REDUCING IMPACT OF DORMANT SPRAYS

Report to the Almond Board of California
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SUMMARY

This past winter was the third year of a study of BMP efficacy research, conducted in Butte County. Treatments generally were similar to those in Year 2, but a number of changes were made. A different study site was selected with orchard soil that had a higher clay content and was therefore judged to offer a greater runoff potential, and the length of the study plots and corresponding buffer strips were scaled down to half the size of those used in Year 2.

In year 2 we showed that vegetated buffer strips measurably reduced diazinon concentration in orchard runoff. However, this year we took account of both total volume and concentration of diazinon in runoff from the treated areas, not just the initial runoff. This more complete accounting suggested that buffer zones of a given width are likely to become saturated, overwhelmed in their ability to reduce runoff of diazinon as the size of the treated area increases. Therefore, it may not be practical to use buffer zones of sufficient width to significantly mitigate diazinon in runoff from large orchards.

Sprinkler irrigation soon after diazinon is sprayed will likely result in reductions in diazinon concentration in the runoff from subsequent runoff-producing storm events especially if the pre-existing soil moisture is not high at the time diazinon is applied and if the soil is a lighter leaching type. It is not likely that the efficacy of this BMP would be influenced by the size of the treated area.

OBJECTIVES

The objectives of the studies were to:

1. Evaluate the efficacy of different widths of buffering vegetation strips in reducing the concentration of diazinon in surface runoff from orchards dormant sprayed with diazinon.
2. Determine efficacy of post-spray sprinkler irrigation in reducing the concentration of diazinon in surface runoff from orchards dormant sprayed with diazinon.
3. Determine if a relationship exists between the area of orchard being drained across a vegetated buffer strip and the resulting reduction in diazinon.

PROCEDURE

The study took place in a mature dormant prune orchard where trees were planted on berms approximately 18 feet apart (Figure 3). A permanent orchard floor cover of native vegetation exists at the site. The study design incorporated five treatments (a control and four treatments) each replicated four times. Replicates were randomly assigned within four blocks of the orchard.

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. 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. The rainfall/runoff event for this study was simulated by using a sprinkler irrigation system. Runoff from each plot drained into an autosampling unit.

Treatments

1. Control: 25-meter long section of orchard floor between 2 berms was sprayed with diazinon (12/14/04). Two days later (12/16/04), simulated rainfall was applied (approx. 0.8 inches of rain equivalent), resulting in runoff.
2. Sprinkler Irrigation: 25-meter long section of orchard floor between 2 berms was sprayed with diazinon (12/14/04). The next day (12/15/04), the area received a light sprinkler irrigation (approx. 0.135 inch of rain equivalent) without causing runoff. On 12/16/04, simulated rainfall was applied (approx. 0.8 inches of rain equivalent), resulting in runoff.
3. 5-Meter Buffer Strip: diazinon treatment and simulated rainfall were identical to control. Runoff flowed across a 5-meter length of unsprayed vegetated orchard floor before reaching autosampler.
4. 10-Meter Buffer Strip: similar to treatment 3, but with a longer buffer strip.
5. 50-Meter Section Plus a 10-Meter Buffer Strip: diazinon treatment and simulated rainfall were identical to control, except sprayed area is increased to 50 meters. Runoff flowed across a 10-meter length of unsprayed vegetated orchard floor before reaching autosampler.

Runoff volume measurements were taken and recorded at each sampler unit each time a sample was collected from the composite holding tank. Immediately following the collection of a sample, the composite tank was emptied and allowed to begin filling once more. Samples were collected at approximately 300, 600, 1,000, and 1,500 gallons of runoff and/or until all runoff from each plot had ceased in order to account for the total volume and concentration of diazinon in the runoff. Source water for the sprinkler irrigation system was also collected.

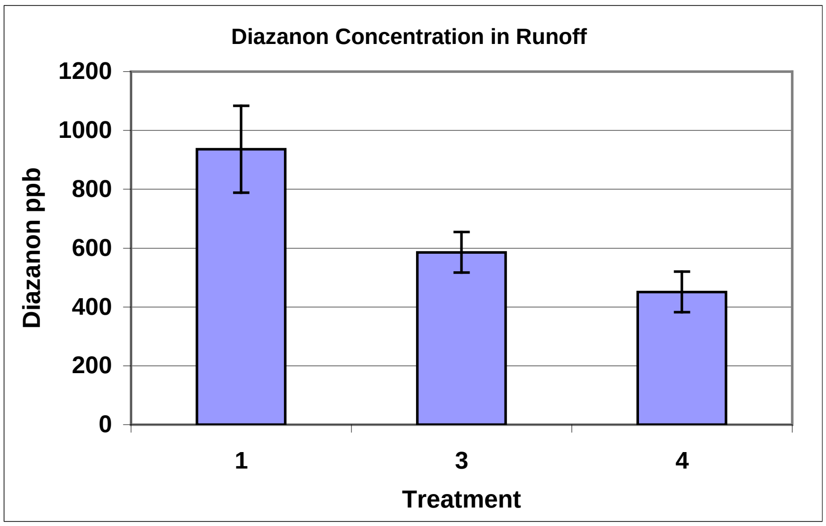
The water samples were transported on ice to UC Davis and frozen for later analysis. Diazinon concentrations were determined by liquid-liquid extraction with ethyl acetate followed by GC analysis with a nitrogen-phosphorus detector.

Data were analyzed by one way ANOV to check for significant treatment differences.

RESULTS AND CONCLUSION

There were no significant differences between mean total runoff volumes for any of the 5 treatments. Figure 1 shows the differences in mean diazinon concentration (ppb) for 25-meter treated areas with 0, 5, and 10-meter buffer zones (treatments 1, 3, & 4). With a 10-meter buffer zone (40% of the width of the treated area) there was a significant difference from the control (no buffer). The difference was not significant with a 5-meter buffer zone (20% of the width of the treated zone).

Figure 1. Average diazinon concentration of runoff from 25-meter treated areas with 0, 5, and 10-meter buffer zones.



Treatments 1 and 4 are significantly different.

Table 1 shows the differences in mean diazinon concentration (ppb) for 25-meter treated areas with 5-meter buffer zones versus 50-meter treated areas with 10-meter buffer zones (treatments 3 & 5). Because there is no significant difference between these treatments, it appears that there is a proportional relationship for size of treated area and size of buffer zone relative to mitigating diazinon in runoff.

Table 1. Concentration of diazinon (ppb) in runoff from 25-meter treated areas with 5-meter buffer zones versus 50-meter treated areas with 10-meter buffer zones.

Treatment	N	Mean	Std Err Mean
3 25+5	4	585.545	68.998
5 50+10	4	643.697	50.867

ANOV results; F=0.4602; df=1, 6; p=0.5228

Table 2 shows the differences in mean diazinon concentration (ppb) for 25-meter treated areas with 10-meter buffer zones versus 50-meter treated areas with 10-meter buffer zones (treatments 4 & 5). Maintaining the same buffer zone while doubling the size of the treated area resulted in a 43% increase in diazinon concentration. This result did not quite reach the level of significance.

Table 2. Concentration of diazinon (ppb) in runoff from 25-meter treated areas with 10-meter buffer zones versus 50-meter treated areas with 10-meter buffer zones.

Treatment	N	Mean	Std Err Mean
4 25+10	3	451.212	68.673
5 50+10	4	643.697	50.867

ANOV results; F=5.3513; df=1, 5; p=0.0686

Table 3 shows the differences in mean diazinon concentration (ppb) for 25-meter treated areas with and without post-spray sprinkler irrigation (treatments 1 & 2). Sprinkler irrigation reduced the diazinon concentration in runoff by 34%, but was not statistically significant.

Table 3. Concentration of diazinon (ppb) in runoff from 25-meter treated areas with and without post-spray sprinkler irrigation. No buffer zones.

Treatment	N	Mean	Std Err Mean
1 25+0	4	935.934	147.81
2 25+0+sprinkled	3	616.388	274.88

ANOV results; F=1.2232; df=1, 5; p=0.3191

In Year 3, sampling accounted for the total volume of runoff and associated diazinon concentration rather than looking only at the initial runoff as was done in Year 2. As in Year 2, this year's data suggests that buffer strips can be effective in reducing diazinon concentrations in runoff. There was a 38% reduction with 5-meter buffer zones and a 52% reduction with 10-meter buffer zones when the treated areas were 25 meters in length. However, of potentially greater importance, Year 3 data show that in order to maintain the same degree of mitigation capability, buffer zones might need to become larger as the size of the treated area becomes larger. Looking at treatment 3 versus treatment 5, no significant difference was seen in diazinon concentrations when both treated areas and buffer zones were doubled in size, but when size of treated area was doubled while maintaining the same size buffer zone (treatment 4 versus treatment 5), there is a 43% increase in the diazinon concentration of the runoff from the larger treated area, and this value approached significance. Collectively, these data suggest that a proportional relationship may exist such that buffer zones would have to become increasingly larger as treated areas become larger. If this proportional relationship is real, then it may be impractical to implement buffer zones sufficiently wide enough to mitigate the runoff from orchards that are typically many hundreds of meters in length and width.

In contrast, post-spray sprinkler irrigation reduced the diazinon concentration by 32%. Although this reduction did not achieve statistical significance, it is nonetheless reasonable to assume that the same result may have been achieved regardless of the size of the treated area. This potential BMP reduces the amount of diazinon available to be picked up by runoff by promoting infiltration of diazinon into the soil where it can be broken down by microbial activity. The size of the treated area is not a variable in this case. Furthermore, because the pre-existing soil moisture was relatively high at the time sprinkler irrigation took place in the Year 3 study, infiltration may not have been as high as may have occurred if the pre-existing soil saturation had been lower.