

# Improving Deposition and Reducing Drift in Orchards

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Spray drift onto neighboring properties must be minimized if growers are to maintain the confidence of non-farm neighbors. Initial tests with air induction nozzles are promising to reduce drift in commercial orchards.

**D**isease and insect control is a critical factor in most commercial orchards, which is becoming more expensive. There is a demand from growers for increased efficiency of spraying. Growers are facing increases in all their input costs while commodity revenues continue to fall. Pesticide, labor and application costs continue to rise. Increasing public awareness of pesticide issues such as food safety and drift onto neighboring properties must be addressed if growers are to maintain market confidence. Legislation regarding air and water quality continues to be implemented and at considerable cost to the grower. Equally, farm safety issues need to be addressed and again require an injection of capital. Attention to detail is necessary to improve efficiency of deposition, reduce drift, and increase sprayer output.

## Drift

Spray drift of pesticides is an important and costly problem facing pesticide applicators. Drift results in damage to susceptible off-target crops, environmental contamination to watercourses, and a lower than intended rate to the target crop, thus reducing the effectiveness of the pesticide. Pesticide drift also affects neighboring properties, often leading to concern and debate. As more people choose to live in the picturesque setting of an orchard and growers continue to sell plots to increase their revenue, so the debate will continue.

Traditional airblast sprayers direct the air from a single, axial flow fan, mounted directly behind the sprayer in an upward and outward direction. Axial

fans are designed to move large volumes of air at low pressures, an increase in fan diameter rather than fan speed is a more efficient way of increasing airflow rate. Landers (2001) observed that in order to accommodate varying crop canopies, e.g. as the season progresses, many modern sprayers are fitted with adjustable pitch propellers to provide variable airflows. An adjustable deflector plate should be fitted at the top and base of the air outlet to direct the air towards, and confine it to the target canopy.

Fan size must be matched to canopy size. For example, many commercial sprayers were fitted with large diameter fans to provide enough air (volume and speed) for citrus and pecan trees. As the trend toward planting dwarf and semi-

dwarf apple trees continues so the size of fan needs to alter if deposition is to be improved and drift minimized.

Similarly, as canopy size has reduced and sprayer design improved, so pesticide application rate has decreased, for example, from hundreds of gallons per acre down to less than a hundred. When changing to high density orchards it makes sense to determine whether the same amount of material per hectare should be applied as in standard plantings. Spray deposition studies have shown significant changes in spray capture efficiency due to canopy volume and leaf area.

The Spray Drift Task Force, a consortium of 38 agricultural chemical companies, conducted many tests with

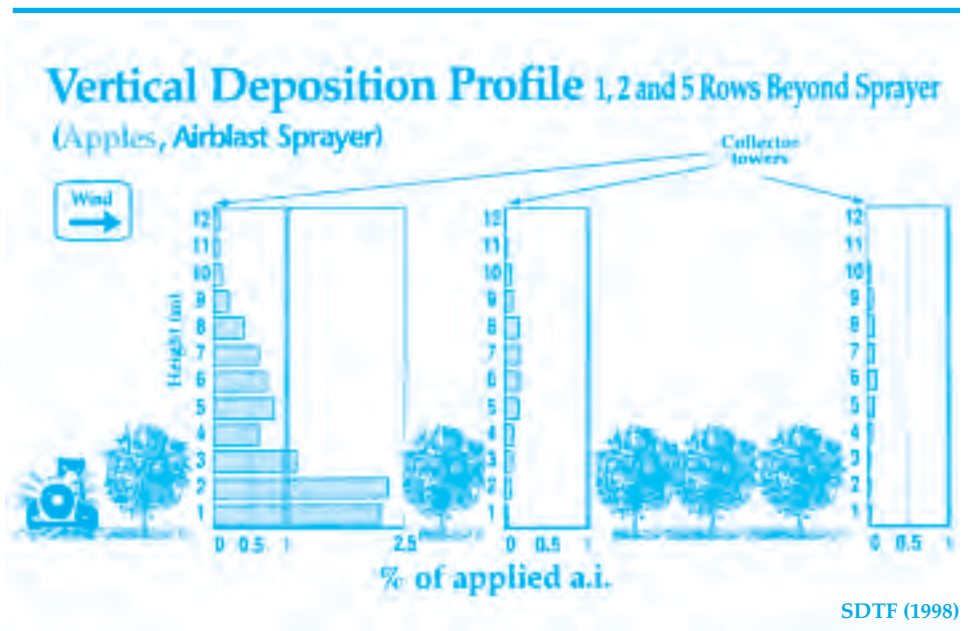


Figure 1. Vertical deposition profile apple trees in full canopy.

SDTF (1998)

airblast sprayers to provide data to support registration of products belonging to their member companies, SDTF, (1998). Results from spraying 14-foot apple trees in full canopy (Fig. 1) show that most of the spray passing the first row moved through the space under the trees. Results show that the highest amount measured was less than 2.5 percent. In comparison, when dormant trees are sprayed in a low wind speed of 4.4 mph, approximately five times more spray passes the first row of trees (Fig. 2), compared to spraying a full canopy. When high winds of 12.2 mph were experienced, 10 times more spray drift was found above the dormant trees after the fifth row than in a 4.4 mph wind (Fig. 3).

Correct adjustment of top and base deflector plates should be carried out to direct the air towards, and confine it to the target canopy. Variable pitch blades must be adjusted to vary the amount of air being delivered into the target.

Tower sprayers and tunnel sprayers are better at targeting the spray into the canopy, reducing drift and increasing deposition. Horizontal penetration into the canopy is preferable to vertical penetration from an air blast sprayer. The ultimate solution to reduce spray drift is to use tunnel sprayers. Tunnel sprayers, developed many years ago, have tremendous advantages in managed orchards using trellis designs and dwarf trees. The use of a spray collection device at the base of the tunnel canopy provides the ability to recirculate spray with subsequent savings in pesticide use and a reduction in drift.

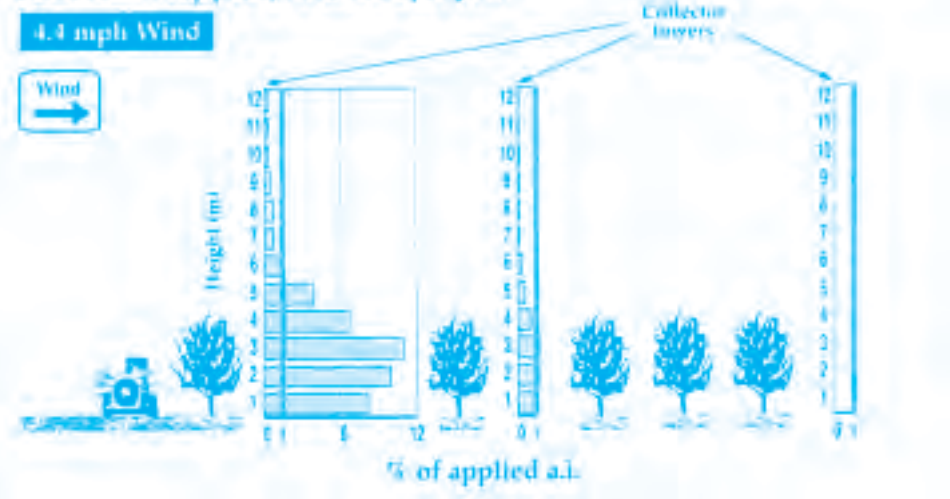
Drift problems increase when a space occurs within the row. Air blast sprayers, with or without a tower, can be fitted with ultrasonic or laser canopy sensors. The sensors also detect the shape of a tree and adjust the spray pattern accordingly. The advantages include reduced drift and ground deposition, reduced pesticide use, and improved logistics.

### Deposition

In the past, trees were drenched with high volumes and coarse droplets at 200–400 gallons per acre resulting in trees dripping with excess pesticide. The belief that too much is better than too little is misplaced. Dripping trees lead to environmental pollution such as soil contamination, and an excessive number of tank loads per acre results in poor time management.

Lower volumes must be used that

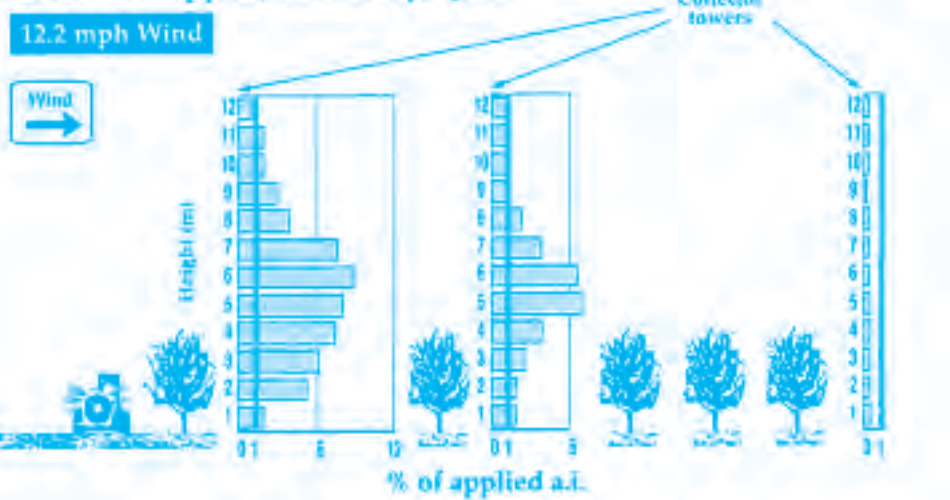
## Vertical Deposition Profile 1, 2 and 5 Rows Beyond Sprayer (Dormant Apples, Airblast Sprayer)



SDTF (1998)

Figure 2. Vertical deposition profile apple trees in dormant canopy 4.4 mph wind.

## Vertical Deposition Profile 1, 2 and 5 Rows Beyond Sprayer (Dormant Apples, Airblast Sprayer)



may result in smaller droplets, although there is a limit to droplet size because of concerns about drift. Nozzles fitted to crop sprayers produce droplets in the range of 10–450 microns. There are 25,000 microns in 1 inch. Droplets under 150 microns generally pose the greatest hazard; droplets less than 50 microns have insufficient momentum for impaction as they remain suspended in the air indefinitely or until they evaporate. Research has shown that a 100 micron droplet, about the thickness of a human hair, takes 11 seconds approximately to fall 10 feet in still air; when a similar size droplet is released into a 5 mph wind it will drift about 75 feet before hitting the

ground. Imagine the distance such small droplets will travel when launched into a 60 mph plume of air emitting from an airblast sprayer!

### Research

Current research at Cornell University involves investigating methods of improving deposition and reducing drift from conventional air blast sprayers, as they are the most commonly used sprayers in orchards in New York State. A multi-disciplinary approach is being undertaken by engineers, pathologists, and entomologists via research and extension. A novel sprayer,

while providing excellent physical characteristics, is not worthy of capital investment if it fails to provide biological efficacy.

If drift is a problem, why not increase droplet size, a practice carried out by some applicators with boom sprayers? Too large a droplet will bounce off the leaves to the ground, thus causing pollution, wasting money, and resulting in less product on the target.

Air induction (AI) or venturi nozzles are flat fan nozzles where an internal venturi creates negative pressure inside the nozzle body (Fig. 4). Air is drawn into the nozzle through one or two holes in the nozzle side, mixing with the spray liquid. The emitted spray contains large droplets filled with air bubbles (similar to a candy malt ball) and virtually no fine, drift-prone droplets. The droplets explode on impact with leaves dissipating the energy, dispersing the liquid and producing similar coverage to conventional, finer sprays. Air induction nozzles are sold by most of the popular nozzle manufacturers in the United States and were chosen as a novel, inexpensive way of reducing drift.

Trials using air induction nozzles on boom sprayers for herbicides in vineyards in Western New York produced encouraging results in 1998 and 1999, excellent weed kill occurred with no drift. If they reduce drift and have no adverse effect on deposition will they work in an airblast sprayer (Fig.5)?

Initial trials with air induction nozzles fitted to air blast sprayers in three vineyards were conducted in New York in 1999 (Landers, 2000).

Air induction nozzles reduced drift compared with the air blast sprayer on Farm A when trials were conducted on a very dull day, but drift levels increased at Farms B and C when spraying took place in high temperatures in excess of 90°F (Table 1). The finer droplets produced by the cone nozzle may possibly have

evaporated preventing them from returning to ground and the drift cards. Constant temperature and humidity is a problem when conducting field trials, and further trials are needed.

Dr. Jim Schupp, of the Hudson Valley Laboratory, Cornell University, Highland, NY, obtained the cooperation of a commercial orchard owner in the Hudson Valley. A number of rows of Red Delicious apple trees were used for our trial.

Sequestrene 330Fe, an iron micronutrient, was used as a tracer incorporated into the spray solution. Leaf samples were collected before and after each application to provide background quantities of iron and analyzed for traces of iron at Cornell University ICP analytical laboratory using an atomic absorption spectrophotometer. Sequestrene 330Fe is a safe foliar feed and was used to show where spray is deposited throughout the tree (Table 2).

Water sensitive cards were attached to the upper and lower surface of the leaves and pinned throughout the trees. Their purpose is to show where deposition occurs within the tree and upon which leaf surface.

Table 3 shows that there was no significant difference between the total amount applied between conventional and air induction nozzles although there is a difference within the location of the iron deposits. Similar results were obtained with the water sensitive paper (showing their value to researchers) and

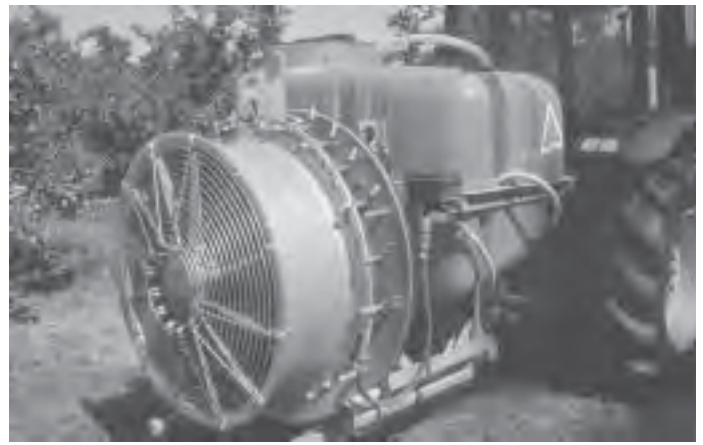


Figure 5. Air induction nozzles fitted to an airblast sprayer.

indicating which surfaces obtained the best coverage (Table 3).

We applied ReTain, a plant growth regulator. Differences between ReTain treated and untreated fruit became very apparent. ReTain treated Red Delicious were a half unit lower on the starch index and much lower in ethylene. Most of the treated fruit were still pre-climacteric and many had internal ethylene below the limits of detection on the Gas Chromatograph.

There were no differences in fruit maturity or preharvest drop with respect to nozzle type. All ReTain-treated trees had delayed fruit maturity compared to untreated controls during a 10 day period of time (which roughly corresponded to the normal harvest window).

## Conclusions

Initial tests with air induction nozzles are promising. Season-long trials are scheduled for the coming season. It will be interesting to see if they reduce insect and disease activity. Further investigations have still to be made into the ability of air induction nozzles to reduce drift in commercial orchards.



Figure 4. Air induction (AI) nozzle.

TABLE 1

Results from drift collection cards placed in New York vineyards.  
Card Area Covered %

Row from target	Farm A		Farm B		Farm C	
	Berthoud	Berthoud & A.I.	D-Wayland	D-Wayland & A.I.	Kinkelder	Kinkelder & A.I.
1	0.9	3.6	21.4	7.5	4.3	2.9
2	0.8	0.5	13.3	3.1	1.9	1.6
3	0.5	0.1	0.6	2.9	1.1	3.5
4	0.2	0	0.1	1.6	0.1	2.1
5	0.1		0.1	1.3	0	0.4
6	0		0.1	0.6		0.4
7			0	0.3		0.2

**TABLE 2****Sequestrene (Fe) deposits on Red Delicious apple trees.**

Sequestrene 330 Fe Trial Fe (ppm)		
LOCATION	AIR BLAST	AIR INDUCTION
Top	22.67	43.3
Middle	29.94	38.04
Bottom	45.97	18.65
Center	31.3	26.4
Total	129.88	126.48

In Germany, drift reduction from orchard sprayers is subject to strong legislation. Concurrent research in the area of air induction nozzles is being undertaken and their results indicate a 90 percent reduction in drift. Collaboration between the authors and German researchers at Landesanstalt für Pflanzenbau und Pflanzenschutz at Mainz is on-going.

Landers (2000b) observes that on many farms, machinery investment has been carried out on an ad hoc basis, but modern business management requires attention to detail in all sectors and machinery management is no exception. Growers must regard their sprayers as part of a spraying system rather than just

**TABLE 3****Water sensitive cards on Red Delicious apple trees.**

Treatment:	AIR BLAST		AIR INDUCTION	
Leaf surface:	Upper	Lower	Upper	Lower
Position				
Top	64.36	58.65	68.38	60.92
Middle	70.83	60.45	70.09	43.14
Bottom	80.94	38.06	36.11	28.46
Center	42.31	34.47	10.62	24.35

a machine. Growers should review the spraying operation to ensure that maximum benefit is made from the use of modern agricultural chemicals and modern sprayers. Sprayers must be well maintained, adjusted and managed according to the guidelines suggested in the *2001 Pest Management Guidelines for Commercial Tree-fruit Production* published by Cornell Cooperative Extension.

### References

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