INTEGRATED PEST MANAGEMENT OF SPOTTED WING DROSOPHILA WITH EMPHASIS IN HIGH-TUNNEL GROWN, FALL-BEARING PRIMOCANE RASPBERRIES

Dr. Jaime C. Piñero
State Integrated Pest Management Specialist, Lincoln University Cooperative Extension
&
Patrick Byers
University of Missouri Extension

Spotted Wing Drosophila (SWD) has very quickly become a devastating pest of berry crops in Missouri. Adults were first detected in monitoring traps in late June, 2013. By early August, infestations to blackberry fruits had already been reported. By mid August, SWD was reported infesting crops state-wide. In addition to small fruit crops, this invasive insect pest also attacks some stone fruits (cherry, nectarine, peach), high tunnel tomatoes, and wild hosts (including pokeweed, autumn olive, crabapple, nightshade, Amur honeysuckle, and wild grape). Raspberries, blackberries, blueberries, elderberries and grapes are at the greatest risk.

Integrated Pest Management options to manage SWD in high tunnels include monitoring, sanitation, exclusion, and timely application of insecticide sprays. For the 2014 season, a monitoring program for susceptible crops is recommended throughout the harvest season.

Research aimed at identifying additional management options will be conducted by the LUCE IPM Program.

SWD flies look similar to the small vinegar flies that are typically found around or on fermenting fruits and vegetables. However, unlike those native vinegar flies, SWD females have a serrated egg-laying device called ovipositor, to cut a slit into the skin of intact fruit to lay their eggs. This makes SWD a more significant pest. These crops also ripen later in the summer when the population increases, further increasing the risk.

This article discusses IPM options to minimize larval infestations by SWD to high tunnel raspberries in the fall. It is very important that farmers also learn how to identify and monitor for SWD and how to detect larval infestations. An identification and monitoring guide is available at: http://www.lincolnu.edu/web/programs-and-projects/ipm. Because SWD most likely has come to stay, successful SWD control will require planning and implementation of a program that integrates multiple components.

EXCLUSION: In high tunnels, screening may protect individual plants or crops. In Japan, extremely fine mesh with openings less than 0.98 millimeter (0.039 inches) wide (18 mesh or finer) was able to protect blueberries. If screening is used, passive venting can be problematic thus; some means of increasing air flow such as using ventilation fans will be required. Mesh screens will exclude

pollinating insects, and pollinator introduction will be needed if the crop is in bloom. Raspberries blossom and set fruit over a long period of time, especially with the primocane crop in a high tunnel, so it may not be practical to screen the crop without introducing pollinators into the tunnel. One option would be to use removable screens with Velcro allowing for attachment at fruit set and early development. If SWD is found by trapping inside the high tunnel, an insecticide application may provide SWD suppression for the rest of the season if exclusion is implemented.

CULTURAL CONTROLS: ***(i) Canopy and Water Management:*** Thin the plant row to 3-4 strong canes per square foot, eliminating weaker shoots and opening the canopy. Consider a trellising system that similarly opens the canopy. This may make plantings less attractive to SWD and will improve spray coverage. Leaking trickle irrigation lines should be repaired, and overhead irrigation should be minimized. Allow the ground and mulch surface to dry before irrigating. ***(ii) Sanitation:*** Removing over-ripe fruit from production areas as soon as possible can minimize SWD egg lay and larval development. Growers in other regions of the country have sent pickers through fields with one container to collect good fruit and another container to collect over-ripe fruit, again, to minimize egg-laying and larval development sites. This practice may better suited for small scale situations such as a tunnel. A final cleanup picking to remove the last berries from the bushes may be worthwhile. Infested fruit that remains in the field allows eggs and larvae to develop fully and, consequently, serves as a source for increased fly populations. The removal of wild host plants near production fields that could support SWD populations is another potential option. Two methods that worked well at eliminating SWD in infested fruits are bagging fruit inside clear or black plastic bags.

INSECTICIDAL CONTROL: This pest is new to Missouri so no research has been conducted within the state on most effective treatments to manage SWD. In addition, SWD populations are building in some regions of the State due to the rapid reproductive potential of this fly, so control actions ought to be taken immediately using recommendations based on findings from other states. <u>But before you spray, confirm that you have SWD in your area by placing monitoring traps or by inspecting fruit</u>. Sprays must be timed to kill adults before they lay eggs, as sprays will not control larvae already in the fruit. After spraying an insecticide, take into account that fruit may still present infestations for a few more days given that eggs and larvae that were present in the fruit before spraying were not killed. Maintain monitoring traps, and re-apply insecticides as needed in accordance with label restrictions. Always read product labels to make sure pesticides are registered for use on raspberries.

***Pesticide Use in High Tunnels*:** In the Midwest states, the pesticide regulatory agencies vary in their interpretation of whether a high tunnel is a type of greenhouse. For example, Indiana considers a high tunnel to be a form of greenhouse. That means the pesticides one selects for high tunnel use must be appropriately labeled for greenhouse use. Other states consider high tunnels to be the same as fields when it

AFTER HARVEST

Materials with longer pre-harvest intervals may be used immediately after harvest to knock back populations that will feed on any remaining overripe or dropped fruit. Residual activity has sometimes been reported to be shorter than what is listed above, so a close watch of traps for return of adults will be needed.

comes to pesticide use. In Missouri, an intermediate approach is followed: a high tunnel is considered to be a greenhouse when the sides are ***closed,*** but a high tunnel is considered a field planting when the sides are ***open.***

SPECIFIC INSECTICIDE OPTIONS. For ***conventional farmers***, the most effective chemicals are organophosphate, pyrethroid, and spinosyn classes of insecticides. Under field conditions, insecticides with fast knockdown activity have performed well at protecting fruit from SWD. Delegate 25WG and Radiant SC are reduced-risk, broad-spectrum insecticides that have been labeled for control of SWD in various crops in all states. Both products maintain populations of most beneficial insects, do not result in mite flareups , and have short re-entry (4 hours) and pre-harvest (e.g., 1 day for Radiant on strawberry) intervals. Neonicotinoids such as Provado and Actara are considered weakly active on SWD flies and are not recommended for control (MSU info). For ***organic farmers,*** Entrust (spinosad) is the only product with residual activity (5-7 days control). Organic growers in the Pacific Northwest have used 2-3 applications of Entrust to effectively protect fruit in the pre-harvest period. It is important to note that Entrust provides ~5 days residual control and Pyganic provides ~2 days of control. Note also that Entrust has a 9 oz/acre seasonal maximum (see below for more details). In some studies by Michigan State University, Azera and Pyganic were found to be weakly active options compared with Entrust (spinosad). Because the Entrust label requires rotation to another product for resistance management, then Pyganic or Azera can very well fit that need. While it doesn't appear to provide residual control, Pyganic applied at 5 day intervals at the high labeled rate has shown to reduce SWD populations in California.

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Table 1. Insecticides labeled for use in raspberries. Products are not complete listings of all available options. **OMRI** indicates an organically compatible insecticide. Where brand names or company names are used it is for the reader's information. No endorsement is implied nor is any discrimination intended against other products with similar ingredients. Read label to ensure that your product matches the site. Alternate the MoA (mode of action) of the product you choose on a yearly basis to minimize resistance build-up. For insecticides that work primarily through ingestion (e.g. spinosad), adding a small amount of cane sugar (2 tsp/gallon water) to the spray tank mix can improve results.

Class (IRAC)	Trade name	Active ingredient	REI	PHI (days)	Rate (per acre)	Comments
Carbamates (1A)	Sevin 80S	Carbaryl	12hrs	7	1-2 quarts	No more than 10 quarts/acre/year. Max of 5 applications/year. 7 day interval between applications
Organophosphates (1B)	Malathion 5EC	Malathion	12hrs	1	3 pints	Use higher rates when insect pressure is heavy. Max application rate is 3.2 pints per acre. Max of 3 applications/year. 7 day interval between applications
Pyrethroids and Pyrethrins (3A)	Bifenture	Bifenthrin	12hrs	3	8 – 16 oz.	Max of 32 oz./acre/year
Pyrethroids and Pyrethrins (3A)	Asana XL	Esfenvalerate	12hrs	7	4.8 – 9.6 fl. oz.	Max of 28.8 fl. oz./acre/year
Pyrethroids and Pyrethrins (3A)	Danitol 2.4EC	Fenpropathrin	24hrs	3	10-⅔ – 16 oz.	Max of 32 oz./acre/year 14 day interval between applications
Pyrethroids and Pyrethrins (3A)	Brigade 2EC	Bifenthrin	12hrs	3	6.4 oz.	Max of 32 oz./acre/year
Pyrethroids and Pyrethrins (3A)	Mustang Max	Zeta-cypermethrin	12hrs	1	4 oz.	Max of 24 oz./acre/season 7 day interval between applications
Pyrethroids and Pyrethrins (3A)	Pyganic EC5.0 **OMRI**	Pyrethrins	12hrs	0	16 – 64 oz.	Apply when non-targets including honey bees are least active. Pyrethrins degrade rapidly in sunlight.
Pyrethroids and Pyrethrins (3A)	AZERA **OMRI**	Pyrethrins + Azadirachtin	12hrs	0	2 Pints (32 fl. oz.)	Greenhouse and field use. Do not apply more than 1 time per day. Do not apply more than 10 times per season. Do notreapply within 3 days

						except under extreme pest pressure
Compounds of unknown or uncertain MoA	Aza-Direct **OMRI**	Azadirachtin	4hrs	0	maximum rate of 3½ pints/Acre	Greenhouse and field use. When pest pressure is heavy or plant canopy is dense, use higher rates and increase spray frequency stated in the label
Neonicotinoids (4A)	Actara	thiamethoxam	12hrs	3	2 – 3 oz.	Max of 6 oz./acre/season 7 day interval between applications
Spinosyns (5)	Delegate	Spinetoram*	4hrs	1	3 – 5 oz.	Max of 19.5 oz. /acre /season. Max of 6 applications/year. 4 day interval between applications
Spinosyns (5)	Entrust **OMRI**	Spinosad*	4hrs	1	1.25 – 2 oz.	Max of 9 oz./acre/season Max of 6 applications/ year. 5 day interval between applications

***Both spinosad and spinetoram are naturally derived substances created through a fermentation process. However, spinetoram is a mixture of chemically modified spinosyns J and L and therefore is not approved for certified organic production. Spinetoran is the active ingredient of Delegate 25WG and Radiant SC, two reduced-risk, broad-spectrum insecticides that have been labeled for control of SWD in various crops in all states. Both products maintain populations of most beneficial insects, do not result in mite flareups, and have short re-entry (4 hours) and pre-harvest (e.g., 1 day for Radiant on strawberry) intervals.**