

## **A fixed-spray system for SWD management in high tunnel raspberries**

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Spotted wing drosophila (SWD) represents a serious challenge for fruit growers in the Northeast and elsewhere. Unlike other fruit flies, SWD has the capacity to lay its eggs in ripe, marketable, soft-skinned fruit. Later maturing berries, such as blueberries, fall raspberries and day-neutral strawberries, appear to be especially vulnerable. SWD was first observed in the Northeastern region in 2010, became widespread during the 2011 field season, and in 2012 decimated fall berry crops throughout the region. Over 50% of the blueberry and bramble growers that responded to an end of season survey of small fruit growers in the Northeast conducted by Cornell University reported significant crop loss due to SWD.

High tunnels are increasingly being used for berry production in NY and elsewhere. Work by Pritts has been instrumental in the development and optimization of high tunnels for raspberry and blackberry production, showing that they perform particularly well under high tunnel conditions, with greater yields, extended harvest season, and greatly improved fruit quality. SWD represents a major economic constraint to the adoption of this profitable production innovation.

Raspberries grown in high-tunnels are particularly vulnerable to SWD. The invasion of SWD has forced raspberry growers to dramatically increase insecticide applications to produce marketable fruit, an especially significant logistical challenge for high tunnel production. Pesticides are the only practical management tools currently available to growers. To achieve a reasonable level of control, they need to be applied frequently (5–7-day spray intervals) over a long harvest period. These repeated insecticide applications are expensive (fuel and operator expenses plus the pesticides), time-consuming and sometimes not fully effective. Moreover, operating application equipment in the high tunnel environment can be very challenging. Previous work has been done in tree fruits using irrigation-type tubing fitted with greenhouse microsprinklers to deliver pesticide sprays directly to the crop canopy from a centralized pump. The supply lines are fixed on support wires within or above the canopy to optimize spray delivery and coverage.

A fixed system to apply insecticides may help mitigate a number of pest management problems in high tunnel production. Fixed sprayer systems may be particularly cost-effective in high tunnels, as the framework to support the fixed lines is already present. A fixed sprayer system would save time in the application of insecticides compared with using conventional application equipment (e.g., a backpack sprayer). Coverage, and therefore effectiveness, may also be improved with a fixed system.

In mid-July 2013, an arrangement of fixed tubing and nozzles for pesticide application was installed in each of three high tunnel (HT) systems currently under bramble production in NY: a high tunnel raspberry research planting at the NYS Agricultural Experiment Station in Geneva, a blackberry research planting at the Cornell Horticulture high tunnels in Ithaca, and a high tunnel raspberry operation at Stonewall Hill Farm (Dale Ila Riggs), in Stephentown, NY. For the raspberry systems (Geneva and Stephentown), the main supply lines consisted of 3/4" polyethylene irrigation tubing strung above the planted rows, and affixed to the cross-struts of

the HT structure using cable ties, with 1/4" micro-tubing drop lines suspended down to the plant canopy every 5' along each side of the row. Each drop line was fitted with a Netafim DAN 7000 series microsprinkler with an 8-mm orifice and a flat circular pattern spreader; each unit contained a 20-psi check valve. The nozzles were oriented laterally facing toward the row center, producing a spray profile in the vertical plane and directed slightly into the canopy. In the blackberry HT system (Ithaca), the structure was similar, but because of the higher plant density of this crop, the drop lines were suspended every 2.5' along the sides of the rows, and an additional overhead supply line was used to contact the row center from drop lines spaced every 5'; nozzles on this line were oriented with the spray profile being horizontal over the canopy. All supply lines were connected to a PVC manifold (mounted on a board near the HT entrance) fitted with an individual pressure gauge and ball valve for each line; the manifold in turn was connected to a portable wheeled greenhouse sprayer (Rear's Nifty Nursery-Cart model) with a 25-gal tank and a 3 HP gasoline motor powering a diaphragm pump. Each tunnel consisted of three planted rows, ranging from 100-120 ft in length; only a single line was operated at a time in order to optimize spray pressure along the extent of the line.

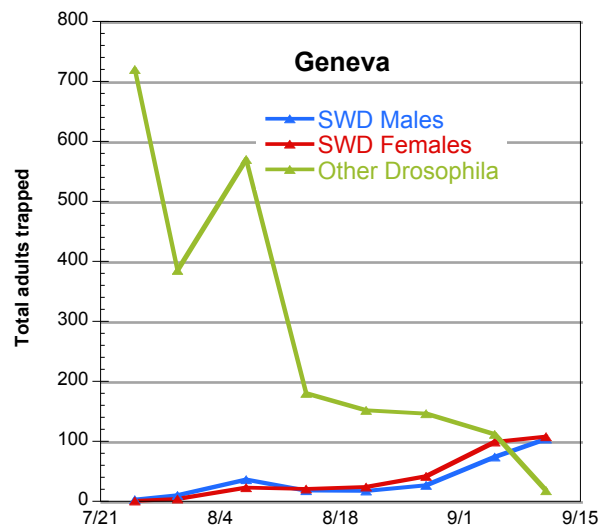
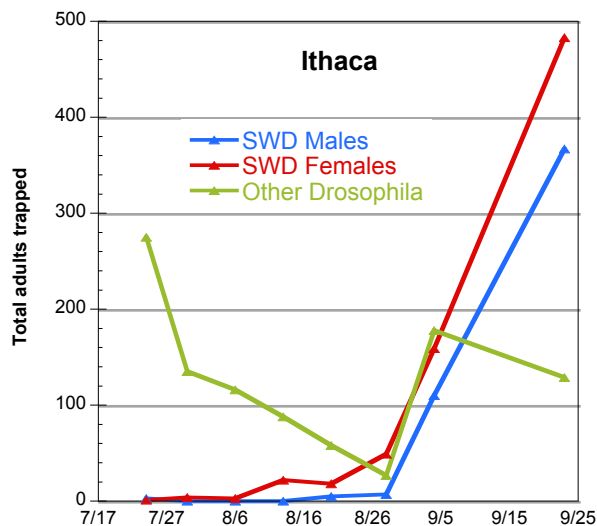


To make an application, all lines were first filled by sequentially opening each valve to receive spray solution from the pump until the line pressure reached 20 psi, or just before the check valves opened. Then, one valve at a time was opened to increase the pressure to 30 psi and spray the pesticide solution from one line, for a total application time of 30 seconds, which thoroughly wet the canopy foliage adjacent to the line of nozzles. The next line's valve was then opened as the first one was closed, to continue the process similarly until all six lines were allowed to spray; total time for priming plus application therefore required approximately 5 minutes, and took approximately 15 gal for the area sprayed (ca. 0.08 acre). To recover pesticide solution

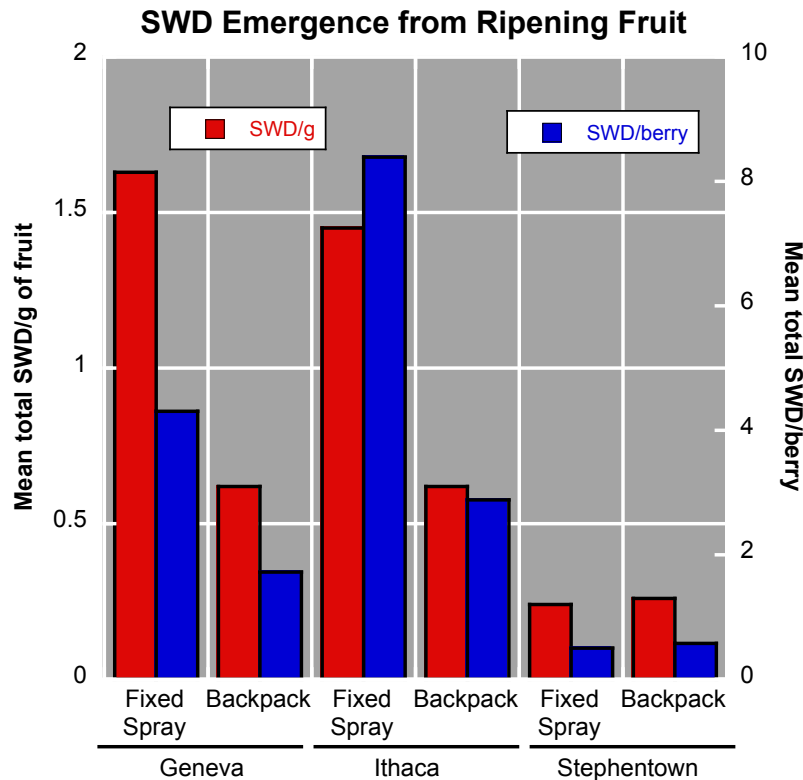


remaining in the tubing after spraying was finished, a length of hose attached to a valve on the PVC manifold drained off much of the contents of the supply lines into a container; this was used to fill a backpack sprayer for treating check rows in an adjacent HT planting not fitted with the fixed spray system.

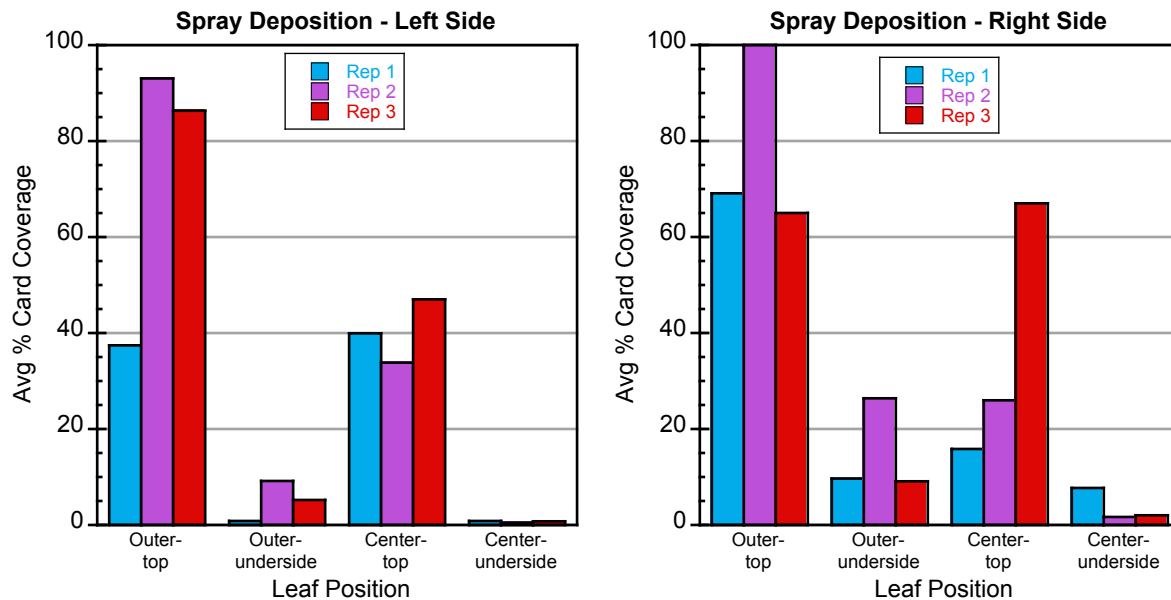
During the last week of July, SWD adult traps were deployed adjacent to the HT systems at each site to get an indication of local population pressure near each planting. Traps were plastic deli cups containing a fermented yeast+flour mixture, with apple cider vinegar as a drowning medium. Numbers of SWD adults captured were very low initially and began to increase starting in mid-August (Fig.); however, to protect the fruit from attack by undetected SWD females, preventive insecticide treatments were also started at the end of July. The two principal products used were Delegate [spinetoram] (3–6 oz/A) and Assail [thiamethoxam] (5 oz/A), to each of which was added 2 lb sugar/100 gal as a feeding stimulant. Sprays were applied weekly, and rotated on the following schedule: Delegate, 29 Jul; 19 & 26 Aug; 16 & 23 Sept; Assail, 5 & 12 Aug; 2 & 9 Sept. At Stephentown, additional sprays of Mustang Max [zeta-cypermethrin] were applied during the two weeks following the 23 Sept Delegate spray. All applications were made at dusk to minimize exposure to foraging bees.



To assess efficacy of the insecticide treatments in preventing SWD fruit infestation, samples of maturing fruit were taken weekly beginning the first week of August, and held at room temperature in the lab to rear out any larvae in the fruit to the adult stage. Numbers of samples taken ranged from 8-13 per site, each consisting of 10–20 berries (~50–100 g total), taken from both the fixed spray planting and a check planting at each site. At Stephentown, a commercial site where ripe fruit was picked nearly daily, there were generally low numbers of flies reared from the fruit, with no major difference between the fixed spray and backpack sprayer treatments (Fig.). In the Geneva and Ithaca HT systems, approximately 2.5 times as many flies were obtained from the fixed spray treatments as from the check plantings. At these sites, the ripening fruit was not harvested as frequently, and the Ithaca blackberry planting was much more vigorous, which resulted in spray coverage not being as thorough.



On 25 Sept, to measure spray deposition from the system in the fully developed canopy, water-sensitive cards were stapled onto the leaves on the outside portion of the row as well as in the inside center of the canopy, both on the leaf tops and undersides, and on the left and right side of candidate rows. The system was run for 30 seconds with water only, and video imaging software was used to assess average card coverage. Results (Fig.) show that spray coverage was highly variable, but predictably best on the outside of the canopy, and markedly better on the tops of the leaves (40-100% coverage, above the average seen in field trials) than on the undersides (1-26%). Cards in the inside center of the canopy were less well covered (16-67% on leaf tops, still acceptable levels; 1-8% on undersides).



Potential new areas of investigation next season include:

- Examining shortening the spray duration times, as it is possible the system is running too long and in effect washing off the active ingredient; changes in rates of water and insecticide may affect coverage and efficacy.
- Adding center overhead lines in the raspberry systems to improve coverage to the insides of the rows.
- Assessing spray coverage on the fruit, by using a fluorescent tracer dye.
- Examining the possibility of direct pesticide injection (dosing pump) rather than mixing pesticide solutions in the tank.
- Investigating whether there is a way to incorporate air-assist into the spray system.
- Quantifying pesticide residue levels on the fruit, or conducting bioassays using lab-reared flies to see how efficacy changes over time.
- Looking at cultural practices that might increase coverage (e.g., positioning of canes, cane pruning).

We believe that the availability of a fixed sprayer system could make growing high tunnel raspberries more feasible in the age of SWD. Fixed sprayer systems may also prove practical for smaller field plantings of high-value blueberries and raspberries. Importantly, the adoption of fixed sprayer systems for berry crops will reduce grower exposure to insecticides, as there will not be a need to travel through the planting to apply them.