Project Number: 94-Y6

Minimizing Environmental Hazards During Dormant Spraying of Orchards

Report to the
Almond Board of California

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ABSTRACT

Organophosphates (OPs) have been applied as a dormant spray to orchard crops, such as almonds, prunes, peaches and other stone fruits, in California for a number of years. The sprays have been very effective in controlling pests such as Peach Twig Borer (PTB) and San Jose Scale. These OPs have also been implicated in wildlife exposures (specifically treaty protected Red-tailed Hawks), drifting onto unregistered sites (such as specialty vegetables), and, more recently, have been found in the Sacramento and San Joaquin river drainages by CA state agencies. Tests of varying diazinon application rates demonstrated that the rate could be reduced while maintaining insect control. At the same time, the exposure of sentinel birds was reduced.

OBJECTIVE

The goal is to maintain efficacy of OP dormant sprays while reducing risks to the environment. The specific aim is to use of lower rates of diazinon and maintain control against PTB. The use of lower levels of OPs will cut down drift onto non-target crops, reduce exposure to wildlife, decrease levels of OPs in surface run-off, and lower costs for growers.

The objectives, as outlined in the proposal, were to:
1. Determine deposition of the chemical on twigs and branches in a dormant almond orchard.
2. Assess the efficiency of pest control of the treatments.
3. Examine the exposure of caged pigeons when appropriate during the treatments.

PROCEDURE

Plot Design

The study took place in the winter of 1994 in a sixth leaf almond orchard at the Red Rock Ranch in western Fresno County. Every other row in the orchard was Nonpareil, alternating with four other varieties. Trees were planted in a diamond pattern with a 22 foot spacing. The orchard was divided into four blocks (based on observed pest infestation levels); 8 different diazinon treatments were assigned randomly to 1 acre plots within each block yielding 4 replicates per treatment (see Figure 1 and Table 1 for plot layout and treatment details). Plots consisted of ten rows by nine trees per row. Rows 1, 2, 9, and 10 were used as guard rows, as were the first two trees on each end of the other rows.

Spray Application

Sprays were applied with an FMC Corporation (Hoopston, IL.) Model 352 Air Carrier sprayer with a 31" diameter high efficiency fan. The sprayer was fitted with a centrifugal pump and was powered via a 540 rpm P.T.O. driveline from the tractor. All applications were made with a gear driven John Deere 2950 tractor operated at P.T.O. rated engine speed in first gear, low range and a travel speed of 1.94 mph. The sprayer was calibrated to deliver the specified

finished volume per acre according to the factory owner's manual and verified by measuring flow rates.

Twig Sampling

Samples were collected from the two centermost Nonpareil rows, from trees 2 and 4 of the center 5 trees in each row. Samples were collected from four locations on each tree: at two heights - Low, about 1 meter (3 feet) above ground, and High, about 2.5 meters (8 feet) above ground; and at two orientations - within the row at the edge of the tree (designated N for north and south sides of the tree), and between rows (designated W for west and east sides of the tree). Samples from each location on the two #2 trees were combined and samples from each location on the #4 trees were combined. Thus each plot had eight twig samples: 1NH, 1NL, 1WH, 1WL, 2NH, 2NL, 2WH, and 2WL. Samples were collected by clipping the twigs directly into glass jars and freezing the samples immediately on dry ice until transport to freezers and subsequent analysis.

Twig samples were returned to UC Davis and remained frozen until analysis. Analysis was completed by extracting the diazinon from the surfaces of the twigs and analyzing for total diazinon per sample with HPLC. Total surface area of each sample was measured with a Licor planimeter and deposits normalized to micrograms of diazinon deposited per square centimeter of twig surface.

PTB Strike Count

PTB twig strikes were counted from the center 5 trees in the two centermost Nonpareil rows in each plot.

Exposure of Pigeons

Domestic pigeons were placed in cages hung in the orchard and exposed to the sprays to mimic exposure of wildlife (such as hawks) to the dormant spray. Birds were kept in the orchard for 1 hour after spraying ended. Pre-exposure blood was sampled one week prior to the tests. Blood and brain were sampled 24 hours after the spray exposure. ChE levels in blood and brain were determined.

RESULTS AND CONCLUSIONS

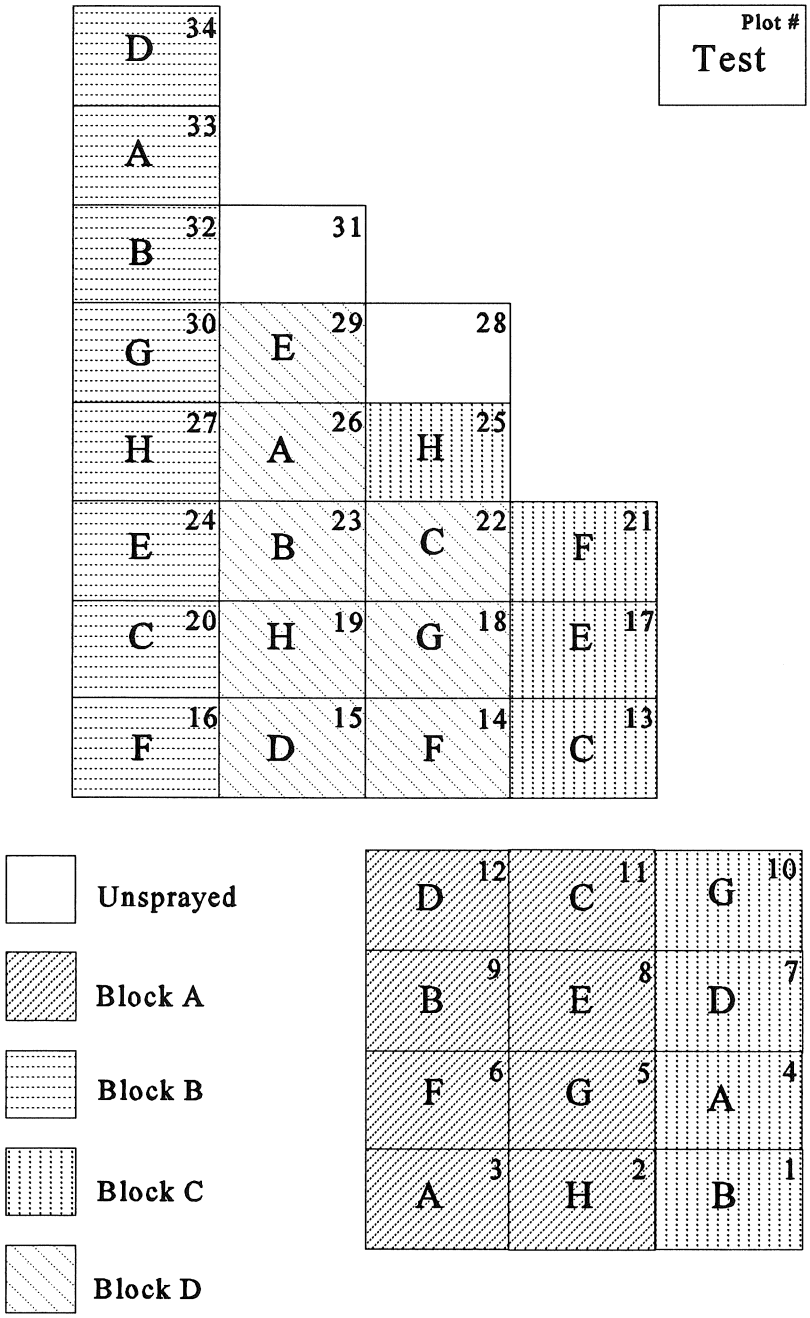
Table 1 summarizes data on tree deposition and PTB strikes after application of diazinon. The amount of diazinon deposited was correlated with its rate of application. The more diazinon applied, the more was deposited on the trees. The volume used in spray application did not affect the deposition: a rate of 1 lb active ingredient (AI) delivered in 50, 100 and 300 gallons per acre gave depositions that were not statistically different (Tests E, G and H). Deposition on the upper part of the trees was determined because it is the most difficult portion to reach with a conventional orchard sprayer, and it is the most frequent location of PTB shoot strikes. The upper deposition was very similar to the overall deposition. PTB strikes were reduced with all diazinon treatment levels compared to controls. The low number of strikes prevented statistical

comparison.

There was a dose response of plasma ChE activity to the rate of diazinon used in the orchard (Table 2). Plasma cholinesterase (ChE) levels were determined since ChEs are targets for organophosphate insecticides like diazinon. Pigeons exposed to the higher application rates (1 and 2 lb AI/acre) had 50% and greater decreases in plasma ChE activity. The birds exposed to the lower rates (0.25 and 0.5 lb AI/acre) had plasma ChE activity that was not statistically different from the controls. There was no statistical difference in brain AChE activities between treatment groups.

This study demonstrated that rates lower than the standard 2 lbs AI/acre of diazinon controlled PTB, at least in orchards with low PTB infestations. The results have led co-investigator and Regional IPM director Dr. Frank G. Zalom to recommend reducing the OP portion of dormant sprays under conditions of low infestation. The rate could be cut from 2 lbs to 1 lb AI/acre. These lower application rates also reduced the risk to our sentinel bird, the pigeon, and should reduce the risk to wildlife such as treaty protected hawks. Using less pesticide should also result in less off-target movement, such as drift onto non-registered crops and possible run-off into river systems.

Figure 1. Test Plot Layout



Test letter designation from Table 1.

Table 1. Control of Peach Twig Borer with Diazinon 50W

Test	Rate	GPA	Deposition	Upper Deposition	Strikes/Tree
A	0	100	0.09 a	0.09 f	1.92
B	0.125	100	0.37 ab	0.4 f	0.78
C	0.25	100	0.38 ab	0.38 f	0.78
D	0.5	100	0.75 bc	0.74 fg	1.05
E	1	100	1.25 cd	1.29 gh	0.28
F	2	100	2.68 e	2.81 i	0.6
G	1	50	1.58 d	1.60 h	0.5
H	1	300	1.76 d	1.70 h	0.4

Rate: pounds active ingredient per acre; GPA: gallons water per acre.
All treatments included dormant oil at 4 gpa, except test G with oil at 3 gpa.
Deposition: on entire tree, values normalized against average deposition of all treatments.
Upper deposition is on the upper part of the tree.
Values with the same letter are not significantly different ($p<0.05$).

Table 2. Cholinesterase Activity of Pigeons Exposed to Diazinon Dormant Sprays

Test	Rate (lb AI/acre)	% Plasma ChE Activity	Brain AChE Activity (nmol/min/mg)
A	0	95.6 $\pm$ 8.4 a	307.9 $\pm$ 14.6 c
C	0.25	95.0 $\pm$ 11.7 a	318.1 $\pm$ 25.9 c
D	0.5	86.8 $\pm$ 26.2 a	307.2 $\pm$ 27.0 c
E	1	50.9 $\pm$ 31.5 b	326.3 $\pm$ 24.8 c
F	2	25.0 $\pm$ 14.6 b	289.2 $\pm$ 15.7 c

ChE Activity values are means $\pm$ standard deviations.
Values with the same letter are not significantly different ($p<0.05$).