Just Enough: Ground Speed and Spray Coverage for Efficient Orchard Spraying

Project No.: **14-WATER3-Niederholzer/Markle**

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Project Goal: Improve spray deposition while reducing application costs.

Objectives:

1) Determine sprayer ground speed needed to move pesticide just above the tops of mature, tall almond trees at different times of the year (dormant vs full bloom vs May vs hull split) using conventional air blast sprayers. Document the differences in speeds and demonstrate grower-friendly means to determine optimum ground speed for a specific sprayer in a specific orchard.
2) Compare leaf coverage at different levels of the canopy using different sprayer ground speeds in spring.
3) Evaluate spray coverage in the tops of almond trees using different sprayer configurations (nozzles, nozzle location on the sprayer, etc.) and spray times (early morning vs mid-day vs evening).
4) Measure drift and ground deposition using a combination of string samplers and Kimbies (cellulose pads).
5) Extend results from this and previous work to growers and PCAs via meetings, publications and internet.

Interpretive Summary:

Two spray coverage studies were done in October, 2015. In the study orchard, spray movement within the tree appeared improved compared with hull split, when the canopy is the densest and spray coverage the most challenging. The improvement in spray flow in the canopy was due to lower tree leaf loss with harvest and changed branch angles due to crop removal.

Spraying in dry air reduced spray coverage, even with temperatures below 80ºF. Spray deposit in upper canopies of almond trees (20-24’ above the ground) was reduced, on average, by at least 15% when applied at moderate temperatures (75-80ºF) but dry air (dry

bulb-wet bulb temps = 9-10ºC) compared to cooler temperatures (65-67ºF) and more moisture in the air (dry bulb-wet bulb temps = 5-6ºC).

At 100 gpa and 2 MPH, using one nozzle size for each open nozzle on the sprayer delivered the same spray deposition as arranging different nozzle sizes so two thirds of the spray volume was delivered from the top half of all nozzles on the sprayer.

Reductions in spray coverage from bottom to top of the canopy were not as dramatic as in previous work from summer (hull split) but were only statistically different in one of the two studies.

Materials and Methods:

Two experiments were conducted in a commercial almond orchard in southern Sacramento Valley on the same day in October, 2015. This was a 10th leaf orchard (50% NP, 50% pollinizers on Lovell peach seedling rootstock) with good but not excessive vigor. Annual production in Nonpareil ranges from 2500-3000 kernel pounds/acre in the last 5 years. In this postharvest spray test, spray movement in the canopy should have been improved compared with hull split timing as the lower canopy had suffered some leaf loss since harvest irrigation cut off and branches were not dragged down by the crop.

A PTO airblast sprayer (36" axial fan) was used in both experiments with a spray volume of 100 gallons per acre (GPA), 2 MPH ground speed, and an operating pressure of 125 psi. No change in open nozzle number (6 per side) was made during the experiments.

The first study assessed differences in spray deposition high (20-24') or low (6-8') in the canopy at different combinations of temperature and relative humidity through the day. The second study tested the established recommendation that 2/3's of the spray volume be delivered by the nozzles in the top half of the spray boom (pg 248, Almond Production Manual, UC ANR publication No. 3364) compared with one nozzle size for all open nozzles.

Study 1: One of three different micro-nutrients (170 ppm cobalt, copper, or molybdenum) plus 16 oz. of non-ionic surfactant per 100 gallons of spray solution were sprayed at different times of the same day: 0930, 1100, or 1300 hours. All sprays were delivered by applying two thirds of the spray volume through the upper half of the hollow cone nozzles on the manifold (from the top of the manifold FMC nozzles sizes #4, #7, #7, #5, #3, #3 using 2-hole swirl plates). Wet and dry bulb temperature (ºC) was measured before and after each application by use of a sling psychrometer in the shade of the orchard. Spray was applied to three tractor aisles on either side of the tree row used in this study. Care was taken so that the direction of sprayer travel was reversed for each side of each tree row. The sprayer traveled down tractor aisles 1, 3, and 5 in one direction and 2, 4, and 6 in the opposite direction. Before and after spraying, leaf samples were taken from lower (6-8') and upper (20-24') canopies of five trees in a single Nonpareil row between tractor aisles 3 and 4. Leaf area and specific leaf weights (leaf weight per leaf area) were determined from pre-spray samples. Micro-nutrient tracers on/in the leaves on a dry weight basis (ppm) were determined at the UC Davis Analytical Lab. The spray volume deposited on leaves low and high in the tree under different spray timings and set ups was calculated from pre-spray tank tracer concentrations and the net amount of tracer recovered from leaves after spraying.

Study 2. One of two different micro-nutrients (130 ppm cobalt or molybdenum) plus 16 oz. of non-ionic surfactant per 100 gallons of spray solution was sprayed in a separate part of the same orchard as Study 1. This study tested the long established recommendation that two thirds of the spray volume applied be delivered through the nozzles in the upper half of the spray boom. One application was delivered using different sized nozzles to apply two thirds of the spray volume through the upper half of the nozzles on the manifold (from the top of the manifold FMC nozzles sizes #4, #7, #7, #5, #3, #3) while the second spray was delivered using the same sized nozzle (FMC #5) at each position. Two holed swirl plates were used in all nozzles. Applications were made between 11 AM and 2:30 PM, when evaporation potential was high, but deposition losses should be similar. Application, sampling and spray deposition determination were the same as in Study 1.

Results and Discussion:

Study 1. Temperatures were below 80ºF (**Table 1**) for all spraying, however relative humidity was low -- 27-38% RH – during the applications. Wind speeds ranged from 3-8 MPH, and wind direction was primarily from the N-NE, with a short interval from the SE.

Average spray deposit was not affected by atmospheric conditions (dry bulb – wet bulb) in the lower canopy (**Table 1**), but was significantly decreased in the upper canopy when sprays were applied at ∆8-10 (dry bulb – wet bulb = 8-10ºC) compared with ∆5 (**Table 1**). Canopy height did not significantly influence average spray deposition, although average upper canopy deposition tended to be less than that in the lower canopy (**Table 1**). Deposit variability from tree to tree and within trees (**Figure 1**) contributed to the insignificant difference in spray coverage from low to high in the canopy. Leaf loss lower in the canopy, dust on remaining leaves and limb positioning all may have contributed to the variability in deposition shown in **Figure 1**. An additional source of variability was a swing in wind direction from N/NE to S around 1100, that lasted less than an hour, but may have changed deposition in upper and lower canopies.

Table 1. Average spray solution deposit (µl/cm^2) on leaves in mature almond trees as influenced by height above the orchard floor and atmospheric conditions during application. Spray was delivered by a 36" axial fan PTO-powered airblast sprayer. Data in the same column (a/b) or row (y/z) followed by the same letter are not significantly different (p≤ 5%). Spray date = October 23, 2015.

Time and atmospheric conditions at start and end of spraying: Temperature (ºF) and Delta T (Dry bulb - wet bulb temperature ºC)			Spray Deposition (µl/cm^2)	Spray Deposition (µl/cm^2)
0925-0950	65-67ºF	∆5-6	0.22 a y	0.18 a y
1110-1130	73-73ºF	∆8.5-8	0.18 a y	0.13 c y
1305-1330	75-76ºF	∆9-9	0.20 a y	0.16 b y

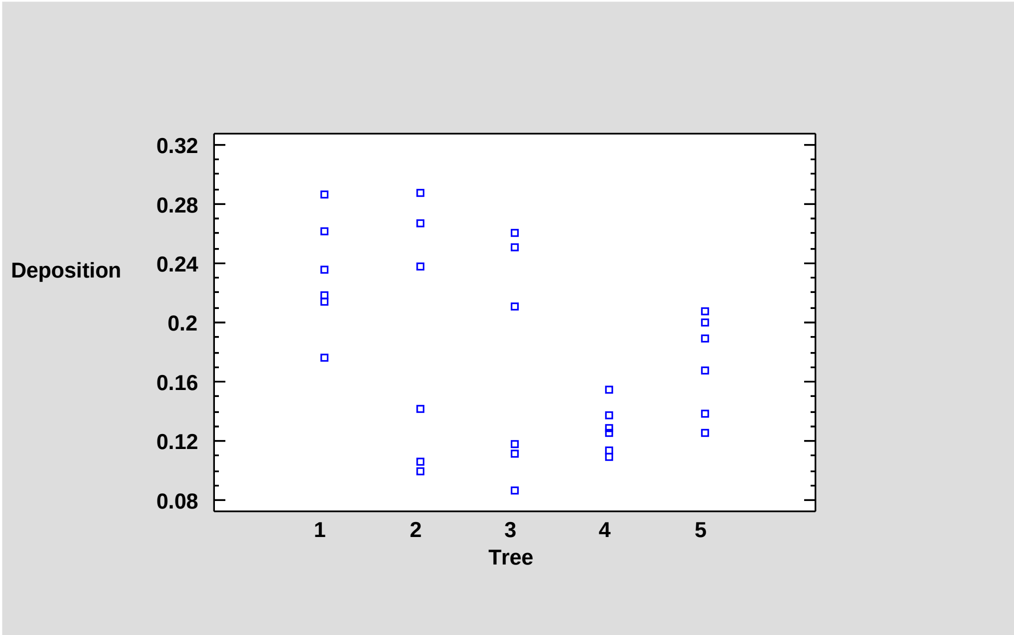

Figure 1. All spray deposition (µl/cm2) data by tree (Study 1).

Study 2. Atmospheric conditions were very similar for this experiment and Study 1, with temperatures below 80ºF, light winds and ∆8-10 for both sprays.

Average spray deposit was not affected by nozzle selection at either height in the canopy (**Table 2**). However, unlike Study 1, canopy height **did** significantly influence average spray deposition (**Table 2**), with lower canopy deposition roughly double that in the upper canopy. Deposit variability from tree to tree contributed to the higher average lower canopy deposition in this Study (**Figure 2**) compared to Study 1.

Table 1. Average spray solution deposit (µl/cm^2) on leaves in mature almond trees as influenced by nozzle selection and arrangement. Spray was delivered by a 36" axial fan PTO-powered airblast sprayer using 6 hollow cone nozzles for each half of the sprayer. Data in the same column (a/b) or row (y/z) followed by the same letter are not significantly different (p≤ 5%). Spray date = October 23, 2015.

Hollow cone nozzle selection and order from the top of the spray boom.	Spray Deposition (µl/cm^2) at 6-8' above the orchard floor	Spray Deposition (µl/cm^2) at 20-24' above the orchard floor
FMC 5,5,5,5,5,5	0.32 a x	0.16 a y
FMC 4,7,7,5,3,3	0.26 a x	0.15 a y

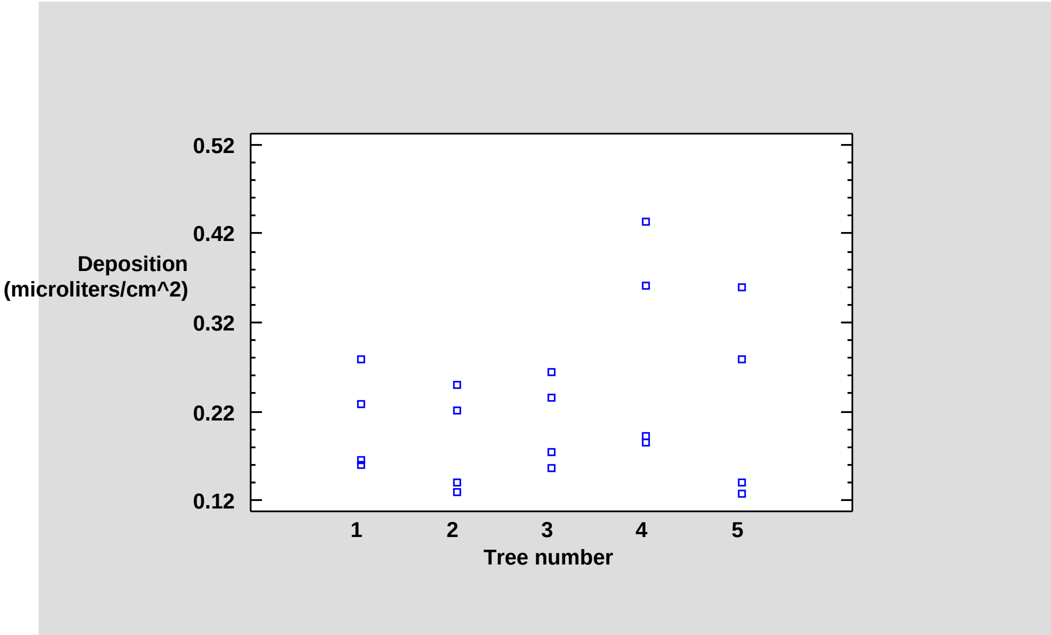

Figure 2. All spray deposition data (µl/cm2) by tree. Study 2**.**