Project Number: 91-Y3

1991 REPORT

MINIMIZING ENVIRONMENTAL HAZARDS DURING DORMANT SPRAYING OF ORCHARDS

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OBJECTIVE

Combined winter dormant oil and organophosphate (OP) sprays introduced to control San Jose Scale and Peach Twig Borer in almonds and stone fruits including parathion, diazinon, methidathion and chlorpyrifos reduced the amount of OPs applied in California orchards up to 40 percent. But, the sprays drifted onto adjacent vegetable fields, and exposed wildlife such as Red-tailed Hawks leading to state-mandated projects on almonds.

The goal of this project is to maintain the efficacy of dormant chemical application while reducing its environmental hazards, especially drift and exposure to wildlife. Experiments are conducted at almond field sites in the Central Valley of California.

Specific objectives are:

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 OPs during dormant spray season.
4. Reduce the exposure of Red-tail Hawks and other wild life to dormant sprays using surrogate species as test subjects when appropriate.
5. Assess the effectiveness of alternative sprayings on insect populations in the orchards.

PROCEDURE

The 1990/91 spray application study was conducted in an 80 acre site outside of Modesto in January 1991. Plots were (a) no application control, (b) conventional air-carrier orchard sprayer (Oma) at 100 gpa, (c) Curtec air-curtain mast sprayer with 5 squirrel cage fans, one atomizer per fan in the lower 4 fans run under standard conditions at 40 gpa, (d) the same sprayer at reduced fan and atomizer rpm, and (e) spraying by helicopter at 40 gpa. Active ingredient rates of diazinon were the same for all applications. Sites of samplers were upwind, 37.5 (A), 75 (B) 100 (C) and 120 (D) meters downwind from the center of the field. Parsley plants and air samplers were at all sites; pigeons were placed upwind, at site A (at the edge of the test plot) and site B. The pigeons were individually caged and stood on filter paper covered fiberglass cage bottoms to mimic exposures of birds perched on branches.

Peach Twig Borer: The impact of treatments on twig borers was evaluated by counting twig strikes resulting from the feeding of overwintering larvae emerging from their hibernacula, and by assessing damage at harvest. Nuts were stored in a cold room at UC Davis in

September, 1991 for the latter test and will soon be hand counted.

Twig Strikes: Six trees from the center of each of the 6 treatments were used. The number of twig strikes per tree were counted on 4/18/91 and statistically analyzed.

RESULTS

Mean deposits of diazinon (ug/cm^2) from twigs from each plot and the mean number of peach twig borer strikes counted on 4/18/91 are plotted in Figure 1. Depositions greater than approximately 6 ug/cm^2 were associated with reduced numbers of borer strikes. Means of both the Curtec modified and unmodified sprayer treatments were significantly different from both the untreated control and the helicopter treatment. The helicopter treatment was not significantly different from the untreated control.

San Jose Scale: Few scales were observed in the orchard before treatment. Male scales were trapped on tent type pheromone traps, and spurs were examined visually. Three pheromone traps were placed in all treatment areas except the second helicopter treatment. The traps were removed at the end of the first generation flight and returned to UC Davis for counting. No significant difference was found between treatments. The total number of male moths captured was only 10 % of last years trial, too low a number to provide a good estimate of population size. Spur samples: Twenty 2 to 3 inch spurs from 5 sample trees of each treatment were collected on 10/17/91 and examined for the presence of adult and immature scales and crawlers. All treatments provided statistically significant control of scales compared to the untreated control (Table 1).

Pigeons: Pigeons that were directly sprayed had consistently lower blood cholinesterase levels than controls or birds at downwind stations 8 and 24 hours after spraying (Table 2). None of the birds showed overt symptoms of OP poisoning. There was moderate correlation between the extent of cholinesterase depression and the residues deposited on filter paper squares on the cages ($r=0.66$, data not shown).

Data of aerosol drift taken by high volume air samplers and deposits of fallout sheets are still being analyzed. Preliminary considerations indicate large differences in air levels and ground deposits of diazinon between the several treatments (Table 3). The extent of deposition onto fallout sheets was modified Curtec> Curtec> Oma > Helicopter (data not shown). Falloff of material was high at 75 meters downwind and beyond for all treatments with respect to ground deposition and for the helicopter, Oma and Curtec in the air.

CONCLUSIONS

The results suggest that application techniques can be devised to reduce drift and exposure of birds and off-site targets. The project is on schedule; the first year put together the team, tested the approach and showed we could simultaneously study spray properties, air levels, residues, sentinel animals and plants and pest control. The second year compared a state of the art air curtain sprayer, a conventional fan and helicopter application. The results suggested that applications could be reduced without loss of effectiveness. The third year will test reduced levels of pesticide and modifications of the air curtain sprayer aimed at significantly reducing drift.

In addition, the banning of parathion and reports that carbaryl has been shown effective for dormant sprays, led to its introduction into the study, since it offers the possibility of uing a compound with low toxicity to wildlife, at least when oils are not present.

Although not supported here, a state-mandated and industry supported Red-tail Hawk project coordinated by the Almond Board is germane to the research underway on spray application technology. During the first year of the two year study live-trapped and radio-tagged hawks were sampled to determine blood cholinesterases and excretory metabolites, and then tracked to determine their home ranges. Air levels of pesticides were determined and land use recorded in a 50 sq mile site near Modesto. The study established that (a) hawks have small (often less than 5 square mile) home ranges in the winter, and (b) exhibited exposures to pesticides used in their home ranges.

The state-mandated Red-tail Hawk project focuses exclusively on hazards to hawks in the orchards. The research undertaken here is a vital component of our efforts to reduce hazards of people and wildlife to dormant sprays and cannot be accomplished under the other project. For example, the state did not require study of (a) spray application equipment, (b) OPs other than parathion, diazinon and methidathion such as chlorpyrifos, or (c) other pesticides.
Changes in Regulation for Dormant Sprays: The scope of this project has been altered due to important changes in dormant spray regulations. (a) Use of parathion ends as of January 1, 1992 by order of the EPA. (b) Significant exposure of hawks to chlorpyriphos occurred in the first year's field study, and we have been told that the CDFA (CEPA) will soon add this chemical to the three OPs listed for reevaluation. (c) Carbaryl, a carbamate pesticide, recently has been approved for use in dormant sprays. It is likely to be most effective when sprayed late in the season before bloom and before it can injure the bees. One good feature is that it has shown low toxicity to several species of birds.

Figure 1

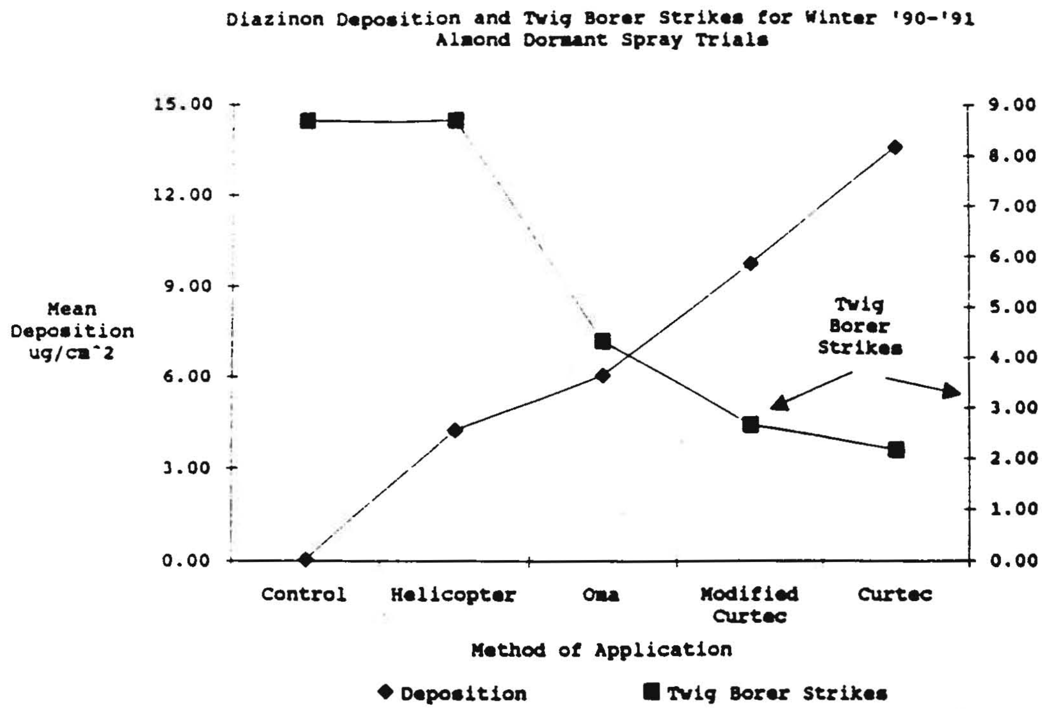

Table 1

Dormant Sprayer Trial - San Jose Scale
Stanislaus Co., 1991

Treatment	# of Scales/Spur*
Untreated	0.17 (0.14) a
Curtec	0.02 (0.04) b
Modified Curtec	0.01 (0.01) b
Air Blast	0.02 (0.02) b
Helicopter	0.02 (0.02) b

* means n. s. different (p>0.05) by DMRT; total no. of adults, immatures and crawlers on 2 spurs (n=5); samples collected 10/17/91

Table 2

Cholinesterase Activity in Pigeons Exposed to Dormant Sprays

Spray Test	Dose Group	Plasma Activity 8 Hour	Plasma Activity 24 Hour	Brain Activity 24 Hour
	UCD Control	1.40 ± 0.26	1.42 ± 0.37	282.3 ± 32.2
Conventional Fan	Field Con	1.82 ± 0.58	1.94 ± 0.57	315.7 ± 23.0
	Direct	1.32 ± 0.15	1.43 ± 0.19	317.7 ± 25.6
	Downwind	1.73 ± 0.45	1.72 ± 0.18	310.3 ± 13.8
Curtec	Field Con	1.68 ± 0.64	1.52 ± 0.56	257.2 ± 9.5
	Direct	1.01 ± 0.39	[1,2,3]0.45 ± 0.20	264.2 ± 6.3
	Downwind	1.78 ± 0.57	1.81 ± 0.45	254.4 ± 35.9
Modified Curtec	Field Con	1.56 ± 0.30	1.74 ± 0.32	301.3 ± 30.3
	Direct	1.31 ± 0.10	1.25 ± 0.30	259.7 ± 25.8
	Downwind	1.45 ± 0.16	1.78 ± 0.70	270.3 ± 29.3
Helicopter	Field Con	[3]1.85 ± 0.16	1.77 ± 0.29	235.4 ± 20.7
	Direct	[1,2]1.43 ± 0.22	[1]1.38 ± 0.08	249.5 ± 43.5
	Downwind	[3]1.94 ± 0.18	1.84 ± 0.15	259.6 ± 25.9

Mean activity ± standard deviation.
Activity is umol/min/ml for plasma; umol/min/mg protein for brain.
Sample size is 3 for all groups except UCD control group is 4.

[1]Different from Field control. P = 0.05, 1-Tail Wilcoxon test.
[2]Different from Field control. P < 0.05, 1-Tail Student's t-test.
[3]Different from Meyer control. P = 0.01, 2-Tail Student's t-test.

Table 3

Diazinon Application Results

Diazinon (ug/Cu m)

type	period	upwind	SITE A	B	C	D
OMA						
12/18/90	during	0.03	6.21	3.28	1.30	
	1 hour	0.11	4.52	1.13	0.60	
	2 hour	0.03	3.07	0.55	0.19	
CURTEC						
12/26/90	during	3.94	13.25	3.63	3.00	
	1 hour	1.84	3.84	0.99	0.38	
	2 hour	1.04	2.26	0.42	0.15	
MODIFIED CURTEC						
12/27/90	during	0.22	11.98	6.48	4.03	1.28
	1 hour	0.07	4.41	2.86	1.91	1.11