Spotted Wing Drosophila
(Drosophila suzukii)

in the
Southern Interior Valleys
of British Columbia

April 2011

Spotted Wing Drosophila (SWD) is an aggressive pest of stone fruits, berries, table grapes and perhaps wine grapes. SWD has been controlled in other commercial fruit growing areas and with diligent area wide control measures B.C. growers also have the ability to control this pest.

Acknowledgment

This publication has been produced by the Okanagan Kootenay Cherry Growers Association, the field staff of the Okanagan Tree Fruit Cooperative and B.C. Ministry of Agriculture. We wish to acknowledge assistance from the following people:

Dr. Peter Shearer, Oregon State University

Dr. Bob Van Steenwyk, University of California

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Disclaimer

Spotted wing drosophila is a new insect pest in the Pacific Northwest, having arrived in California in 2008. Although there has been an immediate response from researchers and growers in California, Oregon, Washington and B.C. there is much to learn and control recommendations will change as new information becomes available. This booklet is our attempt to outline what is currently known as of April, 2011. We urge you to read this carefully and to consult, on an ongoing and regular basis, the sources listed on the back page of this publication.

Identification

Adults: in summer, tan coloured flies with red eyes, about 2-3 mm (1/8 inch) long. Overwintering forms are darker. Males have a single black spot on the outer edge of each wing (Figure 1). Females do not have spots on their wings but have large saw-like ovipositors (for egg laying) (Figure 2). A microscope is needed to identify females. Cherry fruit fly adults are bigger (about 5 mm long) than spotted wing drosophila and have banding patterns on their wings (Figure 3).

Eggs: white, oval with two filaments at one end, 0.6 mm long (Figure 4).

Larvae: white, maggot-like and up to 4 mm long at maturity (Figure 5).

Pupae: brown, football-shaped, two stalks with small finger-like projections on one end, 3 mm long (Figures 6).

Refer to **http://www.agf.gov.bc.ca/cropprot/swd_identification.pdf** for additional information on characteristics of this pest.

Figure 1. Spotted Wing Drosophila Adult Male with wing spots.

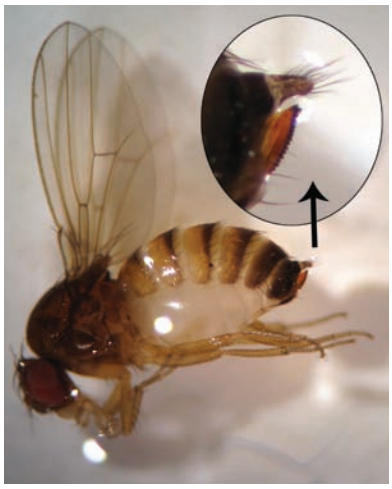

Figure 2. Spotted Wing Drosophila Adult Female. Inset shows ovipositor.

Figure 3. Top, Spotted wing drosophila adult; Bottom, Cherry fruit fly adult, note banding patterns on wings.

Figure 4. Spotted wing drosophila egg.

Figure 5. Spotted wing drosophila larva on cherry.

Figure 6. Spotted wing drosophila pupa.

Hosts

Crops affected by Spotted wing drosophila:

Cherries	Table Grapes
Peaches	Blueberries
Nectarines	Raspberries
Apricots	Blackberries
Plums	Boysenberries
Prunes	Strawberries
Asian Pears	Cold Hardy Kiwi

SWD's effect on wine grapes is not currently known, but research is ongoing.

SWD has also been found in the following non-crop hosts:

Oregon Grape	Black Currant
Blue Elderberry	Mulberry

Research on susceptible hosts is ongoing and this list is expected to increase over time.

Life Cycle

Spotted wing drosophila overwinter as adult flies. Adults emerge in the spring and lay eggs in ripening fruit. Egg-laying lasts 10-59 days, with 7-16 eggs laid per day. Each female can lay about 384 eggs during her lifetime. Eggs hatch in 12-72 hours, larvae mature in 3-13 days, and pupae reside in fruit or outside of fruit for 4-15 days. In the laboratory at constant temperature, one generation takes 50 days at 12°C, 21-25 days at 15°C, 19 days at 18°C, 8.5 days at 25°C and 7 days at 28°C. Adults will feed on dropped and decaying fruit.

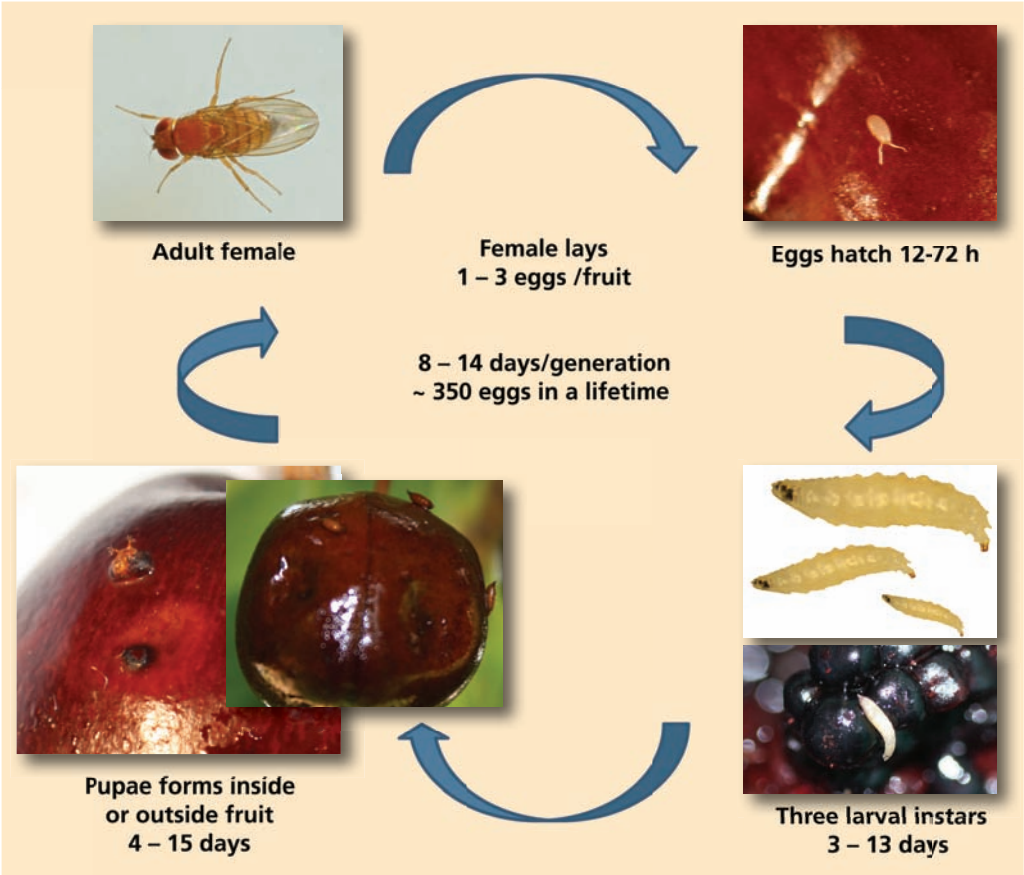

Figure 7. Spotted wing drosophila life cycle.

Damage

Females lay eggs under the skin of ripening fruit. Larvae hatch and begin to feed within the fruit causing softening in the area of feeding. There can be several larvae in a fruit which hastens softening and fruit collapse. Holes the size of pin pricks from the females' egg laying activities are evident within the soft areas of infested fruit (Figure 8). Besides contamination with larvae, these oviposition holes provide entry points for diseases such as brown rot and botrytis.

Not all drosophila larvae found in fruit are spotted wing drosophila. Other drosophila species will lay eggs in damaged fruit and drosophila larva cannot be identified to species. Larvae have to be reared out to adults to confirm spotted wing drosophila.

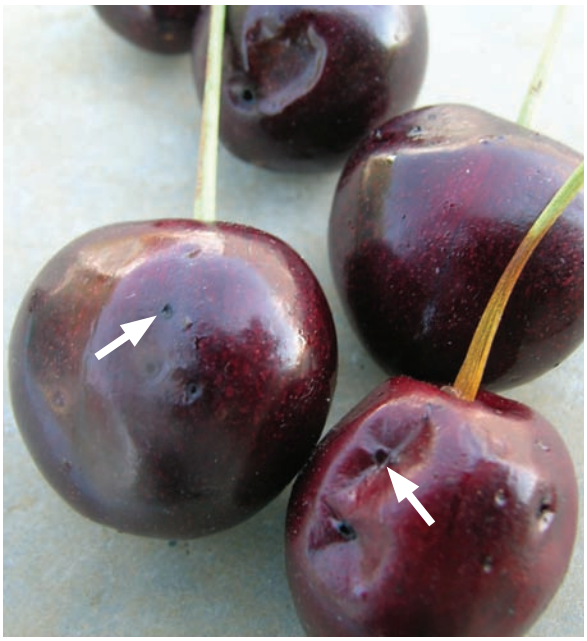

Figure 8. Spotted wing drosophila damage to peach and cherry, note egg laying scars (arrows). Some infested cherry fruit will NOT have the damage signs shown below.

Sugar or Salt Test for Larvae

A sugar or salt test can be used to check for the presence of larvae in the fruit at harvest. For the sugar test, make a solution using ¼ cup sugar to 4 cups water (large batches use 17 kg per 100 Liters of water). The resulting solution should have a brix reading of at least 15. If less than 15 then add more sugar. Lightly crush fruit sample in a container or plastic zip-lock bag to break the skins and add the sugar solution. Wait for about 10 minutes. Any larvae in the sample will float to the surface. A magnifying glass might be needed to find the larvae as the first instars may only be 1 mm long. Cherry fruit fly, leafroller, cherry fruit worm and sap beetle larvae will also be found if present in the sample being tested (Figures 9, 10, 11 & 12).

For the salt test, dissolve 1/4 cup table salt in 4 cups of warm water (use 0.25 kg per 4 Liters of water for large batches). Place uncrushed fruit in a shallow container, cover with salt solution and wait for 10 – 15 minutes for larvae to come out of infested fruit.

Figure 9. Drosophila larva has projections at ends.

Figure 10. Cherry fruit fly larvae have posterior blunt ends.

Figure 11. Mature Cherry fruit worm caterpillar, young caterpillars are white.

Figure 12. Oblique banded leafroller larva..

Trapping

Spotted wing drosophila adults can be monitored with apple cider vinegar baited traps. Traps can be made from deli cups with 4-5 holes drilled (use a 3/16 inch drill) on one side of the container to allow flies to enter. Holes shouldn't be too big or other large insects can get in (Figure 13). Deli cup traps can be purchased from Growers Supply Co. Ltd. You can also use commercial vinegar/ fruit fly traps (Figure 14). Add about 1½ inch (4 cm) pure apple cider vinegar to the trap and hang near fruit level in a shady area. Replace apple cider vinegar once a week and look for male flies (black spots on wings) in apple cider solution. Do not dump the old apple cider solution on the ground as this will attract more flies into the orchard. Check traps for both female and male flies in the spring as overwintered females outnumber males. Use a magnifying glass or hand lens to help identify male flies. A microscope is needed for the identification of female flies. Identification keys are available at the Ministry of Agriculture website: **http://www.agf.gov.bc.ca/cropprot/swd_identification.pdf**. Contact B.C. Ministry of Agriculture staff or the Packing House for assistance with fly identification.

Work done in Oregon and replicated in the Similkameen indicates that black and red coloured traps may be more attractive than clear ones. Research trials from Oregon also indicate that a combination of apple cider vinegar and red wine is more attractive to spotted wing drosophila adults. Use 2 parts pure apple cider vinegar to 3 parts red wine (alcohol content of red wine should be 12% or more) (Todd Adams, Oregon Department of Agriculture and Dr. Peter Landolt, Yakima Agricultural Research Service).

Traps are a useful indicator of spotted wing drosophila presence but are not a reliable measure of population pressure in an individual block. Infected fruit have been occasionally found prior to trap captures. As long as SWD have been found in the area of your block control sprays will have to be applied.

Figure 13. Apple cider vinegar trap. Yellow sticky tape not required.

Figure 14. Contech fruit fly trap.

Sanitation

Research on effectiveness of sanitation in control of spotted wing drosophila is underway, however we do know that SWD populations can build up quickly and the larger the population of an insect, the greater the risk of damage. It is recommended that growers and packers apply the following sanitation practices to help minimize the build up of spotted wing drosophila population:

- Pick crops clean. Try not to leave any fruit in the orchard after harvest.
- Be aware of alternate hosts. They may have to be removed or the crop picked unripe.
- Use postharvest sprays immediately after harvest, particularly on cherries or berries that are difficult to pick clean.
- Manage cull fruit daily by one of the following methods:
  - Bury fruit to a depth of more than 12 inches.
  - Seal fruit in plastic bags.
  - Solarize fruit by sealing in plastic bags or cover cull piles with plastic and seal the edges and allow to heat in the sun for a week.
- It might help to mow the orchard floor immediately after harvest to destroy fruit on the ground that may be host to SWD.

Products registered in Canada for use on cull piles are Dibrom (naled), Prelude (permethrin) and Dragnet (permethrin). These products have not yet been tested on SWD.

Chemical Control

When planning spray programs consider the following:

- Start control programs when SWD has been found in your area (not just your block) and the fruit has started to turn colour.
- Maintain continuous coverage right through harvest.
- Alternate pesticides. This will reduce the risk of resistance development and reduce the risk of exceeding Maximum Residue Limits (MRL).
- Rain will reduce efficacy of most pesticides. Reapply after heavy rains or shorten spray intervals after light rains.
- The population size of SWD increases all summer long, so that risk of damage increases with late harvested crops.
- Fruit becomes increasingly more susceptible to SWD attack as it ripens.
- SWD attacks a wide range of hosts, but some hosts seem to be more attractive to SWD. Cherries and berries seem to be more attractive than peaches, which seem to be more attractive than wine grapes.
- Check MRL's of the market you are shipping into.
- Read pesticide labels before use.

Most SWD control sprays also control cherry fruit fly, but not all cherry fruit fly sprays control SWD. The following tables have been compiled to assist growers in making spray material decisions.

Emergency use registrations for spotted wing drosophila control on stone fruit and grapes in British Columbia (Registrations are valid from June 1, 2011 until November 30, 2011).

Check MRL requirements for countries that your cherries may be shipped to.

Trade Name (active ingredient)	Group	Registered Crop	Rate	Maximum Number of Sprays	Pre-harvest Interval (days)	Worker Re-entry	Further Information on SWD Control
Delegate WG (spinetoram)	5	Stone fruit	420 g/ha (170 g/acre)	3	5 (cherry) 3 (peach, nectarine plum, apricot, prune)	12h	Label spray intervals are 7 days for stone fruit and 5 days for grapes. Some indication it may be effective longer than 7 days for SWD.[1] Mortality 82-96%.[2] Also controls leafrollers and cherry fruit fly.
		Grape	280 g/ha (113 g/acre)	3	4	12 h	
Entrust 80 W (spinosad)	5	Stone fruit	109 g/ha (44 g/acre)	3	5 (cherry) 3 (peach, plum, nectarine, apricot, prune)	12 h	Label spray interval is 5 days, but may only be effective for 3 days.[1] Mortality 95-100%.[2] Entrust is allowed in organic production. Also controls leafrollers and cherry fruit fly.
		Grape	109 g (44 g/acre)	3	4	12 h - 17 days	
Malathion 85 E (malathion)	1B	Stone fruit	610-855 mL/ 1000 L water	2	3	12 h	Label spray interval is 7 - 14 days, which should be effective for SWD.[1] Mortality 84-100%.[2] Also controls aphids. Pre-harvest Interval is 3 days for aphids. SWD rate will probably not control cherry fruit fly. May cause leaf drop or fruit finish problems on cherries, particularly when hot, or in lower water volumes. More effective over 20°C.
		Grape	880 mL/ 1000 L water	1	3	12 h - 2 days	
Ripcord 400 EC (cypermethrin)	3	Stone fruit[1]	150-175 mL/ha (61-71 mL/acre)	2	2	*24 h; 4 days (cherry thinning)	Label spray interval is 7 days, but shorter (3-5 days) when temperatures are over 25^{0}C. Mortality 80-93%[2] (based on other pyrethroids tested). May cause mite flare-ups. Will not control leafrollers, but should control cherry fruit fly.
		Grape	150 mL/ha (61 mL/acre)	2	7	*24 h	

[1] Dr. Bob Van Steenwyk - University of California

[2] Dr. Peter Shearer - Oregon State University. See figure 15 for efficacy trial results from Oregon State University.

* Re-entry required by Worksafe BC (WCB)

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The products below are not registered for spotted wing drosophila (SWD) control in Canada, but are registered on crops listed for other insects.

Trade Name (active ingredient)	Group	Registered Crop	Max. # Sprays	Pre-harvest interval (days)	Worker Re-entry	Further Information
Success 480 SC (spinosad)	5	Stone fruit	3	7 (Cherry, Plum) 14 (Peach, Nectarine, Apricot)	dry	Same active ingredient as Entrust, although this product is not registered for SWD.
	5	Grapes	3	7	dry to 15 days	
Diazinon 50 W (diazinon)	1B	Cherry, Apricot, Plums, Prunes		10	24 h*	Not tested, but other organophosphates effective on SWD. Label spray interval 10 days, but may be effective on SWD for less than 10 days.
	1B	Peach		20	24 h*	
	1B	Grape		16	24 h*	
Admire 240 FL/ Alias 240 SC (imidacloprid)	4	Peach, Nectarine	2	7	24 h	Not effective on SWD adults (mortality 5-34%), see figure 15. Testing underway on SWD larva, but currently not recommended.
	4	Cherry	5	10	24 h	
Assail 70 WP (acetamiprid)	4	Stone fruit	4	7	12 h (except 6 days thinning)	Not very effective on SWD adults (mortality 28-57%), see figure 15. Testing underway on SWD larva, but currently not recommended.
	4	Grape	2	7	12 h - 13 days	
Guthion 50 WP / Sniper 50 WP (azinphos-methyl)	1B	Peach, Apricot	2 (4kg/ha per year)	21	14 d	Not tested, but other organophosphates effective on SWD. Suggested spray interval 10 days. Last date of use for any azinphos-methyl product is December 31, 2012.
	1B	Cherry	2 (4kg/ha per year)	15	15 d	
	1B	Grape	2	28	28 d	
Zolone Flo (phosalone)	1B	Cherry	3	14	14 d	Not tested, but other organophosphates effective on SWD.
Cygon 480 EC / Lagon 480 E (dimethoate)	1B	Cherry	1	21	24 h*	Not tested on SWD. Some indication it may be effective on SWD larva but adult mortality unknown. Phytotoxic to some cherry varieties, particularly Lapins.

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Trade Name (active ingredient)	Group	Registered Crop	Max. # Sprays	Pre-harvest interval (days)	Worker Re-entry	Further Information
Sevin XLR (carbaryl)	1A	Cherry		2	24 h*	Not recommended for SWD. Has not been very effective on SWD when used for cherry fruit fly close to harvest.
		Grape		5	24 h*	
GF-120 (spinosad)	5	Cherry		0	dry	Not effective on SWD.
Malathion 25 WP (malathion)	1B	Cherry, Plum		3	24 h*	This formulation is registered for aphids, not for SWD. Should not cause as much leaf drop or fruit finish problems as the 85E formulation. See Malathion 85E for other precautions.
		Peach		7		

*Worker re-entry interval: an asterisk (*) indicates that no re-entry is shown on the label, but the WorkSafe BC re-entry interval may apply and is shown.

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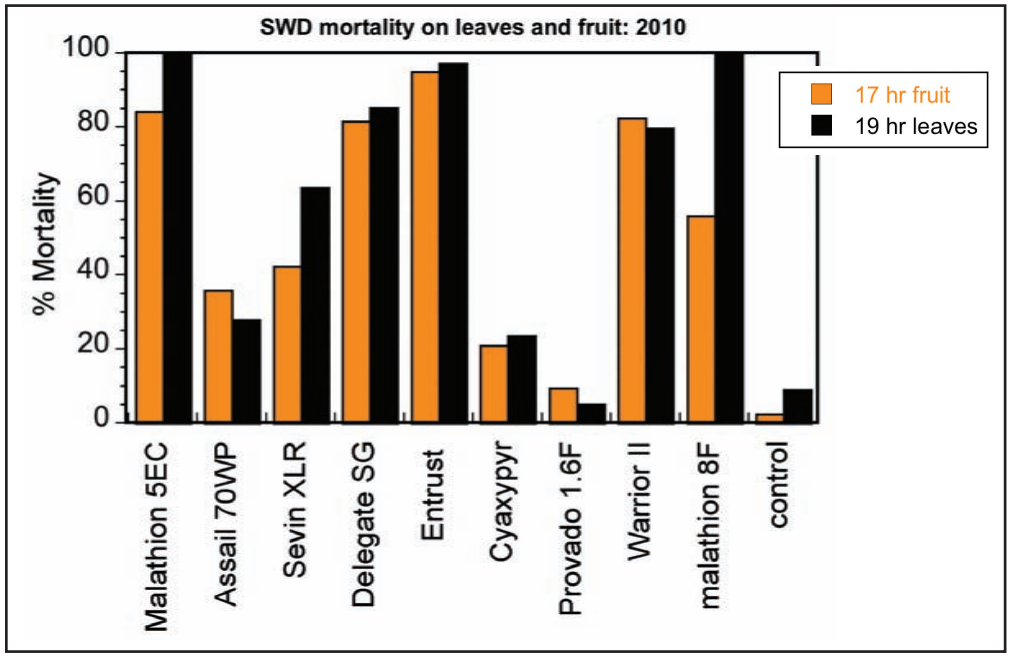

Figure 15. Mortality of adult SWD after being placed on fruit and leaves collected from treated trees.

Notes:
Product names in Canada in brackets: Provado (Admire), Warrior (Matador). Matador is a synthetic pyrethroid insecticide. Cyaxypyr is not registered in Canada.

Further information

B.C. Ministry of Agriculture:
http://www.al.gov.bc.ca/cropprot/swd.htm

Oregon State University:
http://swd.hort.oregonstate.edu/

Washington State University:
http://extension.wsu.edu/swd/Pages/default.aspx

California: UC IPM on line:
http://www.ipm.ucdavis.edu/PMG/r105400311.html

Okanagan Cherry Growers Association:
http://www.bccherry.com/

Contact

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Photo credits

Cover: B.C. Ministry of Agriculture.

Figures 1& 2: Sheila Fitzpatrick, Agriculture & Agri-Food Canada, Pacific Agri-Food Research Centre, Agassiz.

Figures 3, 4, 5 & 6: Brigitte Rozema & Howard Thistlewood, Agriculture & Agri-Food Canada, Pacific Agri-Food Research Centre, Summerland.

Figure 7: Adult female, Brigitte Rozema & Howard Thistlewood, Agriculture & Agri-Food Canada, Pacific Agri-Food Research Centre, Summerland; three larval instars, Beverly S. Gerdeman, WSU Northwestern Washington Research and Extension Center; Egg and pupae, B.C. Ministry of Agriculture.

Figure 8: B.C. Ministry of Agriculture.

Figures 9 & 10: Betsy Beers, Washington State University.

Figures 11,12,13 & 14: B.C. Ministry of Agriculture.

Figure 15: Peter Shearer, Oregon State University.