debris present in the orchard at the time of application can be a source of esfenvalerate leaving an orchard seems to be supported by data presented in Table 13. Vegetative debris, even in the almond orchard which had bare ground but still harbored fallen leaves and other organic matter, was collected at the screen by the autosampler pump, moved there by the runoff. Esfenvalerate was found in samples from all 4 plots at a mean level of 2320.18 ng per gram of vegetation. The ultimate fate of treated vegetation that may enter a water body such as Gilsizer Slough is not known.

Table 13. Data for vegetative debris collected from mesh screens in the almond orchard (site 520XPROPB).

Weight of vegetative debris (g), total esfenvalerate (ng/g), and total load of esfenvalerate associated with vegetative debris in runoff collected from the 2200 ft^2 plots and calculated on a per hectare basis, n=4.

Variable	Mean	±	SEM
Weight of vegetation (g)	12.40	±	3.11
Total esfenvalerate (ng/g)	2320.18	±	579.23
Total load (µg/plot)	28232.80	±	8161.83
Total load (µg/hectare)	1377195.81	±	398133.86

An attempt to isolate sediment from the glass bottles used for collecting the esfenvalerate samples did not yield useful results. Although we did collect and measure sediment from the bottles (Table 14), the amount of sediment was not sufficient for analysis by the California Department of Fish and Game Analytical Laboratory which performed the other chemical analyses for this study.

Table 14. Weight of sediment collected from glass bottles used to collect esfenvalerate samples

n=5 bottles per plot, n=4 plots per orchard.

Crop and ground cover	Sediment (g/ bottle) [1] Mean	±	SEM
Prune, Planted Cover	5.983	±	0.635
Almond, Bare Ground	4.771	±	1.000
Peach, Weeds/Disked	3.417	±	1.454

[1] ANOVA Statistics - F=1.4045; df=2,9; P=0.2945

Smart Sprayer Technology

Project title: Sacramento Valley Regional Pesticide BMP Implementation Program;

Grant Manager: Coalition for Urban/Rural Environmental Stewardship.

One task in this project is to evaluate the effectiveness of Smart Sprayer technology in reducing ground deposition and hence orchard runoff of dormant season pesticides. Smart Sprayers have tree seeing technology that enables the sprayer to shut off nozzles if no tree or branch is adjacent to the sprayer nozzles. In-field water quality runoff studies were performed to evaluate the efficacy of Smart Sprayer™ technology versus conventional sprayers in reducing the concentration of diazinon in surface water runoff from orchards sprayed during the winter dormant season. The runoff study was performed in winter 2005 by David Brown of CSU Chico.

This study represented the first large scale field experiment quantifying the effects of target-sensing spraying on reducing insecticide runoff from dormant orchard applications. The results found that target-sensed spray application technology reduced spray application rates by 40%, consistent with expected performance, given the orchard configuration. Ground deposition was reduced by 41% when compared to conventional air-blast applications. Concentration of diazinon in surface water samples due to surface water run-off events was reduced by 44% when using the target-sensed technology versus the conventional air-blast applications. These results, when combined with previous studies finding equivalent target deposition with conventional and target sensing applications, strongly establish the benefits of target sensing orchard spraying for reducing adverse environmental effects of pesticide application.

F SUMMARY

The following preliminary conclusions can be made based on the results of the second year of this multi-year effort:

- All sites were in compliance with currently adopted load-based and concentration-based TMDL objectives for diazinon, as well as with the USEPA national criterion. These results indicate that the combination of changes in diazinon use patterns, changes in management practices and modifications to labeling have been successful in reducing instream ambient diazinon concentrations and loads below the historically observed levels that resulted in listing these waters as impaired.

- The recently proposed Basin Plan Amendment for Control of Diazinon and Chlorpyrifos Runoff to the San Joaquin and Sacramento River Basins (CVRWQCB 2007) has significant implications for the TMDL for diazinon for the Sacramento and Feather Rivers. These objectives are expected to modify the targets of the TMDL, and may result in re-evaluating the need to list the Sacramento and Feather Rivers as 303(d)-listed impaired water bodies. The affected water bodies already comply with the more scientifically valid TMDL targets proposed in this amendment. At a minimum, continued compliance with the proposed objectives would be expected. Additionally, the amendment indicates that future compliance monitoring requirements may be satisfied through ongoing monitoring conducted under the Conditional Waiver for Irrigated Lands Program.
- The Coalition and its Subwatershed groups continue to promote management practices to reduce diazinon runoff after dormant orchard sprays. Outreach presentations included information on the diazinon label changes, the finalized diazinon TMDL and the new dormant orchard spray regulations. Also included was information on available BMP options to protect surface waters from potential impacts of dormant season runoff of alternatives to diazinon, specifically pyrethroid insecticides.
- Management practices continue to be evaluated for effectiveness in minimizing diazinon runoff from orchard sprays. In the winter 2007, a second study on the impact of orchard floor vegetation on dormant runoff will be performed, this time in a San Joaquin Valley almond orchard. This study will provide information useful to orchard growers in the Sacramento Valley. Another potential management practice being studied this upcoming winter will be evaluation of an enzyme shown to rapidly breakdown diazinon. Preliminary plans call for use of the enzyme after a dormant orchard insecticide treatment, either to treat runoff water at field edge or as an application to the orchard floor after a diazinon application.