DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

Agriculture and Natural Resources

FSA7079

Biology, Identification and Management of Spotted Wing Drosophila

Donn T. Johnson
Professor and
Extension Entomologist - Fruit

Joseph O'Neill
Graduate, Horticulture Department

The spotted wing drosophila (SWD) (*Drosophila suzukii*, family Drosophilidae) is a fly from Southeast Asia that attacks ripening and ripe soft fruit.

Background

The spotted wing drosophila was first found in California in 2008. In 2009, it spread north to British Columbia and to Florida. In 2010, this pest appeared in Michigan, Mississippi, North and South Carolina, Utah and Wisconsin. In 2011, apple cider vinegar baited traps captured SWD flies from Virginia to Maine and in Alabama, Georgia, Louisiana, Montana, Ohio and Tennessee. In 2012, spotted wing drosophila was confirmed in Arkansas, Colorado, Idaho, Illinois, Indiana, Iowa, Kentucky and Minnesota (Burrack et al. 2012).

Identification

The white, oval SWD eggs are 0.6 mm long by 0.18 mm wide with two filaments at one end (Fig. 1 and 2). Eggs may be laid either on the fruit surface or the female ovipositor cuts through fruit skin to insert egg inside the fruit (Walsh 2009).

Legless SWD larvae (Fig. 3 and 4) cannot be distinguished from other *Drosophila* larvae. They all range from 1 to 3.5 mm long, are white and cylindrical with two stalks or small finger-like projections on one end (spiracles) and two black mouthparts on the other (Davis et al. 2010).

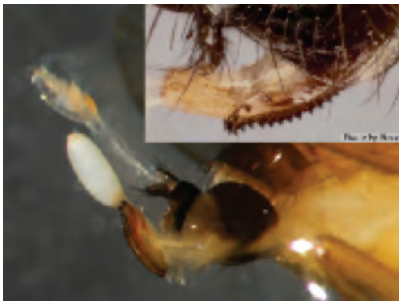

FIGURE 1. SWD adult female serrated ovipositor and egg.
Photo: Beers et al. (2010)

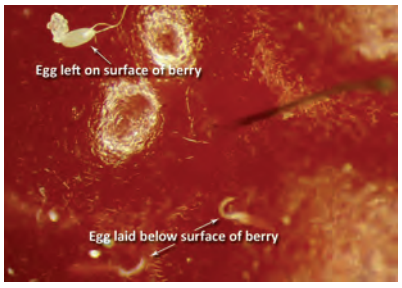

FIGURE 2. SWD eggs on and below surface of fruit.
Photo: Gerdeman (2011)

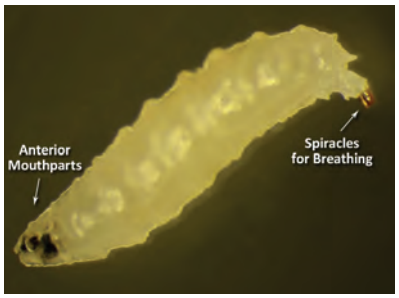

FIGURE 3. Larva up to 6 mm with dark mouth hooks and spiracles.
Photo: Gerdeman (2011)

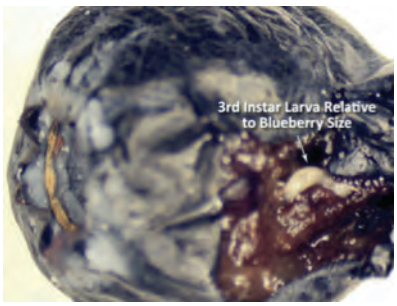

FIGURE 4. SWD larva on a blueberry. **Photo: Gerdeman (2011)**

Arkansas Is Our Campus

Visit our web site at:
https://www.uaex.uada.edu

The SWD pupae (Fig. 5) are initially white or transparent and football shaped with distinct, star-shaped projections on the head end. Pupae become darker brown with red eyes when mature.

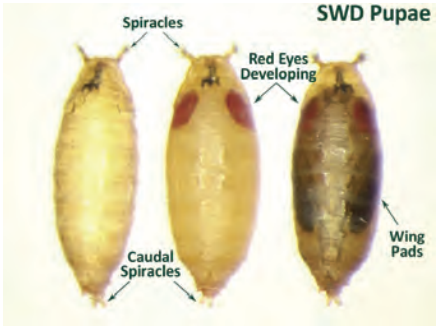

FIGURE 5. Three SWD pupal stages.
Photo: Gerdeman (2011)

Females are slightly larger than males (Beers et al. 2010). Adult SWD are small (2 to 3 mm) with clearly visible red eyes, small featherlike antennae called aristae and pale brown bodies with darker stripes on the abdomen. Unlike most vinegar flies, SWD adult females have a serrated ovipositor (Fig. 1 and 7) used to cut through fruit skin during egg laying (Walsh 2009).

Adult SWD males have one black spot toward the tip of both wings (Fig. 6) and two bands of sex combs on each foreleg that distinguish them from most other *Drosophila* species, whereas the female has no wing spot but has a serrated ovipositor (Fig. 7) (Hauser 2011).

FIGURE 6. MALE SWD with black spot on wings and large red eyes.
Photo: Davis et al. (2010)

Biology

Overwintered adult flies emerge as spring temperatures exceed 48°F. Adults are most active around 68°F. A single female lays one egg per fruit but in her lifetime lays up to 350 eggs. Eggs hatch within 12-72 hours. Larvae develop through three instars in as few as 5 days. Larvae pupate either inside or outside of the fruit, and flies emerge in 4-15 days (Gerdeman 2011). The SWD completes a full generation in as few as 13 days. SWD has as many as 13 generations per year in California and 5 in British Columbia (Davis et al. 2010).

Damage

Adults and larvae cause the most damage to the fruit. Females can saw into fruits during egg laying and cause a depression that can lead to secondary fungal and pest infestations (Davis et al. 2010). Larvae tunnel in the fruit rendering fruit unmarketable (Fig. 4, 8 and 9).

In 2009, in California yield loss estimates ranged from zero to 80%, depending on location and crop. The greatest crop losses have been reported for blueberries, blackberries, raspberries, cherries and strawberries (Bolda et al. 2010).

FIGURE 7. FEMALE SWD with serrated ovipositor.
Photo: BugGuide.net

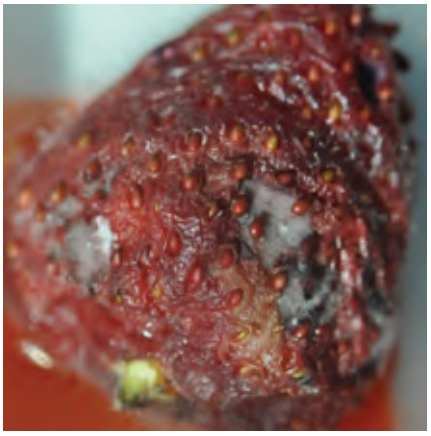

FIGURE 8. Strawberry damage.
Photo: Walton et al. (2010)

FIGURE 9. Raspberry damage.
Photo: Fraser et al. (2011)

Susceptible Hosts

In the United States, SWD infestations have been observed in fruits including blackberry, blueberry, boysenberry, grapes, raspberry, strawberry; tree fruits: apricot, cherry, mulberry, nectarine, peach, persimmons, plum, pluot; and to a lesser extent, vegetable fruits including melons and tomatoes.

Seasonal trap monitoring of SWD flies illustrates that SWD fly numbers per trap increase as the season progresses and peak in the fall. Therefore, June-bearing strawberries have limited risk of SWD damage; mid-season blueberries have some risk; and day-neutral strawberry cultivars and peaches harvested in late summer are more vulnerable. In September, heavy SWD infestations were found in berries

of blackberries, primocane fruiting raspberries and strawberries in high tunnels.

Sampling

Adult SWD are relatively easy and inexpensive to trap (Fig. 10).

FIGURE 10. Trap with 3/16-inch diameter holes in side, screen top and yellow sticky card inside.
Photo: D. Johnson

A month before fruit begins to ripen, make six traps as follows: use a 1-quart plastic deli cup, puncture ten 3/16-inch diameter holes near the cup top. Cut hole in lid 3 1/2 inches in diameter and super glue a piece of hardware screen cloth (1/4-inch mesh) to the lid. Wire a plastic wing trap top or plastic plate to the cup trap to protect it from rain (Lee et al. 2012).

Make 1 quart of trap bait by mixing 4 teaspoons of dried baker's yeast (2 packages), 2 teaspoons sugar, 1 quart water, 1/4 teaspoon of unscented Ulta Pure dish soap (Colgate-Palmolive Co.) and let stand overnight (Cowles 2012; Lee et al. 2012). The dish soap breaks the surface tension so flies will sink in the liquid bait. Add 2 inches of bait, snap on screen top and attach wire rain guard over cup trap (Fig. 10).

About a month before fruit ripening begins, hang six baited traps at fruit level in the shade inside and outside of the susceptible fruit planting. Weekly, sift flies from liquid bait as you pour out old liquid bait into a gallon discard bottle and add new bait. **Do not dump liquid bait near any cup traps or inside the fruit planting.** Record weekly numbers of SWD males per trap (Fig. 1 and 7).

It is important to remember that many native *Drosophila* feed on rotting fruit. Therefore, check for SWD larvae by collecting at least 30 relatively sound fruit **that you would eat** and use the fruit floatation method to confirm presence of SWD larvae. Fruit are floated in a solution of sugar water or salt water (1 quart water + 1 cup sugar **OR** 1 cup salt in 1 gallon water). After 30 minutes, larvae will float to the surface and can be counted (Hueppelsheuser 2010). Continue trap and fruit monitoring through harvest.

Cultural Control

Sanitation: Avoid SWD damage by frequent, complete harvest of fruit. Any unmarketable fruit should be removed from the field and either frozen for 4 days and disposed of in the trash or solarized for several days to kill any eggs and larvae (Caprile et al. 2011).

Water Management: Leaking drip lines should be repaired, and overhead irrigation should be minimized.

Exclusion: Fine-mesh floating row covers can help protect some crops with lower growing heights.

Mass Trap: Placing four to five baited traps per tree may be used to mass trap and reduce SWD numbers (Davis et al. 2010).

Chemical Control

Insecticide treatments should be applied at least every 7 days and re-applied immediately after a rain event. Effective insecticides with preharvest intervals (PHI), restricted entry intervals (REI) and longer days of residual activity amenable to picking schedules should be selected. Also, rotate insecticide modes of action (IRAC #) between treatments (Table 1). Re-apply when baited traps indicate continued presence of SWD populations and/or you see new SWD larvae in fruit (Bruck et al. 2011). Be sure to read the label for general directions to apply an insecticide to a specific fruit or vegetable crop.

Entrust (spinosad) is the most effective organic approved control method against SWD, but there are limitations on its use as described in the label. Pyganic is also registered and can be used in rotation, but it provides short residual control of SWD (Bolda 2011). There is concern about resistance development.

References

Beers, E. H., T. J. Smith and D. Walsh. 2010. Spotted wing drosophila. Washington State University Tree Fruit Research and Extension Center: Orchard Pest Management. http://jenny.tfrec.wsu.edu/opm/displaySpecies.php?pn=165

Bolda, M. 2011. Suspected tolerance to pyganic (pyrethrin) found in spotted wing drosophila. Posted on August 23: http://ucanr.org/blogs/blogcore/postdetail.cfm?postnum=5585

Bolda, M. P., R. E. Goodhue and F. G. Zalom. 2010. Spotted wing drosophila: potential economic impact of a newly established pest. Agric. Resource Econ. Update 13(3):5-8.

Bruck, D. J., M. Bolda, L. Tanigoshi, J. Klick, J. Kleiber, J. DeFrancesco, B. Gerdeman and H. Spitler. 2011. Laboratory and field comparisons of insecticides to reduce infestation of *Drosophila suzukii* in berry crops. Pest Management Science. doi: 10.1002/ps.2242.

BugGuide. Spotted wing drosophila. Online: 2/20/2011, http://bugguide.net/node/view/336267

Burrack, H., J. P. Smith, D. G. Pfeiffer, G. Koeher and J. Laforest. 2012. Using volunteer-based networks to track *Drosophila suzukii* an invasive pest of fruit crops. J. Integrated Pest Management 3(4):B1-B5.

Caprile, J., M. L. Flint, M. P. Bolda, J. A. Grant, R. Van Steenwyk and D. Haviland. 2011. Provisionary guidelines: management of spotted wing drosophila in home garden situations. Online: http://www.ipm.ucdavis.edu/EXOTIC/drosophila.html

Davis, R. S., D. Alston and C. Vorel. 2010. Spotted wing drosophila. Utah State University Extension and Utah Plant Pest Diagnostic Laboratory.

Gerdeman, B. 2011. Spotted wing drosophila; slides and images. WSU Extension. Online: http://whatcom.wsu.edu/ipm/swd/slides.html

Hueppelsheuser, T. 2010. Assessment of solutions used for the purpose of determining spotted wing drosophila larval infestation in blueberry fruit. http://whatcom.wsu.edu/ipm/swd/documents/LavalExtraction.pdf

Lee, J. C., H. J. Burrack, L. D. Barrantes, E. H. Beers, A. J. Dreves, K. Hamby, D. R. Haviland, R. Isaacs, T. A. Richardson, P. W. Shearer, C. A. Stanley, D. B. Walsh, V. M. Walton, F. G. Zalom and D. J. Bruck. 2012. Evaluation of monitoring traps for *Drosophila suzukii* in North America. J. Econ. Entomol. 105:1350-1357.

Walton, V., J. Lee, D. Bruck, P. Shearer, E. Parent, T. Whitney and A. Dreves. 2010. Recognize fruit damage from spotted wing drosophila (SWD). Oregon State University Extension Service. EM9021. http://swd.hort.oregonstate.edu

TABLE 1. Insecticide class, preharvest interval (PHI), restricted entry interval (REI), relative efficacy and residual activity against spotted wing drosophila (SWD) on blueberries, caneberries, strawberries, grapes and stone fruits.

Class (IRAC #)	Trade Name	Active Ingredient	PHI (days)	REI (h = hrs or d = days)	Efficacy Against SWD[h]	Expected Residual Control (days)
Carbamate (1A)	Sevin	carbaryl	7	12 h	G	10-14
	Lannate	methomyl	3[a]	48 h	E	7-10
Organophosphate (1B)	Imidan	phosmet	3 or 7[a]	24 h or 3 d[a]	G	7
	Diazinon	diazinon	7	3 d to 5 d	E	7-10
	Malathion	malathion	1 or 3[b]	12 h	E	7-10
Pyrethroid (3A)	Brigade	bifenthrin	0 or 3[c]	12 h	E	10-14
	Asana	esfenvalerate	7 or 14[d]	12 h	E	10-14
	Danitol	fenpropathrin	2 or 3[e]	24 h	E	10-14
	Mustang Max	zeta-cypermethrin	1 or 14[f]	12 h	E	10-14
Spinosyn (5)	Delegate	spinetoram	1, 3 or 7[g]	4 h	E	5-7
	Success	spinosad	1, 3 or 7[g]	4 h	G-E	5-7
	Organic Options					
Pyrethrin (3A)	Pyganic	pyrethrin	0	12 h	G	0
Spinosyn (5)	Entrust	spinosad	1, 3 or 7[g]	4 h	E	5-7
UN	Aza-Direct	Azadirachtin	0	4 h	F	

Read label to confirm preharvest interval (PHI) and restricted entry interval (REI):
[a]PHI = 3 days for blueberry, 7 days for stone fruit
[b]PHI = 1 day for blueberry or caneberry, 3 days for grape, stone fruit (REI = 3 days) or strawberry
[c]PHI = 0 day for strawberry, 1 for blueberry, 3 for caneberry
[d]PHI = 7 days for caneberry, 14 days for blueberry or stone fruit
[e]PHI = 2 days for strawberry, 3 days for blueberry, caneberry or stone fruit, 21 days grapes
[f]PHI = 1 day for blueberry, caneberry or grape, 14 days stone fruit
[g]PHI = 1 day for caneberry, 3 days for blueberry, 7 days for grape or stone fruit
[h]Relative efficacy ratings (E = excellent, G = good, F = fair, P = poor)

JOSEPH O'NEILL is a graduate of the Horticulture Department, University of Arkansas, Fayetteville. **DR. DONN T. JOHNSON** is professor and Extension entomologist - fruit, Department of Entomology, University of Arkansas Division of Agriculture, University of Arkansas, Fayetteville.

FSA7079-PD-3-13RV