Mitigation of Environmental Effects from Spray Applications in Orchards

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Introduction

Orchard crop protection is vital for pest- and disease-free healthy trees. Ensuring adequate spray coverage to maintain product quality is a primary focus for growers and orchard managers. Conversely, there continues to be concern that EC-formulated pesticides, containing organic solvents as precursors to ozone, degrades air quality. The California Department of Pesticide Regulation has determined that 75% of pesticide emissions within the San Joaquin Valley (SJV) are due to non-fumigant applications. There are 15 air quality non-attainment areas within the state, including all of the SJV and parts of Sutter County. Peak ozone season within the state (May-October) coincides with in-season spray applications. Pesticide reduction, through reduction in the use of EC pesticides, is a key strategy in meeting air quality targets.

A collaborative study was developed to determine and estimate spray efficacy for a conventional and reduced application spray. The fundamental goal of spray application and testing is pest control efficacy, however it is often not reported or measured during drift or efficiency studies. A coordinated research and outreach project was the goal of this project using the combined resources of ARS for nut deposition and pest control efficacy, CURES focus on spray drift concerns and UCD's interest in equipment and spray performance defined by deposition, drift and economics of operation. This initial project developed field test protocols that can be used in future projects addressing the almond industry needs for spray application research.

Figure 1. Hull split late July 2010.

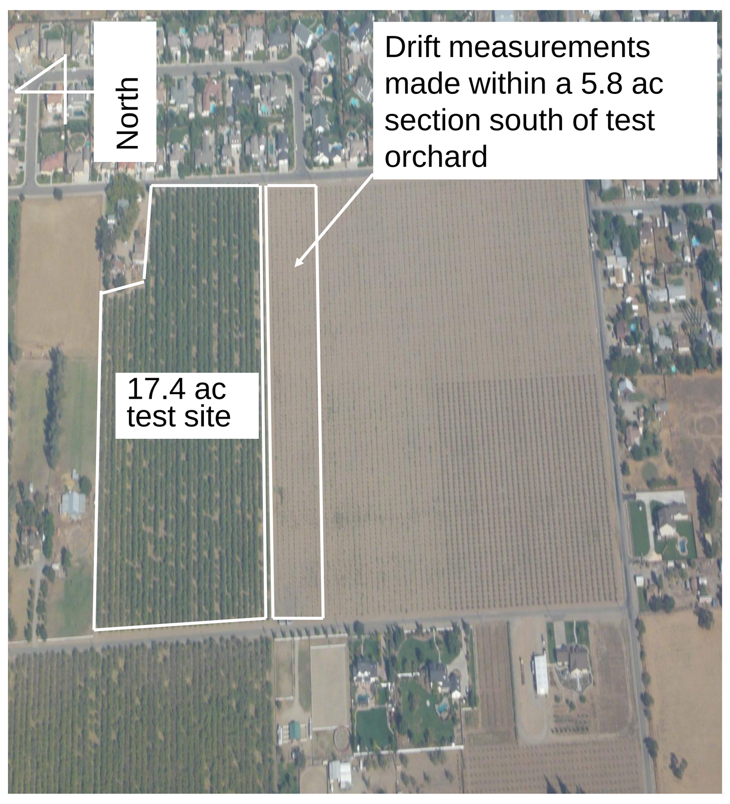

Figure 2. Test site located in Sutter County.

Objectives

1. Measure spray deposition within trees, on the ground surface and off-target drift for a conventional and reduced volume hull-split application;
2. Evaluate and compare differences from deposition recovery of active ingredient and non-toxic tracer on various media;
3. Collaborate with industry on spray drift measurement recovery (CURES) and pest control efficacy on nut samples (USDA-ARS) from the different applications;
4. Develop a collaborative study on spray application research that will establish field test protocols that can be used in future studies for evaluating spray efficacy under different field conditions and application scenarios.

Spray Material and Equipment

Spray applications were made with a tractor towed TurboMist sprayer (Model 30P) at full airflow, 540 rpm PTO rpm, and 2 mph ground speed for the conventional and reduced volume treatments. The sprayer was calibrated off-site prior to the tests. Each application used 22 nozzles; the bottom two nozzles on each side of the sprayer were turned off. Nozzles for the 50 gal/ac treatment were D1.5/DC25 disc cores; the 100 gal/ac treatment used D4/DC25 disc cores. The application rates of materials were constant for the 50 and 100 gal/ac treatments. Spray mixes for both treatments were Brigade® WSB insecticide/miticide at 1.5 lbs/ac, Kanemite™15 SC miticide at 31 fl. oz/ac, a nonionic surfactant R-11 at 8 oz/ac, and a fluorescent tracer at 20 ppm finished volume.

Figure 3. Conventional spraying for hull split in late July 2010.

Figure 4. End of row applications showing off-canopy and through canopy drift.

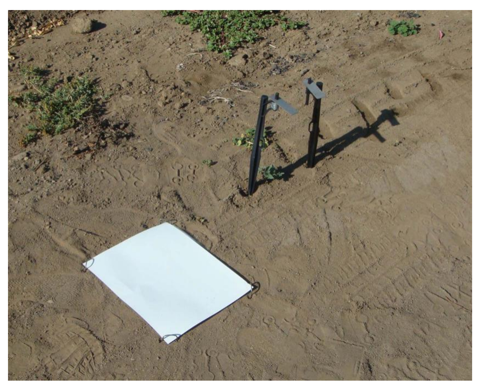

Figure 5. Drift deposition media: Mylar sheets (8 x 12 in) and stainless steel plates (1 x 3 in).

Results

The orchard was configured with 31 tree rows running in an east-west direction. Tree rows alternated with Nonpareil, Carmel and Butte varieties. Five rows on the northernmost section of the orchard were left as an untreated control. The southernmost section of the orchard (six rows) was used for drift tests split along a north-south centerline; the eastern section was used for the reduced application drift tests, the western section for conventional spray application drift tests. Three equally spaced transects were used to measure drift sedimentation at 25, 50, 75 ft perpendicular to the orchard row direction and south of the orchard. Twelve rows were treated with the reduced application (adjacent to the untreated control section) while 8 rows were treated with the conventional application. Treatment areas were calculated to allow a single tank of each treatment to cover the entire test area.

Spray deposition within trees and on the ground was measured using artificial samplers. Three replicate measurements were taken for each spray treatment. Each replicate consisted of samplers within four trees, ground deposition samplers beneath trees, ground deposition samplers between trees and ground deposition samplers along the treatment row. Half of all samples were measured for fluorescent tracer deposition, the other half are being measured for active ingredient deposition. Results presented here are preliminary and represent tracer deposition.

Table 1. Fluorescent tracer deposition for conventional and reduced spray applications (standard deviations in parentheses).

Sampler location	50 gal/ac	100 gal/ac
	----- Deposition, µliters/cm² -----	
Tree	2.7 (1.0)	4.2 (1.8)
Ground		
Treatment row	1.0 (0.1)	1.7 (0.4)
Beneath tree	0.8 (0.3)	2.3 (0.2)
Between trees	0.8 (0.1)	1.4 (0.6)

Table 2. Fluorescent tracer deposition along drift transects south of orchard for conventional and reduced spray applications (standard deviation in parentheses).

Sampler location	50 gal/ac	100 gal/ac
	----- Deposition, µliters/cm² -----	
Drift 25 ft	0.05 (0.09)	0.33 (0.44)
Drift 50 ft	0.03 (0.07)	0.14 (0.21)
Drift 75 ft	0.03 (0.07)	0.10 (0.20)

The large standard deviations associated with drift samples was likely due to the lack of a sustained north wind during testing conditions.

Figure 6. Off-target drift leaving the south western edge of the orchard foot-print.

Figure 7. Drift sedimentation transect south of test site.

Table 3. Untreated "control" nuts response to NOW egg placement.

Days after spray treatment control nuts were collected, d	Nut location in tree	Location of egg placement	Survival rate %
1	Low+High	Hulls	6.5
14	Low+High	Hulls	20.3
14	Low	Hulls	1.0
14	Low	Suture	5.0
14	High	Hulls	20.3
14	High	Suture	31.5

Figure 8. Spray deposition media in tree: stainless steel mesh cylinders (1 in dia., 3 in long).

Figure 9. Collection of sprayed nuts for NOW exposure tests.

Establishment of Naval Orange Worm (NOW) in the control almonds was low this year and may indicate a shift in the lab colony. Colony establishment may also be a response from unknown nut factors. Nuts collected on day 14 supported NOW development to a greater degree than those collected on day 1.

Table 4. Results from exposure to NOW 1 and 14 days post spray application after egg placement on hulls.

Nut Location in tree	Days after spray application, d	Application rate gal/ac	Survival rate %
Low	1	50	0.0
Low	1	100	0.0
High	1	50	0.5
High	1	100	0.1
Low	14	50	0.2
Low	14	100	0.0
High	14	50	5.3
High	14	100	10.7

Table 5. Results from exposure to NOW 14 days after spray application based on initial placement of eggs.

Nut Location in tree	Larvae placement location	Application rate gal/ac	Survival rate %
Low	In suture	50	9.2
Low	In suture	100	9.3
High	In suture	50	28.3
High	In suture	100	31.0
Low	Hulls	50	0.2
Low	Hulls	100	0.0
High	Hulls	50	5.5
High	Hulls	100	0.0

Assessments of NOW exposed to treated nuts (larvae placed on hulls) showed that both spray treatments provided excellent control for nuts in the lower portion of the trees one day post treatment. Survival was greater for nuts in the higher location of trees, however was less than 1%. Fourteen days post treatment survival of NOW exposed to treated nuts found survival within low nuts less than 1% while survival in high nuts was 5.3% for the reduced application and 10.7% for the conventional application. A further study on initial location of larvae on treated nuts exposed 14 days after spray applications found a dramatic increase in survival based on larvae placement on the hulls versus within sutures. These nuts had split open and approximately 50% of the surface area had not received pesticide deposit, supporting the need for a post hull-split spray application in areas affected by NOW.