Over-tree Irrigation in Pear Orchards Influences Persistence of Foliar Residues of Four Pesticides

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Additional index words. *Pyrus communis*, dodine, fenarimol, amitraz, formetanate

Abstract. Residues of two fungicides (dodine and fenarimol) and two insecticide/acaricides (amitraz and formetanate) on pear (*Pyrus communis* L.) leaves were reduced by over-tree sprinkler irrigation applied 24 or 72 hours after pesticide treatment. The difference in residue persistence following over-tree irrigation applied at 24 vs. 72 hours after pesticide treatment was significant only for fenarimol. Residues on leaves from nonirrigated trees at 96 hours post-treatment had declined 24% to 57% from initial levels. Over-tree irrigation further reduced residues by 14% to 47%. For all compounds except dodine, foliar residues measured at 96 hours post-treatment were reduced from initial levels to a greater extent by factors other than over-tree irrigation. Chemical names used: dodecylguanidine monoacetate (dodine); α -(2-chlorophenyl)- α -(4-chlorophenyl)-5-pyrimidinemethanol (fenarimol); *N*'-(2,4-dimethylphenyl)-*N*-[[2,4-dimethylphenyl]imino]methyl]-*N*-methylmethanimidamide (amitraz); *N,N*-dimethyl-*N*'-[3[[[methylamino]carbonyl]oxy]phenyl]methanimidamide (formetanate).

Over-tree irrigation has become an integral management component in many pear orchards in the Pacific Northwest of the United States. In addition to providing summer irrigation for trees, over-tree systems may be used for frost protection, summer cooling, pesticide and fertilizer delivery, and reducing pest density and damage (Lombard et al., 1966; Westigard et al., 1979). However, over-tree irrigation may provide conditions for increased incidence of pear scab (Sugar and Lombard, 1981) and may advance fruit maturity in some cultivars (Lombard et al., 1966).

Irrigation follows summer pesticide applications in many orchards in southern Oregon, because moving spray application equipment through orchards with wet soil is difficult and may be disruptive to soil structure. Westigard et al. (1974) reported that over-tree sprinkler irrigation reduced residues of several pesticides on pear leaves by 30% to 90%. In that study, trees were irrigated immediately after pesticide residues dried, and samples for residue analysis were collected 24 h after pesticide application.

The present study measured the persistence of two fungicides (dodine and fenarimol) and two insecticide/acaricides (amitraz and formetanate) following over-tree irrigation. Only formetanate had been included in the previous study of residue persistence on pear (Westigard et al., 1974). Irrigation water was applied at two post-treatment timings.

Each pesticide was applied until runoff by handgun sprayer to 24 'Bartlett' pear trees as single-tree replicates selected randomly within a block of 25-year-old trees planted in a 3.7 × 7.3-m spacing. Products and rates applied were as follows: Rubigan 1EC (fenarimol), 0.23 ml-liter⁻¹; Dodine 65WP (dodine), 0.9 g-liter⁻¹; Mitac 50WP (amitraz), 0.9 g-liter⁻¹; and Carzol 92SP (formetanate), 0.37 g-liter⁻¹. Eight trees treated with each pesticide were not irrigated during the study's course, eight trees were irrigated by over-tree sprinklers 24 h after pesticide application, and eight trees were irrigated 72 h after pesticide application. Immediately before irrigating at 24 h after pesticide application, 50 leaves were collected at random from each of eight trees treated with each pesticide for analysis of the initial deposit. Sprinklers delivered 3.8 mm water/h for 18 h. No measurable natural precipitation occurred during the study. Ninety-six hours after pesticide application, 50 leaves were collected at random from each replicate tree in all treatments. Leaves were frozen and transported to cooperating laboratories for residue analysis. Analyses of amitraz, formetanate, and fenarimol residues were performed by the Dept. of Agricultural Chemistry, Oregon State Univ., Corvallis, using the methods of Hornish et al. (1984), Jenny and Kassmart (1976), and

Hartley and Kidd (1987), respectively. Dodine residue analysis was performed by Cascade Analytical, Wenatchee, Wash., using the method of Newsome (1976).

Leaf residue levels were reduced by irrigation and by other factors, possibly including photodecomposition, microbial activity, or other environmental factors (Liechtenstein, 1972). Residues on leaves from nonirrigated trees declined by 24% to 57% at 96 h post-treatment (Table 1). Post-treatment over-tree irrigation reduced residues by 14% to 47% of the levels on leaves from nonirrigated trees at 96 h. For all compounds except amitraz, factors other than over-tree irrigation reduced residue levels more than did irrigation. However, residues of all compounds except dodine were reduced significantly ($P \leq 0.05$) by over-tree irrigation when compared with residues from nonirrigated trees. Over-tree irrigation at 72 h post-treatment reduced leaf residues to the same extent as irrigation at 24 h, except with fenarimol, which had lower residues with irrigation at 72 h than at 24 h.

The proportional loss of residues due to factors other than irrigation was greater for dodine (57%) than for the other compounds studied, while dodine residue loss due to over-tree irrigation was the least (29% and 14% for irrigation at 24 and 72 h, respectively). Despite fenarimol's ability to move apoplastically through the leaf (Lilly Research Laboratories, 1984), the loss of fenarimol residues in pear leaves in this study was similar to that of the other pesticides, to which such movement has not been ascribed. In the previous study by Westigard et al. (1974), 92% of the formetanate residue was lost by over-tree sprinkling immediately after residues had dried. This is more than the residue amount lost after 24 h in the present study (66%). This difference suggests that residues may be more susceptible to removal by over-tree irrigation immediately following residue drying than 24 to 72 h later.

These results indicate that over-tree irrigation of pear trees within 72 h of applying the four pesticides studied reduces leaf residues and may affect pest control. Where retaining foliar pesticide residues is preferred to the potential benefits of over-tree sprinkler irrigation, alternative irrigation methods should be chosen. In addition, environmental fate studies of pesticides in orchards with over-tree sprinklers should include pesticide movement with irrigation water away from target plants. As shown in this study, however, residues lost within 96 h of pesticide application due to factors other than irrigation were often greater than losses attributable to over-tree irrigation.

Table 1. Pear leaves sampled for pesticide residues before and after over-tree sprinkler irrigation.

Treatment	Mean leaf residue (ppm) ^a			
	Amitraz	Formetanate	Dodine	Fenarimol
Initial deposit ^b	184 a	86 a	210 a	11 a
No irrigation ^c	140 b	44 b	90 b	6.9 b
Irrigation at 24 h ^a	96 c	29 c	64 b	4.7 c
Irrigation at 72 h ^a	90 c	30 c	77 b	3.6 d

^aMean separation in columns by Fisher's protected LSD ($P \leq 0.05$).

^bInitial deposit samples collected 24 h after pesticide application.

^cSamples collected 96 h after pesticide application.

Received for publication 8 Apr. 1992. Accepted for publication 26 May 1993. Oregon Agricultural Experiment Station technical paper 10094. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

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