Within Canopy Movement and Deposition of Insecticide Residues in Orchards During Spray Operations

Allan S. Felsot, Quentin Macdonald, Judy R. Ruppert
Washington State University, Department of Entomology, Food & Environmental Quality Lab

1 Introduction

The tree fruit industry has set a goal of reducing production costs by 30% through technology innovation while producing the highest quality fruit. Application technology offers one possible method for achieving this goal. We are studying alternative sprayers and determining whether reduced application rates are feasible. We are also studying alternative row spraying practices. During crop year 2003 we compared bioactivity and residue distribution following one and two sprays of Guthion (azinphos-methyl) or Assail (acetamiprid) at label recommended rates (1X) or 0.25X and 0.5X rates. We also examined whether spraying in alternate rows or skipping rows could provide sufficient residues to control codling moth neonates.

2 Procedures

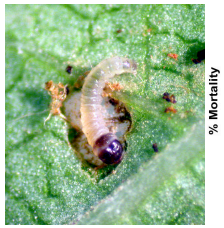
Plots were located at a commercial orchard southwest of Quincy, WA. Gala apple trees were delineated for treatments using a stratified block design. Treatment blocks consisted of 5 rows by 40 trees that were divided into four replicates of 10 trees each. Treatments were sprayer (Pak-Blast, an airblast type sprayer, or Proptec, air-assisted tower mounted sprayer), application rate (0.25X, 0.5X and 1X), or row spray pattern (every row, alternate row, skip row).

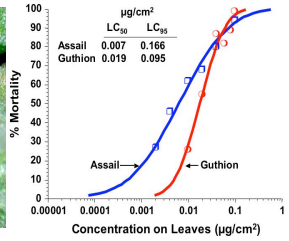
Guthion rates were 0.25, 0.5, and 1 lb AI/acre. Assail rates were 0.075 and 0.150 lb AI/acre. For the "every row" spraying pattern, both sides of a single row were sprayed. For the "alternate row" pattern, only the outer side of two adjacent rows were sprayed. For the "skip row" pattern, the outer two rows of a three-row group were sprayed, leaving the middle row unsprayed.

Apples and surrounding foliage were randomly collected from two branches from each of six trees within a replicate plot. Leaf disks (5 cm^2) were punched and then bioassayed using neonate codling moth (CM) larvae. Leaf disks were extracted and residues quantified by GC.

3 Dose-Response Relationship for Neonate Codling Moth

Probit analysis was used to generate LC50 and LC95 estimates (24-h exposures) that were compared to recovered insecticide residues ($\mu g/cm^2$).





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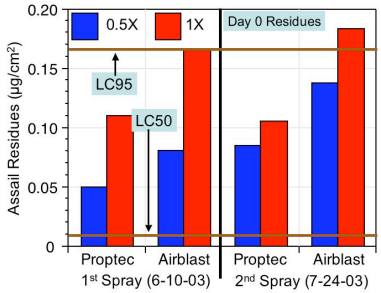
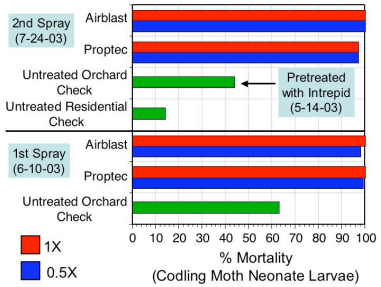
Most CM eggs are laid on foliage surrounding apples, and after hatch the larvae search for apples. Thus, foliar residue deposits could be functionally important for controlling CM feeding on apples. Experiments with reduced application rates of Assail showed that airblast and Proptec sprayers deposited residues sufficiently above the LC50 (0.007 $\mu g/cm2$) to control codling moth (see below, left-hand graph). Bioassays of field-treated leaves showed nearly 100% mortality of all larvae within 24 hours of exposure even at the 0.5X (0.075 lb AI/acre) application rate (see below, right-hand graph). Note that untreated leaves collected from the subject orchard had been treated with Intrepid (methoxyfenozide) in May. This ecdysone agonist has moderate activity against CM larvae and suggests some potentiation of Assail's bioactivity.





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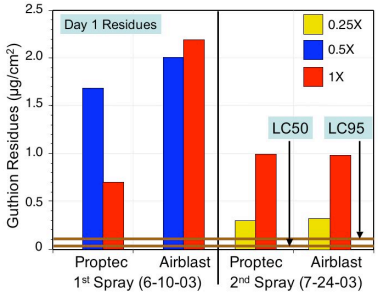
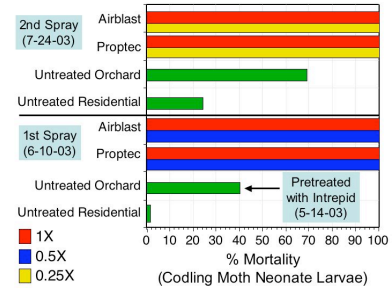
Guthion residues recovered after reduced application rates (0.25 lb AI/acre; 0.5 lb AI/acre) were significantly above both the LC50 and LC95 estimates for neonate CM larvae (see below, left-hand graph). As predicted from the residue recovery, mortality of CM neonates on leaves was 100% at all application rates (see below, right hand graph). We noted that residues were sufficient to give over 90% mortality of larvae even after three hours of exposure (data not shown).





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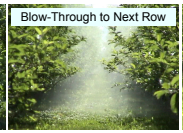
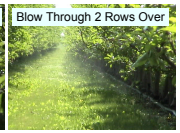
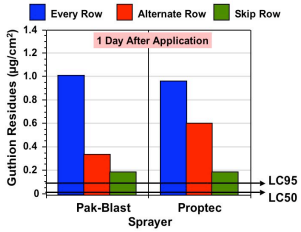
Residue and bioactivity results from reduced application rate experiments suggested that alternate row spraying may be feasible for controlling CM larvae. Video of spraying operations showed significant cross row movement of spray, suggesting that residues may be sufficient to control CM larvae on non-sprayed adjacent rows. The graph to the right shows that Guthion residues were above the LC95.







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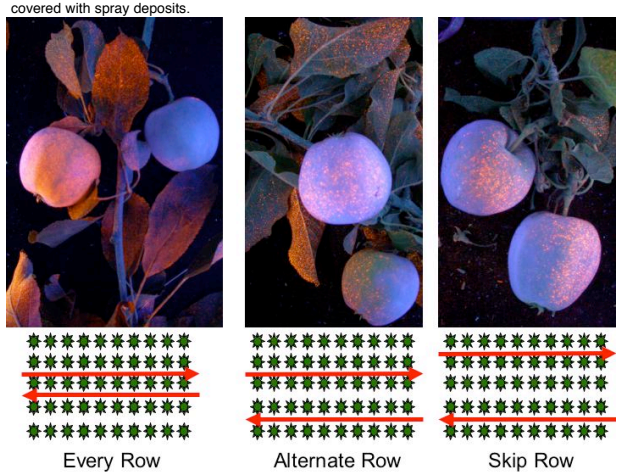
Spray deposition from a Pak-Blast sprayer in the the alternative row spray pattern experiments was visualized using a red fluorescent tracer dye. Note the change in particle deposition density from left to right, especially on leaves. In the "every row" treatment, some apples were not fully covered with spray deposits.



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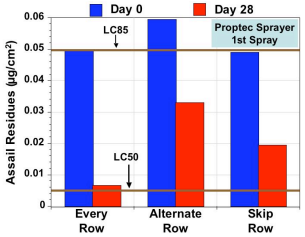
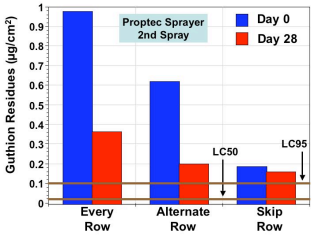
Assail residues (graph below on left) following all row spraying pattern treatments were at the estimated LC85 (Proptec sprayer; 1X rate). After 28 days, residues were at or above the LC50. Guthion residues remained above the LC95 for 28 days following a second application (1X rate) with a Proptec sprayer (graph below on right).





9 Conclusions

1. Initial spray deposition from both an airblast & a Proptec sprayer resulted in Guthion (azinphos-methy)l residues greater than the laboratory estimated LC50 and LC95 at all application rates.
2. Residues of Assail (acetamiprid) were above the LC50 and LC80 at all application rates.
3. Alternate row and skip row spray patterns indicated residues on foliage not sprayed directly with Assail or Guthion were high enough to cause 100% mortality of larvae. Guthion residues were still above the LC95 28 days after application. Assail residues were still above the LC50 28 days later, but bioassays showed near 100% mortality of larvae exposed to treated foliage (data not shown).
4. Data suggested that significant reductions in application rate and area treated have the potential to provide efficacious control of CM larvae.

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