Spotted Wing Drosophila, *Drosophila suzukii*

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INTRODUCTION

Spotted Wing Drosophila (SWD), *Drosophila suzukii*, is an invasive insect pest of raspberries, blueberries, blackberries, grapes, and stone fruit. SWD is native to Asia and was first found in California in 2008. It has spread to most of the primary fruit growing regions in the U.S., and in August of 2012, SWD was confirmed in Ramsey, Hennepin, Anoka, and Olmsted Counties of Minnesota. Since 2012, SWD has spread throughout Minnesota and has now been detected in virtually all of the counties in the state. To date, the primary crop attacked has been raspberry and blueberry but strawberries, grapes and wild blackberries were also found to be infested.

**BIOLOGY**

SWD adults look very similar to other small vinegar flies you might occasionally see flying around overripe bananas on your kitchen counter that are typically referred to as fruit flies. However, unlike these other flies, which typically feed on overripe or deteriorating fruit, SWD can feed on healthy, intact, ripening fruit.

SWD females have a unique, serrated ovipositor (used to lay eggs, Fig. 2) that can puncture the skin of many berry species, lay 3 or more eggs per berry, and thus produce numerous larvae (white maggots) per berry.
The larvae feed within the fruit causing brown, sunken areas. The larvae will then leave the fruit to pupate and later emerge as adults (Fig. 3). One generation, from egg to adult, may occur in as few as 7-10 days, depending on temperature. Therefore, multiple generations of SWD can occur in a year, with populations building throughout the summer. The overwintering stage of SWD is the adult and its ability to survive Minnesota winters remains unknown.

**DAMAGE**

SWD has become one of the most damaging, invasive pest species we have dealt with in Minnesota. As previously stated, SWD larvae feed on healthy, intact, ripening fruit. In particular, SWD feeds on thin skinned, soft fruit such as raspberries, blackberries, blueberries, strawberries, grapes, plums and cherries (Fig. 4). It is possible that symptoms of larval feeding won’t appear until after the crops are harvested and sometimes not until the fruit is in possession of the consumer. In addition to the damage caused directly by the larvae, the feeding makes the fruit susceptible to infestation by other insects and rot fungi and bacteria.

**MANAGEMENT**

Susceptible types of fruit typically become susceptible to SWD infestation at first coloring through harvest. SWD can also lay eggs in over-ripe fruit, making sanitation for this pest a key as well. This window of susceptibility, where fruit is ripening, is where management action should be focused. If SWD flies are present in traps, or larvae are found during the susceptible window, the available management options will depend on several factors including the level of infestation, management approach (e.g. organic or conventional), and the timing relative to harvest date.

Currently, there is no economic threshold that has been established for SWD, so a conservative approach is to use fly capture on your farm, or regional SWD trap data, as an indication of early activity, and to initiate protective measures if SWD is present and berries are at a susceptible stage. If fruit is ripening or ripe and SWD flies are trapped, growers should: 1) Implement cultural controls where possible, and 2) Protect fruit until harvest using registered insecticides.
Monitoring

Critical to implementing an Integrated Pest Management (IPM) program for SWD is development of an effective monitoring program on your farm. Monitoring should occur from flowering until the end of harvest. This allows the grower to identify the start and end of fly activity, although the most critical time period to monitor is when fruit color first starts to develop until the crop is harvested. This is when the fruit are susceptible to SWD infestation.

Adult SWD flies can be trapped using commercial or homemade traps. Commercial traps from Scentry (uses water + soap) and Trece (uses apple cider vinegar), both using a lure and drowning solution, are available from Great Lakes IPM. Instructions for making your own trap are available on Oregon State University’s Extension page.

Traps should be checked 1-2 times/week for SWD flies - more often if fruit is harvestable, by looking on the yellow sticky trap (if used) and in the liquid drowning solution. Fresh drowning solution, whether water or vinegar, should be placed in the trap at each check and disposed of away from the trap location. Records should be kept for SWD captures to document the periods of fly activity and the corresponding stage of fruit ripeness should be noted as well.

Cultural Control

Several cultural practices can be used including the use of timely harvests and removing over-ripe fruit from fields as soon as possible to minimize SWD egg lay and larval development (Fig. 6). To minimize egg laying 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, which is discarded. This practice may work better in small scale situations vs. large scale commercial operations. A final picking to cleanup or remove the last berries from the bushes may be worthwhile, but this approach has not yet been evaluated and again would likely depend on the scale of the operation.

Figure 5. Commercial SWD trap (S. Wold-Burkness, U of MN).

Traps should be hung in the fruit zone, in a shaded area of the canopy, using a wire attached to the top of the trap (Fig. 5). Make sure the trap is clear of vegetation with holes exposed so SWD can access the trap.

Figure 6. Fallen fruit which can become a source of SWD reinfestation (S. Wold-Burkness, U of MN).
The removal of wild host plants near production fields that could support SWD populations could be another potential option but has not been field tested. Wild hosts include plants such as honeysuckle wild grape, pokeberry, black raspberry, and blackberry.

Recent research in Oregon has compared various ways to increase mortality of SWD in infested berries, i.e., how best to dispose of infested fruit.

Two methods that worked well at eliminating SWD were:

1. Bagging fruit inside clear or black plastic bags, and
2. Solarizing, where 1-2 ml clear plastic sheeting is placed over the fruit in a sunny location and sealed around the edge using soil.

**Important Note:** simply burying infested fruit was not effective. Cooling (i.e., refrigeration at 37-39F) fruit immediately after harvest may also be beneficial by preventing egg hatch, and/or slowing larval development and causing larval mortality (Marwa et al. 2017).

**Physical Exclusion**

Growers in northern climates are increasingly using high tunnels for season extension and to improve yield and fruit quality (Fig. 7). High tunnels may also serve as a pest management tool through physical exclusion of insect pests.

In 2015, tunnels covered with plastic or fine mesh netting were evaluated as an alternative to insecticide application for protecting fall bearing raspberries from SWD infestation in MN (Rogers et al. 2016). Berries in plastic-covered tunnels had low mean season-long levels of infestation by SWD of 2%, compared to netted tunnels at 35%, insecticide-treated open plots at 60% and untreated open plots at 81% of berries infested (Rogers et al. 2016).

Micro-climate data suggest that temperature and humidity levels in plastic-covered tunnels were often above and below optimal temperature and humidity levels respectively, for development, mating and/or oviposition of SWD. These sub-optimal conditions may have limited overall population growth compared with the tunnel covered with netting. Therefore, both exclusion and modification of micro-climate may be effective and complementary as pest management strategies for fall-bearing raspberry and may be a viable alternative to insecticide applications, particularly for small-acreage and organic production.

**Chemical Control**

Properly applied, insecticides can be effective, but insecticide applications must also be coupled with timely harvests in between sprays, and with close adherence to the re-entry (REI) and pre-harvest (PHI) intervals for each insecticide must be observed (see Table on last page).

Given the potential for rapid population increase by SWD, active management is needed until the end of harvest. For
raspberries, we recommend a 5-day spray interval be maintained, where possible (7-day interval should be the maximum allowed), as soon as the first berry color change is evident and flies are present. For each insecticide, the maximum rate/acre should be used, with high volume for maximum coverage in the canopy (e.g., >25-40 gallons water/ac), and for example, the use of air-blast sprayers to improve coverage (Fig. 8). For raspberry this continues to primarily be a rotation of Mustang Maxx, Malathion and Delegate (or Entrust, for organic growers).

Alternating insecticides is also essential to minimize the risk of SWD developing insecticide resistance*.

Organic Options

Organic fruit growers should be aware that the insecticidal control options available to them are, in general, less effective than conventional insecticides against SWD, and will require more timely application. However, experience in the west coast states and in Michigan indicate that SWD can be controlled in organic production through more intensive monitoring, timely applications, if flies are detected, and shorter intervals between sprays. It is also extremely important to implement cultural controls to help reduce the overall population level. This includes pruning to open the canopy and improve spray coverage, and making sure berries are harvested on a timely schedule. A recent 2016 publication on organic options from Michigan State is also available.

*A Note on Insecticide Resistance Management

The potential for insecticide resistance to develop is a concern with SWD because of the rapid development of each generation of flies and the general tendency for Drosophila flies to develop insecticide resistance. In addition, with the relatively high level of insecticide use to manage this pest, the increased exposure of SWD flies can lead to a more rapid development of insecticide resistance. One of the most effective approaches for reducing the likelihood of resistance to insecticides is to rotate among chemical classes. This can be done by using the chemical class as a factor when choosing which products to use. Conventional growers should be rotating among organophosphate (Malathion), pyrethroid (Brigade, Mustang Maxx), and spinosyn (Entrust) or spinetoram (Delegate) active ingredient classes as they spray throughout the season. Organic growers are limited to using Entrust, Pyganic, and Grandevo WDG. Grandevo is a new bacterial based product that has shown excellent efficacy against SWD in recent Michigan State trials. The current challenge is finding adequate supplies of product to purchase in Minnesota.

Some insecticide labels will have specific information about rotating chemical classes to avoid resistance development. For example, after two applications of a spinosyn-containing insecticide such as Entrust or Delegate, growers must rotate to a different class of insecticide. Resistance management is more challenging for organic growers who have fewer registered products to choose from that are effective against SWD.

Figure 8. A grower using an air blast sprayer to apply insecticides to raspberries (S. Wold-Burkness, U of MN).
References


Visit https://www.fruitedge.umn.edu/swd for the most up to date information.
Table 1: Insecticides labeled for berry crops in Minnesota.

<table>
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<tr>
<th>TRADE NAME</th>
<th>ACTIVE INGREDIENTS</th>
<th>GRAPE</th>
<th>BLUEBERRY</th>
<th>CANE BERRIES</th>
<th>STRAWBERRY</th>
<th>REI (HR)</th>
<th>CLASS</th>
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<td>ALTACOR¹</td>
<td>CHLORANTRANILIPROLE</td>
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<td>4</td>
<td>DIAMIDE</td>
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<tr>
<td>EXIREL</td>
<td>CYANTRANILIPROLE</td>
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<td>-</td>
<td>-</td>
<td>12</td>
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<td>BRIGADE²</td>
<td>BIFENTHRIN</td>
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<td>ENTRUST</td>
<td>SPINOSAD</td>
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<td>3</td>
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<td>DELEGATE</td>
<td>SPINETORAM</td>
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<td>3</td>
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<td>ORGANOPHOSPHATE</td>
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¹NOT LABELED FOR SWD CONTROL
²RESTRICTED USE PESTICIDE (RUP)