Project Number: 90-Y2

PROJECT REPORT
1990

Project Title: Minimizing Environmental Hazards During Dormant Spraying of Almond Orchards and Other Crops

Project Leader: Barry W. Wilson

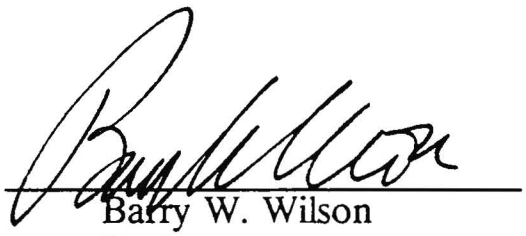
Location: UCD Campus

Cooperating Personnel: J.N. Seiber, W.E. Steinke, D.K. Giles, F.F. Zalom, D.M. Fry, UCD; W. Asai, Cooperative Extension.

Keywords: Almonds, Prunes, Dormant Sprays, Organophosphates, Wildlife, Pesticide Drift, Spray Techniques

Commodity's: Almonds, prunes, peaches, nectarines, other orchard crops

AES/CE: 3954 H



12/3/90

Barry W. Wilson
Professor

Date

Summary

Regulatory Actions

When the report of our Red-Tail Hawk orchard research (discussed in the original application) was submitted to California Department of Fish and Game (CDFG), and submitted by them to the California Department of Food and Agriculture (CDFA), CDFA required the registrants of parathion, diazinon and methidathion to submit new data. The letter to the registrants called for studies of the behavior of hawks in the orchards, routes of exposure and toxicity of the organophosphates (OPs), both alone and in combination with the oils used in the sprays. Chlorpyrifos was not listed, nor were studies of spray application and drift specified.

A consortium of chemical companies and the Almond Board was formed, a protocol of ours was approved by CDFA, and a two year research project specifically aimed at defining the hazards to the Red-tailed Hawks started September 1, 1990. The protocol focuses on: (1) Tracking hawks by radiotelemetry and determining their exposure to sprays over a 5 x 5 mile region south-east of Modesto; (2) Determining blood enzymes and OPs on the birds, in the air, and on the trees and soil of the region, (3) Establishing the acute toxicity of the chemicals to oral, dermal, and, if possible, inhalation routes, first with pigeons, then with captive bred American Kestrels, and (4) Determining no-effect-levels for dominance and, if feasable, food-getting behavior, of kestrels. In toto, the studies will establish the ways hawks are exposed to the chemicals, and suggest no-effect levels of exposure. The PI of the Red-Tail Hawk Study is Barry W. Wilson; coinvestigators include wildlife biologist D. Michael Fry, and analytical chemist James N. Seiber.

Whether orchard spray technology will be able to provide such exposure levels and reduce drift is not addressed in the state approved protocol; such mitgation is the focus of the research undertaken here.

Objectives

The research underway here focuses on the impact of spray technology in almond and other orchards on drift and toxicity to birds. Currently, it is supported by annual grants obtained from the Almond Board ($20,000), the Prune Board ($3,000) and WRPIAP ($20,000). Together, the Red-Tailed Hawk and the Spray projects constitute an integrated, interdisciplinary, in depth approach to understanding and mitigating the hazards of dormant sprays to wild-life and non-target crops. (The Draconian approach; that of cancelling the dormant sprays is likely to increase hazards inherent in the more frequent in-season foliar sprays that occur during the reproductive season.)

Specific objectives of the spray study are to: (1) Evaluate alternative spray techniques and equipment; (2) Monitor residues in selected parts of the orchard ecosystem and its surroundings; (3) Measure off-target movement of spray during dormant spraying; (4) Reduce the exposure of Red-tailed Hawks and other wildlife to dormant sprays, and (5) Assess the effectiveness of alternative sprayings on insect populations in the orchards.

Progress

The first integrated field study was carried out during January 1990 in an almond orchard approximately 5 miles southwest of Modesto, California. There were 63 X 66 trees,

in approximately 42 acres (17 ha), consisting of three varieties of almonds (Carmel, Nonpareil and Price).

Two 4.6-acre (1.86 ha) experimental plots containing 20 X 20 trees each and a similar "check" plot to check for insect infestation were established.

A conventional air blast sprayer applied approximately 150 gal/acre, and a mast type machine (Mister Miser) applied a concentrate at 43 gal/acre. Three blocks, each consisting of 20 rows, 20 trees per row, were equipped with air samplers. Potted parsley plants were placed with the up and downwind air samplers. Domestic pigeons were in cages that hung from branches directly in line with the spray, and at four downwind locations, next to the downwind air samplers.

The conventional, air carrier sprayer with an axial fan and hydraulic nozzles is widely used in California and provided a basis for comparison of other sprayers. The sprayer had been previously characterized with regard to droplet spectrum and initial droplet velocity. Its performance was compared to that of the "Mister-Miser" equipped with a vertical mast holding four fan-atomizer combinations positioned at various heights. These hydraulically powered units allowed spray liquid to be emitted from various heights in the canopy, targeted to the location of the pests. Such sprayers have the potential to remove much, if not all, of the vertical component from the initial velocity of the droplets. The fans were positioned to deliver an increased spray volume to locations in the canopy where the target was most dense.

Measurements included the deposition on plant surfaces (mass per area or weight), deposition on ground surfaces (mass per area) and concentration of pesticide in the air downwind from the application site (mass per volume, time integrated over the entire application). Air samples were collected on a variable height mast at least one distance downwind both during and for periods of time after application was complete to provide measures of the integrated horizontal flux of pesticides (vapor and particulate) moving off target by simple drift, and of pesticide vapors released to the air from the target after spraying ends ("lift-off"). Gauze patches were attached to the cages to collect spray reaching the pigeons. Fog samples were collected downwind of the spraying operation both during and after application to provide maximum concentration values for pesticides in fog. All analyses were performed with standard gas chromatographic methods using equipment in Seiber's laboratory.

San Jose Scale and Peach Twig Borer were monitored following each treatment. Relative population levels of San Jose Scale were determined with sticky tape and pheromone traps. Populations were sampled directly by removing infested twigs. Sticky tape traps are clear plastic tapes that are wrapped around the scaffold limbs. Emerging males and crawlers that are migrating to a new location stick to the surface of the tape. The tape traps were placed in the trees in April and monitored at biweekly intervals throughout the spring. Samples of scale infested twigs were removed from each treatment replicate and dissected to determine mortality directly. Pheromone traps were monitored weekly during April and May. Peach Twig Borer populations were evaluated in each treatment replicate by counting the number of twig strikes on each of 10 trees following emergence from hibernacula (which occurs in February).

Pigeons were placed in cages and hung from trees in treated areas during and for several hours following completion of spray application. Later in the day, the birds were transferred to clean cages and returned to Davis. The next day, blood samples were taken, the birds sacrificed, and their brains removed, frozen at -70 °C until homogenization and assaying for cholinesterase activity.

For the period 1-19-90 to 1-30-90, 5.1 % (213 gr) of the diazinon applied initially by the conventional sprayer was lost via flux to the air while 2.3 % (94.8 gr) of the diazinon applied by the mast sprayer (Mister-Miser) was lost. Diazinon concentrations on sentinel parsley plants 92 ft (28 m) from the edge of the plots were 1.5 and 0.79 ppm for the conventional and Mister-Miser treatments, respectively. 76% of the diazinon applied by the conventional sprayer and 16 % of the pesticide applied by the Mister-Miser were found in the soil. Exposure of the gauze patches on the side of the bird cages was low and similar in magnitude for the two treatments. No birds showed any immediate symptoms of pesticide poisoning. One day later, there was no detectable decrease in brain or blood cholinesterases, confirming that exposures were low, even in birds placed directly in the path of the sprayers. Acute toxicology studies underway on pigeons demonstrate they are sensitive to OPs, with LD50's below 5 mg/kg and exhibit reduced blood and brain cholinesterases after oral exposures.

The tables summarize part of the data obtained in the field study.

Conclusions

The results of the field study indicated that drift and deposition on soil could be reduced using a mast-type sprayer while still maintaining capacity to control orchard pests. In addition, the data suggest that exposure directly on feathers, and inhalation of the sprays by birds in the orchard are not sufficient to reduce blood and brain cholinesterases after a single exposure.

Summary Tables

Recoveries

94.9 ± 6.5%

Horizontal Flux

$ug/m^2/hr$

Hours	Conventional	Mister-Miser
0 - 6.5	1372	726
23 - 29	408	97

Twig Deposition

ug/cm^2

Treatment		High	Low
Conventional	N-S	3.9	5.7
	E-W	4.6	6.7
Mister-Miser	N-S	0.7	1.0
	E-W	0.6	0.8

Drift

ug/m^3

Site	Conventional	Mister-Miser
A (Edge)	6.6	3.8
B (224 ft)	2.7	1.9
C (478 ft)	0.05	0.97

Patches on Bird Cages

ug/cm^2

Conventional	1.8
Mister-Miser	1.3

Pesticides in Fog

ppb

Compound	Spray Day 1	Spray Day 2
Diazinon	90.1	44.1
Chlorpyrifos	6.3	3.6
Parathion	13.0	8.9
Methidathion	178	15.8
Diazinon oxon	1.1	2.0
Paraoxon	1.4	5.5

Peach Twig Borer Control

Strikes/tree

Untreated	8.34
Conventional	1.88
Mister-Miser	5.38

3 trees/replicate; 5 replicates
Statistically different from each other.

San Jose Scale Control

Males in pheromone traps

Treatment	5/25/90	6/20/90
Untreated	56.67	36.00
Conventional	38.67	16.00
Mister-Miser	41.33	22.70

No significant difference, n=3
No scale crawlers on sticky tapes

Pigeon Brain Cholinesterases

Treatment	Plasma ChE umol/min/ml	Brain AChE umol/min/mg
Conventional	1.30 ± 0.17	0.305 ± 0.016
Mister-Miser	1.57 ± 0.25	0.299 ± 0.008
Controls	1.43*	0.301*

Grand means ± SD for 5 locations; N=3. Except * n=2.

Response to Critique:

Reviewers of the original proposal commented upon the need for a two year project, routes of exposure and use of surrogate animals.

1. **Two Years:** The field tests can only be conducted once a year, since the specific meterological and biological conditions cannot be duplicated during other seasons. Last

years study suggested that a mast sprayer can reduce drift and maintain insect control. This years test will use another (more easily adjustable) sprayer , and will compare its performance with that of a conventional fan sprayer and helicopter. Since no single machine will be available to the growers, it is important to establish parameters applicable to more than a single sprayer design and mode of application. We have set up a row of almonds on the UCD campus to perform preliminary tests year-round, but the "acid-test" must still be testing in the field. The short time available for conducting the tests, the expense of duplicating equipment and field personnel and the number of analyses required, limit field tests to one a year.

In addition, the season in which these studies must be performed falls between funding cycles. The funds we received this year were used to support analyses from the 1989/90 test, and setting up and carrying out the 1990/91 test to come.

2. **Routes of exposure**: We have recently found out that the inhalation facility of Dr. Otto Raabe, at the Institute for Toxicology and Environmental Health on campus has instrumentation modifiable for studying inhalation exposure of birds. Thus, we will be examining oral, dermal and inhalation routes of exposure of the pesticides on birds during the course of the experiments.

3. **Alternate Species:** Audubon Society Christmas counts of birds wintering in the Central Valley indicate the density of Red-Tailed Hawks in the orchards is approximately 2 per square mile, too few to be studied in any single orchard. The work proposed here emphasizes field and laboratory studies of animals exposed in orchards to known spray applications, and conducted over areas too small to enable us to capture hawks to determine their exposure to the sprays. Also, animal welfare considerations preclude the use of wild hawks as subjects for acute toxicology at high doses. We will establish baseline data on acute toxicology in the pigeon, then study a smaller number of cage bred kestrels and compare these results to exposure data obtained on hawks trapped in the wild. The behavior of wild hawks over larger areas of orchards is the major focus of a separate study.

AES/CE MAR 84 Workgroup/Department _____

University of California
Division of Agricultural Sciences

Project Plan/Research Grant Proposal

Project Year 1991/1992 Anticipated Duration of Project 2 years

Project Leader Barry W. Wilson Location UCD Campus

Cooperating Personnel J.N. Seiber, W.E. Steinke, D.K. Giles, F.F. Zalom, D.M. Fry, UCD
W. Asai, Cooperative Extension

Project Title Minimizing Environmental Hazards During Dormant Spraying of Almond Orchards and Other Crops (Almond Board)

Keywords Almonds, Dormant Sprays, Organophosphates, Wildlife, Pesticide Drift Spray Techniques

Commodity(s) Almonds, Peaches, Prunes, Nectarines, Other Orchard Crops Relevant AES/CE Project No. 3954H

Problem and Its Significance:

See Separate Page

Objectives:

See Separate Page

Plans and Procedures:

See Separate PAge

BUDGET REQUEST

Budget Year 1991/1992

Funding Source _____

Salaries and Benefits		
Postdocs/RA's	_____	_____
SRA's	Henderson, McChesney, Roubach	8894
Lab/Field Assistance	_____	_____
Subtotal		Sub 2 8894
Employee benefits		Sub 6 2717
		TOTAL 11611
Supplies and Expenses		Sub 3 2500
Equipment		Sub 4 500
Operating Expenses and Equipment Travel (Davis campus only)		Sub 5 Ø
Travel		Sub 7 6000
		TOTAL 20611

Department account number ~~440385 59158/3~~

(continued from front)

Originator's Signature _____ Date 12/11/90

COOPERATIVE EXTENSION

County Director _____ Date _____

Program Director _____ Date _____

AGRICULTURAL EXPERIMENT STATION

Department Chair _____ Date 12/12/90

LIAISON OFFICER _____ Date _____

Almond Board of California

Project Year: 1991/92
Anticipated Duration: 2 years
Project Leader: Barry W. Wilson
Location: UCD Campus

Cooperating Personnel: J.N. Seiber, W.E. Steinke, D.K. Giles, F.F. Zalom, D.M. Fry, UCD; W. Asai, Cooperative Extension.

Project Title: Minimizing Environmental Hazards During Dormant Spraying of Almond Orchards and Other Crops

Keywords: Almonds, Dormant Sprays, Organophosphates, Wildlife, Pesticide Drift, Spray Techniques

Commodities: Almonds, peaches, nectarines, prunes, other orchard crops

AES/CE: 3954 H

PROBLEM AND ITS SIGNIFICANCE:

Combined dormant oil and organophosphate (OP) sprays were introduced to control San Jose Scale and Peach Twig Borer in almonds and stone fruits. Pesticides used include parathion, diazinon, methidathion and chlorpyrifos. Overall use of OPs was reduced up to 40 percent. However, raptors (e.g. red-tailed hawks) are exposed to and poisoned by OPs during dormant-spraying season (1,4,5) and the sprays appear in fog (2) and have drifted onto adjacent vegetable fields (6). CDFA placed dormant sprays under reevaluation because of the exposure of raptors (3), and also is examining their drift onto adjacent fields (6). In addition, the oils used in the sprays are subject to Federal Reregistration, and there is a possibility that many may be withdrawn from use. OP registrants and formulators, working with the Almond Board support a 2 year project that began September, 1990 to meet the specific data gaps identified by CDFA concerning hazards to hawks and other wildlife (3). The research underway here is more inclusive; it brings together the two important problems of wildlife exposure and drift, arguing that one cannot be adequately addressed without studying the other, at the same time as it emphasizes spray technology and mitigation, matters not dealt with in the reistrant-supporterd study.

This multidisciplinary field research project of spray engineers, entomologists, chemical and biochemical toxicologists and wildlife biologists was approved by the Almond Board in the fall of 1989, out of phase with the usual funding cycle of the organization. It is designed to improve integrated pest management of orchards in California and reduce environmental hazards stemming from it.

There are more than 400,000 acres of almonds and hundreds of thousands more acres of prunes, peaches, and other stone fruits that face the problems discussed here. The results, when combined with the results of the Red-Tailed Hawk project, should lead to recommendations on how to reduce the drift of dormant sprays without increasing exposure of birds to the direct effect of the sprays.

OBJECTIVES:

The goal is to maintain the efficacy of dormant chemical application while reducing environmental hazards, especially drift and exposure to wildlife. Experiments will continue at field sites in the Central Valley of California in order to:

1. **Evaluate** alternative spray techniques and equipment.
2. **Monitor** amount of residues in selected parts of the orchard ecosystem and its surroundings.
3. **Measure** off-target movement of spray during dormant spraying.
4. **Reduce** (in conjunction with the Red-Tailed Hawk project, the exposure of Red-Tailed H.hawks and other wildlife to dormant sprays using surrogate species as test subjects when appropriate.
5. **Assess** the effectiveness of alternative sprayings on insect populations in the orchards.

The results will provide information to **improve the recommendations** for the integrated pest management of orchards and to meet requirements for reevaluation of dormant sprays imposed by the California Department of Food and Agriculture (CDFA).

SUMMARY OF FIRST FIELD TEST

Drift, flux measurements, residues, and response of pigeons in cages to 50W diazinon and Volk Supreme oil applied by a conventional fan sprayer at 150 gal/acre and a mast sprayer (Mister-Miser) at 43 gal/acre were studied in a mature almond orchard near Modesto in January 1990. Drift and residues were reduced with the mast sprayer. Many pesticides were found in the fog above the orchard in addition to the diazinon that was applied.

Partial control of pests was achieved with the Mister-Miser application. Pigeons directly exposed to the spray showed no acute symptoms, and birds stationed up to 400-500 ft from the orchard maintained high blood and brain cholinesterases. The results suggest low-volume, mast-type sprayers may help control drift, and that direct exposure to feathers may not be an important route of exposure of birds to OP sprays. (The results are reported in more detail in a separate progress report.)

PLANS AND PROCEDURES:

Detailed procedures were presented in the original application. The following extends and modifies them to reflect our latest plans and designs, and respond to the criticisms and suggestions of the Almond Research Advisory Committee and others.

The pesticide under study in our field tests is diazinon (O,O-diethyl O-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate), currently an important component of orchard sprays. It is less toxic than parathion, posing less risk to investigators who must enter the orchard shortly after the sprayer passes to collect samples, and is less sensitive to weather conditions than chlorpyrifos. (The acute toxicology of diazinon, parathion, methidathion and chlorpyrifos to pigeons are being compared in controlled laboratory studies. Whether or not studies will be undertaken on carbaryl, under consideration for dormant spraying, depends on the extent of its use in the field.) The oil under study is Volk Supreme, that we have been assured will remain in the market.

The spray conditions under study are: (a) a conventional (ca 100 gal/acre) air carrier spray control,(b) one or two test spray techniques designed to improve deposition on the branches and twigs and reduce the entrainment of pesticide aerosol into the fog and onto the ground and (c) no spray when appropriate. The number of tests depends on the funds and equipment available.

Study sites are commercial orchard plots in the Modesto area. Soil, plant and air residues, sentinel birds and surrogate plants are studied in the path and downwind of the

sprayers. Experiments will be conducted at the Kearney Field Station of the University of California when appropriate.

Parameters to be determined include: diazinon spray, residues in soil, plants and air, in potted plants such as parsley, on caged sentinel birds and birds captured in the orchards when appropriate. Our first choice of a sentinel bird is the pigeon. Blood ChEs, brain CHE levels of caged birds (and metabolites in excreta when approrpiate) will be studied. An air curtain mast sprayer and helicopter application will be studied in the upcoming spray season, and the data will be used to design a study of a large plot next year, as a prelude to submitting our recommendations.

Last years proposal included a detailed discussion of many of the methods to be used in the studies. Changes and improvements of experimental design are presented here.

DORMANT SEASON: 1990/91

An orchard has been chosen near Modesto for this years (1990/91) dormant season study. Five treatments will be applied, each to a one acre (0.40 ha) block of dormant almond trees. Blocks will not be replicated, but samples will be collected from six random trees within each block. The treatments are: 1) conventional air carrier sprayer adjusted to industry "standard" and application at a rate of 100 gallons per acre (gpa) of finished tank mix; 2) conventional air carrier sprayer with fan adjusted to stall air at the top of the trees and flow rate through each nozzle proportioned to correspond with the relative density of target in the area of the tree sprayer by that nozzle, but the total flow rate equal to 100 gpa; 3) a helicopter operating at approximately 30 gpa; 4) the "CurTec" air curtain sprayer as designed at Michigan State University and now commercially manufactured (further description to follow), operating at approximately 30 gpa; and 5) an unsprayed check plot. Active ingredient applied per acre will remain constant for all trials.

The air curtain sprayer to be used is similar in concept but improved in execution and fabrication over the machine (Mister-Miser) used last year. This commercially available machine was designed at Michigan State University and is currently on loan for our research. Four squirrel cage fans are placed at various heights on a 20 foot vertical mast, with output air being directed to the side and into the tree canopy. Fan axis of rotation is vertical. A rotary atomizer is placed in the center of the air output duct from each fan, with its axis of rotation being horizontal and oriented front to back. On this particular unit, an extra fan, without atomizer, has been mounted at the top of the mast. This will allow a region of moving "clean" air to be placed over the spray, helping to contain the spray in the plant canopy and reducing mixing with the free atmosphere.

Deposition of the spray on twigs will be studied at two heights in each of the four quadrants of the canopy. Samples from opposite sides and the same height will be pooled, yielding four samples per tree; upper east-west, lower east-west, upper north-south, and lower north-south. Samples will be washed and mass per square centimeter of twig surface

will be determined using standard methods.

Downwind drift will be measured during the application, as will all weather conditions necessary to establish atmospheric stability parameters for the time of application.

The pigeon trials will be redesigned. Each bird will stand on a wide perch, mimicing a wild bird standing on a large branch. The gauze pads will be replaced by mylar collectors, since the patches may not have reflected the actual deposition on the cages.

Insect control efficacy will be monitored as was done last year.

One innovation will be an experiment in which a "natural marker" (a hydrocarbon chemical which is a natural component of petroleum, but is not present in the spray oil, will be added to the OP-oil spray mix. This will permit us to track the movement of spray material from an individual orchard, or portion of an orchard.

A row of almond trees set up on the Davis CAmpus is being used for preliminary tests of sprayers, before setting up the field studies themselves.

DORMANT SEASON: 1991/92

In the following season, the most promising ground-based application system will be compared against aerial application, a conventional orchard sprayer, and an untreated check, with whatever modifications are necessary based upon the 1990/91 tests. The blocks will be larger than in preceding years, on the order of 10 acres (4 ha), in order to establish, on a pilot scale, the efficiency, efficacy, and environmental protection offered by the improved pesticide application systems, performed as a grower would do, and sampled as described above for the smaller plots. Including studies of Steinke and Asai before the start of this project, we will have amassed four years of data regarding twig deposition and drift to provide a basis for recommendations on spraying techniques.

Anticipated Problems: Weather; our first choice for a field study is foggy weather. We plan to wait as long as possible for a foggy stretch to carry out the work. However, the helicopter application must be done under visual flight rules. Atmospheric stability parameters will be established at the time of application, permitting us to compare data gathered from different days, using procedures outlined in Steinke and Yates (7,8)

Animal exposure: The animal part of the study is based on the plausible assumption that a large part of the exposure of birds in the orchards to OPs is due either to direct contact of the birds to the spray, the branches or to drift. It is important to study both drift and animal exposure in the same study to avoid a situation where conditions that would reduce one problem might exacerbate the other.

Infestation: Orchard sites with a plentiful supply of insects will be sought to maximize the

information gained from the study. Sprayer modifications: Funds to modify sprayers are a major limiting factor. Our experimental design provides for adding on treatments if additional funds are obtained.

Preliminary tests: Tests of the sprayers, bird cages and air samplers will be performed on the UCD campus or at the Kearney Field Station.

RESEARCH SCHEDULE:

SEASON:	Fall 90	Winter 90	Spring 91	Summer 91	Fall 91	Winter 92	Spring 92	Summer 92	Fall 92
Prepare Site	XXXXX					XXX			
Modify Sprayer	XXXXX			XXXXXXXX					XXXXXXXX
Field Study		XXXXXXX	XXX			XXXXXXX			REPORT
Analyses			XXXXXXXXXXXXX				XXXXXXXXXXXX		
Data Processing				XXXXXXXXXXXXX				XXXXXXXXXXXXX	

PROPOSED SECOND YEAR BUDGET

		UCD	Almond	RTH	WRPIAP
Salaries & Benefits					
Senior Scientists					
B. Wilson (Coordinator)	10%	11445			
J. Seiber (Ag. Chemist)	5%	5202			
W. Steinke (Ag. Engineer)	5%	2743			
D.K. Giles (Ag. Engineer)	3%	2194			
F. Zalom (Entomologist)	2%	1598			
Students					
D. Bartkowiak (Pharm/Tox)		13839*			
J. Yamamoto (Pharm/Tox)		4500**			
Technicians					
P. Nieberg (Animal Care)	5%	3150			
J. Henderson (Biochem.)	15%		1000	4804	1500
M. McChesney (Analyt. Chem.)	15%		5907		3500
SRA IV (Ag. Eng.)	15%		4704		4703
Lab. Asst. I (Biochem.)	15%			3638	
Supplies & Expenses					
Birds, Purchase & Care				3800	
Birds, Biochemistry		500		1500	
Chemical Analyses		500	1000		2000
Spray Engineering			1000		3200
Equipment					
Spray Equip. Shipping/Expenses					4000
Cages		2000	500		500
Computer for Field Work					5000
Travel					
Field Study			6000		
Data Processing/Office/Reporting		1000	500	500	1000
TOTALS		48671	20611	14242	25403
Prune Board		**4000**			

Prune Board funds will be used to augment the sprayer protion of the project, especially the costs of rentals, and modifying exisiting sprayers.

WRPIAP = Western Regional Pesticide Impact Assessment Program; UCD = University, Almond = Almond Board of California (Proposed),
RTH = Acute Toxicity Contribution from Red-Tail Hawk Project

* Ecotoxicity Training Grant
** NIH Environmental Toxicology Training Grant
UCD: UCD personnel on project, percent contributions and salaries.
* Donna Bartkowiak is an Ecotoxicology Trainee; ** Julie Yamamoto is an NIH Environmental Toxicology Trainee. These students will assist in the field studies and toxicology research. **** Contributions are assumed from the Almond Board ($20,000 or more) plus the Western Regional Impact Assessment Program (contributed $20,000 this year) and the Prune Board (contributed $3000 this year); Ciba-Geigy has contributed pesticide to the spray study. The funds shown here indicate a contribution from the Red-Tailed Hawk project for support of acute toxicology research.

Jack Henderson is an experienced biochemistry laboratory technician working with Dr. Wilson. He will supervise the blood, brain samplings and enzyme assays. Michael McChesney is an experienced laboratory technician of Dr. Seiber. He will supervise the air and residue samplings and perform the analyses.

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