Pesticide Deposition on Citrus Orchard Soil Resulting from Spray Drift and Runoff

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A substantial loss of pesticide spray mixture is evident during application to citrus trees. Some losses occur as a result of the spray passing between and through target trees. Additional losses occur as the result of runoff and drip from the target trees. The total amount of spray not retained on the tree has been variously estimated to range from 25-40% of the spray gallonage used, depending upon orchard conditions and operational parameters. The waxy composition of the citrus leaf surface is not conducive to the retention of large quantities of aqueous spray mixture. In principle, the amount of runoff could be limited by maintaining the gallons of spray/tree low. The amount applied, however, is dictated by the requirements of the pest-control situation (CARMAN 1975). Gallonage can be minimized if pests reside on the exterior foliage (lepidopteran larvae, aphids, katydids) or the pest is active (mites, thrips) and would be likely to contact treated foliage even if not directly exposed to the spray. If the pest is sessile or may frequently reside in the interior of the tree (scales), increased gallonage is required to penetrate the exterior barrier of foliage to wet the foliage, fruit, twigs, and branches inside the tree. Runoff losses of pesticides are then countenanced in order to achieve a thorough wetting of the tree. The most frequently encountered gallonages used for scale control in mature California citrus groves range from 1500 to 3500 gal of spray/A.

Aside from the economic disadvantage associated with the non-useful deposition of pesticides, the pesticide reaching the soil surface has been suggested (GUNTHER *et al*. 1975, SPENCER *et al*. 1975) as a source of toxicants to workers entering organophosphorus pesticide-treated fields. Tests were therefore conducted to characterize with reasonable accuracy the magnitude and distribution of spray mixture reaching the orchard floor when dilute spray gallonages in the range generally used are applied with oscillating boom spray equipment of the type currently in use.

MATERIALS AND METHOD

The spray liquid was collected by placing 6 sets of racks, each designed to hold either 10 or 13 wide-mouth, 1-pt Mason jars at 1-ft intervals, beneath a tree as shown in Figure 1. The racks were placed in position and the tree was sprayed. The jars

Bulletin of Environmental Contamination & Toxicology,
Vol. 18, No. 6 © 1977 by Springer-Verlag New York, Inc.

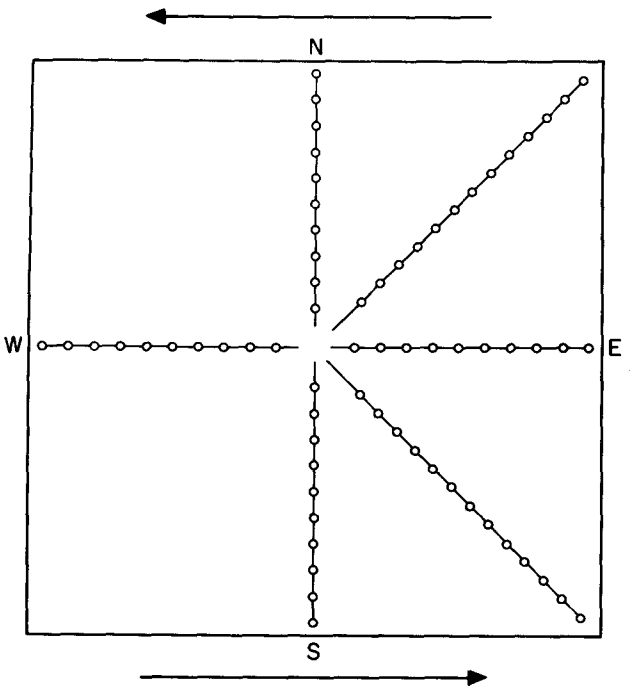

Fig. 1. Diagram of rack orientation and jar (circles) positions beneath a citrus tree. Arrows indicate direction of spray rig during pesticide application.

were capped and collected after it was apparent that runoff had ceased. After the jars were dry externally, the amount of spray collected was determined by the difference in weight of the jars before and after application. An oscillating boom spray rig was used and only water was applied so that tests could be replicated using the same trees. The spray disc size was varied from 5/64 in. to 9/64 in. by 1/64-in. increments and the resulting gallonage of water delivered was 1,520, 1,810, 2,340, 3,000, and 3,650 gal/A, respectively. The spray rig moved at 1.4 mph and the boom, consisting of 15 guns, was operated at 500 psi water delivery pressure and 66 oscillations/min. The parameters used simulated normal commercial practice. The target tree was sprayed twice from each side, once directly and once one row removed to include additional runoff resulting from the next row operation during a spraying operation. Tests were conducted on each of 5 trees using each of the 5 gallonages. The mature navel orange trees used were planted at 90 trees/A with a 22 x 22

ft spacing. The mean tree height was 15.7 ft, the mean in-row tree width was 19.1 ft (9.6 ft radius), and the mean across-row width was 19.8 ft (9.9 ft radius). The collection racks sampled spray fall-out and runoff from over the entire 22 x 22 ft tree area spacing. Racks extending beyond 11 ft from the tree trunk represented the diagonal of the 22 x 22 ft planting space for each tree.

RESULTS AND DISCUSSION

Figure 2 gives the composite profile for 5 trees for the spray reaching the orchard floor as a result of 5 different spray gallonages. The soil surface inside the canopy of the tree received the greatest portion of the runoff. Within the periphery of the tree, the percent of the total runoff was 68, 68, 73, 71, and 73, respectively, with increasing gallonage applied. Relatively less spray fell on the soil surface between the trees. Figure 2 shows the runoff profile with increasing gallonage applied. Figure 3 shows that runoff increases with increased gallonage applied. Additional retention of water as a result of a more thorough wetting of the tree with increased gallonage applied accounts for the non-linear relationship shown. Runoffs from a 1,520, 1,810, 2,340, 3,000, and 3,650 gal/A application were 3.4, 6.0, 9.4, 13, and 16 gal/tree, respectively. Runoff data expressed in percent of spray applied are shown in Figure 4. With increasing gallonage applied, runoffs were 20 ± 4, 30 ± 8, 36 ± 11, 39 ± 6, and 40 ± 9%, respectively. These percent values were within the 25-40% range earlier approximated; they can be used roughly to estimate soil pesticide burden. For example, at 3,650 gal/A a 10 lb a.i. application of pesticide would deposit a maximum of 4 lb/A on the soil surface or 0.044 lb/tree on a 90 tree/A field. The estimate is oversimplified in that it assumes that the pesticide concentration in the runoff liquid is unchanged as a result of contact with the tree surfaces. The pesticide is likely formulated to facilitate its penetration into and deposition on the tree; thus, pesticide is retained on the tree while water runs off. The results here should not be extrapolated to non-citrus tree crops.

ACKNOWLEDGMENTS

This work was supported in part by the California Department of Food and Agriculture under Contract No. 4288 entitled "Worker Reentry Safety in Citrus Groves." The technical assistance of D. Aitken, C. Gericke, and J. L. Pappas is gratefully acknowledged.

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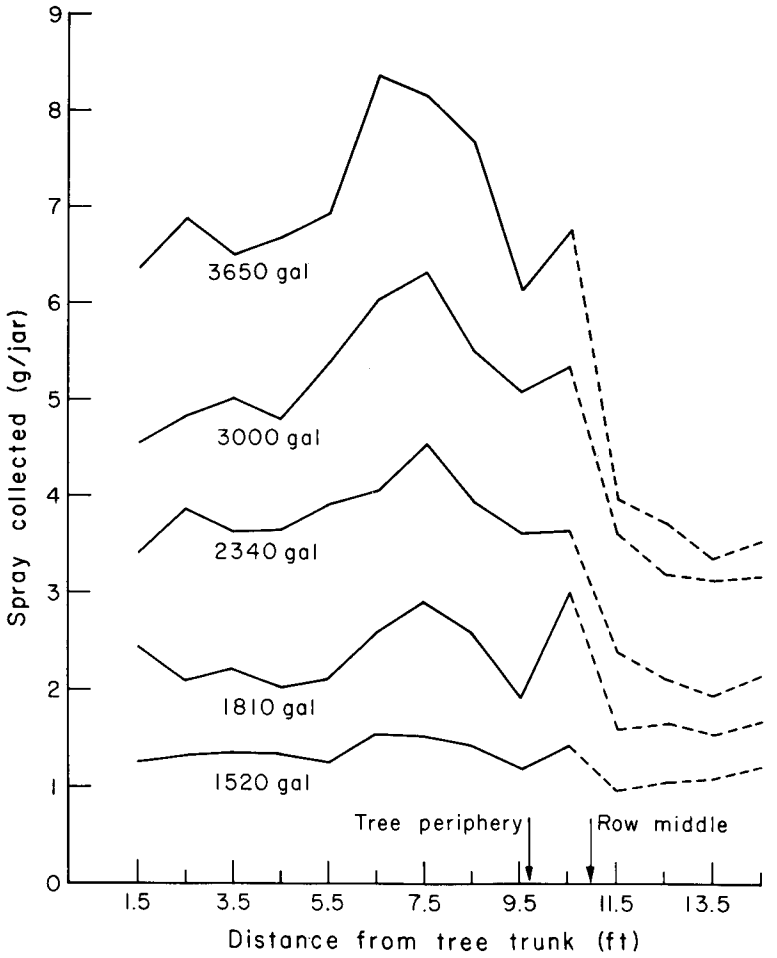

Fig. 2. Amount of spray collected in jars positioned at various distances from the tree trunk; 5 different gallonages of spray/A were applied. The tree planting was 22 x 22 ft; the dotted lines thus represent the diagonals of the plots which extend out to the row middle.

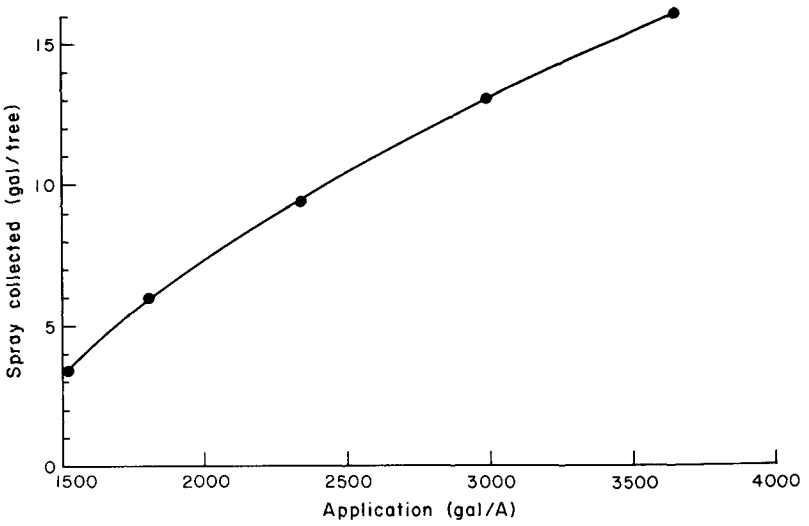

Fig. 3. Spray runoff collected in gal/tree after application of 5 different gallonages/A.

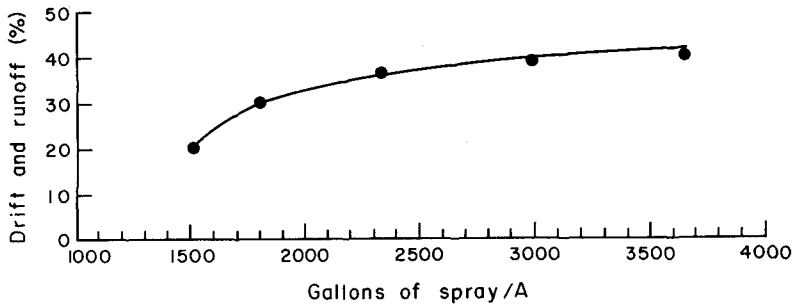

Fig. 4. Spray runoff collected (as % of spray applied) after application of 5 different gallonages/A.