REDUCING IMPACT OF DORMANT SPRAYS

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ABSTRACT

Previous work from this project provided evidence that the pest control efficacy of diazinon could be maintained with reduced application rates, reducing dangers to wildlife. A table-top model of filter strips was devised to model reduced runoff of diazinon. We continue such studies to see the extent to which reduced rates and selected orchard management practices reduce runoff of pesticides. The Almond Board studies are carried out in conjunction with a CALFED project; its objective is to monitor the surface runoff of pesticides from orchards in Glenn and Merced counties, and examining the toxicity of the runoff. Simulated rainfall was used on sprayed field plots in modeling experiments to determine the hydrologic response to rain events, by Wallender and his student Till Angerman, and to use this methodology to compare the ability of different cover crops to diminish runoff. Following rainstorm events, Hinton and his team collected runoff water in the orchards and found it was toxic to Ceriodaphnia (a water flea recognized by the EPA as an aquatic toxicity test organism). Other studies showed that runoff of diazinon was reduced from an orchard floor with vegetation compared to runoff from a floor of bare soil.

OBJECTIVE

The long-term plan of this project is to compare the efficacy, runoff and toxic impact of chemicals from FQPA risk group categories: the organophosphate diazinon (Group 1) and the pyrethroid esfenvalerate (Group 2). These were chosen as representative chemicals for two of the "Risk Cups". Both are neurotoxins, but with differing toxicities and major mechanisms of action. The objective of the toxicity projects are (as with our previous red-tail hawk studies) to attain levels of chemicals that are not toxic to mammals and birds or, hopefully, to test water organisms.

PROCEDURE

Orchards in Merced and Glenn Counties were selected for studies of pesticide runoff. Diazinon and esfenvalerate were applied as dormant sprays with a fan sprayer, following normal practices. The Merced Co. orchard was used to study pest control efficacy as well as runoff. Treatments were applied to 3 replicate plots in a randomized block design (see Table 1 for details of treatments). The Glenn Co. orchard was used to study the effects of cover crops in the row middles on pesticide runoff. Diazinon and esfenvalerate were applied in one plot each in the orchard, with different cover crops (non-tillage clover, perennial sod mix, resident vegetation and bare ground) in replicate rows. Surface water runoff samples were collected in glass jars and

kept cold (ice chest/refrigeration) until the toxicity tests were carried out and then frozen for later chemical analysis.
Modeling experiments were carried out on the UCD campus and in the Glenn Co. orchard. Diazinon was sprayed using a conventional fan sprayer. A rain simulator was used on the test plots and runoff samples were collected over time to obtain discharge hydrographs and capture total runoff. This field data is being used to calibrate a computer model. The goal is to develop an inexpensive methodology to determine the orchard specific hydrologic response to rain events, to use this methodology to compare the ability of different cover crops to diminish runoff and to reveal the orchard (and cover crop) specific potential to yield pesticide residue to the downstream environment.

Pest control efficacy is being carried out by Dr. Zalom's group using methods such as Peach Twig Borer strike counts and use of pheromone traps for San Jose Scale.

Aquatic toxicity tests are carried out by Dr. Hinton's group. The water samples are serially diluted and Ceriodaphnia are added. The animals are observed 24 hours for mortality. The lowest dilution which results in mortality statistically different from controls is the Lowest Observable Effect Concentration (LOEC). It is reported as % dilution; the lower the number, the more toxic the sample.

Chemical analysis is carried out by Dr. Wilson's group. The water samples are thawed and pushed through a 0.45 um filter to remove particulates. Pesticides are extracted by liquid-liquid extraction with ethyl acetate, and analyzed by gas chromatography.

RESULTS AND CONCLUSION

Runoff levels from 2 rain events at the Merced Co. orchard are presented in Table 1. Diazinon was found in all samples, though usually higher in the diazinon treated plots. Esfenvalerate was seen in the plots where it was sprayed, otherwise it was not detected (there is one anomalous result from plot 6 that is being rechecked). The amount of pesticides in the runoff is reduced in the second rain storm. It is not surprising that most of the pesticide washes off with the first rain, and less is found after subsequent rain events.

The pest control data is being collected this spring.

Figure 1 shows the correlation between the aquatic toxicity tests and the measured pesticide concentrations in the runoff from the Merced Co. orchard. The high toxicity of the samples is expected since the water is collected in the sprayed plots, representing the worst case before any dilution of runoff can occur.

Figure 2 shows the runoff profiles from 2 rows in the diazinon treated plot at the Glenn Co. orchard. The runoff from the row with resident vegetation has a lower diazinon concentration than the row with bare soil. Also, the water doesn't begin running off of the vegetation until several hours after the runoff from bare ground. This is similar to the work we reported in past years (carried out by H. Watanabe) done on a table top model. The presence of vegetation delayed and reduced the amount of water that ran off after a simulated rainfall. The same effect was observed in the field experiment.

The results from the modeling experiments are preliminary (Figure 3). In the rain simulation, the maximum discharge rate can be estimated accurately which is important for modeling prolonged (natural) rain storms. The shape of the hydrographs together with the temporal distribution of the concentration graphs are important field data, which gives insight into the temporal character of pesticide residue mass to downstream the environment. Once the flow can be accurately simulated, off-site transport of pesticide residue will be similarly estimated. Can we determine an orchard's residue contribution to open water bodies by knowing the endpoint of it's cumulative mass function? Diazinon concentration rate graphs appear well behaved and seem to be predictable.

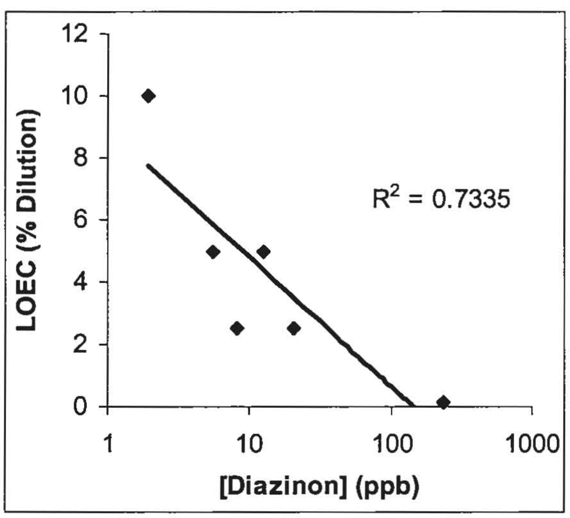
This work is ongoing (it is the second in a three year study supported by CALFED). We are fortunate to be able to pull together the number of disciplines represented and put them at the dual service of obtaining new knowledge and providing grower groups with information , helping them improve their Best Management Practices. We value grower participation as an important part of a triad of government, university and industry working to meet the needs of an ever changing agricultural landscape.

Table 1. Pesticide Concentrations in Surface Runoff in a Merced Co. Orchard

Treatment	Sample Plots	2/2/99 Rain Event		2/8-2/9/99 Rain Event	
		[Diazinon]	[Esfenvalerate]	[Diazinon]	[Esfenvalerate]
Untreated	3	14.0	nd	1.5	nd
	6	12.3	10.5	2.4	nd
	12	43.3	nd	4.3	nd
Diazinon	1	233.1	nd	30.4	nd
	5	82.4	nd	43.2	nd
	10	177.1	nd	62.3	nd
Esfenvalerate	4	17.0	1.7	2.7	0.46
	7	236.0	5.1	2.0	0.55
	9	8.2	nd	2.5	0.17
Spinosyn	2	6.6	nd	1.3	nd
	8	27.2	nd	0.96	nd
	11	20.4	nd	5.2	nd

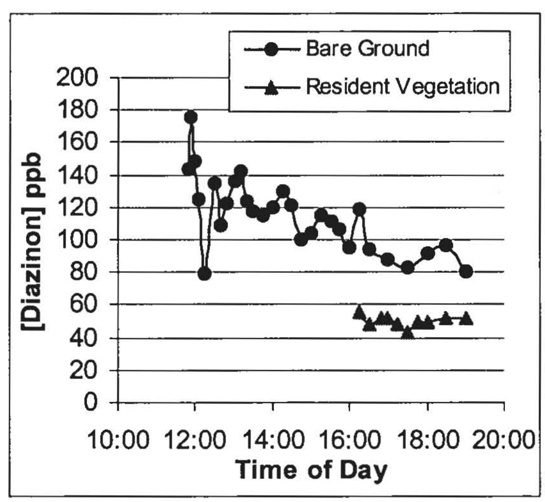
Untreated plots were not sprayed.
Treatments (included supreme oil @ 5 GPA and 8 lbs/ac Kocide 101): Diazinon - 4EC @ 2 qt/ac; Success® (Spinosyn) - 2SC @ 6 oz/ac; Asana® (Esfenvalerate) - XL @ 10 oz/ac.
[ ] of diazinon and esfenvalerate in runoff is in ppb.

Figure 1. Toxicity of Runoff Water to Ceriodaphnia, Merced Co. Orchard



LOEC is the lowest % dilution of the sample water that caused mortality in the Ceriodaphnia. The lower the number, the more toxic the sample.

Figure 2. Effect of Ground Cover on Diazinon Runoff from a Glenn Co. Orchard



Runoff samples were collected during a 3/24/99 rain event.

Figure 3. Empirical Hydrographs and Pesticide Concentration