Ecologically-based Insect Pest Management in High Tunnels

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Integrated Pest Management in High Tunnels

- Plant resistance
- Cultural control
  - Prevention
  - Exclusion
- Biological control
  - Predators
  - Parasitoids
- Pest Monitoring
- Insecticides

Integrating cultural and biological controls of insect pests and mites can greatly expand the number of effective options in our IPM toolbox

IPM and cultural controls (field)

- Host plant resistance
- Transplanting
- Crop rotation
- Crop density / spacing
- Soil quality management
- Sanitation
- Farmscaping/habitat manipulation
- Trap cropping
- Cover crops
- Use of mulches
- Intercropping
- Alter planting / harvest dates

Natural enemies

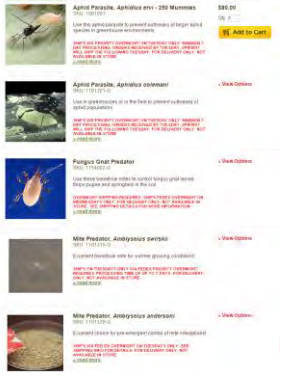
- **Predators** (e.g., beetles & predatory bugs)
- **Parasitoids** (parasitic wasps, some flies)
- **Pathogens** (virus bacteria, fungi)

Aphid parasitoid

Biological control is proactive

DEMO Specialists

- Releases of parasitic wasps and/or predatory insects need to be done earlier in the season (based on pest monitoring)
- Normally, several releases need to be done (based on calendar)
- Usually, released biological control agents are expected to perform without provisioning them with anything other that the prey / host they are supposed to attack
- It takes time for results to be visible



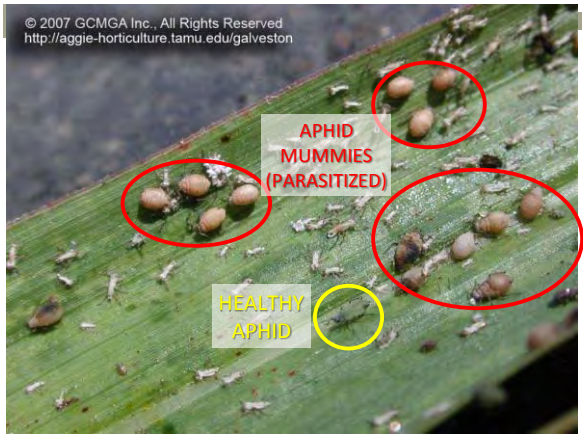
One example

Marshall, MO 2012

- Aphid outbreak
- Parasitic wasps present but not enough to control aphid population
- Purchasing and releasing more wasps or predatory insects not feasible
- Needed to suppress aphids to allow wasps to 'catch up'
- Recommended application of OMRI-listed insecticidal soap
- Soap killed most healthy aphids and did not affect the mummies. **Outbreak controlled without insecticides!**

Having flowering plants likely provided nectar to parasitic wasps

Collecting leaves with aphid mummies after spraying insecticidal soap to assess potential negative effects on parasitic wasps



Spider Mite Biocontrol

***Phytoseiulis persimilis* (predatory mite)**

- Aggressive predator, can also eat pollen
- Needs RH over 75% and temperature of 68F
- Only eats Spider Mites
- Cost: $35.00 for 2,000 predatory mites (http://www.arbico-organics.com)

***Amblyseius californicus* (predatory mite)**

- Also a predator, but not as aggressive
- Eats mites, thrips, and pollen
- Needs RH over 75% and temperature of 68 degrees Fahrenheit
- Cost: ?? Source: ??

Trap Cropping

Using very attractive plants to pull insect pests away from cash crop

2013 – 2014 Approach:

- Trap Crop plants located at the row ends
- 8 trap crops per row protected 70 Zephyr squash plants (cash crop)

Trap Cropping: cucumber beetles

Since 2011, Jose Fonseca (St. Peters, MO) has minimized cucumber beetle damage to seedlings (in a hoophouse) using potted trap crops

He experimented with trap crops (Blue Hubbard squash) transplanted outside high tunnel in 2014 and 2015

- Imidacloprid (**systemic**) applied to trap crops in pots
- Imidacloprid also applied to transplanted trap crops outside high tunnel
- 3-5 weeks of protection

Trap Cropping: Spider mites

- **Bush beans** can be used as trap crops for spider mites in tomatoes
- The beans attract the spider mites and show damage very quickly, which will help with monitoring
- Once pest spider are present, release predatory mites (*Phytoseiulus persimilis*) to the beans at an approximate ratio of 1 to 100
- The bush beans will reproduce *P. persimilis* some of which will disperse to attack more mites
- Cost? Ca. $ 35 for 2,000 *P. persimilis*

Bush Bean Trap Crop for Spider Mites in Tomatoes


Predatory mite, *Phytoseiulus persimilis*, attacking a two-spotted spider mite.

Trap Cropping: Thrips

- **Marigolds** are very attractive to thrips and also support natural enemies such as Minute pirate bug (*Orius insidiosus*) by providing pollen
- Thrips Predator Mites (*Neoseiulus cucumeris*) ($ 48.50 for 50,000 mites) can also be released to feed on thrips larvae
- **Ornamental pepper (var. Black Pearl) is** very attractive to aphids and thrips, and also provide pollen to *O. insidiosus*.
- Since pepper plants germinate and grow slowly, plants need to be started well in advance to be used as banker plants.
- Minute pirate bugs hunt better in peppers (cash crop) than in tomatoes because of trichomes (sticky hairs) present in tomato leaves


Minute pirate bug, *Orious insidiousus*, praying upon a thrips.


Tomato leaf surface - covered in trichomes (red) which secrete oil and hairs. Both structures protect the plant against pests

Trap Cropping: Whiteflies


Eggplant as trap crop for whiteflies in Poinsettia

Squash as trap crop for whiteflies in tomato


Released Minute pirate bug, *Orius insidiosus*, feeding on whitefly nymphs

Eggplants inoculated with *Encarsia formosa* for control of **greenhouse whitefly** and *Eretmocerus mundus* for control of **Bemisia (sweet potato) whitefly**

Banker Plants

Mini-rearing system for natural enemies of pests

APHIDS

Pest of most vegetable crops

Green Peach Aphid *Myzus persicae*

Others – cotton & potato aphids, etc.

Biol. Control agents

Predatory midge
Aphidoletes aphidimyza

Lacewings
Chrysoperla rufilabris

Ladybeetles
Hippodamia convergens

Minute pirate bugs
Orius insidiosus

Parasitic wasps
Aphidius testaceipes

Courtesy of Dr. Tom Coudron (USDA-ARS)

Non-crop plants that provide alternative hosts for parasitoids, prey for predators, or plant-based resources such as nectar and pollen for omnivores

Why banker plants?

The expense associated with frequent shipments of natural enemies is not sustainable for most small diversified vegetable growers. So, helping beneficials reproduce is a great option to reduce costs.

- Natural enemies are 'released' from banker plants continuously to control the "real" pests on cash crops at no expense to growers.
- Barley, wheat, or other small grains to raise **(non-pest) grain-specific aphids (e.g., Bird cherry aphid**
- These aphids, in turn, attract beneficial insects which can control populations of other types of "pest" aphids within the tunnel

Picture: greenhousecanada.com

Aphid Banker Plant System for Greenhouse IPM, Step by Step

Prepared by Margaret Skinner[1], Cheryl F. Sullivan[1] & Ronald Valentin[2]
[1]University of Vermont Entomology Research Laboratory
661 Spear Street, Burlington, VT 05405-0105

[2]Biobest USA, Inc.
2020 Fox Run Road, RR 4
Leamington ON N8H 3V7 CN Canada

If you buy the wasps:

Rate: ~ 1 wasp/100 sq ft.
Cost: 2.5 cents per sq. ft.

Source: North Carolina State Univ.

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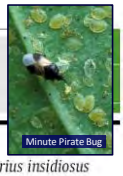


Minute Pirate Bug

Influence of banker plants and spiders on biological control by *Orius insidiosus* (Heteroptera: Anthocoridae)

Sarah K. Wong, Steven D. Frank *
North Carolina State University, Department of Entomology, Campus Box 7613, Raleigh, NC 27695, USA

- 12 hoop houses producing native and ornamental grasses
- Insect pests: Western Flower Thrips and two-spotted mites
- Banker plant: Black Pearl Pepper

- More than **twice as many** thrips were recorded in the control treatment houses than in the banker plant treatment houses
- More than **six times as many** spider mites in the control houses than the banker plant treatment houses

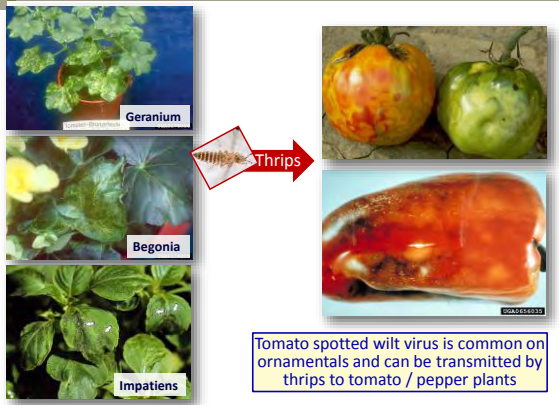
On-going research in Vermont: **habitat pots** (made up of sweet alyssum, beans, marigolds and lantana) to provide **pollen and nectar** to parasitic wasps and predatory insects

Sweet alyssum, in high tunnel tomatoes to support commercially available natural enemies

Indicator Plants

Plants very susceptible to plant diseases (transmitted by insect vectors), thus they provide early warning

Intermixing tomatoes and potted ornamentals in the same tunnel can lead to viral disease problems



Tomato spotted wilt virus is common on ornamentals and can be transmitted by thrips to tomato / pepper plants

Indicator plants: Petunia

- One challenge: Thrips are resistant to many pesticides
- Petunias (cultivars Calypso, Super Blue Magic and Summer Madness) are very susceptible to common viruses transmitted by Western Flower Thrips

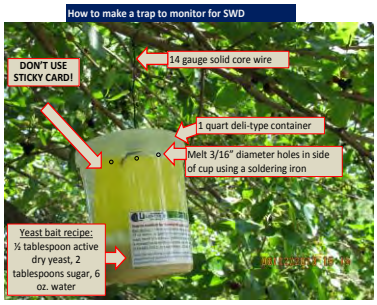
Indicator plants: Petunia

- Place petunia indicator plants in areas with higher thrips populations (based on sticky card counts)
- Just four days after infection, local brown lesions form around feeding sites indicating infection
- Infected petunia plants do not serve as source of virus
- But care must be taken to ensure they don't become a source for a pest outbreak

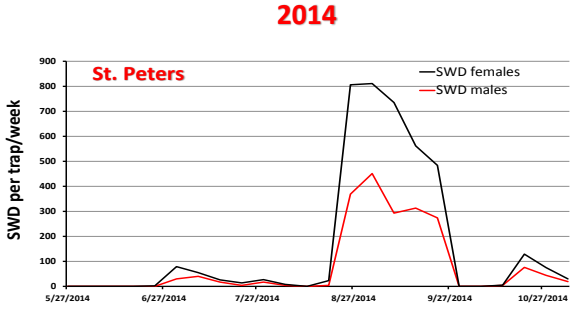
Growers can use petunias to monitor for **TSWV** and **INSV** quickly without having to check the whole crop

Monitoring

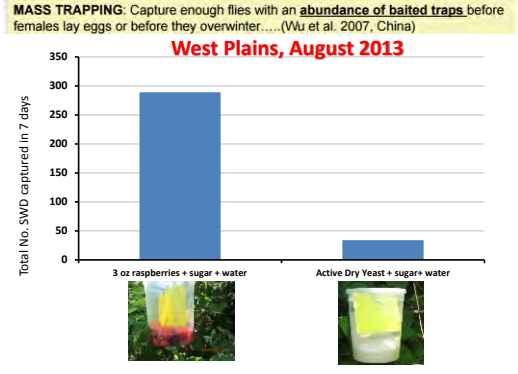
- ✓More synthetic lures are commercially available but none beats the yeast / sugar (home-made) bait
- ✓Traps indicate presence of SWD; but they do not indicate infestation (egg-laying in fruit)
- ✓Number of flies captures are not predicting potential for infestation



Seasonal SWD captures



Is mass trapping an option to suppress SWD?



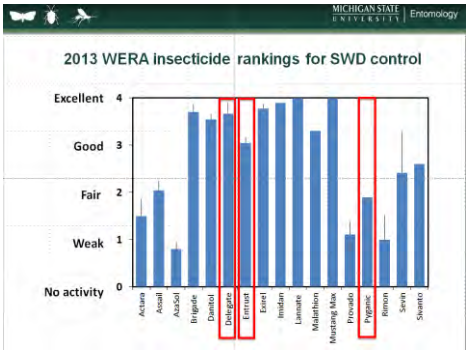
Insecticidal options for 2016

Effectiveness of Insecticides and Miticides for Brambles[1]

Chemical	IRAC Group (mode of action)	Common Name	pest mites	raspberry crown borer	raspberry fruitworm	leafrollers	raspberry sawfly	green June/Japanese beetle	cane borer	root chafer	strawberry clipper	plant bugs	stink bugs	aphids	spotted wing Drosophila	PHI (days)	REI (hours)
Pyrethroids																	
Asana	3A	esfenvalerate	MT			G		E				E	G			7	12
Brigade/ Capture	3A	bifenthrin	MT	E		E		G	E			E	E	E		3	12
Danitol	3A	fenpropathrin	MT			E		E	G			E	E		E	3	24
Mustang Maxx	3A	zeta-cypermethrin	MT			E		E				E	E		E	1	12
Pyganic	3A	pyrethrins	ST		F	P	P				F	P	P	P	F	0	12
Neonicotinoids																	
Actara	4A	thiamethoxam	MT									G	G			3	12
Admire	4A	imidacloprid	MT					F		G					F	12	3/7[a]
Assail	4A	acetamiprid	ST					G	G			G	F			7	12
Insect Growth Regulators																	
Confirm	18	tebufenozide	ST			E										14	4
Intrepid	18	methoxyfenozide	ST			G										7	4
Knack	7C	pyriproxyfen	ST													7	12
Others																	
Altacor	28	chlorantraniliprole	ST	G		E									F	3	4
Delegate	5	spinetoram	MT		E	E	G		F						E	1	12
Dipel	11	B. thuringiensis	ST			F										0	4
Entrust	5	spinosad	ST		G	G	G								G	1	4
Malathion	1B	malathion	MT				G								G	12/24[a]	1
Sevin	1A	carbaryl	MT			G	G	G			G	G	P		G	7	12
Miticides																	
Acramite	UN	bifenazate	ST													G	1	12
Kanemite	20B	acequinocyl	MT													G	1	12
Savey	10A	hexythiazox	ST													E	3	12
Zeal	10B	etoxazole	MT													E	12	0

Delegate: Effective, but not OMRI-listed

- **Spinetoram** is a new chemical in the spinosyn class of insecticides
- It is a semi-synthetic spinosyn (not for certified organic production)



Dr. Rufus Isaacs

MICHIGAN STATE UNIVERSITY DEPARTMENT OF ENTOMOLOGY

Rainfall and control of SWD

Blueberry insecticide precipitation wash-off re-application decision chart - spotted wing Drosophila

Insecticides	Rainfall = 0.5 inch		Rainfall = 1.0 inch		Rainfall = 2.0 inches	
	*1 day	*7 days	*1 day	*7 days	*1 day	*7 days
Imidan	OK	Insufficient	OK	Insufficient	Insufficient	Insufficient
Mustang Maxx	OK	Insufficient	OK	Insufficient	Insufficient	Insufficient
Lannate	OK	Insufficient	OK	Insufficient	Insufficient	Insufficient
Malathion	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient
Delegate	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient
Assail	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient

* Number of days after insecticide application that the precipitation event occurred.

How to make insecticide sprays against SWD more effective

- All fruit flies have **sponging**-lapping mouthparts, so they must feed on liquids
- Sugar is a phagostimulant (food component that induces sustained feeding)

Horticultural Entomology

Sucrose Improves Insecticide Activity Against *Drosophila suzukii* (Diptera: Drosophilidae)

RICHARD S. COWLES,[1,2] CESAR RODRIGUEZ-SAONA,[1] ROBERT HOLDCRAFT,[2] GREGORY M. LOEB,[3] JOHANNA E. ELSENSOHN,[3] AND STEVEN P. HESLER[3]

J. Econ. Entomol. 109(2): 860–865 (2016); DOI: 10.1093/jee/tow100

"We can't solve problems by using the same kind of thinking we used when we created them"

- Albert Einstein