Spotted Wing Drosophila IPM in Raspberries and Blackberries

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Input provided by the Northeast IPM SWD Working Group, 2018.

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Spotted Wing Drosophila IPM in Raspberries and Blackberries

Spotted wing drosophila (SWD) represents a major challenge to producers of soft skinned fruit crops in the northeastern US and elsewhere. Raspberries and blackberries are a preferred host for SWD and therefore especially vulnerable. The arrival of SWD in the Northeast in 2011 prompted considerable research activity to develop strategies for its management. Although more research is needed, there is enough information available to recommend a set of best management practices (BMPs) that emphasizes the use of multiple tactics including monitoring, cultural control, and chemical control.

This document summarizes BMPs with a focus on brambles. Note that brambles include red and black raspberries and blackberries, all susceptible to SWD. Production practices differ among cultivars and this may influence which BMPs are relevant. In particular, for floricane raspberries, where fruit is produced on two-year old canes in early to mid-summer, harvest may be completed prior to peak SWD populations, depending on cultivar and season, thus avoiding the risk of infestation. For primocane raspberries, where fruit is produced on new canes, fruit ripens later in the season when SWD populations are high and risk of infestations is extreme. A similar situation exists for blackberries.

About SWD and Its Impact

Scientific name: *Drosophila suzukii* (Matsumura)

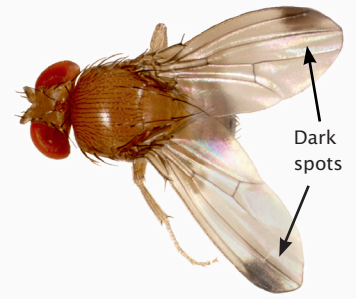
Common name: Spotted wing drosophila

Distribution: Originally from Asia, SWD is now established throughout North and South America and Europe.

Invasion: SWD was first detected in the North American continent in California in 2008 and rapidly spread north into Oregon, Washington, and western Canada, south into Florida, and now has been found in much of the USA. SWD was first reported in the Northeast in the late summer of 2011.

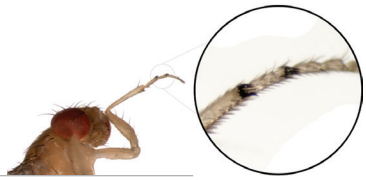
Spotted Wing Drosophila Identification

A dried specimen, male SWD. Note the characteristic dark spot on the leading edge of each wing.



Male SWD

A male SWD has two sets of "combs" on each foreleg that show up as black dots under hand lens. These help them clasp the female during mating.

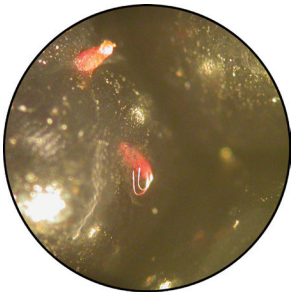


A dried specimen, female SWD. Note, she doesn't have spots on her wings.

Female SWD

The female's saw-toothed ovipositor, shown highly magnified, sets her apart from other vinegar flies and allows her to lay eggs into ripening fruit.

Above photos by Ashfaq Sial, University of Georgia; ovipositor photo at right by Juliet Carroll, Cornell University.

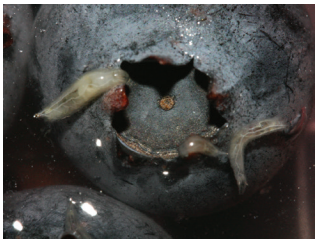


An SWD egg laid into a blackberry. Although white, the egg appears pink just below the fruit's skin in the center of this photomicrograph. SWD eggs have long, flexible breathing tubes, also called respiratory horns. The blackberry fruit's style, the remnant female part of the flower in the upper left, looks about the same size as the egg. Photo by Juliet Carroll, Cornell University.

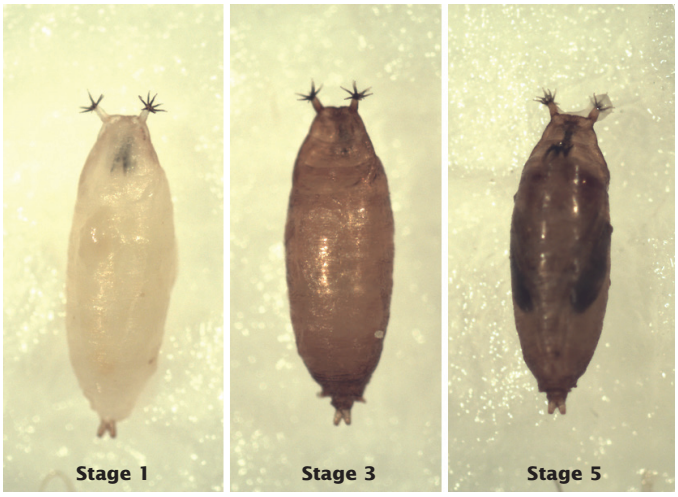
Several SWD larvae floating above hardware cloth in a salt flotation test. The different sizes are different instars; SWD has three instars. First and probably second instars are shown in this photograph. Photo by Dean Polk, Rutgers University.

These first (smallest) and third instar SWD larvae emerged from blueberries in a salt flotation test. Photo by Dean Polk, Rutgers University.

An SWD larva dissected from fruit. On the right, the black lines inside the mouth are the mouth hooks used to macerate and feed on fruit. Photo by Dean Polk, Rutgers University.



Larvae of SWD emerging from blueberry fruit immersed in salt water. These are probably second (smaller) and third (larger) instars. Photo by Dean Polk, Rutgers University.



The earliest stage of the SWD pupa, stage 1, is pale colored. The appendages on the head-end look like stars. As the SWD pupa ages it darkens to a tan color, stage 3. As the SWD pupa nears complete development of the adult within, stage 5, the wings start to show through as darker areas along the sides. Photos by Dara Stockton, Cornell University.

This live male SWD, grown in a lab, pauses for the camera. Wing spots will darken as he ages. Red eyes, a golden brown body, and clear iridescent wings distinguish this vinegar fly. Plus, it's slightly larger than common vinegar flies (a.k.a. fruit flies) (*Drosophila melanogaster*) that invade our kitchens in late summer. Photo by Elvira de Lange, Rutgers University.

In 2012, SWD first appeared in late June/early July, causing widespread injury to berry crops. A similar pattern was observed in 2013 and 2014.

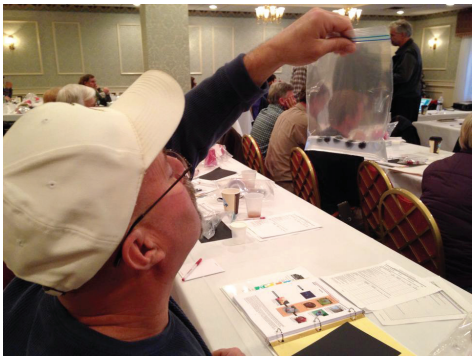
Susceptible crops and wild hosts: On a diversified farm where several susceptible crops are grown, it may be more challenging to control SWD. The timing of fruit harvests and the fruiting season of wild hosts should be tracked in order to better time and optimize SWD management on all crops being grown on the farm.

Brambles are particularly susceptible, especially fall-bearing cultivars. Blueberries are also a preferred crop host, with later-maturing varieties more vulnerable than early season varieties. Female SWD lay eggs in blueberries from the time of first coloring through harvest. June-bearing strawberries are less susceptible to injury than day-neutral varieties harvested later in summer. Elderberries are also susceptible as well as cherries and plums. Nectarines and peaches can also be attacked if permitted to tree ripen, and under a low-spray management system. Some thin-skinned cultivars of grapes are also vulnerable, though most are not. However, damaged grapes are susceptible to SWD and other drosophilids, often exacerbating problems with sour rot. SWD uses the fruit of a number of wild species of plants to reproduce in mid to late summer such as dogwood, bush honeysuckle, wild Ribes, buckthorn, and pokeweed.

Potential for economic impact: SWD has caused significant impact, especially for mid-summer and later-maturing fruit when populations tend to increase. Risk of marketing fruit contaminated with SWD larvae can be high, resulting in re-

A berry grower examines SWD specimens with a hand lens at an SWD Workshop. Photo by Juliet Carroll, Cornell University.

During an SWD Workshop, a berry grower tries out a hand lens for on-farm use to identify SWD and the damage it causes. Photo by Juliet Carroll, Cornell University.



Checking fruit for SWD larvae with salt flotation at an SWD Workshop—it's easy for this berry grower. Photo by Juliet Carroll, Cornell University.

jected shipments and consumer complaints. Growers have resorted to frequent pesticide applications thereby increasing economic and environmental costs as well as disrupting established IPM programs.

Identification and biology: SWD looks superficially like your everyday vinegar fly, *Drosophila melanogaster*, of genetics fame, but vinegar flies are generally not a serious economic threat to fruit growers. Female vinegar flies typically lay eggs in damaged and/or overripe fruit and hence, are mostly just a nuisance. On the other hand, female SWD have very robust ovipositors (the rear end portion of the fly used for egg laying) and lay their eggs in ripening and ripe, marketable fruit before it is harvested, leading to damage and contamination with larvae.

Adult SWD are 2–3 mm in length, with red eyes, a tan-colored body with darker bands on the abdomen. Males have characteristic single spots at the leading edge of the tip of the wing and two dark stripes on their front legs. Females lack wing and leg spots, but are distinguished by the robust, serrated ovipositor (visible under magnification). There are three instars of larvae, which are white, nondescript and legless maggots, about 0.5 to 2 mm long.

Development rate is dependent on temperature, the optimal range falling between 68°F and 77°F; so cool temperatures in the spring will result in longer periods between life stages and warm temperatures in the summer will result in shorter periods between stages. Very hot temperatures and very cold temperatures will also slow the rate of development. Adult flies live for 30–60 days and a female can lay as many as 380 eggs in her lifetime.

SWD is most abundant from mid-summer through the fall in the Northeast. Surveys for adult SWD indicate they are at very low numbers in the spring (usually undetectable), first appear in mid-June, and build through the summer, peaking in August and September. Later in the fall in response to lower temperatures and shorter days, adult SWD cease to reproduce. To what extent SWD successfully overwinters in the Northeast is under investigation, but results so far indicate that very few make it through the winter in a normal year. Adults do overwinter in slightly warmer areas such as New Jersey.

- Spotted Wing Drosophila Identification Guide – Michigan State University (http://neipmc.org/go/swdmsu)
- Identifying *Drosophila suzukii* – Oregon Department of Agriculture (http://neipmc.org/go/swdoda)

Best Management Practices for SWD on Brambles in the Northeastern USA

SWD presents a major economic threat to bramble production in the northeastern US and elsewhere. There are management practices, however, that can be used to help reduce its impact. Below we present information on management practices that, based on our current research results, can be used to mitigate the impact of SWD on brambles. Recommended practices include monitoring, cultural methods, and chemical control methods.

Monitoring Thresholds

None established. Because there is no economic threshold for SWD, we are currently recommending a conservative approach. Any fly capture on your farm triggers protection of fields if berries are at a susceptible stage. If fruit are ripening or ripe and SWD flies are trapped, growers should: 1) continue monitoring to assess SWD distribution, 2) implement cultural controls where possible, 3) protect fruit through to harvest using registered insecticides, and 4) consider post-harvest controls including temperature treatment and soft-sorting machinery.

A trap for monitoring SWD. In the jar hangs a plastic bag containing a gel that releases an attractant odor drawing the SWD in through the small holes. The jar has drowning solution of water and a drop of unscented soap that captures the SWD. The red and black contrasting colors attract SWD, as well. Many types and designs of traps are available. Place traps in a shaded location. Photo by Juliet Carroll, Cornell University.

Monitoring Adult SWD

Monitoring adult SWD using baited traps can be helpful in deciding on when to initiate control tactics, although its usefulness in brambles is dependent on cultivar and when fruit ripens to become susceptible. It makes the most sense for floricane raspberries, which ripen in mid-summer before SWD populations are very high. Adult monitoring can provide a heads-up of infestation risk. Note that it is best to learn to identify the female SWD since females are often captured before the more obvious males are captured. However, monitoring for males can prove useful when keeping in mind that females may have arrived already once males are caught. Adult monitoring is not very helpful for primocane raspberries that ripen in mid to late summer when SWD populations are already well established.

Traps baited with an actively fermenting yeast plus whole wheat flour solution placed in a separate, screened holding container within a larger trap that includes a drowning solution of apple cider vinegar plus a drop of unscented soap have proven fairly successful in capturing adult SWD (instructions can be found here: http://blogs.cornell.edu/newfruit/files/2017/01/SWDTraps_CornellFruit-1vwi4oo.pdf). Alternatively, and less messy, one can use a bait container with ½ tsp yeast and 2 tsp sugar in 2 fl. oz. water. Synthetic lures (one manufactured by Scentry and another by Trécé) are available through IPM supply companies. Results in 2016 indicate the commercial lures work about as well as the homemade fermenting bait lure and have the added advantages of lasting six weeks and using water plus a drop of unscented soap for the drowning solution.

Traps should be frequently checked, daily or at least once per week; see fact sheets for details on servicing traps. Daily checking of traps results in fewer fruit flies to sort through to find SWD. Although the commercial synthetic lures with water drowning solution are more selective than the fermenting baits, the lures are not very specific for SWD and therefore capture many different fruit flies and other insects. Research is ongoing to improve trap efficiency and develop a better early warning system.

Monitoring for Fruit Infestations

Monitoring for SWD larvae in ripe fruit is recommended for all brambles on a regular (at least weekly) basis. This provides producers with real-time estimates of infestation risk and possibly information on the effectiveness of SWD management practices. Suspicious fruit can be inspected for larvae by performing a salt flotation, which will cause lar-

As SWD larvae feed on the raspberry, juice leaks out, and it slumps off of the fruit receptacle.

A raspberry hangs off the receptacle, attached by the dissolved area of fruit where SWD were feeding.

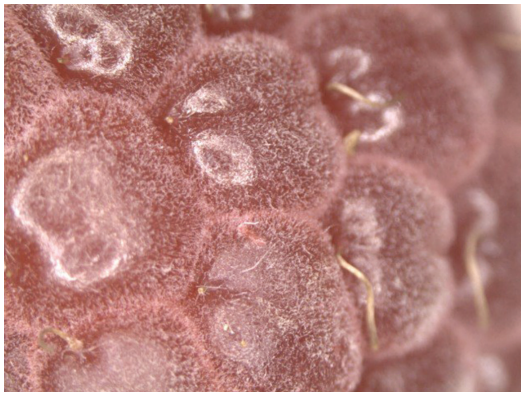
In raspberry, a characteristic symptom of SWD infestation is when the fruit receptacle, normally cream colored, becomes stained reddish pink with juice, which leaks out of the fruit in response to larval feeding.

Photos by Juliet Carroll, Cornell University.

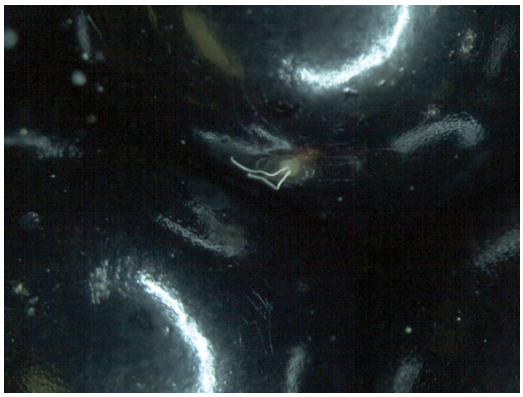
vae to emerge from fruit. All methods use a saturated salt solution made from 1 cup (236 cc) table salt to 1 gal (3.8 liters) of warm water. This solution will kill the larvae. Results of the tests can be either: 1) yes/no SWD found, or 2) a count of SWD larvae can be quantified as, for example, 43 larvae/100 fruit. Quantifying SWD counts will provide an indication of SWD population growth or decline and a perspective on whether control measures are working.

In large-scale commercial fields, at least 1 quart of fruit or at least 100 fruit per block per harvest should be observed for infestation. A suggested method used in the Pacific Northwest was adapted for small-scale growers in "Guidelines for Checking Fruit for SWD Larvae in the Field" (http://blogs.cornell.edu/newfruit/files/2017/01/SaltFloatation-2kmt284.pdf). In this method it is easiest to see second and third instar (half to full-grown) larvae.

Devastation! That's what the nearly invisible SWD infestations can cause when, what appears to be perfect fruit is harvested, and a few days later third instar larvae emerge. Photo by Sue Gwise, Cornell University.



Difficult to see on the fuzzy raspberry surface, even in this close-up view, are the delicate, white filaments of the breathing tubes on the SWD egg, which lies just under the fruit's skin. The long, tan structures are the leftover flower styles—the female parts of the plant. Photo by Faruque Zaman, Cornell University.



In this close-up view of a blackberry, the delicate, white filaments of the breathing tubes, two per egg, can readily be seen against the glossy, black fruit. Photo by Faruque Zaman, Cornell University.

Another salt flotation method that is also fast and will isolate half grown or larger larvae (second or third instar) requires more equipment and may be easier to do indoors. Use a standard sample of 1 qt (~1 liter) of fruit per monitored field. You could use 1 pint (~0.5 liter) if you have a small planting. Place the field run, unsorted fruit sample in a shallow 8 × 12 in baking pan, and pour over 2 qt (2 liters) of warm salt water. Place a ¼″ (6.4 mm) mesh hardware cloth that has been cut to fit the pan, over the berries and press down to gently massage the fruit to break the skins, without mashing them up. Place two pieces of round steel bars on top the hardware cloth to weight down the fruit, and then wait about 10 minutes for any maggots to float to the surface.

A more accurate method, the filter method, takes a little more time, but will isolate even the smallest larvae and eggs. Use the same amount of fruit as above and place in a 2 gal Ziploc bag (or into two 1 gal bags). Gently press the berries to break the skins. Add salt water to cover the fruit in the bag(s), squeezing out the air to keep berries immersed, and stand the bags for about one hour in a plastic tub so they are upright. Bend a piece of ¼″ hardware cloth in a large funnel, and pour the contents of the bag through the funnel into a reusable stainless steel coffee filter. Then rinse the empty bag and berries with a sprayer to wash off any remaining larvae into the stainless steel coffee filter. Use a strong hand lens or a dissecting microscope to count the larvae caught in the coffee filter. This method is detailed in: Van Timmerman, S., Diepenbrock, L.M., Bertone, M.A., Burrack, H.J., Isaacs, R. 2017. A filter method for improved monitoring of *Drosophila suzukii* (Diptera: Drosophilidae) larvae in fruit. *Journal of Integrated Pest Management*. 8(1):23; 1–7.

Fruit that appears sound but from which leaking juices are noticed can be a sign that SWD may be developing in the fruit. Dried drops of juice seen on leaves below a fruit cluster or on fruit in the field are also signs of possible SWD infestation, especially if no bird damage, cracking, or other obvious signs of damage are seen on the fruit.

Exclusion netting supplements this high tunnel where raspberries are being grown. The 0.95 mm × 0.95 mm (80 gram weight) insect netting prevents SWD from gaining entry to the high tunnel. Care must be taken to prevent gaps and to exclude SWD when entering and exiting the high tunnel. Photo by Laura McDermott, Cornell University.

To hold down the exclusion netting on a frame, a spring wire channel lock system works well, as shown. Photo by Greg Loeb, Cornell University.

- Recognizing Fruit Damaged by Spotted Wing Drosophila, *Drosophila suzukii* – USDA (http://neipmc.org/go/swdusda)
- Recognize Fruit Damage from Spotted Wing Drosophila (SWD) – Oregon State University (http://neipmc.org/go/swdosu)

Cultural Practices

Good sanitation is very important. Try to prevent the buildup of ripe and overripe fruit through clean picking and frequent harvests. Pruning plantings to create a more open canopy may help reduce habitat suitability for SWD adults and improve insecticide coverage. Fruit crops that mature earlier in the season may likely escape major damage.

A male SWD on blackberry can be seen near the center of the photograph. Another male stretches his wings while standing on a stem at left. Photo by Juliet Carroll, Cornell University.

1. Resistant cultivars. Plant resistance is a key component of pest management but unfortunately, all brambles are generally susceptible to SWD. The one aspect that varies among cultivars that does affect risk is time of fruit ripening. As noted above, those cultivars that ripen fruit early in the growing season may be at less risk. However, this may depend on where you are located in the Northeast, because in the mid-Atlantic states or after unusually mild winters SWD may arrive very early in the growing season, placing early, floricane varieties at risk.

2. Sanitation. Excellent sanitation will reduce SWD populations. Fruit should be harvested frequently and completely to prevent the buildup of ripe and overripe fruit. Unmarketable fruit should be removed from the field and either frozen, "baked" in clear plastic bags placed in the sun, or disposed of in bags off-site. This will kill larvae, remove them from your crop, and prevent them from emerging as adults. If there is a large pile of cull fruit, these can also be solarized by placing 1–2 mil clear plastic sheeting over the pile in a sunny location and sealing well around the edge using soil. If possible, remove leftover fruit in waste piles to reduce SWD food resources.

3. Canopy, weed, and water management. Canopy, weed, and water management will make the environment less favorable for SWD. Prune and thin the planting to 3–4 canes

Inside the exclusion netting over a blueberry planting. SWD infestation can be kept to a minimum without insecticide sprays, provided no SWD get inside. Therefore, monitor for SWD inside the exclusion net, with traps and fruit sampling. Photo by Greg Loeb, Cornell University.

per square foot of row to maintain an open canopy, increase sunlight, and reduce humidity. Leaf removal on the lower foot of canes, mowing and eliminating weeds in this area reduces the shady, moist area near the ground, which can provide an optimum environment for SWD. This will make planting less attractive to and/or less hospitable for SWD and will improve spray coverage. Incorporating an upright V-trellis system allows better exposure to insecticides than most other trellis systems where floricanes are internal within the canopy. For more information specific to pruning and training brambles, see the SWD blog, "Pruning Caneberries to Minimize SWD Habitat within the Planting," June 2017 (http://blogs.cornell.edu/swd1/2017/06/27/pruning-caneberries-to-minimize-swd-habitat-within-the-planting/). Repair leaking drip lines and avoid overhead irrigation when possible. Allow the ground and mulch surface to dry before irrigating. Higher catches in traps adjacent to fields where they remain wet longer, or are adjacent to creeks have been observed. Improving drainage, fixing irrigation leaks, and understanding what makes potential hot spots can all aid in SWD management.

4. Row covers to advance fruit ripening time of primocane raspberries. Fall raspberries can be encouraged to fruit earlier by placing row covers over the rows after they are mowed in spring and to leave the row covers on for about 6 weeks. Once primocanes are about 18 inches tall, row covers can be removed. Primocanes will flower about two weeks earlier using this method, and a significant amount of fruit may be harvested before SWD populations become unmanageable.

5. Exclusion netting. Research indicates that fine mesh netting (less than 1 mm in diameter) can be used to cover berry plantings and exclude SWD adults. In blueberries, where most of the research has been conducted, exclusion netting has minimized SWD infestation at a commercial scale for several seasons. See the following summary of the blueberry research, Riggs, D.I., Loeb G., Hesler, S., and McDermott, L. 2016. Using insect netting on existing bird netting support systems to exclude spotted wing drosophila (SWD) from a small scale commercial highbush blueberry planting. NY Fruit Quarterly (24):9–14. (http://nyshs.org/wp-content/uploads/2016/10/McDermott-Pages-9-14-NYFQ-Book-Summer-2016.pdf). Research is also being conducted to test the use of netting over brambles with some initial success.

6. Regular fruit sampling. Talk to your local cooperative extension agent about a monitoring program. Fruit can be inspected for evidence of larval feeding. Small holes in berries where the eggs were laid may leak juice when the berry is gently squeezed; this is especially diagnostic on blueberry. Fruit with small indents or bruises where the berry surface appears to have flattened or deflated may be damaged. Use salt flotation to check fruit for larval infestation. Suggested methods can be found above under, "Monitoring for Fruit Infestations."

7. Cleaning up an infestation. If an infestation is found, it is possible to "reset" the field by picking off every berry that pulls off and disposing of this fruit (see under sanitation). The field is then treated with insecticide to protect subsequent fruit that ripens.

8. Post-harvest practices. Cool berries immediately. Chilling berries immediately after harvest to 32°F–33°F will slow

A well-managed raspberry field will reduce SWD risk—manage weeds, mow row middles, practice sanitation. Pruning to thin the canes will reduce humidity, increase sun penetration, and increase heat: conditions less favorable for SWD. Photo by Rufus Isaacs, Michigan State University.

or stop the development of larvae and eggs in the fruit. The use of forced-air cooling will improve shelf life and reduce the berry temperature rapidly, thus slowing SWD development. U-Pick customers should be encouraged to follow this strategy to improve fruit quality at home by refrigerating fruit.

9. Stay informed. Recommendations are subject to change based upon new information. Keep in touch with your local cooperative extension office with any questions.

Chemical Control

To manage SWD effectively on mid- to late-summer ripening brambles without the use of exclusion netting, insecticides will be needed. There are six key factors that play into the decisions about when and what to apply when insecticide use is considered: 1) SWD has been caught in the area; 2) the crop is susceptible; 3) the fruit is ripening, ripe, or harvest is underway; 4) SWD larvae have been found in fruit; 5) the need to protect pollinators from insecticides; and 6) the market destination. Some export markets do not allow insecticide residues of the same types or levels as allowed in the US.

Many states have SWD monitoring programs or you can monitor for SWD. Servicing SWD traps and scanning through the insects caught in the traps is time-consuming and tedious. Traps in a local area or county region can provide some sense of whether SWD is on your farm. Recent research estimated a trap sample should cover about 6.7 acres. Therefore, it may be best to routinely sample fruit using the salt flotation method, especially if you have a large farm or do not trap with this intensity.

Brambles are susceptible to infestation from the time when fruit begin to color, with susceptibility increasing as ripeness increases. Insecticide applications aren't needed if there are no ripening fruit in the field.

Many of these insecticides have a short pre-harvest interval (PHI), but reentry and picking might still be problematic if the planting is open for U-Pick seven days per week. For U-Pick operations, it may prove helpful to close off an area and not allow entry within the PHI after treatment, or to close for 1 day per week when treatments can be applied and the PHI observed. For fruit destined for a processor there may be zero tolerance for SWD infestation. This can create significant challenges when trying to reduce the number of insecticide applications. If infested fruit is detected via salt flotation, it may be possible to completely harvest all ripening fruit, spray an insecticide to protect the developing fruit and maintain insecticide protection while the next flush of fruit ripens.

Numerous insecticides are labeled for SWD control, including several that have recently received 2(ee) recommendation approvals. Check with your local cooperative extension service for products labeled against SWD. Chemical control primarily targets the adults but recent research shows that some materials also kill young larvae already inside the fruit. Due to SWD's high reproductive rate, short generation time, and mobility it is generally necessary to apply insecticides multiple times (at least weekly) during the harvest season.

Insecticides that are effective and labeled for use on brambles are organophosphates, carbamates, pyrethroids, spinosyns, and diamides. It is important to rotate insecticides with different modes of action (MoA, IRAC group, see next paragraph on pesticide resistance management) to prevent insecticide resistance from developing in SWD. Insecticide registration status changes yearly, so always check the label to verify it can be used on brambles. For instance, specific insecticides for SWD in brambles are listed in the Cornell Pest Management Guidelines for Berry Crops, cropandpestguides.cce.cornell.edu, which is updated yearly.

Pesticide Resistance Management

The arsenal of pest management products for berry crops in the US (and New York in particular) is relatively small compared to other large acreage crops such as wheat, corn, soybeans, potatoes, etc. Given the smaller complement of products available for berry insect management, it is imperative for growers to use them wisely to prevent development of resistance in berry insect and mite populations as well as to prevent exceeding maximum residue limits (MRLs) for fruit exported to other countries. Resistance occurs when an insecticide or acaricide (miticide) is overused or misused against a particular pest species. These improper usages lead to selection of resistant forms of the pest, which then dominate the population over time, shifting it from susceptible to resistant. Not only does resistance develop to the specific product that has been overused or misused, it also develops to other products with the same mode of action (MoA, similar mechanism of toxicity or control on the pest species). To prevent or delay the development of resistance in pest populations it is advisable to use alternations, sequences, or rotations of products from different IRAC (Insecticide Resistance Action Committee) MoA groups. In all cases, be sure to follow label instructions.

Behavioral and Biological Control

Research characterizing attractants and repellents for attract-and-kill and push-pull technologies, testing biopesticides, and identifying insect parasitoids and predators for managing

SWD is underway. The use of hummingbird enrichment in berry plantings has shown promise, providing, in one study, a 59% reduction in SWD adults caught in the hummingbird feeder zone.

Resources

1. Michigan State University: http://www.canr.msu.edu/ipm/invasive_species/spotted_wing_drosophila/

2. Raspberry and Blackberry Production Guide for the Northeast, Midwest, and Eastern Canada (NRAES-35). Download a free fair use PDF copy at http://host31.spidergraphics.com/nra/doc/Fair%20Use%20Web%20PDFs/NRAES-35_Web.pdf

3. For assistance with diagnosing raspberry and blackberry problems, use the online Berry Diagnostic Tool at http://blogs.cornell.edu/berrytool/ or contact your local cooperative extension office for assistance.

4. Noncrop Host Plants of Spotted Wing Drosophila in North America – Michigan State University: https://www.canr.msu.edu/ipm/uploads/files/SWD/em9113.pdf

5. Guidelines for Checking Fruit for SWD Larvae in the Field – Cornell University: http://blogs.cornell.edu/newfruit/files/2017/01/SaltFloatation-2kmt284.pdf

6. SWD Distribution Maps are available as well on the Cornell Fruit Resources Page (http://fruit.cornell.edu/spottedwing/distribution/), which includes a map of New York with confirmed trap captures according to county.

7. SWD Resource Database from the Northeastern IPM Center: http://neipmc.org/go/searchswd

8. Spotted Wing Drosophila fact sheet – NYS IPM Program: https://ecommons.cornell.edu/handle/1813/42883.3

9. Cornell Fruit Resources: Spotted Wing Drosophila (SWD): http://www.fruit.cornell.edu/spottedwing/

10. Spotted Wing Drosophila blog – NYS IPM Program: http://blogs.cornell.edu/swd1/

11. Spotted Wing Drosophila: A Key Pest of Small Fruits in New Jersey: https://njaes.rutgers.edu/fs1246/