REDUCING IMPACT OF DORMANT SPRAYS

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SUMMARY

This past year's field study focused on evaluating the efficacy of different widths of vegetated buffer strips in reducing the concentration of diazinon in surface runoff from dormant-sprayed orchards; and determining if a relatively small amount of sprinkler irrigation following pesticide application helps reduce the diazinon concentration in surface runoff. A lack of rainfall in the previous year of the study orchard resulted in no runoff being generated. This led to a better appreciation of how the uncertainties of natural rainfall can put field studies such as this one at risk. As a result, this year a sprinkler irrigation system was utilized to simulate rainfall.

OBJECTIVE

The research focuses on assessing efficacy and impacts of alternatives to dormant season uses of diazinon and practices that can mitigate runoff. Mitigation measures are tested by measuring diazinon levels in experimentally controlled runoff water samples.

PROCEDURE

The study took place in a mature prune orchard northeast of Gridley. Trees are planted on berms approximately 20 feet apart. A permanent cover was established at the site. Three replicates of each treatment were randomly assigned within complete blocks of the orchard. All plots contained relatively equal resident vegetative cover (classified by species composition and relative density).

Diazinon was applied to the plots at a common rate and dilution: 15.1 L active ingredient plus 363.4 L of water per acre (Diazinon AG500 Insecticide, Loveland Products Inc., Loveland, CO). The simulated dormant spray was applied with a CO_2-charged backpack sprayer directly to the orchard floor between two berms within each plot. It was not applied with a conventional air-blast sprayer to 1) reduce the variability of volume and total active ingredient applied in the plots, 2) reduce the potential for drift from one plot to the next, and 3) ensure that equal areas of ground are treated in all plots. The simulated spray can be viewed as a worst case scenario where all of the pesticide applied was deposited under the trees on the ground. For each treatment, diazinon was sprayed on the orchard floor between two berms with diazinon during the dormant season. Subsequent rainfall runoff in each plot was to drain into an autosampling unit.

Treatments

1. Control: 50-meter long section of orchard floor was sprayed; autosampler at edge of treated area.

2. 10-Meter Buffer Strip: treatment identical to control; runoff flowed across a 10-meter length of unsprayed vegetated orchard floor before reaching autosampler.
3. 20-Meter Buffer Strip: similar to treatment 3, but with a longer buffer strip.
4. 30-Meter Buffer Strip: similar to treatment 3, but with a longer buffer strip.
5. 100-Meter Section Plus a 20-Meter Buffer Strip: 100-meter long section of orchard floor was sprayed with diazinon; runoff flowed across a 20-meter length of unsprayed vegetated orchard floor before reaching autosampler.
6. Sprinkler Irrigation: treatment identical to control (no buffer); diazinon application followed by 0.42 inch of sprinkler irrigation without causing runoff.

The composite water samples collected from the autosamplers were transported on ice to UC Davis and frozen for later analysis. Diazinon concentrations were determined by liquid-liquid extraction with ethyl acetate followed by GC analysis with a nitrogen-phosphorus detector.

Diazinon concentrations were normalized within each of the three replicates (for the six treatments) to the proportion of the diazinon concentration (ppm) in the control (which was set to 1.00). Data were analyzed by one way ANOVA following arcsine transformation for the proportional data, and by the Tukey-Kramer multiple range test.

RESULTS AND CONCLUSION

The effect of buffer strips on the concentration of diazinon in runoff is shown in Table 1. Vegetated buffer strips reduced the diazinon concentration in surface runoff; all were significantly different than the control. There is no significant difference in diazinon concentration between 10 m, 20 m and 30 m buffer strip plots. No significant difference was observed between the 50 m and 100 m plots. This suggests growers could devote a relatively small area of vegetated buffer and still have an impact on diazinon runoff.

Table 1. Effect of Buffer Strips on the Diazinon Levels in Surface Runoff

Treatment	[Diazinon] ppb [1]	Normalized to Control [2, 3]	
1. Control - No buffer	332.1 ± 99.6	1.00 ± 0.00	a
2. 50 m + 10 m buffer	178.1 ± 101.3	0.47 ± 0.14	b
3. 50 m + 20 m buffer	229.5 ± 129.9	0.56 ± 0.23	b
4. 50 m + 30 m buffer	67.93 ± 13.8	0.27 ± 0.12	b
5. 100 m + 20 m buffer	143.6 ± 99.1	0.37 ± 0.17	b

Values are mean ± SE. Levels are measured in the first 2271 gallons of runoff.
[1]ANOVA results; F=1.03; df=4,10; p=0.436
[2]ANOVA results following arcsin transformation; F=8.11; df=4,10; p=0.0035;
[3]Means followed by different letters differ significantly at $p<0.05$ by Tukey-Kramer multiple range test.

Treatment 6 received a light sprinkler irrigation (0.42 inch of rain equivalent) without creating runoff. Later that same night, one inch of natural rainfall fell on the study site. The following day, simulated rainfall occurred (an average 1.75 inches of rain equivalent across all plots), and runoff from the test sections drained into the autosampler unit of each plot. Post application sprinkler irrigation reduced diazinon concentration in orchard runoff by 45% (Table 2). This difference was not statistically significant, possibly because of the interference of the natural rain with the experimental design. This result is in line with our previous work with microplots, which suggests post dormant spray application sprinkler irrigation could reduce diazinon concentration in orchard runoff (Joyce *et al*., 2004). Validation of this approach seems warranted given the promising results obtained in spite of the unforeseen problem.

Table 2. Effect of Post-Spray Irrigation on the Diazinon Levels in Surface Runoff

Treatment	[Diazinon] ppb [1]	Normalized to Control [2]
1. No buffer	332.1 ± 99.6	1.00 ± 0.00
6. Sprinkle Irrigated	250.5 ± 171.2	0.59 ± 0.27

Values are mean ± SE. Levels are measured in the first 2271 gallons of runoff.
[1]ANOVA results; F=0.170; df=1,4; p=0.702
[2]ANOVA results following arcsine transformation; F=3.98; df=1,4; p=0.12

One of the most promising aspects of this study was the use for the first time of simulated rainfall on our large-scale field plots. This gives us more control over the timing of rainfall events relative to pesticide application, soil moisture and other variables than is possible with unpredictable natural rainfall.

REFERENCE

Joyce, B. A., Wallender, W. W., Angermann, T, Wilson, B. W., Werner, I., Oliver, M. N., Zalom, F. G. and Henderson, J. D. 2004. Using infiltration enhancement and soil water management to reduce diazinon in runoff. J. Amer. Water. Res. Assoc. pp 1063-1070.