REDUCING DORMANT SPRAYS: EFFICACY, ENVIRONMENTAL AND ECONOMIC IMPACTS

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ABSTRACT

Organophosphates (OPs) such as diazinon and chlorpyrifos 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 effective in controlling pests such as Peach Twig Borer (PTB) and San Jose Scale. But, these OPs have been shown to expose wildlife (specifically treaty protected Red-tailed Hawks), drift onto unregistered sites (such as specialty vegetables), and appear in the Sacramento and San Joaquin river drainages at levels lethal to Ceriodaphnia, an invertebrate species used as a sentinel by the EPA. Last winter's floods prevented planned field tests to monitor diazinon residues and surface water runoff from orchards with normal and reduced rates of diazinon. Graduate student Hirozumi Watanabe used a micro-ecosystem model to study runoff under the direction of investigator Mark Grismer. The use of vegetative filter strips (VFS) reduced the amount of diaz!inon in runoff from the model orchard floor after simulated rainfall following a spray application.

OBJECTIVE

The goal of this study was to maintain the efficacy of dormant chemical application while reducing its environmental hazards, especially drift, exposure to wildlife, and surface run-off from the orchard. Specific objectives included:

1. Reduced Rate: Establish the efficacy of reducing application rate of diazinon from 2 to 1 lb AI/acre or less in research plots at selected sites in the Central Valley.
2. Residue Levels: Monitor diazinon residues and surface water runoff with normal and reduced application rates in the field.
3. Best Management Practices: Develop IPM recommendations and Best Management practices to minimize OP surface run-off while maintaining insect control and economic benefits.
4. Invertebrate Toxicity: Run toxicity test with, and monitor blood cholinesterase (ChE) levels of sentinel aquatic species, *Ceriodaphnia*, when appropriate.
5. Multiple Stress Models/Collaborations: Integrate studies with research supported by commodity groups, state agencies and with research on multiple stresses and ecosystems sponsored by the UC Davis EPA Center for Ecological Health Research.
6. Outreach: The findings will be reported to California state agencies and federal agencies, grower groups and the industry using the extensive network of the University of California.

PROCEDURE

1. Reduced Rate: flooding prevented field studies of reduced dormant applications of diazinon.
2. Residue Levels: levels of diazinon in surface runoff were studied in a micro-ecosystem model of an orchard floor.
   Micro-ecosystem model: A microecosystem was used to study the movement of pesticide in an orchard floor due to rainfall. The system consists of a model orchard floor, a pesticide sprayer and rainfall simulator, with sample collecting devices for surface runoff flow, rootzone interflow, and subsurface infiltration (Figure 1).
   The floor box (1.0 m x 2.0 m x 0.25 m) is divided into 3 sections along the length, at a 3% incline. A sprayer is located 18 cm above the soil surface, with 1 nozzle positioned over each soil section. Diazinon was applied at a rate of 2.5 lb a.i./acre in a volume of 100 gal/acre. The sprayer moved at a rate of 0.5 mph. The rainfall simulator is located 1.0 m above the soil surface. Rain was pumped for 1 hour at a rate of 2 in/hr.
   The model floor consists of 3 cm of sand covered with 9 cm of silt loam soil packed into the box. The effects of vegetative filter strips (VFS) were studied using commercial fescue sod (Figure 2). The sod had a 3 cm root zone and was placed over the soil. Comparisons were made using 0, 50 and 100% coverage of the floor by VFS. The orchard floor models were saturated and dried for two weeks to obtain structural stability in the soil and at the soil root interface. The soil was characterized prior to the experiments. Soil and water samples were taken and stored for later analysis.
   Pesticide Analysis: Diazinon was extracted from water samples using solid phase extraction C-18 columns and from soil samples with hexane and iso-propanol. Diazinon was measured using a gas chromatograph with a nitrogen-phosphorus detector.
3. Best Management Practices: the micro-ecosystem results along with our field studies will be used in the development of IPM recommendations and Best Management practices.
4. Invertebrate Toxicity: toxicity tests were not done due to lack of field test samples.
5. Multiple Stress Models/Collaborations: the micro-ecosystem model data is being use in the construction of a computer model to study the movement of pesticides in the orchard.
6. Outreach: our results are presented to grower groups (Prune, Almond and Peach Boards) and to farm advisors at workgroup meetings. We have also discussed our work with representatives of state agencies (Departments of Pesticide Regulation, and Water Resources).

RESULTS AND CONCLUSIONS

The amount of water that flowed out of the model as surface runoff was reduced 60% and 83%, with 50% and 100% VFS coverage respectively, compared to 0% coverage. There was no significant difference in the diazinon concentration in the surface runoff between the tests. In the test without any VFS coverage, all of the diazinon was lost in the surface runoff (Figure 3). With VFS coverage, there was also movement of diazinon in rootzone interflow and in infiltration outflow into the sand layer. The total diazinon losses from the model floor with 50% and 100% VFS coverage was reduced 33% and 73%, respectively, compared to bare soil (0% VFS coverage). Vegetative filter strips have the potential to reduce diazinon runoff from orchards where dormant season sprays are used. VFS placed between rows or near drainage areas may play a role in the Best Management practices for dormant season sprays.

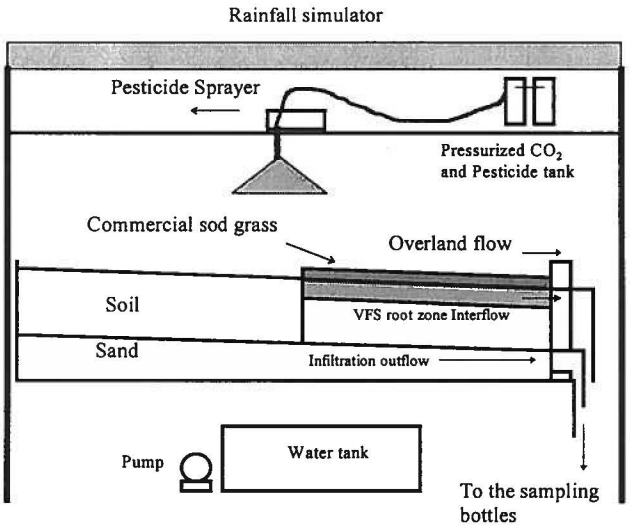

Figure 1. Micro-Ecosystem Model

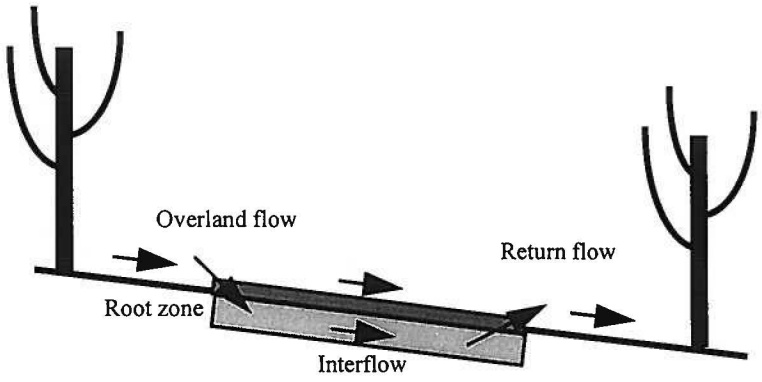

Figure 2. Flow Through Inter-row Vegetative Filter Strips

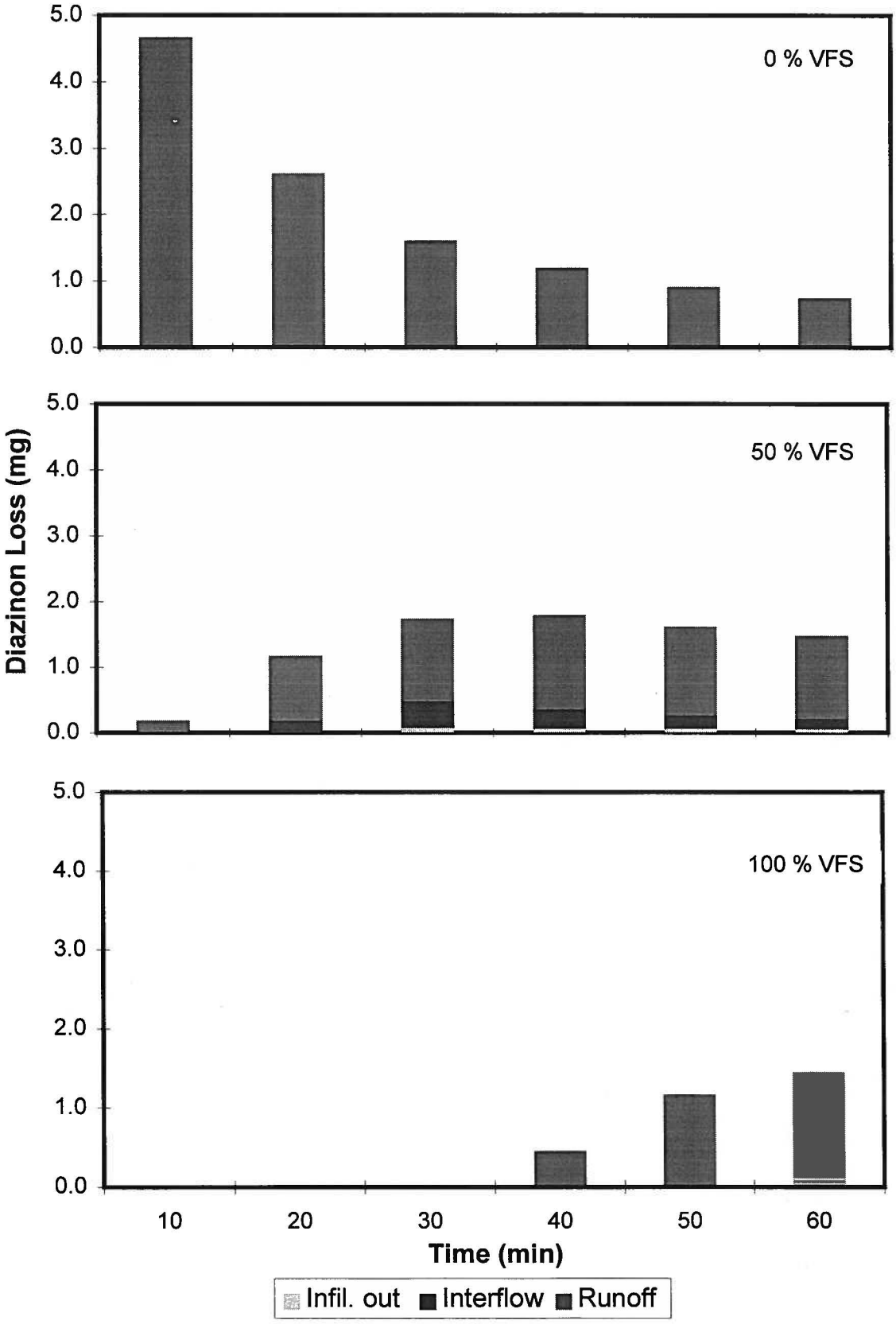

Figure 3. Diazinon Losses After Rainfall Simulation