Pesticide Reduction with Containment Spraying of High-density, Dwarf Apple Orchards

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Project Purpose

With the adoption in commercial apple orchards of fully dwarfed trees and ultra-high-density planting/training systems, containment or tunnel spraying becomes a feasible alternative to conventional airblast spraying. By spraying only within a moving canopy extending from the sprayer on both sides of the row being treated, tunnel spraying can dramatically reduce drift of agricultural chemicals to non-target areas and substantially decrease the quantity of chemical required. The potential environmental benefits are unmeasured. The quality of pest control should be enhanced, while at the same time, significantly reducing the quantity of pesticide used. A change in technology such as this can only enhance the sustainability and competitiveness of apple farming in a steadily urbanizing part of the US.

Through this project, the Massachusetts Fruit Growers' Association (MFGA) and the University of Massachusetts Fruit Program (UMass) addressed the following objectives: (1) demonstrate the feasibility of tunnel-sprayer technology in Massachusetts orchards; (2) estimate drift to demonstrate whether or not this approach will reduce environmental risk within and near orchards; (3) assess efficacy of reduced chemical application rates per acre in an effort to adjust rates and recommendations to account for much smaller tree volume per acre.

Summary of Results

The Lipco Tunnel Sprayer was delivered to the UMass Cold Spring Orchard on October 1, 2010. Hans Wörthle from H&W Equipment visited on October 19 and 20, along with a crane, to assemble the tunnel sprayer. It was tested briefly and then winterized.

Figure 1. Lipco Tunnel Sprayer at the UMass Cold Spring Orchard Research & Education Center.

Significant work with the sprayer began in April 2011. Because of the dramatic differences between it and conventional sprayers, it took time to become familiar with its operation and manipulation. First observations were: 1) the sprayer is very tall and because it is offset behind the tractor, it requires more care when driving down a tree row; 2) a wind parallel to the row can blow drift out of the front or back of the sprayer; and 3) the tunnel sprayer is much quieter than an airblast sprayer.

Using published charts relative to the fluid flow out of the sprayer nozzles, we adjusted the tunnel sprayer and an airblast

Figure 2. Rear view of a typical airblast orchard sprayer.

sprayer to deliver the same amount of material per acre. Observation suggested that the airblast sprayer resulted in much more drift, but coverage appeared better than with the tunnel sprayer. This observation puzzled us, so we measured flow out of all of the nozzles and found that the published flow rates were wrong. To obtain the desired flow, we purchased new nozzles, and selected air-induction nozzles (to increase particle size and reduce drift potential). With the new nozzles, the tunnel sprayer provided excellent coverage, with far less drift than the airblast sprayer.

Drift (utilizing water-sensitive paper) was measured on a reasonably calm day. The airblast sprayer, although calibrated well, produced some drift beyond the target trees. It was estimated to be approximately 10-20% of the spray material; this amount would be much larger on a windy day. The tunnel sprayer, however, produced no measurable drift.

To measure the relative effectiveness of spraying with a tunnel sprayer versus a conventional airblast sprayer, a study was conducted in 2012, comparing the applications of two nutrient sprays with each sprayer. A block of approximately 200 Silken trees that were trained to a tall-spindle system was used for this trial. Trees were divided among six replications of an experiment including an untreated control and calcium chloride (at the recommended rate) and an experimental formulation of calcium from Key-Plex applied with the tunnel sprayer or with the conventional airblast sprayer. Treatments were applied three times throughout the summer. Leaf samples and fruit samples were collected at the end of August. Leaf samples were submitted to the UMass Soil & Tissue Analysis Laboratory for the assessment of nutrient element concentrations. The fruit samples were submitted to the Fruit Program's Fruit Analysis Laboratory for the assessment of calcium concentrations. Unfortunately, fruit tissue results were not yet available at this writing. Leaf analyses, however, showed no significant differences between the types of sprayers, and

Figure 3. Even under nearly calm conditions, the airblast sprayer has the potential to create spray drift if it is not well calibrated.

Figure 4. Airblast orchard sprayer in operation. Spray material clearly passes through the canopy. Likely, most will fall on the trees in the next row, but if weather conditions are undesirable, this material may move into non-target areas.

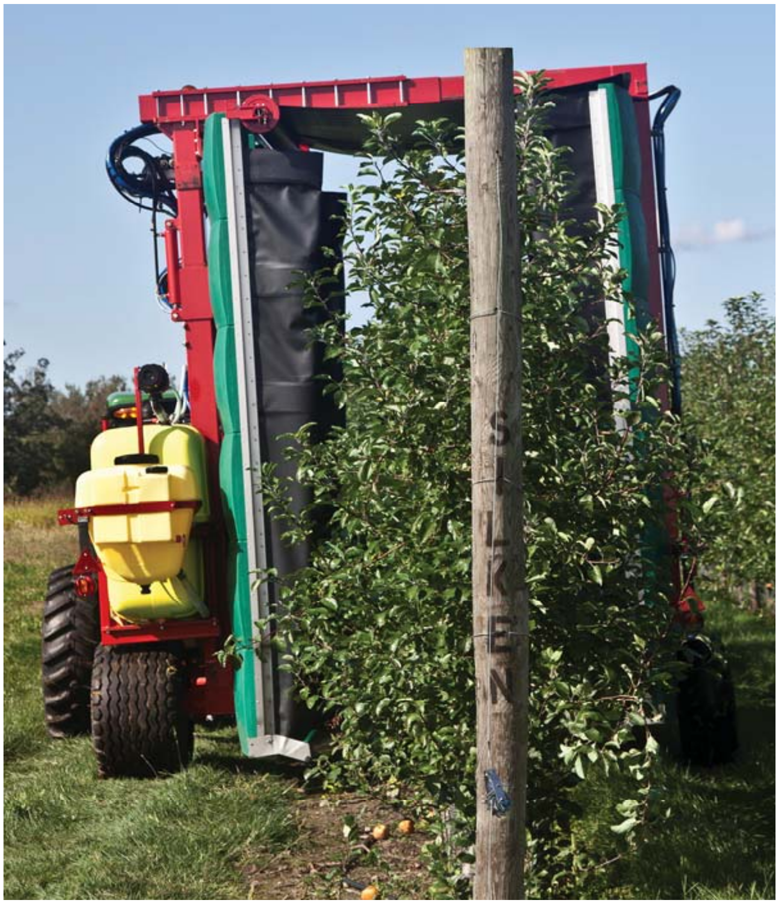


Figure 5. The Tunnel Sprayer directs material into the canopy from the outside and captures that which passes through the canopy.

the expectation is that there likewise will be no differences in the fruit samples.

Educational programs began in earnest in 2011. Details of this project have been recorded in a blog: http://masscon.blogspot.com (Massachusetts Containment Spraying Blog). Four video presentations are provided in the blog to describe progress during the early stages of the process. The blog has been visited a total of 1,579 times since its creation 16 months ago. The videos were also provided on YouTube (http://www.youtube.com/user/wrautio1) and, in total, have been viewed 3,142 times.

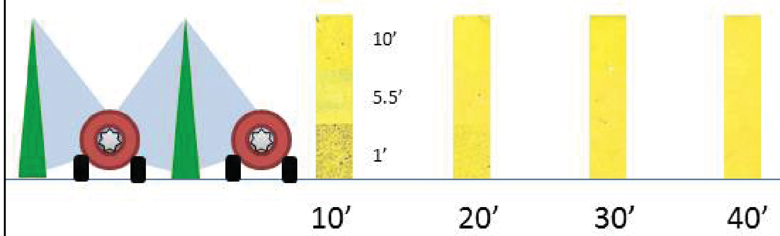
Hands-on demonstrations were conducted at twilight meetings on May 17, 2011, and April 17, 2012, at the UMass Cold Spring Orchard Research & Education Center (35 and 30 farmers in attendance in 2011 and 2012, respectively), and presentations (with video) were given at three additional twilight meetings (May 18, 19, and 26, 2011) with total attendance of 129 farmers. It also was demonstrated at the 2012 Annual Summer Meeting of the Massachusetts Fruit Growers' Association at the UMass Cold Spring Orchard Research & Education Center on July 16, 2012, with approximately 100 farmers in attendance. Small-scale demonstrations were conducted several times during the two years to a total of approximately 200 individuals.

In total, about 350 people have seen a hands-on demonstration of the tunnel sprayer. About 130 have seen presentations given in person with video demonstrations, and another 4,700 have viewed web-based presentations.

Figure 6. Water sensitive paper showing drift from the airblast sprayer (left photo) and the lack of any spray drift from the tunnel sprayer (right photo).

Drift Trial

September 26, 2011
2:00-4:00PM



Weather conditions:

Sunny, 82ºF, 65% RH
Wind: S to SW, average speed 1.75 mph, maximum 5.8 mph (row direction N-S)

The tunnel sprayer produced no measurable drift

Figure 7. The drift trial measured drift onto water sensitive paper at 1, 5.5, and 10 feet from the soil surface on posts 10, 20, 30, and 40 feet from the outer tree row.

Outcomes and Lessons Learned

1. *Sprayer is feasible under our orchard conditions. Hydraulic manipulation of the height and widths of the sprayer allows adjustment specific to tree size and slope.*
2. *Spray use is reduced by 10 to 20%, likely with no change in efficacy (the latter point still needing full verification).*
3. *Drift is nearly nonexistent with the tunnel sprayer; whereas, it is represents 10-20% of the spray material with an airblast sprayer. Environmental benefits are not easily measured but could be significant. Likewise, eliminating drift may allow farming closer to humans, without any risk of off-target exposure.*
4. *This technological advancement comes at a cost of about $30,000 per sprayer. The extra cost cannot be offset by the cost benefit of reduction in spray material. The potential environmental benefits must be weighed before deciding to purchase such a sprayer. In some settings, it may be becoming impossible to use airblast technology because of the proximity to human dwellings, and this sprayer provides an alternative.*
5. *Overall, the sprayer worked very well, performing exactly as expected. We cannot recommend it to the general grower because of price; however, we can recommend it under situations where drift is an insurmountable problem.*

Acknowledgements

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