Spray Swath Analysis/Drift Management

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Objectives:

To minimize off target movement and to improve infield efficiency and distribution of almond crop production products.

Interpretive Summary:

Agricultural aircraft were tested to monitor spray pattern variability, canopy penetration, and drift potential. None of the aircraft tested were out of compliance for pattern variability. None of the aircraft tested showed a high propensity to drift. Some showed little potential for drift but may have droplets too large to give adequate coverage. The overall spray droplet distribution was near perfect with a span of 1.02. Coverage on the floor was light indicating excellent interception of spray within the canopy. Horizontal drift was minimal. Thus, risk to adjacent crops and environmentally sensitive areas are minimal. This information will help improve efficacy, reduce off site movement by drift, and off site movement by runoff due to the material being on the tree rather than the soil. Results indicate that most aerial applicators are set up to apply almond production products in a safe and efficient manner.

Materials and Methods:

Swath analysis is accomplished by a process using the California Agricultural Aircraft Association (CAAA) Fluorometer. The aircraft is loaded with water and Rhodamine Dye. The aircraft flies over and sprays a specially treated string. The string is then analyzed by the Fluorometer. A pattern is displayed and swath variability is determined. If variability is too high (greater than 20 percent) then adjustments are made to the spray boom and the aircraft is retested. Also, certain pattern characteristics may indicate a potential to drift. If these are noticed, the usual correction is to shorten the boom length.

Drift potential is measured by flying over a set of Syngenta water sensitive cards. These cards are then scanned and analyzed utilizing the WRK DropletScan System. Data derived provide droplet spectra analysis for Volume Medium Diameter (Dv 0.5), (Dv 0.1), and (Dv 0.9). Dv 0.5 means that half of the spray volume is made up of droplets that size or larger and one-half the volume is made up of droplets that size or smaller**.** Dv 0.1 means that ten percent of the spray volume is made up of droplets that size or smaller and Dv 0.9 means that ten percent of the spray volume is made up of spray droplets that size or larger. Droplets are measured in microns. The other key data relating to drift potential, and possibly the more important one, is the percent of spray volume below 200 microns. This latter information is related to the driftibility to droplets. The lower the percent of volume below 200 microns, the less potential there is for drift.

Orchard floor coverage and canopy penetration. Droplet cards were placed on the berm and on the orchard floor middle.

Horizontal drift. Droplet cards were placed down wind from the application at 50 feet from the center of the swath and at 50 foot intervals out to 300 feet.

Treatment parameters. The almond orchard was used for a similar study in 2007. At that time it was a three leaf orchard. The application was made by a Huey rotary winged aircraft. The swath width was 70 feet. The rate was 20 gallons per acre. The temperature was 98 F, with 25% relative humidity. The wind was out of the Northwest at 3 miles per hour.

Results and Discussion:

Swath analysis: All aircraft tested at or below the minimum industry accepted swath variability of 20 percent. Thus, all aircraft would give a uniform distribution of the spray. Therefore, this data is not reported.

Droplet analysis: Thirty three aircraft were tested for those droplet parameters that would indicate a drift potential. None exceeded the ten percent of spray volume below 200 microns All met or greatly exceed this industry standard (**Table 1**).

The Dv 0.1 is also an indication of drift potential. The nominal number is 200 microns. If smaller, the potential for drift increases. Generally, those aircraft that had Dv 0.1 below 200 microns tended to have a larger percent of the spray volume below 200 microns. Conversely, those aircraft that tested for larger Dv 0.1 tended to have smaller percentages of the spray volume below 200 microns. This means less drift potential but when droplets become too large, the potential to decrease coverage, and thus efficacy, increases.

While the overall averages are above the optimum droplets sizes and thus the potential for drift is reduced the droplet spectra are not overly large so that efficacy may not become an issue.

The percent average for spray volume below 200 microns indicates a strong possibility to minimize drift. It should be noted, however, that other factors such as wind speed, humidity, temperature, and spray tank additives can also affect drift potential. Therefore, all of these factors must be taken into account when applying almond production products by air.

Table 1
Droplet Spectra Analysis

Aircraft *	Dv 0.5	Dv 0.1	Dv 0.9	% < 200 micron
1 S	450	201	690	9.3
2 S	495	214	790	7
3S	474	202	684	7.2
4 B	417	215	624	6.5
5 B	446	202	675	8
6 B	476	235	808	5
7 S	376	202	575	8
8 B	524	247	779	5
9 B	682	313	931	3.5
10 B	430	215	653	7
11 S	410	210	714	7.5
12 B	551	299	747	3
13 B	610	251	891	5
14 B	489	268	699	3.5
15 B	428	210	638	7
16 H	434	217	637	6.6
17 B	476	257	645	3
18 B	372	227	589	6
19 S	492	234	754	5.5
20 S	447	227	682	6.2
21 S	626	260	1033	4
22 B	590	253	878	5
23 B	384	201	609	9.4
24 S	491	237	752	5
25 S	440	237	614	6
26 B	417	205	653	8
27 S	509	229	794	5.3
28 B	562	273	856	4.5
29 B	441	220	646	6.2
30 B	428	211	638	6.4
31 B	457	208	706	7
32 H	434	217	637	7.5
33 S	425	251	641	3.5
Mean	473	232	717	6.0
Optimum	400	200-250	600	10

***B = biwing, S = single wing, H = rotary wing (helicopter)**

For the cards that were placed in the berm area and orchard floor middle, percent coverage was analyzed. This gives an indication of penetration through the canopy and interception by the canopy. The data is compared with the work done by a helicopter in 2007 in the same orchard and location within the orchard (**Table 2**).

TABLE 2
In Orchard % Coverage

Aircraft	Berm	Floor
OH 58 (2007)	5	7
Huey (2011)	2.4	11

The berm coverage is reduced by half over the 4 year period. This is due to the age of the trees and much more canopy to intercept the spray droplets. The coverage on the orchard floor is higher. This is probably due to less canopy coverage and the fact the type of aircraft used in 2011 probably exerts a much stronger downward air thrust.

Table 3 compares horizontal drift in 2007 with 2011. Again the same aircraft are compared. Results indicate that the horizontal drift near the swath center is greater with the Huey but that as the distance from center increases, the drift from either aircraft is minimal.

Table 3
Horizontal Drift % Coverage

Aircraft	50 ft	100 ft	150 ft	200 ft	250 ft	300 ft
OH 58 (2007)	.37	.1	0	0	0	0
Huey (2011)	4.86	.3	.01	0	0	0

The 50 foot data is from the center of a 70 foot swath. Therefore, the data is actually 15 feet from the outer edge of the swath. This card was just outside the drip line of the outer row of trees. Thus, the coverage is expected at this point and it is not a problem for adjacent crops or environmentally sensitive areas.

Research Effort Recent Publications:

2009. Deposition Testing and Pattern Refinement for Spray Swath Analysis and Drift Minimization including Variable Rate Application. Annual Summary. Cotton, Inc. Tulare, CA.

2009. Research presentation at the CAAA District 2 meeting. October, 2009. Stockton, CA

2010. Aerial Deposition Alliance Program. Report to Rice Research Board of California. December. 2009.

2010. Deposition Testing and Pattern Refinement for Spray Swath Analysis and Drift Minimization. Annual Summary. Cotton, Inc. Tulare, CA

2010. Almond Research data presented in the annual “On The Deck” Publication of the California Agricultural Aircraft Association. Lincoln, CA.

2010. Crop Canopy penetration in cotton. Report to Cotton, Inc. Cary, NC.

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ASAE, Calibration and Distribution Pattern Testing of Agricultural Application Equipment. ASAE Standard 572, ASAE S386.2, St. Joseph, MI, Feb. 1988.

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Gardisser, D.R. and D.K. Kuhlman. Agricultural Aircraft Calibration and Set up for Spraying. MP 348, UACES, 1993.

Kuhlman, D.K., and D.R. Gardisser. 1991. Optimizing Aerial Applications by Using Proper Set Up and Operation. WRK Inc. Manhattan, KS.

Noyes, R.T., D.R. Gardisser, and D.K. Kuhlman. Aerial Pesticide Drift Management, MP 392, UACES, 1997.

Stocker, R., N Akessson, and W. Peschel. 2003. Reducing Drift able Fines in Aerial Application of Pesticides-A Reverse Venturi Atomization Chamber. ASAE Paper No. AA03-11, NAAA/ASAE Technical Session, Reno, NV. Dec. 2003.

Wolfe, R.E., Bretthauer, S. and D.R. Gardisser. Determining the Affect of Flat-fan Nozzle Angle on Aerial Spray Droplet Spectra. ASAE Paper No. AA05-003. NAAA/ASAE Technical Session. Reno, NV. 2005.