

Drift Potential and Spray Coverage of Traditional Vs. Modified and New Technology Sprayers in Mid-Columbia Orchards

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INTRODUCTION: The Mid-Columbia region is a major pear, cherry and apple growing area in northern Oregon and southern Washington. There are about 25,000 acres of pears, cherries, apples and wine grapes in the region. Tree-fruit and vineyard growers rely heavily on pesticides for control of a variety of pests and diseases, and they primarily use airblast sprayers to apply chemicals. Airblast sprayers are visibly inefficient, releasing a large cloud of pesticide droplets subject to extensive air drift. The concern about pesticide drift is twofold, first as a threat to residential areas and second as a contaminant of streams which has huge impacts on local fish populations. There is an urgent need to evaluate new sprayer technologies that improve coverage and reduce pesticide air drift resulting from the widely used airblast sprayers.

OBJECTIVE: The objective is to quantify and compare the potential of using modified spray application practices and new sprayer technology to reduce air drift and limit off-target pesticide movement.

METHODS: A water soluble fluorescent tracer (Fluorescein, at 15 ppm concentration) and water sensitive paper were used to quantify the spray deposition on the targets. Leaves were removed from pre-defined zones of trees in rows 1-8 downwind from the spray swath (figure 1). Nylon screens of 56% porosity and known area (8"x8") were used as drift collectors. The screens were framed and mounted on wooden poles at 3 different elevations of 1m, 2m, and 3m, and at transverse distances of 15m, 30m, and 50m downwind from the spray swath (figure 2). The average height of the trees in the orchard was 2m.

Sprayers used in this study:

- 1) A traditional 500-gallon PTO driven air-blast sprayer (Air-O-Fan, Reedley, CA) with hydraulic cone nozzles (45 swirl plate, 120 PSI);
- 2) Modified version of the same air-blast sprayer with restricted airflow intake using plywood doughnuts of 1/2 and 2/3rd area of the air intake (figure 3);
- 3) Airblast sprayer with air-induction nozzles (Tejet flatfan AI110025, AI11003, AI11004, AI10002) (figure 5);
- 4) An electrostatic sprayer (On-Target Spraying System, Wilsonville, OR) (figure 10);
- 5) Two new technology tower sprayers (Protec tower sprayer, Blueline, Moxee, WA, and Hardi Arrow tower sprayer, Hardi, Fresno, CA) (figures 11 and 12).

100 GPA was used for concentrated spray trials and 200 GPA was used for dilute (dormant season, figure 4) spray trials. Samples were analyzed using a spectrofluorimeter (Model LS50B, Perkin-Elmer, Fremont, CA). Meteorological recorders (15 Channel HOBO Weather Station, Onset Computer Corp, Bourne, MA) were used to record temperature, solar radiation, relative humidity, wind speed and wind direction, to enable calculation of potential for drift, and refine recommendations about optimum conditions for application. The sprayers were assessed for their drift potential and spray coverage in the Mid-Columbia orchards. The trials identified which sprayer types and calibration options are most effective in pesticide drift reduction.

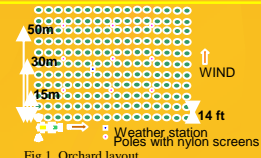


Fig 3. Plywood donuts of 1/2 and 2/3rd fan intake area.



Fig 2. Spray drift targets mounted on wooden poles.

Engine rpm	1000	1250	1500	1750	2000
Right side of sprayer	38.19	43.59	41.49	45.05	49.10
Left side of sprayer	39.16	46.53	41.25	45.02	49.09

Table 1. % Reduction in wind speed from airblast sprayer with plywood donut



Fig 4. Airblast sprayer with 2/3rd area plywood donut

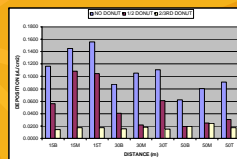


Fig 6. Drift potential from airblast sprayer with and without plywood donuts. BM and T are 1m, 2m and 3m sampling heights, respectively.

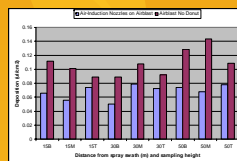


Fig 8. Drift potential of air-induction and hydraulic cone nozzles.



Fig 10. On-Target electrostatic sprayer



Fig 11. Protec sprayer



Fig 12. Hardi sprayer

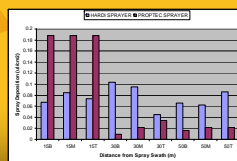


Fig 14. Drift potential - tower sprayers.



Fig 5. Air-Induction nozzles on airblast sprayer

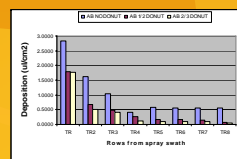


Fig 7. Spray coverage from airblast sprayer with and without plywood donuts.

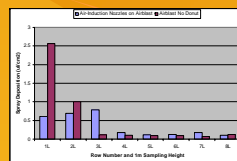


Fig 9. Spray coverage from air-induction and hydraulic cone nozzles.

	Electrostatic ON		Electrostatic OFF	
	Right side	Left side	Right side	Left side
Average Velocity	590.8	131.4	461.5	144.0
Chlorination (mg/l)	0.01389	0.00330	0.00303	0.00354
Tracer extracted (mg)	0.00430	0.00040	0.00144	0.00078
Deposition (µg/cm ²)	2.38	0.46	4.28	0.50

Table 2. Spray deposition with electrostatic on vs. off in the first two rows from spray swath.

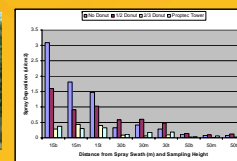


Fig 13. Dormant spray drift potential from airblast and tower sprayers.

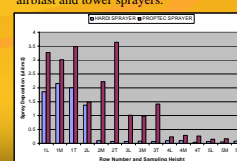


Fig 15. Spray coverage - tower sprayers.

RESULTS AND DISCUSSION: Air-stream characteristics that influence the coverage and drift include air volume and velocity. These are influenced by fan type, size, speed, volute design, etc. Meteorological parameters such as wind speed and direction, temperature, relative humidity, etc. play an important role in achieving maximum application efficiency. Most of these factors interact rather than act independently. Hence it is important to spray only when weather conditions permit as specified by the chemical labels and sprayer guidelines.

Airblast Sprayer: Spray drift is high due to the small, light-weight droplets produced. The low profile and radial airflow pattern and largely unidirectional airflow results in non-uniform spray coverage in different sections of the canopy, especially with concentrate applications.

Airblast sprayer with restricted air intake: The radial airspeeds from airblast sprayer were measured with and without plywood donuts to restrict the fan's air intake. The donuts reduced drift and enabled the spray output to be lowered to match the different growth stages of the canopy while maintaining the same tractor speed (figures 6, 7 and 15). The percentage reduction in the airspeeds were measured at different engine RPMs with and without the air-intake restriction. The donuts reduced the airspeed outputs by 40% (Table 1). Since the effect of air-stream on droplet size is proportional to velocity difference between spray and air-stream, the droplets from the sprayer with donuts were larger than the ones without the donuts and was visually evident with less spray cloud.

Air-induction nozzles: Air-induction nozzles provided less drift potential (figure 8) with larger droplets, however, spray coverage was lower than that of the conventional nozzles (figure 9). The biological efficacy of the air-induction nozzles needs further investigation.

Electrostatic sprayer: There was a difference between the charged and non-charged droplets deposition, the charged droplets had slightly higher deposition and had lower drift potential and vice-versa (table 2).

Tower sprayers: The tower sprayers (Protec and Hardi) had nozzles oriented such that they sprayed horizontally whereas the airblast sprayer sprayed upwards into the air; hence the tower sprayers had low drift potential with improved and uniform spray coverage when compared to the airblast sprayer. During the dormant season, the Protec tower sprayer had significantly low drift potential compared to the airblast sprayer. The use of plywood donuts also dropped the drift potential considerably (figure 13). Both the tower sprayers had similar and low drift potential (figure 14) but the coverage was slightly better from the Protec sprayer (figure 15). The Hardi used air-assisted hydraulic nozzles with low speed but high volume of air to transport and deliver the droplets, thus providing uniform coverage with less drift. Protec rotary atomizers use high rotational speeds (6000-10,000rpm) to produce fine droplets. The airflow is highly constricted downwind of the fan which substantially reduces the swath width. The Protec sprayer operates at low pressures in the 15-35 psi range, thus could be controlled using variable rate controllers for precision spraying.

CONCLUSIONS: This research focused on controlling pesticide drift from different sprayers at the initial point of emission (the sprayers themselves) and not rely on controlling the movement of pesticides after their release into the environment. It was found that the traditional airblast sprayer had better spray coverage but higher drift potential than the other sprayers that were tested. The Protec and Hardi tower sprayers and the modified air-blast sprayer using air-induction nozzles and low cost plywood donuts were better in terms of drift reduction. Air-blast sprayers have low profile and are inefficient, however, spray drift from air-blast sprayers can be substantially reduced by proper calibration, new nozzle technologies and spray practices.

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