Testing for Potential Resistance of Spotted Wing Drosophila (SWD) to Commonly Used Insecticides in Cherry Orchards

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CALIFORNIA CHERRIES

UC CE UNIVERSITY OF CALIFORNIA Agriculture and Natural Resources Cooperative Extension

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Spotted Wing Drosophila (SWD)

- Spotted wing drosophila (SWD), *Drosophila suzukii* (Matsumura), invasive pest
- First detected in California in 2008, now in 41 US states, Canada, Mexico, and many European countries
- Adult flies ~1/32 in (<6 mm), light brown with red eyes
- Females are uniquely devised with a 'serrated' ovipositor - capable of laying eggs on healthy fruits
- Male flies have a dark spot on the wing, and two "combs" on front legs

Female

Serrated ovipositor

Male

Photos: M. Hauser; https://extension.usu.edu/pests/research/spotted-wing-drosophila

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SWD Damage in Caneberries and Cherries

- Fruits become susceptible to SWD damage as soon as fruit color begin to change,
  - Blueberry: green to purple
  - Cherry: green to pink/red
- Females lay eggs inside the fruit, and larvae feed on it internally
- The larvae pupate inside, partially inside, or completely outside of the fruit
- Infestation can lead to secondary pest/disease invasion

Photo: E. Burkness, D. Haviland; C. Teasdale, M. Hauser, UCIPM

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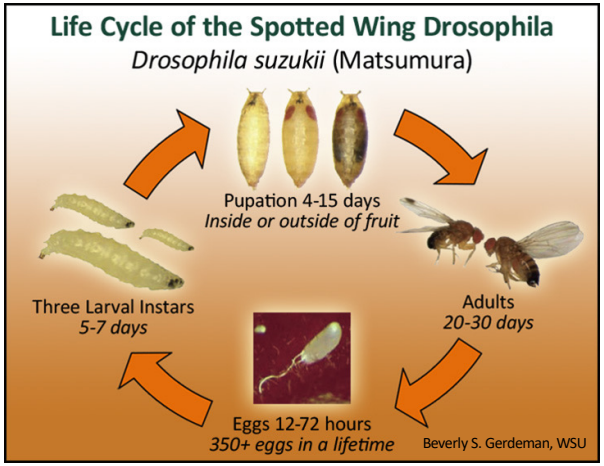
SWD Life Cycle



- SWD can complete a single generation in 8-10 days at 77^{0}F

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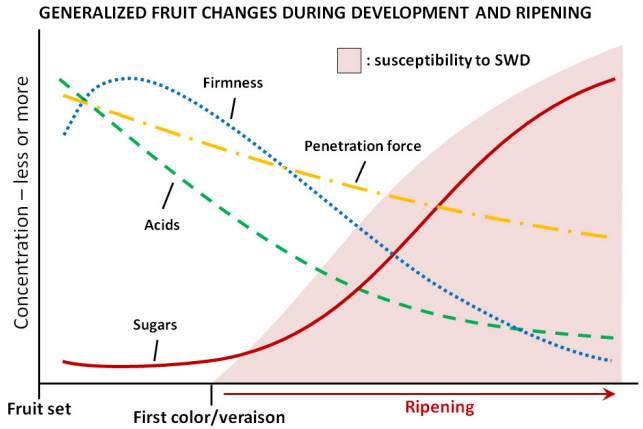
Fruit Susceptibility to SWD



Marco Rossi-Stacconi, © Oregon State University Fruit susceptibility to spotted-wing drosophila (adapted from **Bellamy et al. 2013;** Lee et al. 2016).

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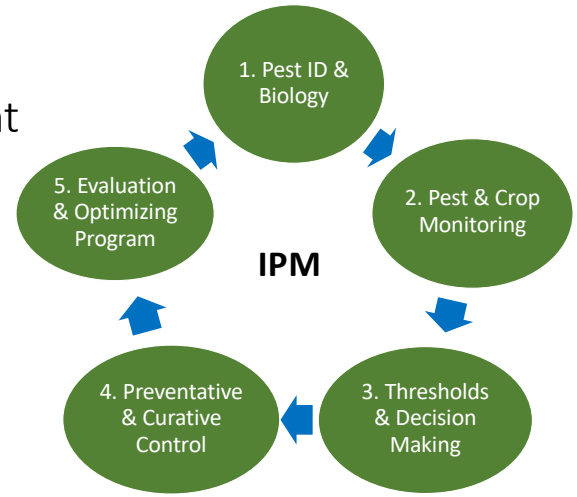
Integrated Pest Management (IPM)



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SWD Monitoring-Commercial Traps

- Sturdier than the deli-cups
- Tight lids prevent spillage
- ~1 quart capacity; bait is ~10 fl oz.
- Liquid bait changed weekly

- Easier to use
- Very efficient in combination with synthetic lure, although can be used in bait-based lures with some modifications
- Synthetic lures : more selective than the baits, still <20% (Cha et al. 2018)

Source: Elizabeth Beers, WSU; http://treefruit.wsu.edu/article/spotted-wing-drosophila-monitoring-for-2017/

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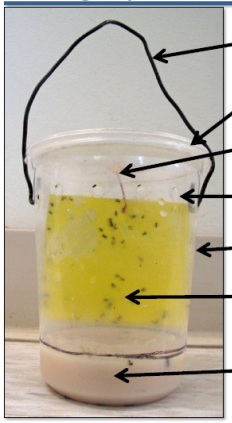
SWD Monitoring-Adult Traps (Homemade)

Building a spotted wing drosophila trap



12" of 14 gauge solid core wire.

Deli cup lid

Plastic-coated paper clip poked through lid; hole sealed with hot glue to prevent water leaking in trap.

Melt 3/16" diameter holes in side of cup using a soldering iron.

32 oz plastic deli cup

Yellow sticky insert cut down to 3.5"x3"

5 oz of yeast bait. Recipe:
1 Tablespoon active dry yeast
4 Tablespoons white table sugar
12 oz water

❑ SWD trap should be hung in a shaded area of the bush/tree

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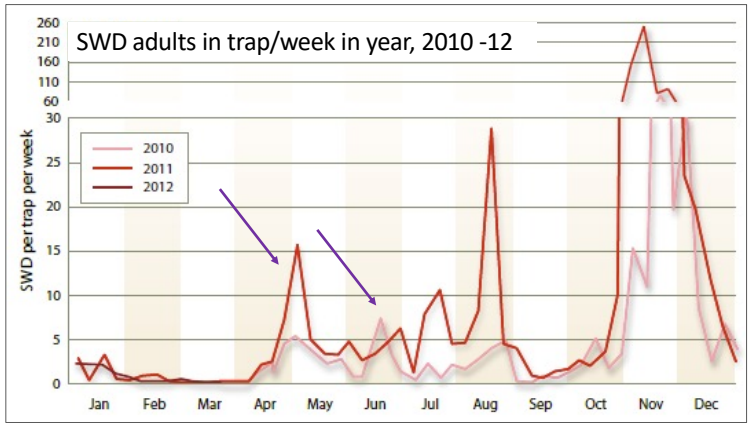
Seasonal Activity of SWD in a Cherry Orchard



- Spring/Early summer flights are critical

Haviland et al. 2016

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Cultural Control

- Removal of wild host plants
- Water/drainage management
- Orchard sanitation
- Timely harvest
- Exclusion netting

-80 grams netting (mesh size 1.0 x 0.6 mm)

- Orchard management/pruning

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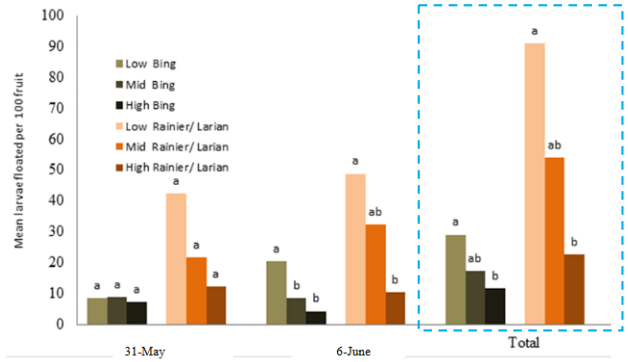
Cultural Control-Orchard management

- Pruning and other ways to create less conducive environment for SWD



❑ Lower part of the canopy had more SWD infestation (Van Steenwyk, UCB)

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Biological Control

Ganaspis brasiliensis

- *Ganaspis brasiliensis* specialize in infesting the maggots of small fruit flies— particularly SWD

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"After years of study, federal regulators authorized the release of *Ganaspis brasiliensis,* a tiny wasp discovered in SWD's home range and with a strong preference for the pest"

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SWD-killing wasps to make their debut

Researchers get ready to release parasitoid wasps in fruit orchards, berry fields and other crops susceptible to spotted wing drosophila.

Leslie Mertz // November 23, 2020

https://www.goodfruit.com/swd-killing-wasps-to-make-their-debut/

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Green light for biocontrol

SWD–killing wasp is given federal approval for release.

Kate Prengaman, TJ Mullinax // March 1, 2022

https://www.goodfruit.com/green-light-for-biocontrol/

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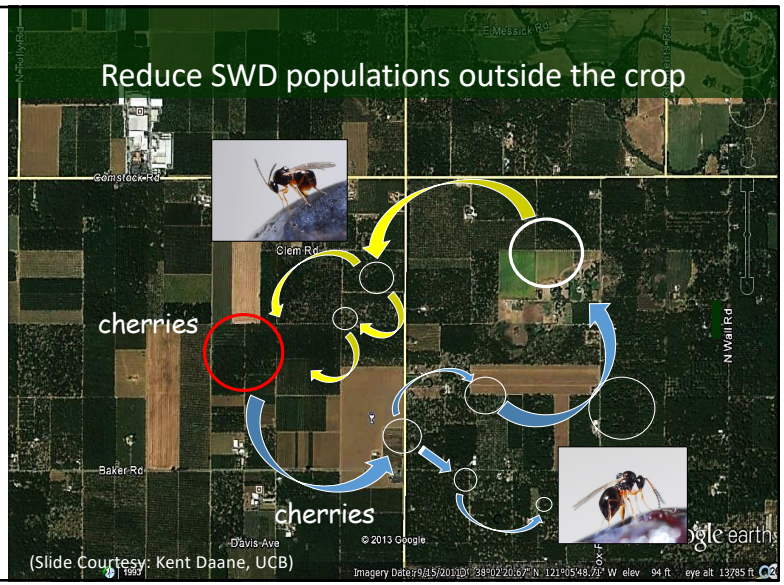
Landscape-scale Control of SWD



(Slide Courtesy: Kent Daane, UCB)

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Insecticidal Control (2021)

SN	Treatments	Rate/A	Adult SWD mortality (%) (Mean±SE) in 1-day field-weathered insecticide residue on cherry fruits after exposure in the lab for		
			24 h	48 h	72 h
1	Exirel (Cyantraniliprole)	16 fl.oz	8 ± 3.3 a	40 ± 10.1 bc	88 ± 5.2 b
2	Movento (Spirotetramat)	9 fl. oz	0 ± 0 a	2 ± 1.7 a	4 ± 3.5 a
3	Pyganic 1.4 EC (pyrethrin)	2 qt.	4 ± 2.1 a	8 ± 3.3 a	16 ± 6.0 a
4	Verdepryn (Cyclaniliprole)	11 fl. oz	8 ± 3.3 a	22 ± 7.6 ab	34 ± 9.2 a
5	Warrior II (lambda-cy)	2.56 fl. oz	24 ± 3.5 b	54 ± 7.2 c	76 ± 8.7 b
6	Control		0 ± 0 a	0 ± 0 a	4 ± 2.1 a

($F = 26.64$, $df = 5, 24$, $P < 0.001$)

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Potential Resistance Risks

- Pest management practice has heavily relied on insecticides – spinosyn, pyrethroids, malathion
- Structured pesticide applications using limited active ingredients, partly due to the MRL issue for export market
- Risk for pesticide resistance

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Pesticide Resistant SWD Population in CA Coast

- In caneberry production area in California's Central Coast, SWD has built resistance to spinosad and some pyrethroids (Gress and Zalom 2018, Ganjisaffar et al. 2022a, Ganjisaffar et al., 2022b).
- **Spinosad** (Entrust): Wild SWD from treated fields exhibited spinosad LC50 values 4.3–7.7 times higher than those from the untreated location (Gress and Zalom 2018)
- Spinosad: Extensive field studies (2017-19) showed widespread resistance with RR based on the LC50 values were as high as 10.7-, 13.2-, and 16.9-fold in 2018, 2019, and 2020, respectively (Ganjisaffar et al. 2022b)

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Pyrethroid resistance (bifenthrin, Type I; zeta-cypermethrin, Type II)

- In 2019, flies collected from caneberry fields in Monterey county, the RR50s ranged from 7.5- to 8.7-fold for both pyrethroids (Ganjisaffar et al. 2022a)
- In 2020, The RR50 values varied from 19.0- to 36.1-fold for zeta-cypermethrin (Mustang Max) and from 15.9- to 47.7-fold for bifenthrin (Brigade) (Ganjisaffar et al. 2022a)
- These studies are the first reports of field-derived pyrethroid resistance in SWD from two major California berry production areas (Central Coast, San Luis Obispo areas)

RR (Resistance Ratio) = LC50 for resistant insects divided by the LC50 for susceptible insects.

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Project Objective

To monitor insecticide resistance status of field-collected SWD populations to commonly used insecticides — spinosad, malathion, and zeta-cypermethrin (a proxy for type II pyrethroids, e.g., Warrior II).

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2022 Study

Wild SWD flies collection

SWD rearing in the lab, UCCE Stanislaus

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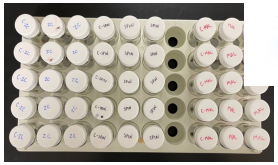
2022 Study

Testing of the resistance using discriminate doses

- Tested against three insecticide active ingredients
  — spinosad, malathion, and zeta-cypermethrin (zeta-cypermethrin as a proxy for type II pyrethroids e.g., Warrior II)
- Vials treated with discriminating doses of insecticides received from Zalom lab, UCD



Malation = 103 ppm

Spinosad = 928 ppm

Zeta Cypermethrin = 6.89 ppm

- The discriminating dose of insecticide used in these experiments was **8 times the LC90 values of malathion and zeta-cypermethrin** and **2 times the LC99 for the spinosad**. So, 100% of the mortality is expected if the flies are still susceptible to the insecticide.

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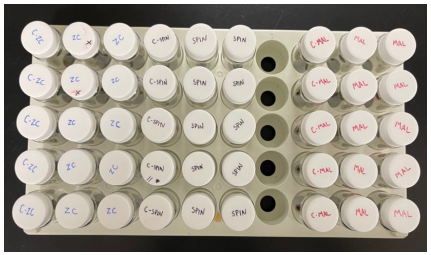
2022 Study

Experiment Set Up

- For each insecticide, we used 10 flies (4-7 days old) in each experimental unit (vial) and replicated 10 times for the insecticide-treated and 7-8 times for the control.

- Transferred the flies to the vials and assess the mortality at 6 hours for zeta-cypermethrin and malathion, and at 8 hours for spinosad.



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2022 Study Results (Preliminary)

- First few attempts failed due to very high control mortality
- Finally, we were able to produce the results successfully

Table: Insecticide susceptibility of cherry orchard collected SWD populations to three commonly used insecticide active ingredients

	Malathion	Zeta-Cypermethrin	Spinosad
Avg. % test mortality (MT)	89.2	97.5	92.5
Avg. % control (MC)	0.0	1.4	6.3
% Corrected mortality [(MT-MC)/(100-MC) x 100]	**89.2**	**97.4**	**92.0**

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Plan for 2023: More comprehensive study

- Continue testing field collected flies and compare with the susceptible (lab) populations
- Collect live flies from 3-5 orchards representing the Valley, and test for potential tolerant to three insecticides – spinosad, zeta-cypermethrin, and malathion,
- Depending on the availability of the discriminating dose, it might be a good idea to test a few more active ingredients, such as bifenthrin, cyantraniliprole (e.g., Exirel)

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Summary IPM Strategy for SWD

- Monitor fields with using traps and check them regularly
- Use cultural practices (harvest frequently, destroy leftover fruits, etc.) whenever possible
- Based on trap capture and the stage of fruit development (ripening or not) apply effective insecticides to protect the fruit
- Select based on insecticide efficacy and label requirements, your target markets; MRL (maximum residue limits) has been a big issues for export market
- Resistance management should be a goal when planning for SWD control. Include bio-based and other softer products into rotation
- Application timing, sprayer type and efficiency, coverage are critical

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Thank You

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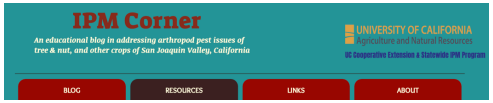

UCIPM Guidelines for SWD in Cherry:
https://ipm.ucanr.edu/agriculture/cherry/spotted-wing-drosophila/

Thanks to Lab members:
Sudan Gyawaly, Chang Vue, Dan Rivers,

Thanks to grower cooperators
Special thanks: Mike Devencenzi

Disclaimer:
Insecticide and other products mentioned in this presentation are based on recent and ongoing research. These products may not be registered for the commercial and household use. Always follow the product label for use

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