OREGON STATE UNIVERSITY EXTENSION SERVICE

SWD series #2

Cultural Control Strategies to Manage Spotted-wing Drosophila

D. Rendon, S. Mermer, L. Brewer, D. Dalton, C. Bezerra Da Silva, J. Lee, R. Nieri, K. Park, F. Pfab, G. Tait, M.V. Rossi-Stacconi, N. Wiman, V. Walton

Spotted-wing drosophila life cycle

Cultural controls can reduce spotted-wing drosophila population pressure by modifying the microclimate within the crop so the environment does not promote SWD reproduction and survival.

The rate of SWD development and reproduction depends on temperature and humidity. Flies can develop from the egg stage to reproductive adults within one to two weeks when temperatures are within optimum range: 71–82°F (22–28°C) and humidity is 80%–90%.

SWD undergo a complete metamorphosis. Eggs develop into three larval stages, pupae and finally adults. During the growing season, the egg, larval and pupal stages last from one to three, five to seven, and four to 15 days, respectively. In the mid-Willamette Valley, SWD have five to ten generations during the growing season (Figure 1, page 2).

Adult life span during the growing season is about three to five weeks. Flies emerging late in the season are adapted to overwintering and may live longer. A single female can lay up to 40 eggs per day and 200–400 eggs total in her lifetime. A female fly lays approximately one to three eggs per oviposition site. Multiple females may lay eggs in the same fruit, giving rise to greater infestation of individual fruits and multiple clutches of larvae.

Immature life stages are sheltered inside the fruit. Eggs are laid directly beneath the skin of the fruit. As the eggs hatch, the larvae consume the fruit pulp. Ultimately, they molt into pupae. Life stages within fruit are protected from adverse conditions, such as dehydration, temperature fluctuations, and full-cover insecticide applications. SWD pupae and adults are more susceptible to adverse environmental conditions

Key points in this fact sheet

- *Spotted-wing drosophila (SWD) undergo complete metamorphosis (egg, larva, pupa, adult). Eggs can develop to pupae inside fruit. The developing larvae feed on the pulp of the fruit and commonly leave the fruit to find suitable pupation sites. SWD pupae are often found in the ground.*
- *Immature life stages within the fruit are protected from adverse environmental conditions and pesticides.*
- *SWD adults are more susceptible to pesticide applications than earlier life stages because they live outside of fruit pulp.*
- *SWD egg laying is more elevated in shady, humid portions of the crop canopy.*
- *Temperatures on weed fabric are less optimal for the survival of pupating SWD larvae.*
- *Overhead sprinklers create a more suitable climate for SWD than drip irrigation.*
- *Canopy pruning concurrently reduces microclimate suitability and egg-laying.*
- *Surrounding vegetation may offer optimal habitat and microclimates and increase pest pressure.*
- *Proper management of surrounding vegetation may reduce SWD survival.*

Oregon State University

EM 9262
December 2019

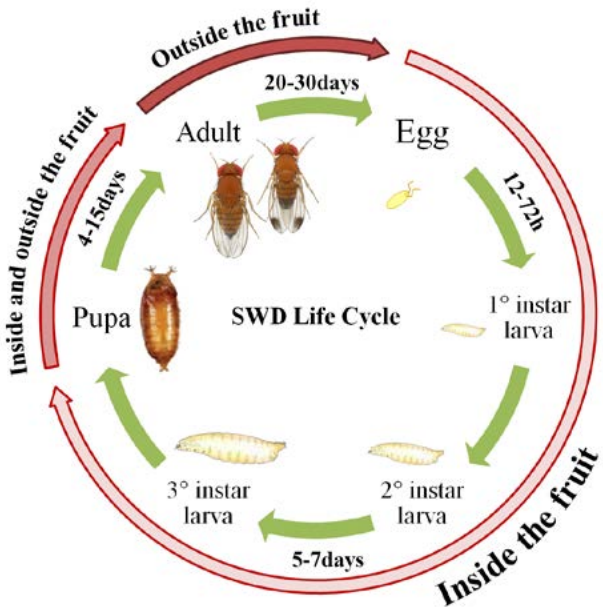

Illustration: Marco Rossi-Stacconi, © Oregon State University

Figure 1. Diagram showing distinctive SWD lifecycle stages and locations of each life stage.

than earlier life stages. SWD can pupate inside or outside the fruit. At high infestation levels, a greater proportion of pupae will be found outside the fruit. In such cases, larvae will drop out of fruit before they develop into pupae. Once out of the fruit, pupae tend to burrow into the soil to find a more suitable and protected environment.

Microclimates

All factors that affect temperature and humidity in an orchard will also affect the environment for SWD (Figure 2). Overhead irrigation increases humidity and can lead to higher rates of SWD reproduction and development compared to drip irrigation.

Weed fabric prevents pupating SWD larvae from burrowing into the soil. SWD find more suitable temperature and humidity conditions an inch under the soil surface, as opposed to warmer and drier conditions found on the soil surface or weed fabric.

Pupae are very susceptible to desiccation and do not survive when exposed to low humidity.

Surrounding vegetation provides more optimal habitat and microclimates for SWD during the hottest hours of the day. Proper management of surrounding vegetation may alleviate SWD pressure by reducing "hot spots" outside the crop where SWD can overwinter or escape field sprays.

Detailed work showed that SWD lay eggs at elevated levels in the center of the plant canopy. Fewer eggs are laid in the upper and outer portions of the canopy. Eggs laid in fruit in the upper and outer portions of the

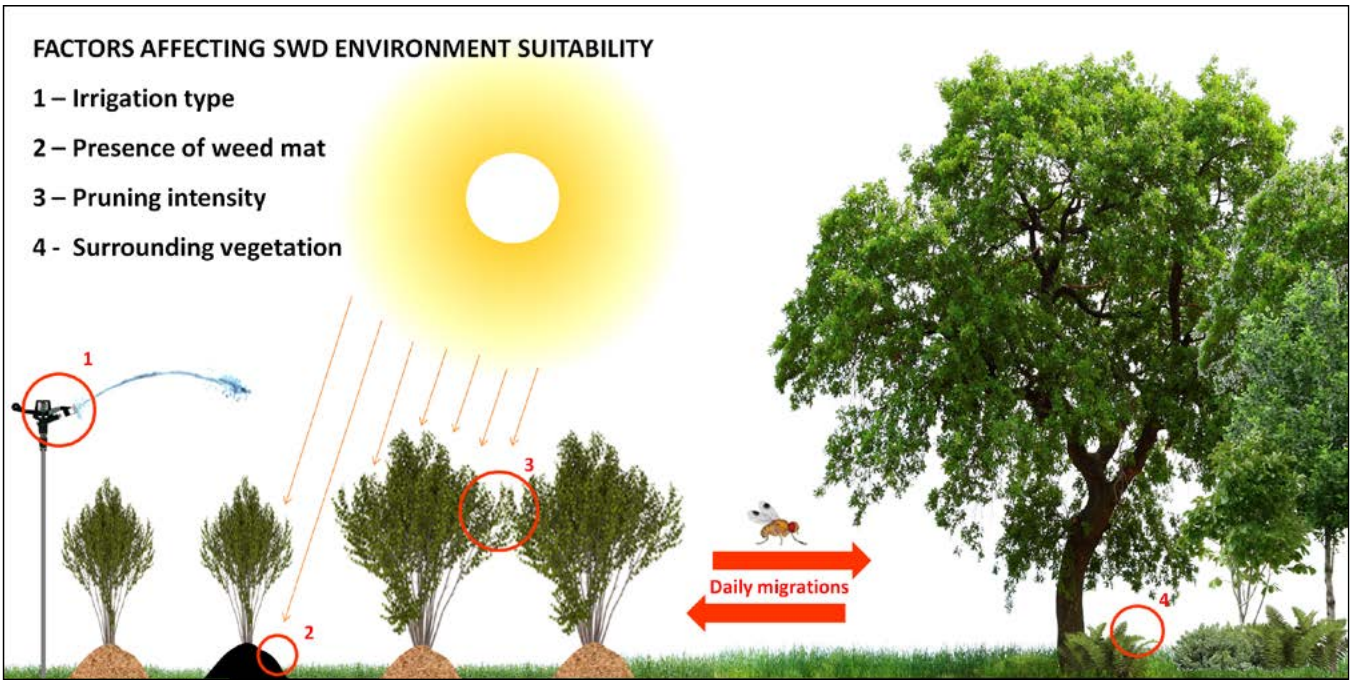

Illustration: Marco Rossi-Stacconi, © Oregon State University

Figure 2. Microclimates can fundamentally change SWD pressure. 1) Drip irrigation reduces relative humidity, creating less suitable microclimates compared to overhead irrigation. 2) Weed fabric reduces the ability of pupating larvae to burrow into more suitable microclimates under the soil. 3) Heavier pruning increases light penetration and reduces shade, resulting in microclimates within the crop canopy that are less suited to SWD. Heavier pruning allows greater penetration of any chemical controls applied to the crop. 4) Surrounding vegetation can serve as a population reservoir if it is close to production areas.

canopy are more prone to high temperatures during the summer period (Figure 3).

Heavier pruning of dense canopies where SWD hotspots occur can reduce suitable microclimates and result in lower SWD pressure on the crop. Areas where pressure is reduced may require less pruning.

Further reading

Coop, L. 2011. IPM Pest and Plant Disease Models and Forecasting. USPEST.ORG. 22 September 2011.

Diepenbrock, L. M. and H. J. Burrack. 2016. Variation of within-crop microhabitat use by *Drosophila suzukii* (Diptera: Drosophilidae) in blackberry. *Journal of Applied Entomology* 141: 1–7.

IPPC. Online Phenology and Degree Day models. Oregon State University. 4 Jan. 2010.

Kanzawa T. 1939. Studies on *Drosophila suzukii* Mats. Kofu, Yamanashi Agricultural Experiment Station 49 (abstr.). *The Review of Applied Entomology* 29:622

Klick, J., W.Q. Yang, J.C. Lee, D.J. Bruck. 2016. Reduced spray programs for *Drosophila suzukii* management in berry crops. *International Journal of Pest Management* 62(4): 368–377.

Mitsui, H., H.K. Takahashi, M.T. Kimura. 2006. Spatial distributions and clutch sizes of Drosophila species oviposition on cherry fruits of different stages. *Population Ecology* 48: 233–237.

Rendon D, K. Hamby, A. Arsenault-Benoit, C.M. Taylor, R.K. Evans, C.R. Roubos, A.A. Sial, M. Rogers, A. Petran, S. Van Timmeren, P. Fanning, R. Isaacs, V.W. Walton . 2019. Mulching as a cultural control strategy for Drosophila suzukii in blueberry. *Pest Management Science*. DOI: 10.1002/ps.5512

Rendon, D. and V.M. Walton. 2019. Drip and Overhead Sprinkler Irrigation in Blueberry as Cultural Control for *Drosophila suzukii* (Diptera: Drosophilidae) in Northwestern United States. *Journal of Economic Ecology* 112, 745–752. https://doi.org/10.1093/jee/toy395

Tochen, S., D.T. Dalton, N.G. Wiman, C. Hamm, P.W. Shearer, V.M. Walton. 2014. Temperature-related development and population parameters for *Drosophila suzukii* (Diptera: Drosophilidae) on cherry and blueberry. *Environmental Entomology* 43:501–510

Tochen, S., J.M. Woltz, D.T. Dalton, J.C. Lee, N.G. Wiman, V.M. Walton. 2016. Humidity affects populations of *Drosophila suzukii* (Diptera: Drosophilidae) in blueberry. *Journal of Applied Entomology*, 140(1–2): 47–57.

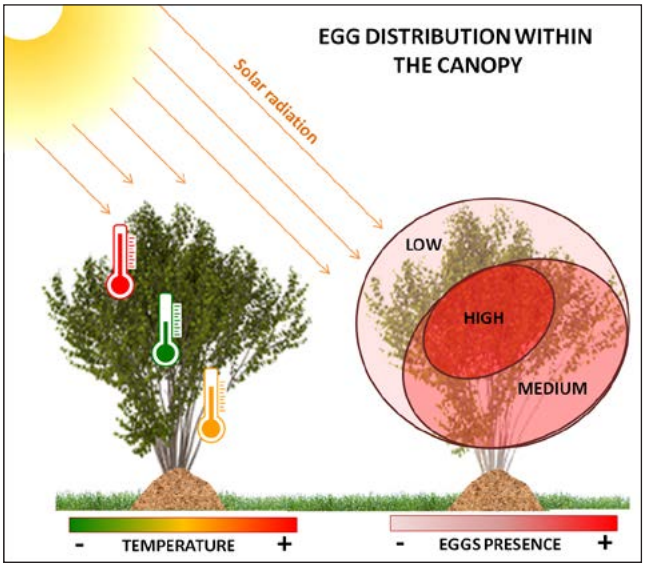

Illustration: Marco Rossi-Stacconi, © Oregon State University

Figure 3. Temperature and sunlight differences within the canopy affect the distribution pattern of eggs by SWD. Because lower temperatures and higher relative humidity are more suitable for SWD survival, flies prefer shaded fruits and fruits in more dense portions of the canopy for egg laying.

Walsh, D.B., M.P. Bolda, R.E. Goodhue, A.J. Dreves, J. Lee, D.J. Bruck, V.M. Walton, S.D. O'Neil, F.G. Zalom. 2011. *Drosophila suzukii* (Diptera; Drosophilidae): invasive pest of ripening soft fruit expanding its geographic range and damage potential. *Journal of Integrated Pest Management* 2: G1–G8.

About this series

Find all nine publications in this series at https://catalog.extension.oregonstate.edu/.

- *EM 9261: How Seasons Affect Population Structure, Behavior and Risk on Spotted-wing Drosophila*
- *EM 9262: Cultural Control Strategies to Manage Spotted-wing Drosophila*
- *EM 9263: Host Range and Characteristics Affecting Fruit Susceptibility to Spotted-wing Drosophila*
- *EM 9264 Alternate Reproductive Substrate Used By Spotted-wing Drosophila*
- *EM 9265: Chemical Control of Spotted-wing Drosophila: Spray applications*
- *EM 9266: Chemical Control of Spotted-wing Drosophila: Insecticide Efficacy*
- *EM 9267: Monitoring Techniques for Spotted-wing Drosophila*
- *EM 9268: Potential Impacts of Irrigation on Biocontrol on Spotted-wing Drosophila Populations*
- *EM 9269: Biocontrol of Spotted-wing Drosophila*

About the authors

Dalila Rendon, former post-doctoral researcher, horticultural entomology, Department of Horticulture; Serhan Mermer, graduate student, environmental and molecular toxicology, Department of Horticulture; Linda Brewer, senior faculty research assistant, Department of Horticulture; Daniel Dalton, graduate student, horticultural entomology, Department of Horticulture, all of Oregon State University; Cherre Bezerra Da Silva, Laboratory of Entomology, Empresa Brasileira de Pesquisa Agropecuaria, Campina Grande, Brazil; Jana Lee, research entomologist, U.S. Department of Agriculture Horticultural Crop Research Unit; Rachele Nieri, post-doctoral researcher, horticultural entomology, Department of Horticulture; Kyoo Park, graduate student, Department of Horticulture, both of Oregon State University; Ferdinand Pfab, post-doctoral researcher, ecology, evolution and marine biology, University of California, Santa Barbara; Gabriella Tait, post-doctoral researcher, horticultural entomology, Department of Horticulture; Marco Valerio Rossi-Stacconi, post-doctoral researcher, horticultural entomology, Department of Horticulture; Nik Wiman, orchard crops specialist, Oregon State University Extension Service; Vaughn Walton, professor of horticultural entomology, Department of Horticulture, all of Oregon State University.

We acknowledge contributions from multiple funding sources and collaborators. Oregon State Blueberry Commission, United States Department of Agriculture (USDA), National Institute for Food and Agriculture awards #2010-51181-21167, #2015-51181-24252, USDA OREI #2014-51300-22238, USDA NWCSFR, and Oregon State University Agriculture Research Foundation. We also thank Drs. Bernadine Strik, Chad Finn, Dave Bryla and Wei Yang for providing blueberry plots. We thank the many growers who have collaborated with us to better understand this pest. We thank OSU NWREC, OSU MCAREC and Lewis Brown research farm staff, WSU Research and Extension Center Staff, Prosser, WA for assisting in field setup, maintenance, trials and sample analysis.

Trade-name products and services are mentioned as illustrations only. This does not mean that the Oregon State University Extension Service either endorses these products and services or intends to discriminate against products and services not mentioned.

This publication will be made available in an accessible alternative format upon request. Please contact puborders@oregonstate.edu or 1-800-561-6719. © 2019 Oregon State University. Extension work is a cooperative program of Oregon State University, the U.S. Department of Agriculture, and Oregon counties. Oregon State University Extension Service offers educational programs, activities, and materials without discrimination on the basis of race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, familial/parental status, income derived from a public assistance program, political beliefs, genetic information, veteran's status, reprisal or retaliation for prior civil rights activity. (Not all prohibited bases apply to all programs.) Oregon State University Extension Service is an AA/EOE/Veterans/Disabled.

Published December 2019