Two invasive species that threaten fruit production: spotted-wing drosophila & brown marmorated stink bug

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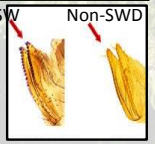
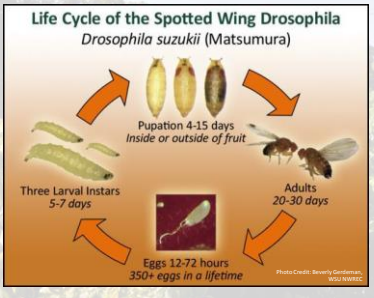
Spotted-Wing Drosophila: SWD

Diptera: Drosophilidae: *Drosophila suzukii*



Life cycle



- Female lay 1-3 eggs into ripening fruit
- Females can start laying eggs one day after adult emergence
- Multiple generations per year
- Optimal development at 65-70ºF
- ~12 day egg to adult
- Adults live 3-6 weeks

World Distribution: SWD is a global pest

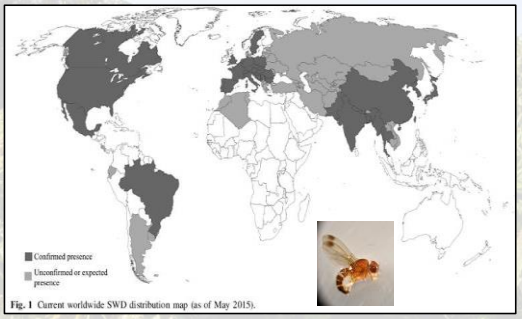
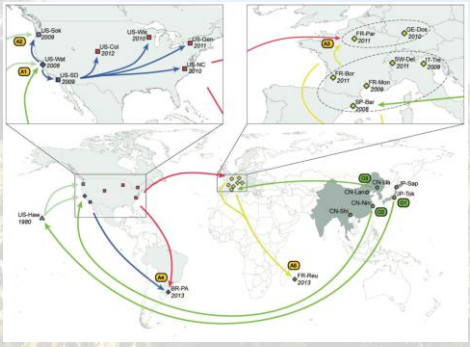


Fig. 1 Current worldwide SWD distribution map (as of May 2015).

Asplen et al., 2015. Journal of Pest Science

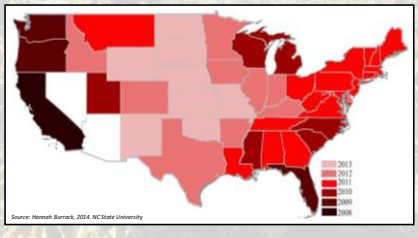
Routes of invasion scenario



Fraimout et al., 2017 Mol. Biol. Evol

US Distribution and economics

- First detected in California in 2008
- Crop losses estimated at $720 million annually
- Costs of SWD management estimated at $130-170 million



Susceptible fruits

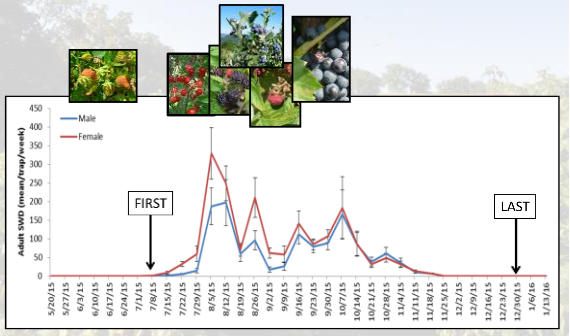
Highest risk	Moderate risk	Alternate hosts
Raspberries	Peaches	Snowberry
Blueberries	Grapes	Elderberry
Cherries	Pears	Pokeweed
Blackberries	Nectarines	Dogwood
Strawberries		Honeysuckle
		Bittersweet nightshade…

Damage from SWD

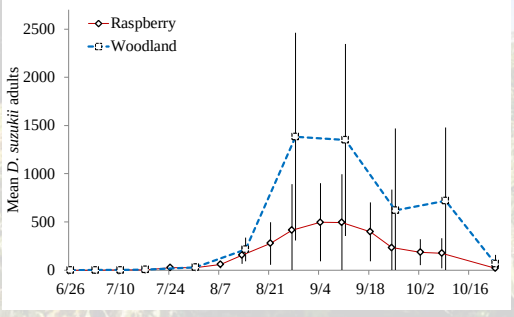
Midwest fruit and SWD

June July August September

Adult phenology



SWD in the landscape



SWD adapts to cold temperature

Can survive several months at 34 F
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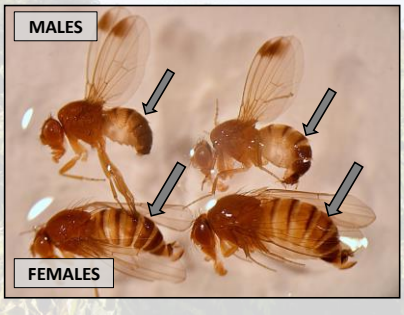
14 F <10% died

Stephens et al. 2015

WINTER-MORPH **SUMMER-MORPH**



Can't survive 3 months at 50 F
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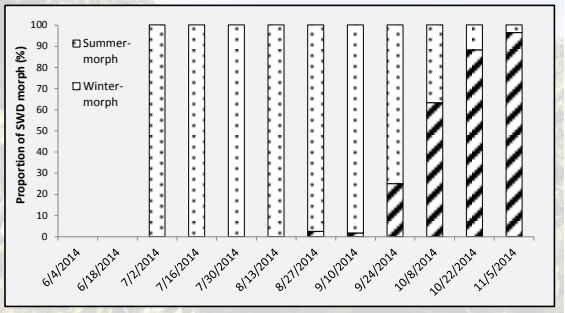
14 F 50% died

SWD adapts to cold temperature

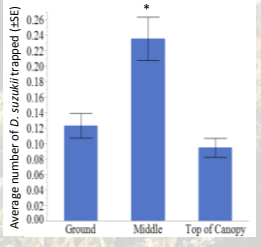


Where are SWD flies in crop?

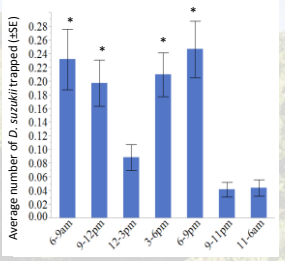
- Clear passive sticky traps
- n = 135 (9 replicates, 15 days)
- Replaced 2-3hr (except overnight)

Spatial and temporal distribution

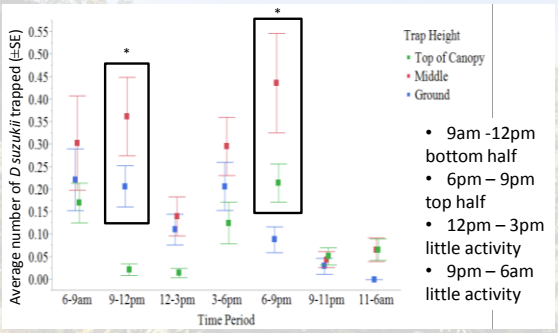
Height



Time

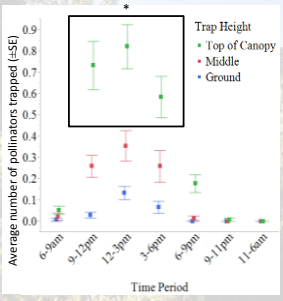


Spatial and temporal distribution combined



- 9am -12pm bottom half
- 6pm – 9pm top half
- 12pm – 3pm little activity
- 9pm – 6am little activity

Spatial and temporal distribution of pollinators



- 9am – 6pm
  top of canopy
- 6pm – 9am
  little activity

Bee genera caught included

- *Apis, Bombus, Eucera, Melissodes* (Apidae)
- *Lasioglossum* and *Augochlora* (Halictidae)
- *Hylaeus* (Colletidae)

How do we manage SWD????

Monitoring

- Start monitoring in late May
- 1 trap/acre, check at least once/week
- Monitor in crop and near woody areas
- YS trap: good homemade bait for monitoring
  - Active Dry Yeast: 1.69g
  - White Sugar: 8.45g
  - Unscented soap: a few drops
  - Water: 150ml

Detection

To see presence of eggs on berry surface:
Look for breathing tubes and pits on fruit surface

To check for larvae:

- Collect sample of coloring fruit
- Place fruits in Ziploc bag
- Crush fruit lightly to break fruit
- Add salt-water mixture (4 cups water ¼ cup salt)
- Leave fruit in mixture for 1h
- Look for larvae floating in the liquid (eggs and smaller larvae difficult to detect)

SWD management

Cultural control: Minimize build up of SWD

- Remove native wild hosts (apples, plums, dogwood, honeysuckle,…)
- Schedule short harvest intervals (2-days)
- Remove over-ripe fruit from field as soon as possible to minimize SWD egg lay and larval development

Cultural control

Sanitation: Dispose off fruit

- Bag fruit inside plastic bag, seal, and solarize
- Place clear plastic sheeting over fruit in sunny location and seal around edge with soil (solarize)
- Collected fruits should be used, destroyed or buried

  Do NOT compost infested fruit!

  If bury fruit, at least 1 ft deep

Cultural control

Canopy and water management

- Prune plants to maintain an open canopy, less attractive to SWD, and improves spray coverage
- Overhead irrigation should be minimized in favor of drip irrigation

Cultural control

Netting (primarily in tunnel production)

- Prevent flies from attacking fruit
- Must be applied before fruit begins to ripen
- Must be secured at bottom so flies cannot enter
- Mesh size should be very small: 1/32” (1 mm) mesh

Biological control

Biological control agents

Candidate species for biological control in quarantine

Promising species of parasitic wasps in permit process for field trials

Ganaspis brasiliensis

Buffington M. and Forshage M.

SWD management

No action threshold for SWD

If fruit ripening and **1st SWD fly trapped**:

1. Use registered insecticides from detection until harvest completed
2. Spray intervals should be relatively short (4-5 days)
3. Spray in evening when flies most active and pollinators not

Chemical control

Class (IRAC)	Trade name	Active ingredient	REI (hrs)	PHI (days)	Rate (per acre)	Probable efficacy
Carbamates (1A)	Sevin	Carbaryl	12	7	1-2 quarts	Good (JB)
	Lannate	Methomyl	48	3	¼-1 lbs	Excellent
Organophosphates (1B)	Malathion	Malathion	12	1-2	1.5 – 2 pints	Good/ Excellent (JB)
	Imidan	Phosmet	24	3	1.3 lb.	Excellent (JB)
Pyrethroids and Pyrethrins (3A)	Bifenture/Brigade	Bifenthrin	12	12hrs	8 – 16 oz.	Good/ Excellent (JB)
	Asana	esfenvalerate	12	7-14	4.8 – 9.6 fl. oz.	Excellent (JB)
	Danitol	Fenpropathrin	24	2	10 ⅔ – 21 ⅓ fl. oz.	Excellent (JB)
	Mustang Max	zeta-cypermethrin	12	1	4 oz.	Excellent (JB)
	Pyganic OMRI	Pyrethrum	12	12hrs	16 – 64 oz.	Good/Fair
Spinosyns (5)	Entrust OMRI	Spinosad	4	1	1.25 – 2 oz.	Good
	Delegate	spinetoram	4	1-3	6 oz.	Excellent
	Success	Spinosad	4	1	4 – 6 fl. oz.	
	Radiant	Spinoteram	4	1	6 – 10 fl. oz.	Excellent

Always read the label and follow the guidelines!!!

Chemical control

Homeowner Insecticides Labeled for Use against Spotted Wing Drosophila (SWD)

Product Name	EPA Reg. No.	Active Ingredient	Efficacy[2]	Fruit Crops Labeled for Use On:
BONIDE CAPTAIN JACK'S DEADBUG BREW FLOWER & VEGETABLE GARDEN DUST	4-479	Spinosad	Very good	apricots, cherries, nectarines, peaches, plums, prunes, bushberries[1] and caneberries[1]
BONIDE CAPTAIN JACK'S DEADBUG BREW CONCENTRATE	4-471	Spinosad	Very good	apricots, cherries, nectarines, peaches, plums, prunes, bushberries[1,4], and caneberries[1,4]
BONIDE CAPTAIN JACK'S DEADBUG BREW RTS	4-471	Spinosad	Very good	apricots, cherries, nectarines, peaches, plums, prunes, bushberries[1,4], and caneberries[1,4]
FERTI-LOME BORER, BAGWORM, LEAFMINER & TENT CATERPILLAR SPRAY	62719-314-7401	Spinosad	Very good	apricots, cherries, nectarines, peaches, plums, prunes, and bushberries[1,4]
BULLSEYE BIOINSECTICIDE	62719-314-56872	Spinosad	Very good	apricots, cherries, nectarines, peaches, plums, prunes, and bushberries[1,4]
MONTEREY GARDEN INSECT SPRAY	62719-314-54705	Spinosad	Very good	apricots, cherries, nectarines, peaches, plums, prunes, and bushberries[1,4]
PROTECT OR PRO	62719-314-87130	Spinosad	Very good	apricots, cherries, nectarines, peaches, plums, prunes,bushberries[1,4] and caneberries[1,4]
SPINOSAD 0.5% SC	62719-314	Spinosad	Very good	apricots, cherries, nectarines, peaches, plums, prunes, and bushberries[1,4]
ORTHO BUG-B-GON SYSTEMIC INSECT KILLER CONCENTRATE	8033-107-239	Acetamiprid	Good	apple, pear, apricot, cherry (sweet and tart), nectarine, peach, plum (chickasaw, damson, Japanese), plumcot, prune (fresh), grapes, strawberries and other low-growing berries, blueberries and other bush and caneberries[1].
ORTHO FLOWER FRUIT & VEGETABLE INSECT KILLER CONCENTRATE	8033-107-239	Acetamiprid	Good	apple, pear, apricot, cherry (sweet and tart), nectarine, peach, plum (chickasaw, damson, Japanese), plumcot, prune (fresh), grapes, strawberries and other low-growing berries, blueberries and other

http://www.fruit.cornell.edu/

Organic production

- Organic insecticides less effective than conventional
- Require more timely application
- Cultural controls even more important
- Rotate Entrust with Pyganic to achieve some resistance management

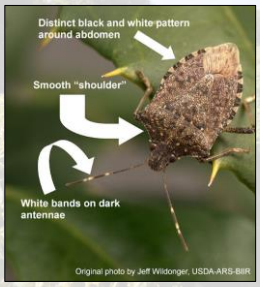
Post-harvest

Refrigeration

- Berries that have no visible damage should be placed directly in refrigerator
- Will slow down or stop SWD development if present, both hatched and unhatched
- Holding berries at 34°F for 72 hrs will kill most eggs and larger larvae
- Freezing berries will kill SWD

Brown marmorated stink bug (BMSB)

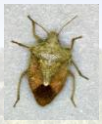
Hemiptera: Pentatomidae: *Halyomorpha halys*



- Mottled brown to grey
- ½-¾" long
- Legs are brown and may have faint white bands

BMSB look-alikes

Acrosternum sp.



Euschistus sp.

Boxelder Bug.

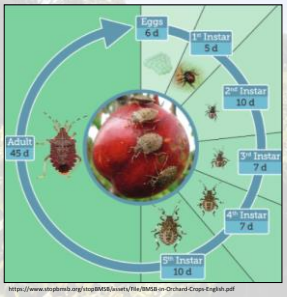
Western Conifer Seed Bug

BMSB

Brochymena

Slide credit Dr. Mike Raupp Univ. Maryland

Life cycle



https://www.stopbmsb.org/stopBMSB/assets/File/BMSB-on-Orchard-Crops-English.pdf

Adults come out of overwintering in spring (late March – June)

Adults begin to feed and sexually mature in ~2 weeks

Lay eggs ~1 week intervals, June-Sept

Each female can lay ~250 eggs

New generation of adults in mid to late summer

One generation in Wisconsin

Life cycle

- Adults emerge in spring, late March through June, depending on location, and begin to feed
- Each female can lay about 250 eggs in her lifetime
- New generation of adults appear in mid to late summer

Eggs

Nymphs and adults

BMSB movement

http://www.stopbmsb.org/stopBMSB/assets/File/BMSB-in-Orchard-Crops-English.pdf

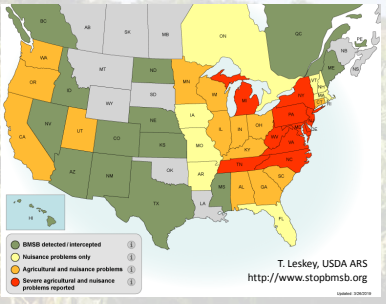
Distribution

Native from Asia (China, Korea, Japan)

Probably came to US on shipping boat in 1996 (Allentown, PA)

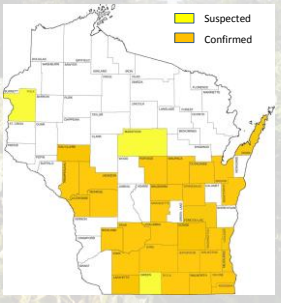
Distribution

2019: detected in 44 U.S. states and 4 Canadian provinces



Distribution in Wisconsin

As of Jan 2020, 29 confirmed counties, 3 suspected
Coordination with Krista Hamilton (DATCP) and PJ Liesch (UW)



- WI first reports in 2010
- Breeding populations in 2012
- 2017, nuisance reports increase and first detection in agricultural crops (apple)

Overwintering and pest status

- Adults overwinter in protected locations - natural rocky outcroppings, houses and structures, in bark of dead standing trees
- Adults sheltering in homes active on warm days in late winter (active in March this year in Madison)

Slide credit Dr. Mike Raupp Univ. Maryland

Host plants

Significant agricultural pest in some areas of the eastern US

- Tree fruits: apple, peach, cherry, pear,…
- Vegetables: peppers, tomatoes, asparagus…
- Fruits: berries, grapes, currant, melons,…
- Field crops: soybeans, corn,…
- Trees: maple, crabapple, oak, black cherry (feeds through the bark)

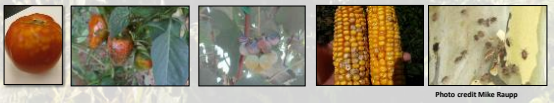


Photo credit Mike Raupp

Damage in apple

- Injury severe and deep in flesh rendering fruit unacceptable for fresh market
- Each probing or feeding eventually results in visible injury

Photo credit Tracy Leskey

Photo credit Tracy Leskey

Damage in apple

- A fruit grower in the Mid-Atlantic region reported loosing 45,000 bushels of apples to BMSB
- In apples alone, BMSB caused an estimated $37 million in crop losses in the mid-Atlantic region in 2010
- In Mid-Atlantic, prior to BMSB, 4 – 6 insecticide applications each year. In 2010 growers applied > 20 applications in the season, and still suffered economic losses
- BMSB has set IPM back 4 decades in Mid-Atlantic!

Slide credit Dr. Mike Raupp Univ. Maryland

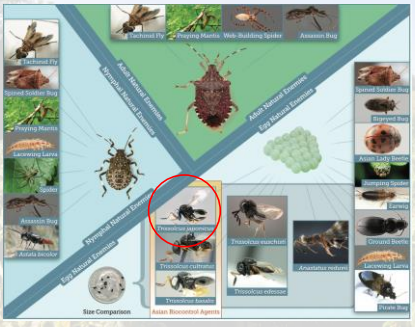
Management options

- Population monitoring
  - Scouting especially along wooded edges
  - Pheromone traps
- Chemical control: neonicotinoids, pyrethroids, carbamates. Not necessary at this stage in WI gardens.
- Biological control: several native parasitoids (*Telenomus podisi*) and predators. Most promising: egg parasitoid *Trissolcus japonicus*

Telenomus podisi

Trissolcus japonicus

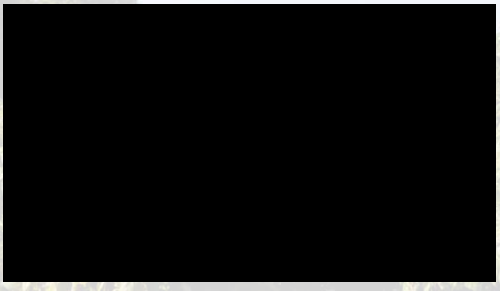
Biological control



http://www.stopbmsb.org/stopBMSB/assets/File/BMSB-in-Orchard-Crops-English.pdf

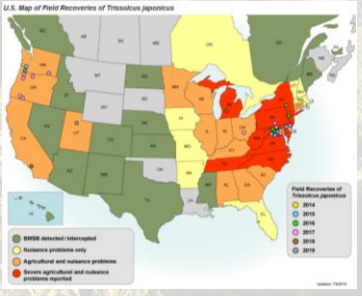
Biological control

Stopbmsb.org: "These stingerless warriors search for and destroy 60–90% of BMSB eggs in Asia"



Biological control

Found in 12 states and British Columbia
Releases have started in some states



Confirmation

If you find or suspect BMSB:

1. Send a good photo of specimen to county office or PJ Liesch
   pliesch@wisc.edu
2. Bring specimen to county office
3. Place specimen in alcohol and send to PJ Liesch:
   Insect Diagnostic Lab
   1630 Linden Dr.
   University of Wisconsin
   Madison, WI 53706

https://insectlab.russell.wisc.edu/patrick-p-j-liesch/#