#116

California Department of Pesticide Regulation
Environmental Monitoring and Pest Management
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Reducing Diazinon Runoff From Orchards - A Preliminary Field Trial

I. Introduction

During two consecutive dormant spray seasons, diazinon, chlorpyrifos, and methidathion were detected in the San Joaquin River and its tributaries in California's Central Valley (Ross 1992 and 1993). These dormant sprays are used mainly on almonds and stone fruits to control peach twig borer and San Jose scale. The dormant sprays are generally applied in January and February during damp periods between storm events. Once applied, these pesticides are subject to runoff into the San Joaquin River watershed during rain events. The increase in diazinon concentrations seen in the San Joaquin River during storm events was determined to be mainly from surface water runoff as opposed to direct deposition in rainfall (Ross 1993).

Of these three major dormant sprays, diazinon concentrations exceeded the acute LC50 value of 0.49 ug/L (determined for the freshwater macroinvertebrate, *Ceriodaphnia dubia*) most frequently. This organism is used routinely by the Central Valley Regional Water Quality Control Board (CVRWQCB) as an indicator of water quality in a given waterway. About 12% of the samples collected in the winter of 1992 and 1993 exceeded the LC50 for diazinon. The LC50 for chlorpyrifos of 0.11 ug/L was exceeded in 2% of the samples while the LC50 for methidathion of 2.2 ug/L was exceeded in 1% of the samples collected. All LC50 values were determined by Bob Fujimora at the California Department of Fish and Game (Fujimora 1993).

In addition, data from the CVRWQCB and the U.S. Geological Survey indicated that *Ceriodaphnia* mortality occurred on 12 consecutive days in the San Joaquin River near Vernalis (Kuivila 1993). Diazinon was detected in all samples at concentrations ranging from 0.3 to 1.1 ug/L (Kuivila 1993). These exceedances coincided with a major storm event which occurred just after a large portion of dormant spray pesticides had been applied in the San Joaquin valley. These findings indicate that diazinon may pose a chronic as well as an acute water quality problem.

Due to the acute toxicity of diazinon to freshwater macro-invertebrates, its relatively high concentrations in surface water after storm events, and its potential to impart chronic effects, additional work will be conducted to mitigate its movement from orchards into surface water. This protocol describes a preliminary study to examine if an existing agricultural practice might potentially reduce the movement of diazinon into surface water during storm events. Vegetative "filter" strips on the orchard floor are currently used to reduce soil erosion and save costs associated with herbicide application. Research indicates that vegetative strips have proven successful in slowing water movement and decreasing pesticide runoff from agricultural fields (Fawcett et al. 1992). Since this cultural practice is currently used by some growers in the central valley and has shown to be effective in reducing runoff in row crops, a preliminary field trial will be conducted to determine its utility in orchards. This and/or additional management practices will be examined in subsequent years once data from the preliminary field trial are evaluated.

II. Objective

To determine if vegetative strips in the row middles of an orchard will retard the movement of diazinon in runoff water during storm events. This is only a preliminary field trial to determine if this management practice is viable.

III. Personnel

This study will be conducted by personnel from the Environmental Hazards Assessment Program in the Environmental Monitoring and Pest Management Branch of the California Department of Pesticide Regulation. Study personnel include:

Project Leader:	Lisa Ross
Field Coordinator:	Blanca Rodriguez
Statistician:	Rosie Gallavan
Senior Review:	Heinz Biermann
Laboratory Liason:	Nancy Miller
Chemist:	To Be Assigned
Agency & Public Contact:	Pat Dunn

ALL QUESTIONS CONCERNING THIS STUDY SHOULD BE DIRECTED TO PAT DUNN AT: (916) 654-1141.

IV. Study Plan and Sampling Methods

An orchard with vegetative strips in the row middles will be compared with an orchard without these strips to investigate the relative retention of diazinon. Ideally, orchards should be similar in soil type, slope, tree row orientation with respect to slope, tree age, and meteorological conditions in order to minimize site differences due to uncontrolled factors. If possible, each field should have a single drainage point where water discharge can be measured using a type of continuous discharge recording device linked to a datalogger. The type of discharge recording device will depend on the fields selected. The single drainage point will also be the site from which water is collected for diazinon and diazinon oxon analysis.

Application. A single application of diazinon at a typical rate will be applied to the orchards within 24 to 48 hours of one another. Ideally the applications should occur simultaneously or sequentially, but other arrangements will be made based on field size, sprayer availability, grower needs, etc. The total amount of diazinon applied will be estimated from the weight of material in the application tank and tubing prior to and after application. Samples of the tank mix from each orchard will also be collected to verify the nominal application rate.

Meteorological Data. Temperature, wind speed and direction, relative humidity, and rainfall will be collected at each orchard using a Met-One Weather system. Data will be recorded using a Campbell 21X data logger operated with a 12 volt battery.

Deposition. Deposition on trees within the orchard during application will be estimated with absorbent fall-out sheets placed on masts. Ten masts will be randomly located in the tree rows relatively free from tree limb coverage. (If a "smart" sprayer is used, positioning of the masts will be adjusted.) The absorbent fall-out sheets will be rigidly mounted perpendicular to the direction of the dormant spray application to maximize deposition. This information will be used for mass balance accounting of the applied pesticide. Concentrations will be reported in mg/m^2.

Soil Sampling. Eight composite soil samples will be randomly collected from each orchard on days 0 (immediately following application), 2, 5, 8, 12, 16, 21, 26, and 31. These days were selected because soil half lives for diazinon have been reported between 7 and 32 days (Sumner et al. 1987, Rao et al. 1985). Four of the eight composite samples will be collected in the tree rows, the other four in the row middles. In the orchard with vegetation in the row middles, soil from the row middles will be collected from below the vegetation. A single composite sample will consist of eight soil plugs randomly collected using a stainless steel cylinder (4.13 cm, inner diameter) pushed 2.54 cm into the soil. Each composite sample will weigh a minimum of 50 g; this is required for chemical analysis. Samples will be weighed in the field to determine the wet weight of each sample. Soil concentrations will be reported in mg/kg, dry weight. The percent soil moisture will also be reported. Only surface soil will be collected since diazinon leaching is not anticipated (Troiano 1988, Glotfelty 1990).

In addition, four background soil samples will be collected from each field prior to application. Soil bulk density, pH, organic carbon content, and percent sand, silt, and clay will also be measured prior to application.

Vegetation Sampling. Vegetation samples will be collected on the same days as soil samples. Four composite vegetation samples will be randomly collected from the row middles. Each composite sample will consist of eight subsamples of vegetation collected from a unit area. Each composite sample will weigh a minimum of 100 g; this is required for chemical analysis. Samples will be weighed in the field to determine the wet weight of each sample. Each vegetation sample will be analyzed for surface concentration of diazinon and the oxon, as well as internal concentration. Concentrations of diazinon and the oxon will be reported in mg/kg, dry weight, and the percent moisture will also be reported.

Water Sampling. During rain events occurring after application, three liters of water will be collected from each field during each sampling interval. One liter will be analyzed for diazinon and the oxon (whole water concentration). The second liter will be filtered with a 4-um glass-fiber filter and the water analyzed for diazinon and the oxon (dissolved concentration). The amount of sediment filtered from the liter of water will be reported in mg/L, dry weight. The difference between the two concentrations will be indicative of the amount of pesticide carried on the sediment. The third liter will serve as a back-up sample. All water concentrations will be reported in mg/L or ug/L.

Water will be collected during two storm events following application. Water will be collected using an ISCO automated water sampler timed to collect water at specific intervals. The first sample will be collected within one hour after runoff commences. Subsequent samples will be collected hourly until a maximum of 6 samples have been collected. If the rain event ceases to produce runoff for 6-hours, samples will be collected for the duration of the runoff event. Additionally, water collection following a third storm event may be added if diazinon is still detected in runoff water from the second storm.

Total number of samples for chemical analysis (including quality control samples):

Tank mix: 2 replicates x 2 sites	= 4
Deposition: 10 replicates x 2 sites	= 20
Soil: 8 replicates x 2 sites x 9 days	= 144
Background: 4 replicates x 2 sites	= 8
Vegetation: 4 replicates x 1 site x 9 days	= 36
Background: 4 replicates	= 4
Water: 6 hourly samples x 2 sites x 2 runoff events	= 24
Quality Control: (blind spikes, 10% of the total)	= 24
Field Blanks (4 soil, 2 vegetation, 2 deposition, 2 water)	= 10
TOTAL	= 270

V. Data Analysis

Mass balance diazinon deposited on site will be determined from deposition cards and soil concentrations measured the day of application. Runoff mass of diazinon in water will be expressed either as a percent of the total amount applied or the amount deposited on site. The relative mass of diazinon in runoff water will be compared between orchards. If data meet the requirements of a parametric test, a paired t-test will be employed to compare diazinon runoff from the two fields. However, if the runoff data show a decline in concentration during the sampling period, two regression curves, one for each field, will be generated. A statistical comparison of the slope and intercept will then be made. A significant difference between the intercept values with curves of similar slope would indicate significantly different runoff between the fields. If a non-parametric test is determined more appropriate, a Wilcoxon Matched-Pairs Signed-Ranks test will be employed. In addition, soil and vegetation half lives will be calculated in both orchards.

VI. Chemical Analytical Methods and Quality Control

Chemical analysis will be performed by the California Department of Food and Agriculture Laboratory. The method detection limit (mdl) for both diazinon and the oxon in both soil and vegetation is 0.25 ug/sample. The mdl for diazinon and the oxon in water is 0.05 ug/L. The percent moisture in soil and vegetation samples will be reported for each sample. Finally, the total sediment load, as described in the above text, will also be reported.

Soil texture, organic carbon, and pH will be determined in our Fresno facility. Soil texture will be determined using the hydrometer method (Bouyoucos 1962) and soil organic matter by dichromate reduction with silver sulfate (Rauschkolb 1980).

VII. Timetable

Field location	November to December, 1993
Equipment Purchases	December, 1993
Equipment Installation	January, 1994
Sample Collection	January to February, 1994
Chemical Analysis	March to April, 1994
Draft Report	July, 1994
Final Report	September, 1994

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