Progress in the Development of an In-Canopy Fixed Spraying System for High-Density Orchards

A. Agnello and A. Landers
Department of Entomology, Cornell University,
NYS Agric. Expt. Station, Geneva, NY 14456

The application of pesticides to fruit throughout the US, as in the rest of the world, gives rise to concern, primarily due to inaccurate application, which often results in high residues and environmental pollution. Inaccuracy, due to over- or under-application, may result in high levels of disease or insect activity. Air and water pollution resulting from pesticide drift is a major concern. There is also a growing concern for food safety and accountability among consumers who purchase fruit. Surveys of fruit growers, based upon stakeholder input, show that evaluation of sprayers, sprayer management and fruit coverage issues are a research priority in tree fruits and apples in particular. Pesticide application to tree fruits using airblast sprayers can be inefficient and inaccurate, resulting in spray drift, off-target contamination, and ineffective pest control.

In 1998, a fixed spraying system was devised at the NYSAES in Geneva, and preliminary trials were conducted to measure its efficiency at applying pesticides and controlling insects and diseases. Spray lines were fixed to metal conduit poles at three different heights and fitted with microsprinkler nozzles. The scope of these preliminary trials was small, but results over two years showed control of diseases and insect pests was equal to that obtained with a conventional airblast sprayer, although engineering constraints prevented its practical implementation in commercial-scale plantings.

In 2005, a similar pesticide application system was devised, similar to a fixed irrigation system, in a larger-scale, 0.9-acre block of apple trees in a cooperating grower's orchard in NY. Two levels of 3/4-inch plastic tubing were positioned in-row through the canopy of the apple trees, and microsprinklers attached directly into the tubing were used to apply all of the seasonal spray materials to these trees. Over the period from midsummer to harvest, applications using the fixed-spray system appeared to protect the fruit as well as those applied with an airblast sprayer. Sprays were applied quickly and efficiently, each taking only a few minutes to completely cover all the trees in the fixed-spray plots. In-season sampling sessions revealed comparable control levels of insects and diseases in both spray treatments. Spray deposition in different canopy sectors, as measured by a dye tracer, was comparable using either method. However, although the system was functional, a number of engineering challenges and anomalies were encountered that needed to be addressed to optimize and improve system performance, and to facilitate grower acceptance and implementation on a commercial scale.

Work began in 2012 on an improved design. The system was constructed in a 1.1-acre section of a super-spindle dwarf (M.9) apple orchard in its 5th leaf, in Wolcott (Wayne Co.), NY. The system plot covers 16 rows comprising 4 varieties in 4-row sets (McIntosh, Gala, Zestar, Honeycrisp), planted on a 10-ft row spacing with 2 ft between the trees, extending 300 ft down each row. Spray nozzles are supplied by 1" diam polyethylene tubing attached to a support wire above the trees (105" height); single or double microsprayer (9.2 gal/hr) nozzles are suspended

on 8" or 28" lengths of tubing reservoirs alternating every 3 ft along the lateral tubing, and are fitted with anti-drip devices. Trials were conducted to test system operation and time requirements to fill and empty the tubing. Water was pumped from a tanker through an input manifold, filling all the tubing reservoirs (45 sec), and then compressed air at 15 psi was used to push the excess liquid through return lines and back into the tank (4.5 min). Finally, compressed air at 40 psi was used to open the check valves and spray out the liquid (9-12 sec).

Without incorporating a reservoir system into the microsprayer assemblies, approximately 3 times as much water (150 gal vs. 50 gal) would have been needed to fill and spray out the 6 rows of the system's tubing that were used in these tests. As this would have taken considerably longer, it can be concluded that the reservoir design can effect a considerable time reduction in spray operation. Field trials starting with the first sprays of the 2013 season will assess the system's efficacy in applying all of the foliar sprays, and data will be taken on effectiveness of pest and disease control, thinning, and spray coverage and distribution.

We have determined that, while this system would not be intended for all planting systems, it could be used in many of the newer high-density blocks where airblast sprayers are not the most suitable or required application method. Because drift and off-target deposition would be reduced with this method, adjacent properties and their occupants would secondarily benefit from lowered risk. Spraying an entire orchard using a fixed system could have several advantages that would justify initial establishment costs and reduce pesticide-associated risks. Spray drift would be minimized without sacrificing adequate crop protection. Pesticide application could be a much more efficient process, achievable in a fraction of the time of tractor spraying, during shorter windows of acceptable spraying conditions, and at times of the year (i.e., early season) when ground conditions may make it impractical to drive through the orchard. Because multiple sprays and re-sprays would be much easier, this enhanced efficiency would make it more practical to use lower rates of pesticides and more "least-toxic" alternative or organically approved materials that have relatively short residual effectiveness, such as botanicals, microbials, oils, pheromones, soaps, or insect growth regulators. Additionally, such a system would have in other potential non-pesticidal uses, such as in frost prevention, irrigation, and sunburn protection.

Continuing work will focus on optimizing efficiency of spray coverage and distribution using practical and economical system design considerations to encourage adoption by the fruit producing industry. In the end, we anticipate that a fixed nozzle arrangement could offer benefits in pesticide application efficiency and accuracy while maintaining crop protection efficacy and production quality in modern apple plantings.