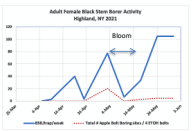
Challenges of Invasive Insect Pest Management in Tree Fruit Production: Addressing Black Stem Borer, Asian Invasive Brown Marmorated Stink Bug, Thrips in Stone Fruit



Peter J. Jentsch

CT. Annual Pomological Society Mtg.
Middletown Elks Lodge
Middletown, CT

Tuesday, November 29, 2022 11:00-11:45 AM

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Blog site subscription: Free

Poma Tech Inc. is a 501(c)(3) Not for Profit, addressing the evolving pest management research and educational needs in support of the tree fruit industry while mitigating food insecurity across the Hudson Valley region of NYS.

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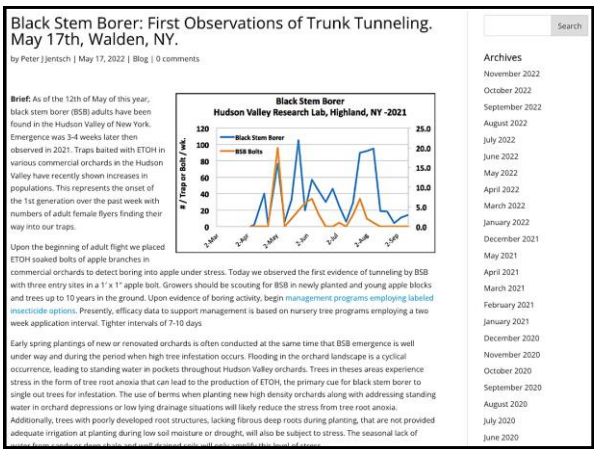

4

Morning Brew: : Tree Fruit Pest Management Conversations via Zoom. Monday, 6AM, April 25th, 2022

by Peter J Jentsch | Apr 23, 2022 | Blog, Uncategorized | 0 comments

2023: Begins Monday March Ends October 1st @ no cost to tree fruit growers

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Black Stem Borer (BSB), *Xylosandrus germanus*

Biology

BSB is an invasive forest (deciduous tree) pest in the U.S.

- Eastern Asia introduction, first detected in 1932 New York & over time in most parts of the U.S.
- Hudson Valley first find in Highland, NY on Pink Lady on M9 – Nic29 rootstock in 2016.
- Observed in 2013 in six orchard sites in the Lake Ontario fruit region of New York contributing to **'Sudden (Rapid) Apple Decline'**
- In the family of **ambrosia beetles**, females introduce symbiotic fungi into colonized trees, using fungi as their main source of food. Beetles found to carry spores of *Fusarium solani*, know to cause collar and root rot (Cambium).

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Black Stem Borer (BSB), *Xylosandrus germanus*

Biology

The black stem borer attacks apparently **'healthy plants'.**

- **Research:** Ohio and North Carolina have shown that **trees growing in saturated soils (water stress) tend to develop and release ethyl alcohol (ETOH) as the root zone goes into anaerobic respiration stress during wet periods.**
- **ETOH acts as a tree host finding mechanism for BSB.**
- 'Drought' stressed trees in sandy and shale soils, also have been infested by BSB.

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Black Stem Borer (BSB), *Xylosandrus germanus*

Tree Stress Producing ETOH

Causes of Tree Stress

Flooding: Standing water

Drought: Very low soil moisture & no irrigation

Biotics: Pathogens & Disease (Fire blight: root, crown and lower trunk)

Sun Scald & Heat

Cold Temp: Winter freeze injury, late spring freeze

Herbicide: Initial or repeated injury to trunks & roots

- **Rely** – Glyphosate Aluminum (Rutgers)
- **Round-up** – Glyphosate

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Black Stem Borer (BSB), *Xylosandrus germanus*

Herbicide Injury

May – 2022

- Flaking bark
- Sunken Lesions
- Cankering
- Dead and dying cambium layer

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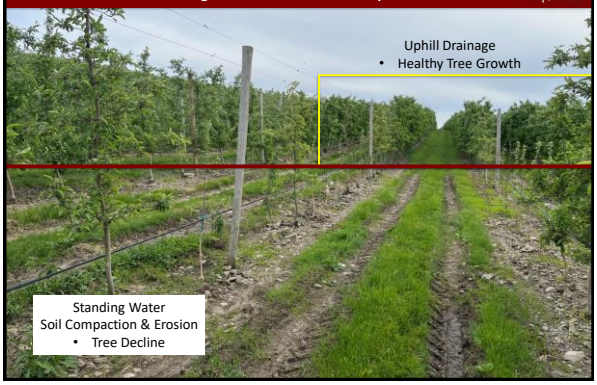
Black Stem Borer (BSB), *Xylosandrus germanus*

Standing Water Tree Decline & Replacement



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Black Stem Borer (BSB), *Xylosandrus germanus*

Orchard Injury

Royal Red Honey Crisp
VFI Geneva 935

- Spring - Early May
- 4th leaf - end row
- Perimeter with hardwood along boarder
- Trunks with white latex

- 2021: Very high BSB populations both endemic, residing in trees, and from woodlands

- 10 trees in row were in decline, drying out / dead

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Black Stem Borer (BSB), *Xylosandrus germanus*

Water Movement & Site Depression

- Down hill water fall line into a slight depression where water would reside for longer periods of time

- High density trees in low lying depressions should be planted in 2-3' berms to shed water, providing oxygen to the root zone, reducing anaerobic respiration and BSB infestation.

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Black Stem Borer (BSB), *Xylosandrus germanus*

Entry Site Observations

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Black Stem Borer (BSB), *Xylosandrus germanus*

Entry Site Observations

11 Black Stem Borer Entry Sites

- Upon removal of tree
- Found entry sites were extensive, primarily above ground
- Fewer entry sites at or slightly below ground level.
- Some trees showed BSB above the 1st scaffold limbs

Ground level.

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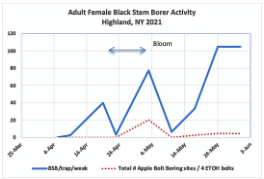
Black Stem Borer (BSB), *Xylosandrus germanus*

Monitoring Adults

Monitoring: Adult flight
- Weekly

Information:
- 1st Adult Emergence
- Multi-Generational
- Pop. Presence & Density

'Tropicana' bottle
- (2) 1" rectangular openings
- Inverted + screw-eye
- Hung at 1.5' from floor
- ETOH Lures (AgBio) monthly
- Soapy water at base
- 'Pour' & rinse into screen



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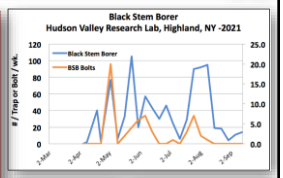
Black Stem Borer (BSB), *Xylosandrus germanus*

Monitoring Adult Boring Activity

Adult female boring activity
- Weekly

Information:
- 1st Adult boring & trunk entry
- Management timing
- Pop. Presence & Density

Monitoring Infestation Bolts
- >1.5" x 12" Apple pruning wood
- Soak **or** drill to 10cm and fill with 95% ETOH
- Place 1.5' from floor



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Black Stem Borer (BSB), *Xylosandrus germanus*
Management: NC State. Sara Vallani & Jim Walgenbach

2018 Insecticide Trial

- 1-year old potted trees: 'Granny Smith' on B.9 rootstock
- Pots placed in plastic bag and watered weekly with 2.5% ETOH solution.
- 7-wk exposure period near wooded area of an orchard with high RAD incidence in 2017.
- Treatments
  - Soil applied systemic insecticides applied one month before field exposure period
  - Foliar applications made weekly beginning at exposure period
  - PermaNet: deltamethrin-impregnated netting wrapped around trunk.

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Black Stem Borer (BSB), *Xylosandrus germanus*
Management: NC State. Sara Villani & Jim Walgenbach

Ambrosia beetle entries in apple trees during 7-wk exposure period. Fruitland, NC. 2018.

Treatment	
ETOH Control	
Venom (soil)	Neonicotinoids: Translaminar (locally systemic)
Admire (Soil)	Dinotefuran 70%
Admire (Foliar)	2F Imidacloprid 21.4%
Karate (Foliar)	**Pyrethroid: Contact** Lambda-cyhalothrin
Lorsban (Foliar)	**Organophosphate: Contact** Chlorpyrifos
Cobalt (Foliar)	
PermaNet	**Pyrethroid: Contact** Deltamethrin

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Black Stem Borer (BSB), *Xylosandrus germanus*
Management: NC State. Sara Villani & Jim Walgenbach

Ambrosia beetle entries in apple trees during 7-wk exposure period. Fruitland, NC. 2018.

Treatment	Rate (/A)	Entries/tree	Entries with adult &/or larva[1]
ETOH Control	—	11.8a	8.6b
Venom (soil)	6.0 oz	11.8a	9.4b
Admire (Soil)	10.5 oz	5.2a	3.4ab
Admire (Foliar)	7.0 oz	7.4a	6.6b
Karate (Foliar)	2.5 oz	6.4a	4.0ab
Lorsban (Foliar)	3.0 qt	6.6a	3.2ab
Cobalt (Foliar)	1.3 qt	3.2a	0.2a
PermaNet	—	2.2a	0.6a

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Black Stem Borer (BSB), *Xylosandrus germanus*
Management: NC State. Sara Villani & Jim Walgenbach

Ambrosia beetle entries in apple trees during 7-wk exposure period. Fruitland, NC. 2018.

Treatment	Rate (/A)	Entries/tree	Entries with adult &/or larva[1]	
ETOH Control	—	11.8a	8.6b	
Venom (soil)	6.0 oz	11.8a	9.4b	
Admire (Soil)	10.5 oz	5.2a	3.4ab	Imidacloprid
Admire (Foliar)	7.0 oz	7.4a	6.6b	
Karate (Foliar)	2.5 oz	6.4a	4.0ab	Lambda-cyhalothrin
Lorsban (Foliar)	3.0 qt	6.6a	3.2ab	Chlorpyrifos
Cobalt (Foliar)	1.3 qt	3.2a	0.2a	
PermaNet	—	2.2a	0.6a	Vestergaard Unavailable

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Black Stem Borer (BSB), *Xylosandrus germanus*
Management: NC State. Sara Villani & Jim Walgenbach

Active Ingredient: Imidacloprid 42.8%

Restriction: Not to be applied during pre-bloom

Post bloom applications may not become systemic until well after BSB have burrowed into the tree.

POME FRUIT – SOIL
Crops Of Crop Group 11 Including: Apple, Crabapple, Loquat, Mayhaw, Pear (including Oriental pear), Quince

Pests Controlled	Rate fluid ounces/Acre
Aphids (including woolly apple aphid) Leafhoppers	7.0 – 10.5
Pome Fruit – Soil Application Apply specified dosage in the following method: 1. Chemigation into root-zone through low-pressure drip, trickle, micro-sprinkler or equivalent equipment.	
Pome Fruit – Soil Application Restrictions Pre-Harvest Interval (PHI): **21 days** Maximum ADMIRE PRO SYSTEMIC PROTECTANT allowed per year: **10.5 fluid ounces/Acre** (0.38 lb AI/Acre) Do not apply pre-bloom or during bloom or when bees are foraging.	

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Black Stem Borer (BSB), *Xylosandrus germanus*
Management

Addressing Tree Stress & BSB Infestations

Drainage

Low site depressions. Additional drainage solutions; grading alleys
Remediation: Create berms to shed water for tree roots

Insecticide Management

After 1st BSB emergence & priot to 1st boring site (Early May):

- Application to trunk / foliage
  - Pyrethroid as contact insecticide
    - **Danitol, Lambda-cyhalothrin (Warrior) – BSB on Label**
    - **Permethrin 38.4%** (2 apps @ 10 fl.oz./A)**, Bifenthrin**

Research

- Push / Pull Management (repellency) strategy to manipulate beetle populations in orchards.
- **Methyl Salicylate & Verbenone**

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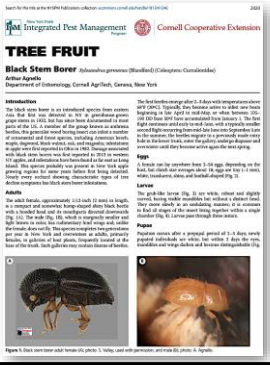
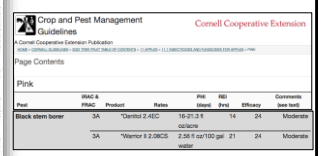
Black Stem Borer (BSB), *Xylosandrus germanus*
Resources



Cornell Resources

2020 BSB Fact Sheet. Art Agnello

2023 Cornell Guidelines



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Brown Marmorated Stink Bug Management

- **Aspects of BMSB Ecology & Biology**
- **Agricultural Monitoring / Scouting**
- **Stink Bug Injury Diagnostics**
- **Insecticide Efficacy Studies**
- **Novel / Innovation Mgt. Research**
- **Biological Control**

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Brown Marmorated Stink Bug
Whats the Problem ??

BMSB as an Invasive Insect: Success (1990's)

- Few constraints (**limited natural biological controls**)
  - Native predator and parasitoids increasing
- Abundance of host plants
- Ideal environmental conditions
- Over-wintering in man made structures

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Brown Marmorated Stink Bug: Host Plant Potential - Food for Success

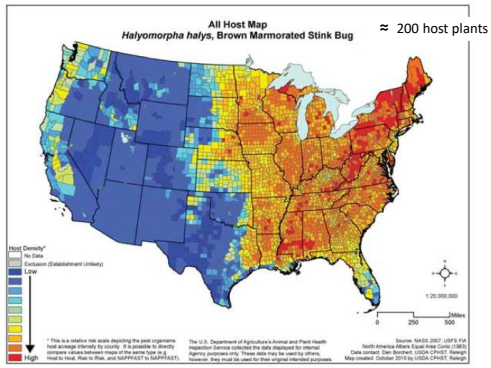

Figure 1: Risk maps displaying the relative density of field, vegetable, and fruit crop hosts plants of BMSB throughout the United States.

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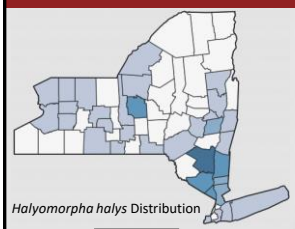
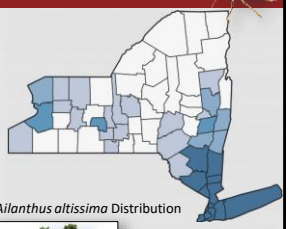
New York Invasive Species Public Map
BMSB Distribution in NYS



Halyomorpha halys Distribution



Ailanthus altissima Distribution

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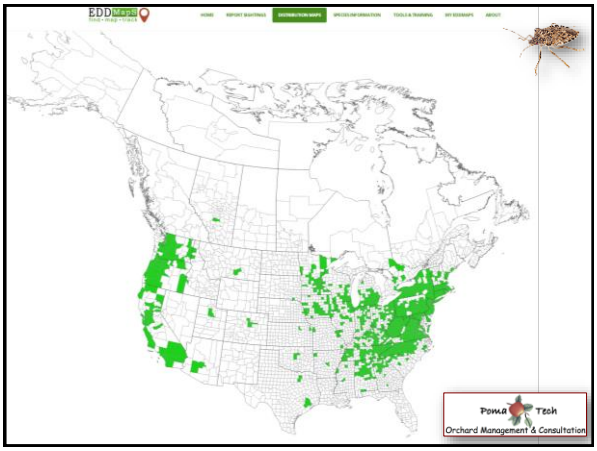

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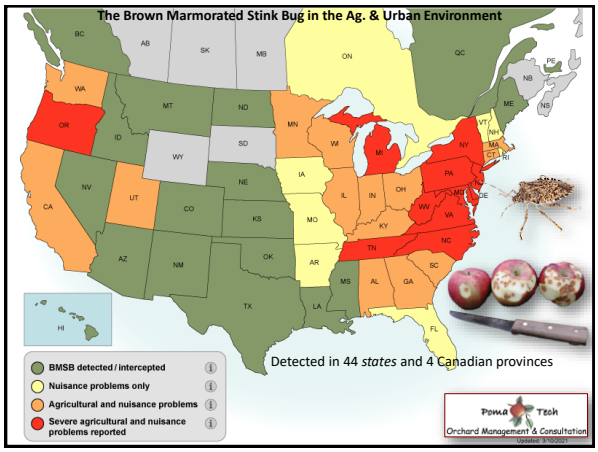
The Brown Marmorated Stink Bug in the Ag. & Urban Environment
BMSB detected / intercepted
Nuisance problems only
Agricultural and nuisance problems
Severe agricultural and nuisance problems reported
Detected in 44 *states* and 4 Canadian provinces
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Move Over, Bedbugs: Stink Bugs Have Landed
Published: September 26, 2010
The New York Times
Maryland 2010
Kelli Wilson and her father, Richard Lee Pry, cleared stink bugs from her porch Friday in Burkittsville, Md. The shield-shaped invaders have damaged fruit and vegetable crops.
By KEN MACURE
Published: September 26, 2010
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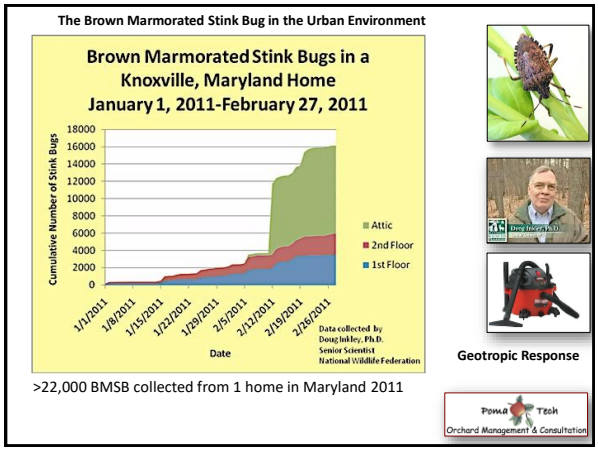
The Brown Marmorated Stink Bug in the Urban Environment
Brown Marmorated Stink Bugs in a Knoxville, Maryland Home
January 1, 2011-February 27, 2011
Cumulative Number of Stink Bugs
Attic
2nd Floor
1st Floor
Date
Data collected by Doug Inkley, Ph.D. Senior Scientist National Wildlife Federation
Geotropic Response
>22,000 BMSB collected from 1 home in Maryland 2011
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Managing the Invasive Brown Marmorated Stink Bug Across the Urban Agricultural Interface.
Udine, NE Italy 2017
UDINE TODAY
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Factors for BMSB Success: Overwintering

Overwintering habitat

- A smaller percent of the population will aggregate in buildings where temperature extremes allow for survival in northern climates, **potentially creating localized cluster points for Ag. infestations (biological advantage)**
- The majority of BMSB reside in the woodland habitat
  (Standing Dead Oak (*Quercus* spp.), Locust (*Robinia* spp.) Lee, Doo-Hyung et al. 2014)
- In woodland habitat, temperatures below -18°C or -0.4°F will kill 90% of the population (Kuhar, T. 2016)

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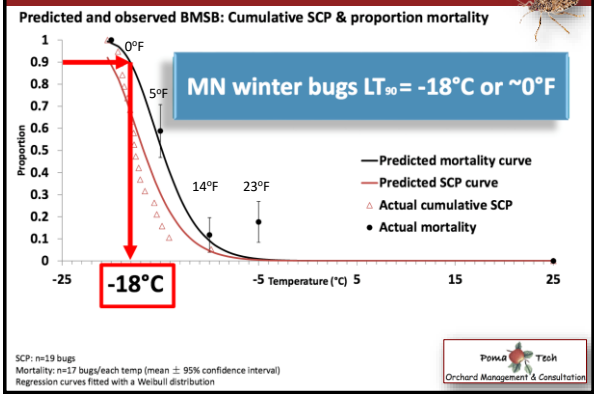
Factors for BMSB Success: Overwintering



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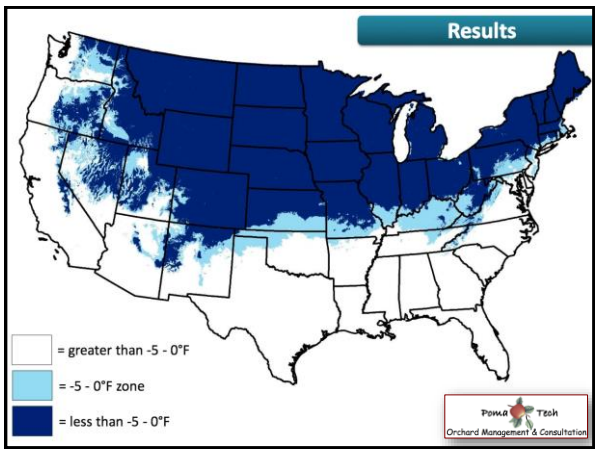

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Factors for BMSB Success: # of Generations

- **Sunlight / Day length** (BMSB adult mating)
  - **13-14h day length** for mating and egg laying to begin
  - Geneva, NY April 29th – Aug 13th
  - HVRL Highland May 1st – Aug. 11th

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Factors for BMSB Success: # of Generations

- **Degree Day Accumulations**
  - It requires **538 degree days** (DD – based 50ºF) to develop from egg to adult.
  - An additional **148 DD** are required for female maturation **at 77ºF.**
  - Total of **686 DD_{50}** for 1 generation;
  - **1224 DD_{50}** for a **2nd complete the adult OW population**

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Brown Marmorated Stink Bug Management

- Aspects of BMSB Ecology & Biology
- **Agricultural Monitoring / Scouting**
- Stink Bug Injury Diagnostics
- Insecticide Efficacy Studies
- Novel / Innovation Mgt. Research
- Biological Control

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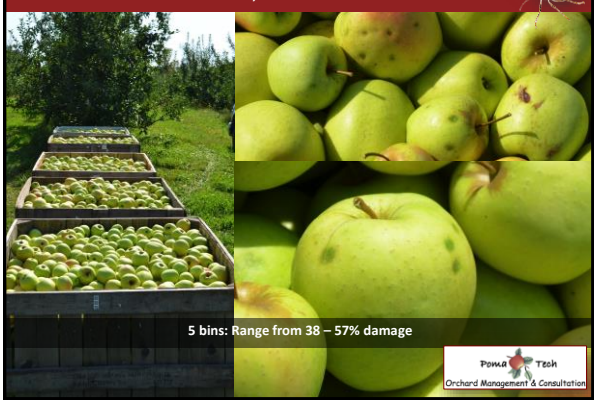
Golden Delicious Apple With BMSB Feeding Injury, Milton, NY October - 2012



5 bins: Range from 38 – 57% damage

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Pink Lady Apple With >20% BMSB Feeding Injury, Campbell Hall, NY November - 2012

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BMSB Feeding Injury Assessment,
Hudson Valley Research Lab, NY 2012
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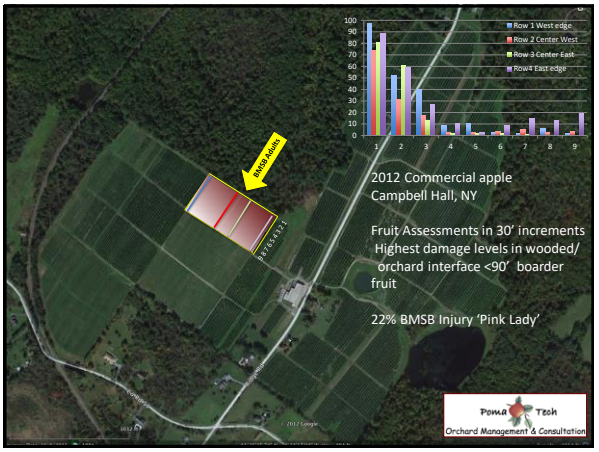
Row 1 West edge
Row 2 Center West
Row 3 Center East
Row 4 East edge
BMSB Adults
2012 Commercial apple
Campbell Hall, NY
Fruit Assessments in 30' increments
Highest damage levels in wooded/
orchard interface <90' boarder
fruit
22% BMSB Injury 'Pink Lady'
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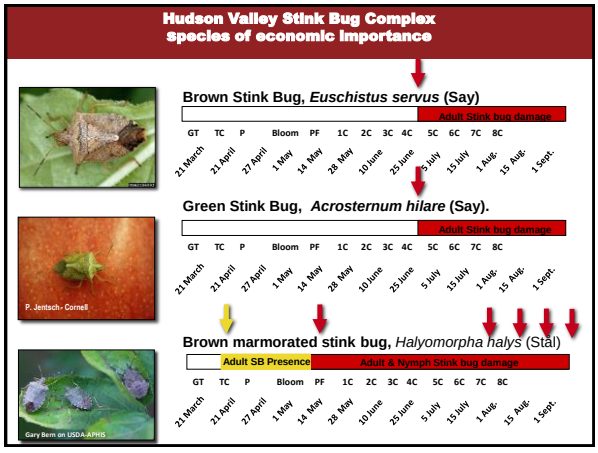
Hudson Valley Stink Bug Complex
species of economic importance
Brown Stink Bug, Euschistus servus (Say)
Adult Stink bug damage
Green Stink Bug, Acrosternum hilare (Say).
Adult Stink bug damage
Brown marmorated stink bug, Halyomorpha halys (Stål)
Adult SB Presence
Adult & Nymph Stink bug damage
GT TC P Bloom PF 1C 2C 3C 4C 5C 6C 7C 8C
21 March
21 April
27 April
1 May
14 May
28 May
10 June
25 June
5 July
15 July
1 Aug.
15 Aug.
1 Sept.
P. Jentsch - Cornell
Gary Bem on USDA-APHIS

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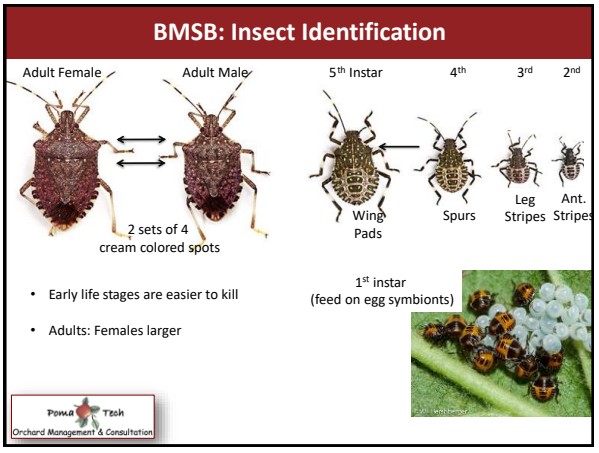
BMSB: Insect Identification
Adult Female
Adult Male
2 sets of 4
cream colored spots
5th Instar
4th
3rd
2nd
Wing Pads
Spurs
Leg Stripes
Ant. Stripes
1st instar
(feed on egg symbionts)
Early life stages are easier to kill
Adults: Females larger
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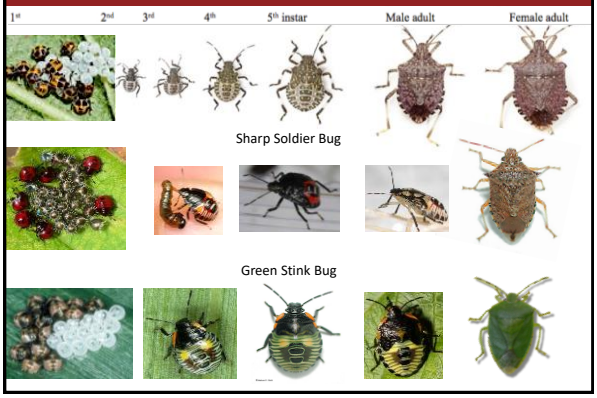
BMSB: Identification



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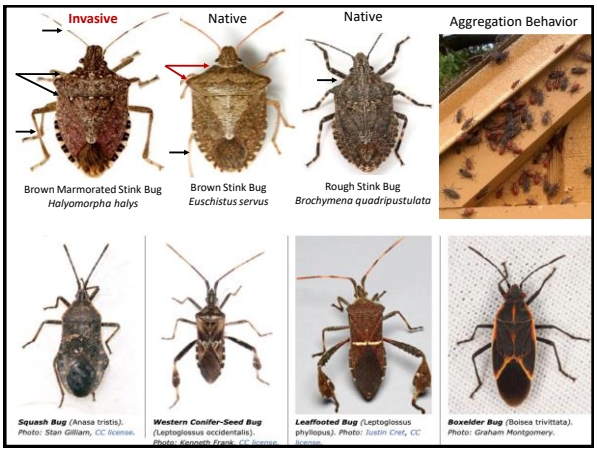

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Brown Marmorated Stink Bug Management

- Aspects of BMSB Ecology & Biology
- **Agricultural Monitoring / Scouting**
- Defining Stink Bug Injury
- Directed Applications
- Novel / Innovation (Research)

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State-wide Trap Monitoring of BMSB in NY

USDA #10 Lure & MDT Using Tedders Traps

Vented trap container:
- clip holding 1 #10 & 1 MDT lure

Cone base

Killing strip of Vapona; bungi cord straps

Plywood /plastic triangle black base to mimmic tree trunk

Screened base to **reduce weeds** and provide contrast for crawling SB

NOT placed in the orchard but along decidious woodland

AgBio-inc.com
Trap, lures, kill strip

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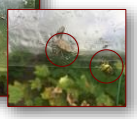
Green & Brown Marmorated Stink Bug: Monitoring

Tedders Trap
+ duel pheromone

AtK Trap (Vestergaard)
+ duel pheromone

Sticky Card Trap
+ duel pheromone



Tedders Trap: Threshold: 10 adults / trap / week

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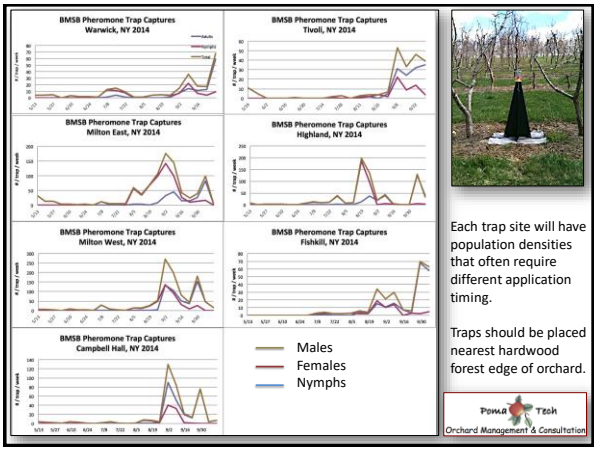

Each trap site will have population densities that often require different application timing.

Traps should be placed nearest hardwood forest edge of orchard.

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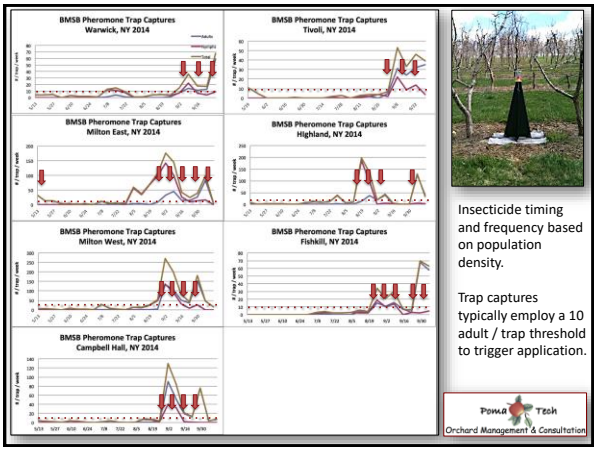

Insecticide timing and frequency based on population density.

Trap captures typically employ a 10 adult / trap threshold to trigger application.

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Green & Brown Marmorated Stink Bug: Scouting

- Green Stink Bug can be observed during the day
- BMSB presence during the late day into the evening.

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BMSB Management: Insecticide Control

- Employ traps to determine presence of BMSB, checked ***weekly*** **AND scout** to determine presence of BMSB in crop
- Use 1 adult / 100' of crop edge as *treatment threshold* **and or** 10 adults / trap using duel pheromone lures.
- Applications will be needed upon reaching *treatment threshold*
  Employ the most effective insecticide available.
  - 1st application: perimeter tree row applications
  - 2nd application: alternate row middle
  - 3rd application: whole orchard
- **Maintain coverage through to harvest if populations are present as late varieties increase in risk as crop diminishes.**
- **MRL's may be exceeded in years of drought (Bifenthrin & Assail)**

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Brown Marmorated Stink Bug Management

- Aspects of BMSB Ecology & Biology
- Agricultural Monitoring / Scouting
- **Defining Stink Bug Injury**
- Directed Applications & Efficacy
- Novel / Innovation (Research)

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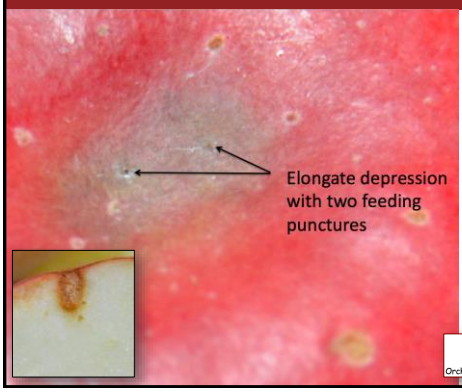
BMSB: Defining Injury
Stink Bug, Hail, Bitter Pit, Maggot



Stink Bug:

- Discolored shallow depression
- Corking to skin surface
- **Feeding puncture**

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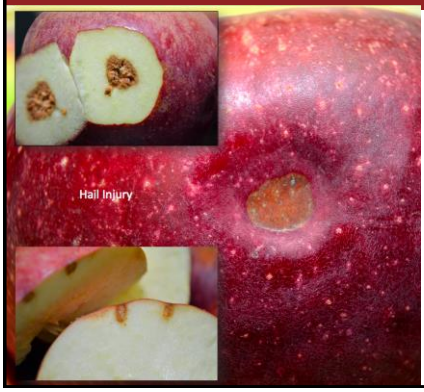
BMSB: Defining Injury
Stink Bug, Hail, Bitter Pit, Maggot



Hail injury:

- **Hail event**
- Discolored shallow depression
- Corking to skin surface
- **No feeding puncture**

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BMSB: Defining Injury
Stink Bug, Hail, Bitter Pit, Maggot

Bitter Pit:

- Discolored shallow depression
- **Corking not to skin surface**
- **No feeding puncture**

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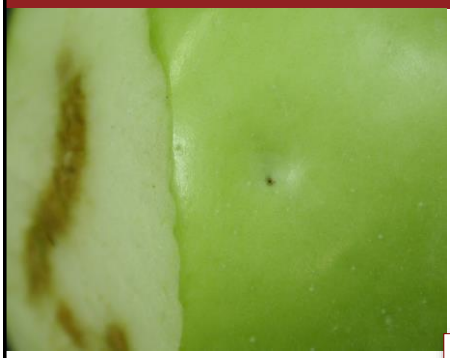
BMSB: Defining Injury
Stink Bug, Hail, Bitter Pit, Maggot



Apple Maggot:

- Sting
- Depression
- No skin
- Discoloratio
- No corking
- Oxidized tunneling or trails

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Brown Marmorated Stink Bug Management

- Aspects of BMSB Ecology & Biology
- Agricultural Monitoring / Scouting
- Defining Stink Bug Injury
- **Directed Applications & Efficacy**
- Novel / Innovation (Research)

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BMSB: Residual Efficacy
Feeding Sheath & Limited Abdominal Contact with Fruit

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BMSB: Body Mass
A.I Required for Mortality Relative to Plum Curcilio

Plum Curculio

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Management Options

Late-Season Insect Pest Management (Aug. 15 to EOS)

Insecticide Group	Product	Active Ingredient	% Adult BMSB Mortality[1]
Pyrethroid	Bifenture	bifenthrin	100
	Danitol	fenpropathrin	95
	Warrior II	lambda-cyhalothrin	73
Carbmate	Lannate	methomyl	92
	Vydate	oxymyl	68
Neonicotinoid	Actara	thiamethoxam	92
	Assail	acetamiprid	87
	Calypso	thiacloprid	58
Neonicotinoid CT.	Venom 70% Scorpion 35%	dinotefuran (2EE – SLF Stone Fruit – Peach, Necarine)	97
Pre-mix	Leverage 360	imidacloprid and β-cyfluthrin	95
	Endigo	lambda-cyhalothrin and thiamethoxam	98
	Voliam Flexi	chlorantraniliprole and thiamethoxam	98

1. Direct contact activity of insecticides against BMSB adults in a lab setting may be very high, yet the activity of field-aged residue may, over time, quickly becomes ineffective at preventing feeding injury.

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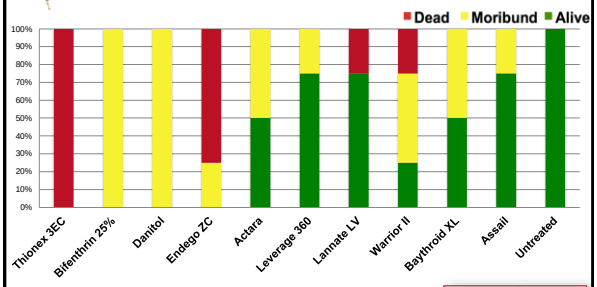
Management Options

BMSB Adult Exposure to Insecticide Residue of Apple Foliage
24h Old Residue @ 1 d



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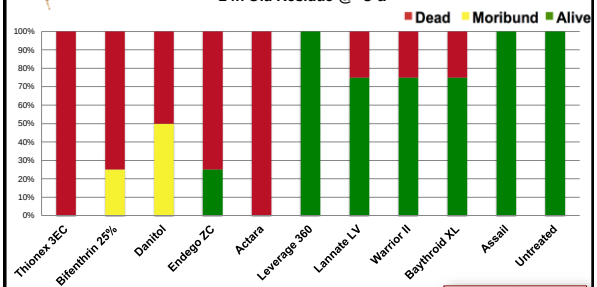
Management Options

BMSB Adult Exposure to Insecticide Residue of Apple Foliage
24h Old Residue @ 3 d



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BMSB mortality based on direct contact bioassays – Various IRAC Groups

G. Krawczyk, PSU FREC 2011.

PRODUCT	ACTIVE INGREDIENT	FIELD RATE tested	FRUIT REGISTRATION*	Percent DIRECT MORTALITY**			RESIDUAL LETHALITY INDEX[1]
				24 h	72 h	120 h	
Agri-Mek 0.15EC	abamectin	15 oz	Apple, Pear, SF, G	2	7	8	16
Altacor	chlorantraniliprole	3 oz	PF, SF, G	3	7	12	N/A
Avaunt	indoxacarb	6 oz	PF, SF, G	0	5	13	11
Beleaf 50SG	flonicamid	2.8 oz	PF, SF	5	10	15	8
cyazypyr		100 ppm	Not registered	5	3	5	
Delegate WG	spinetoram	7 oz	PF, SF, G	0	3	15	N/A
Esteem 0.86EC	pyriproxyfen	5 oz	PF, SF	0	5	8	N/A
M-Pede	insecticidal soap	2%	PF, SF, G	0	2	5	N/A
M-Pede Spray	insecticid soap	2%	PF, SF, G	10	15	15	N/A
Neemix 4.5	azadirachtin	16 oz	PF, SF, G	0	2	8	N/A
Rimon 0.83EC	novaluron	30 oz	PF, SF	0	2	2	N/A
Stylet Oil	mineral oil	2%		2	2	5	
Voliam Xpress	lambda-cyhalothrin chlorantraniliprole	10 fl oz	PF, SF	40	40	38	53 N/A
Voliam Flexi	thiamethoxam chlorantraniliprole	6 oz	PF, SF, G	100	100	100	56 N/A

*PF- Pome Fruits, SF- Stone Fruits, G- Grapes
** Mortality includes dead plus moribund

[1] – based on dry residual bioassays T. Leskey, USDA ARS

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BMSB mortality based on direct contact bioassays – organophosphates, IRAC 1B

G. Krawczyk, PSU FREC 2011.

PRODUCT	ACTIVE INGREDIENT	FIELD RATE tested	FRUIT REGISTRATION*	% DIRECT MORTALITY**			RESIDUAL: LETHALITY INDEX[1]
				24 h	72 h	120 h	
Acephate 97UP	acephate	4 oz	Nonbearing/border	13	42	63	88
Acephate 97UP	acephate	1 lb	Nonbearing/border	10	45	73	88
Diazinon 50W	diazinon	3 lb	PF, SF	0	3	7	20
Guthion	azinphos-methyl	2 lb	PF	3	13	27	71
Imidan	phosmet	4 lb	PF, SF	2	20	35	20
Lorsban Adv.	chlorpyrifos	3 pt	Before bloom	42	73	82	89
Penncap-M	methyl parathion	6 pt	Not registered	65	82	87	93
Thionex 50W	endosulfan	2 lb	PF, SF	52	98	100	90
Thionex 50W	endosulfan	4 lb	PF, SF	33	98	100	90

*PF- Pom Fruits, SF- Stone Fruits, G- Grapes
** Mortality includes dead plus moribund

[1] – based on dry residual bioassays T. Leskey, USDA ARS

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BMSB mortality based on direct contact bioassays – pyrethroids, IRAC 3

G. Krawczyk, PSU FREC 2011.

PRODUCT	ACTIVE INGREDIENT	FIELD RATE tested	FRUIT REGISTRATION*	Percent DIRECT MORTALITY**			RESIDUAL: LETHALITY INDEX[1]
				24 h	72 h	120 h	
Asana XL	esfenvalerate	14 oz	Apple, Pear, SF	15	27	48	43
Baythroid XL	beta-cyfluthrin	2 oz	PF, SF, G	7	13	37	55
Baythroid XL	beta-cyfluthrin	2.8 oz	PF, SF, G	42	30	53	55
Bifenture EC	bifenthrin	12.8 oz	G, Pears	98	100	100	92
Brigade 2EC	bifenthrin	10 oz	G, Pears	100	100	95	92
Danitol 2.4EC	fenpropathrin	12 oz	PF, SF, G	87	65	60	67
Danitol 2.4 EC	fenpropathrin	16 oz	PF, SF, G	95	82	82	67
Hero	bifenthrin zeta-cypermethrin	10 oz	Not registered	93	87	82	92 52
Lambda-Cy EC	lambda-cyhalothrin	4.4 fl oz	Not registered	52	40	35	53
Mustang Max	zeta-cypermethrin	4 oz	PF, SF, G	67	37	30	52
Pounce 25 WP	permethrin	16 oz	PF, SF	45	42	35	77
Warrior II	lambda-cyhalothrin	2 oz	PF, SF	73	72	77	53
Warrior II	lambda-cyhalothrin	2.5 oz	PF, SF	52	51	53	53

*PF- Pome Fruits, SF- Stone Fruits, G- Grapes
** Mortality includes dead plus moribund

[1] – based on dry residual bioassays T. Leskey, USDA ARS

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BMSB mortality based on direct contact bioassays – carbamates (IRAC 1A)

G. Krawczyk, PSU FREC 2011.

PRODUCT	ACTIVE INGREDIENT	FIELD RATE	FRUIT REGISTRATION*	Percent DIRECT MORTALITY**			RESIDUAL: LETHALITY INDEX[1]
				24 h	72 h	120 h	
Carzol SP	formetanate	1 lb	PF, SF	58	68	68	64
Lannate LV	methomyl	2 pt	Apple, Peach, G	88	90	90	90
Lannate LV	methomyl	3 pt	Apple, Peach, G	87	92	92	90
Lannate SP	methomyl	6 oz	Apple, Peach, Nectarine	52	55	60	90
Lannate SP	methomyl	9 oz	Apple, Peach, Nectarine	88	92	92	90
Lannate SP	methomyl	12 oz	Apple, Peach, Nectarine	85	87	87	90
Lannate SP	methomyl	16 oz	Apple, Peach, Nectarine	92	98	98	90
Sevin XLR Plus	carbaryl	3 pt	PF, SF	3	12	8	9
Vydate L	oxamyl	4 pt	Apple, Pear	52	58	63	34
Vydate L	oxamyl	6 pt	Apple, Pear	68	73	82	34

*PF- Pome Fruits, SF- Stone Fruits, G- Grapes
** Mortality includes dead plus moribund

[1] – based on dry residual bioassays T. Leskey, USDA ARS

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BMSB mortality based on direct contact bioassays – neonicotinoids, IRAC 4A

G. Krawczyk, PSU FREC 2011.

PRODUCT	ACTIVE INGREDIENT	FIELD RATE tested	Fruit REGISTRATION*	Percent DIRECT MORTALITY** 24 h	72 h	120 h	RESIDUAL LETHALITY INDEX[1]
Actara	thiamethoxam	4 oz	PF, SF, G	92	95	97	56
Actara	thiamethoxam	5 oz	PF, SF, G	77	95	98	56
Admire Pro	imidacloprid	7 oz	PF, G	82	87	88	40
Assail 30SG	acetamiprid	6 oz	PF, SF, G	87	87	63	19
Assail 30SG	acetamiprid	8 oz	PF, SF, G	83	83	95	19
Assail 70WP	acetamiprid	3.4 oz	PF, SF, G	78	83	75	19
Belay	clothianidin	6 oz	PF, Peach, G	100	100	100	56
Calypso 4F	thiacloprid	8 fl oz	PF	58	52	53	18
Endigo ZC	lambda-cyhalothrin thiamethoxam	3 oz	PF, SF	93	95	87	53 56
Endigo ZC	lambda-cyhalothrin thiamethoxam	5 oz	PF, SF	98	100	98	53 56
Leverage 360	imidacloprid beta-cyfluthrin	2.8 oz	PF, SF, G	95	93	88	40 55
Scorpion 35SL	dinotefuran	5 oz	G	97	98	97	67
Venom	dinotefuran	3 oz	G	93	98	98	67

*PF- Pom Fruits, SF- Stone Fruits, G- Grapes
** Mortality includes dead plus moribund

[1] – based on dry residual bioassays T. Leskey, USDA ARS

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BMSB mortality based on direct contact bioassays – mixes (IRAC various)

G. Krawczyk, PSU FREC 2011.

PRODUCT	ACTIVE INGREDIENT	FIELD RATE tested	FRUIT REGISTRATION*	Percent DIRECT MORTALITY** 24 h	72 h	120 h	RESIDUAL LETHALITY INDEX[1]
Endigo ZC	lambda-cyhalothrin thiamethoxam	3 oz	PF, SF	93	95	87	53 56
Endigo ZC	lambda-cyhalothrin thiamethoxam	5 oz	PF, SF	98	100	98	53 56
Hero	bifenthrin zeta-cypermethrin	10 oz	Not registered	93	87	82	92 52
Leverage 360	imidacloprid beta-cyfluthrin	2.8 oz	PF, SF, G	95	93	88	40 55
Voliam Xpress	lambda-cyhalothrin chlorantraniliprole	10 fl oz	PF, SF	40	40	38	53 N/A
Voliam Flexi	thiamethoxam chlorantraniliprole	6 oz	PF, SF, G	100	100	100	56 N/A

*PF- Pom Fruits, SF- Stone Fruits, G- Grapes
** Mortality includes dead plus moribund

[1] – based on dry residual bioassays T. Leskey, USDA ARS

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Management Options

Product	Active Ingredient	Rate / A	REI Hrs.	PHI Days	Efficacy (USDA)	Max. per crop / season	App. Interval
Actara 25WDG	Thiamethoxam	2.0-5.5 oz/A	12	35	+++	16.5 oz./A (0.258 lb. a.i./A)	10d
Asana XL 0.66EC	Esfenvalerate	4.8-14.5 fl oz/A	12	21	++	101 fl oz/A (0.525 lb AI/A).	NA
Baythroid XL 1EC	Beta-Cyfluthrin	1.4-2.8 fl oz/A	12	7	++	2.8 fl oz/A (0.022 lb AI/A).	14d
Bifenture EC	Bifenthrin	5.2-12.8 fl oz/A	12	14	++++	32 fl ozs (0.50 lbs ai)	30d
Bifenture 10DF	Bifenthrin	12.8-32.0 oz/A	12	14	++++	80 ozs (0.50 lbs ai)	30d
Brigade WSB	Bifenthrin	12.8-32.0 oz/A	12	14	++++	80 ozs (0.50 lbs ai)	30d
Closer SC***	Sulfoxaflor	2.75 – 5.75 fl oz/A	12	7	+	17.0 fl ozs (0.266 lbs ai)	7d
Danitol 2.4EC	Fenpropathrin	10.66-21.33 fl oz/A	24	14	+++	42.56 fl ozs (0.80 lbs ai)	10d
Endigo ZC	Thiamethoxam / Lambda-cyhalothrin	5-6 fl oz/A	24	35	++++	19 fl oz./A (0.172 lb ai) NY	10d
Gladiator	Zeta-Cypermethrin / Avermectrin B1	19.0 fl oz/A	24	28	++++	19 fl oz./A (0.172 lb ai) NY	21d
Lannate 2.4LV*	Methomyl	2.25 pt/A	72	14	++++	240 ozs (0.50 lbs ai)	7d
Lannate 90SP*	Methomyl	8-16 oz/A	72	14	++++	5.0 lbs	7d
Leverage 360	Beta-Cyfluthrin / Imidacloprid	2.4-2.8 fl oz/A	12	7	+++	2.8 fl oz/A	14d
Surround 95WP	Kaolin	25-50 lb/A	4	0	+	NA	0d
Voliam Xpress EC	Chlorantraniliprole / Lambda-cyhalothrin	6-12 fl oz/A	24	21	+++	31.0 fl oz/A	10d
Vydate 2L*	Oxamyl	4-8 pt/A	48	14	++	281 fl oz/A (128 oz AI/A).	7d
Warrior 1CS	Lambda-cyhalothrin	2.56-5.12 fl oz/A	24	21	++	20.48 fl. oz. (0.28 lb. a.i.)**	5d
Warrior II 2.08CS	Lambda-cyhalothrin	1.28-2.56 fl oz/A	24	21	++	10.24 fl. oz. (0.28 lb. a.i.)**	5d

* Although these materials have excellent topical ratings in lab bioassay studies, field efficacy studies have shown economic fruit injury from BMSB feeding, suggesting low residual levels.
** Post bloom applications
*** Feeding inhibition up to 72hr. post application
(+) low to (++++) high efficacy

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Brown Marmorated Stink Bug Management

- Aspects of BMSB Ecology & Biology
- Agricultural Monitoring / Scouting
- Defining Stink Bug Injury
- Directed Applications & Efficacy
- **Novel / Innovation (Research)**

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Proceedures Con't

- Generator + 500W Halogen light directed toward the field population of BMSB.
- Plastic sheets to define location and number of BMSB trap and kill data.
- Study was designed to:
  1. Determine the attractiveness of lights with net relative to net alone
  2. Determine the number of BMSB observed coming from field versus forest sides of trap

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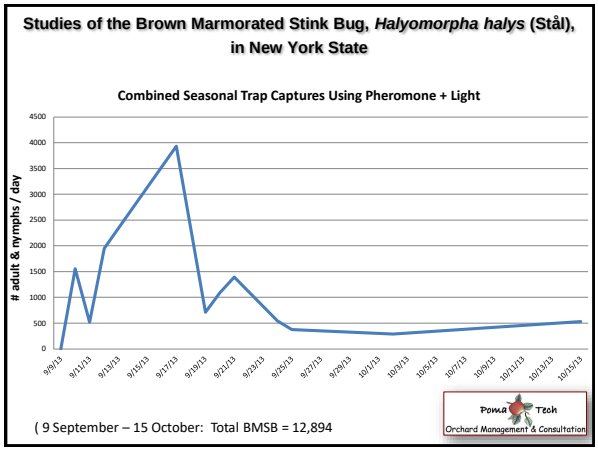

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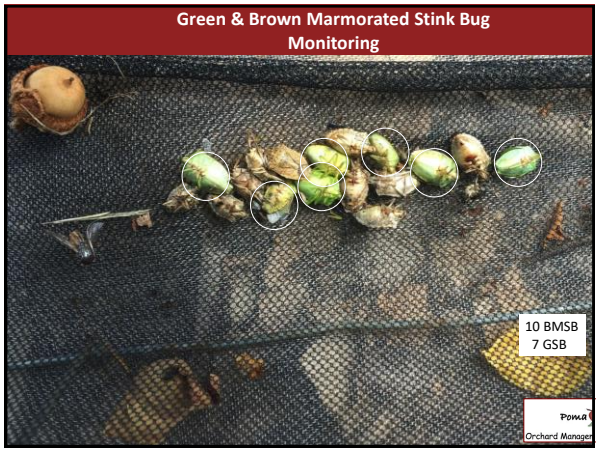
Green & Brown Marmorated Stink Bug Monitoring
10 BMSB
7 GSB
Orchard Manager

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Stand alone ATK System between wooded edge trees
• Dusk to Dawn 1000 lumen solar light
• Duel BMSB pheromone

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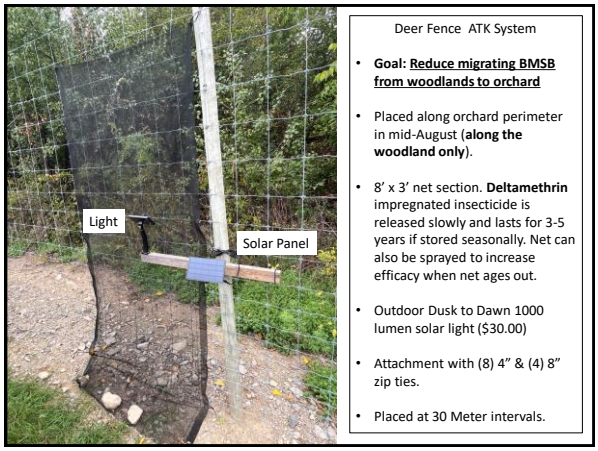
Light
Solar Panel
Deer Fence ATK System
• Goal: Reduce migrating BMSB from woodlands to orchard
• Placed along orchard perimeter in mid-August (along the woodland only).
• 8' x 3' net section. Deltamethrin impregnated insecticide is released slowly and lasts for 3-5 years if stored seasonally. Net can also be sprayed to increase efficacy when net ages out.
• Outdoor Dusk to Dawn 1000 lumen solar light ($30.00)
• Attachment with (8) 4" & (4) 8" zip ties.
• Placed at 30 Meter intervals.

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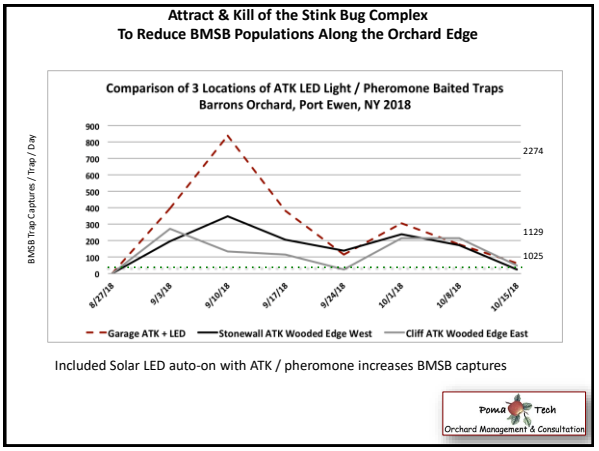
Attract & Kill of the Stink Bug Complex
To Reduce BMSB Populations Along the Orchard Edge
Comparison of 3 Locations of ATK LED Light / Pheromone Baited Traps
Barrons Orchard, Port Ewen, NY 2018
BMSB Trap Captures / Trap / Day
900
800
700
600
500
400
300
200
100
0
2274
1129
1025
8/27/18
9/3/18
9/10/18
9/17/18
9/24/18
10/1/18
10/8/18
10/15/18
Garage ATK + LED
Stonewall ATK Wooded Edge West
Cliff ATK Wooded Edge East
Included Solar LED auto-on with ATK / pheromone increases BMSB captures
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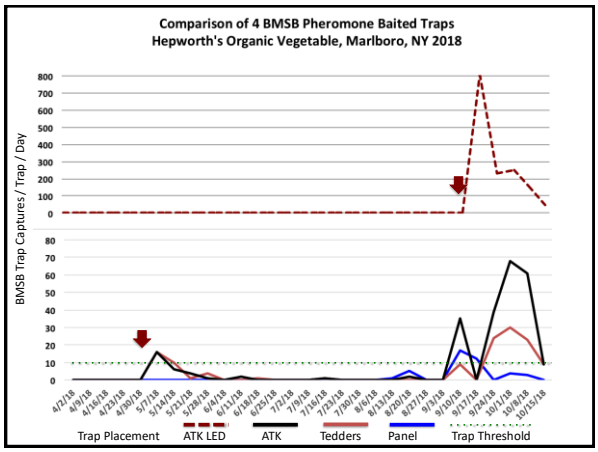

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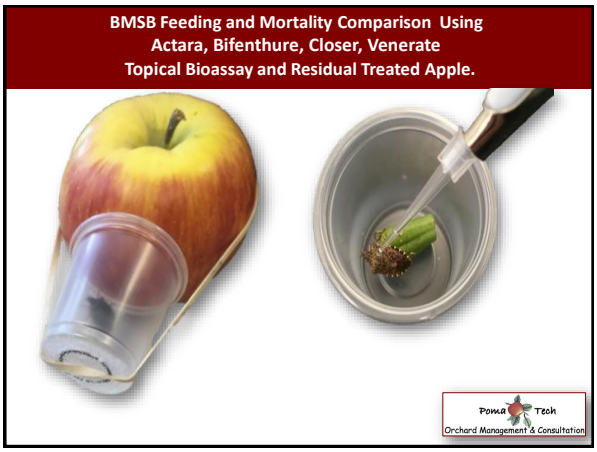

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Topical Bioassays

- **Goal: Determine efficacy of novel mode of action, 'anti-feedent response' reduces BMSB feeding response in comparison to standard mortality trial. Venerate 0 DTH.**
- Stink bug were separated into individual cups for male and female
- Individuals received 2 uL of distilled water, 0.25% LI700, individual insecticide to the dorsal thoractic plate.
  - Treatments: **Actara, Bifenthure, Closer, Venerate, UTC**
  - Doses: 1, 0.5, 0.25, and 0.1 times the top label rate
- **Mortality status** (alive, moribund, dead) was recorded at 24, 48, 72 hours and at 7d post treatment.

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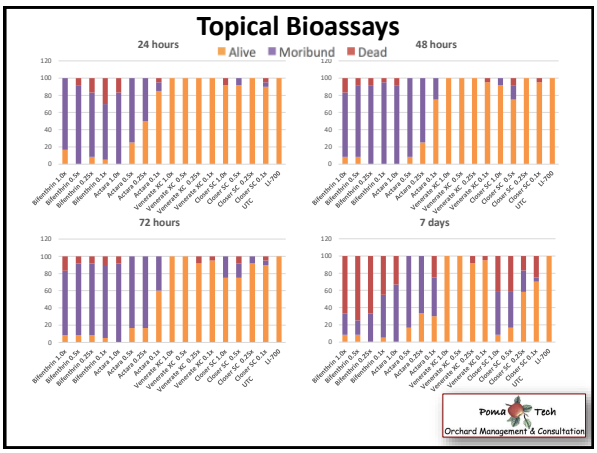

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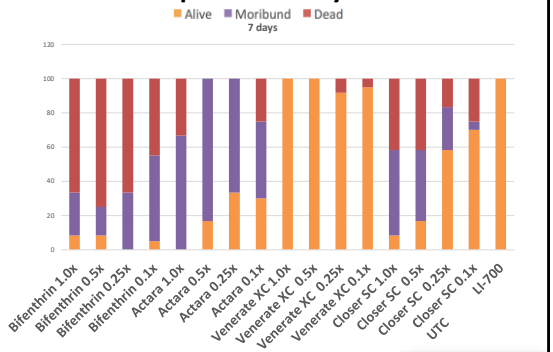
Topical Bioassays



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2017 Field Application

Applications using tractor mounted sprayer on 20th Sept. 300 psi. using dilute handgun applications:

- Closure SC 5.75 fl.oz./A
- Bifenthrin SC 32.0 fl.oz./A
- Actara 25 WDG 5.5 oz./A
- Venerate XC 128.0 fl.oz./A

- BMSB adults placement beginning on 20th Sept.
  - 24h; 48hr; 72hr placement. Collection made after 7d of placement.
  - Insects placed inside portion cups with screened bottoms, rubber band onto the north side of the tree and the north side of those apples to reduce sun exposure.
  - Fruit harvested on 12 Oct. for fruit feeding evaluations

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Field Application: Fruit Residue

BMBS placed on apples 24 hours after pesticide application on Sep.20, 2017.

	Number of feeding sites per fruit	Dimpling per fruit	Corking per fruit	Clean fruit (%)	Survival (%)
Closer SC	0.1a	0.1a	0.1a	90a	0a
Bifenthrin	0a	0a	0a	100a	0a
Actara	0a	0a	0a	100a	0a
Venerate	0a	0a	0a	100a	20a
UTC	0.7a	0a	0a	50a	20a
Kruskal-Walis Test, Prob>ChiSq	0.0115	0.8123	0.8123	0.0136	0.3071

Means followed by the same letter are not significantly different by Steel-Dwass Method at α=0.05 Apples were rated on Oct.12, 2017. BMSB survival were recorded 7 days after exposure to the fruit.

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Field Application: Fruit Residue

BMBS placed on apples 48 hours after pesticide application on Sep.20, 2017.

	Number of feeding sites per fruit	Dimpling per fruit	Corking per fruit	Clean fruit (%)	Survival (%)
Closer SC	0.1b	0.1a	0.1a	90a	0a
Bifenthrin	0b	0a	0a	100a	10a
Actara	0.1b	0.1a	0.1a	90a	0a
Venerate	0.2ab	0a	0a	80ab	40a
UTC	1.2a	0.4a	0.4a	20b	0a
Kruskal-Walis Test, Prob>ChiSq	0.0001	0.4313	0.4313	0.0002	0.0873

Means followed by the same letter are not significantly different by Steel-Dwass Method at α=0.05 Apples were rated on Oct.12, 2017. BMSB survival were recorded 7 days after exposure to the fruit.

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Field Application: Fruit Residue

BMBS placed on apples 72 hours after pesticide application on Sep.20, 2017.

	Number of feeding sites per fruit	Dimpling per fruit	Corking per fruit	Clean fruit (%)	Survival (%)
Closer SC	0.2a	0.2a	0.2a	90a	80a
Bifenthrin	0.2a	0.2a	0.2a	90a	10b
Actara	0.2a	0.2a	0.2a	90a	100a
Venerate	0.1a	0a	0a	90a	70a
UTC	1.2a	0.1a	0.1a	40a	30ab
Kruskal-Walis Test, Prob>ChiSq	0.0687	0.9254	0.9254	0.0795	0.0006

Means followed by the same letter are not significantly different by Steel-Dwass Method at α=0.05 Apples were rated on Oct.12, 2017. BMSB survival were recorded 7 days after exposure to the fruit.

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BMSB Adult Topical Treatment

- Applications were made topically to BMSB adults on 28th Sept. placed on the tree in 10 replicates for each treatment
  - Insects were placed inside portion cups with screened bottoms with a rubber band on the north side of the tree and the north side of those apples to reduce sun exposure as much as possible
  - Adult BMSB were **removed after 7 days.**
- Fruit was collected on 12th October for fruit feeding evaluations

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BMSB Adult Topical Treatment

BMSB treated topically on Sep.28, 2017 and placed on apples for 7 days.

	Number of feeding sites per fruit	Dimpling per fruit	Corking per fruit	Clean fruit (%)	Survival (%)
Closer SC	0.3a	0.2a	0.2a	90a	30b
Bifenthrin	0.1a	0a	0a	90a	0b
Actara	0a	0a	0a	100a	10b
Venerate	0a	0a	0a	100a	100a
UTC	0.9a	0a	0a	60a	90a
Kruskal-Walis Test, Prob>ChiSq	0.1288	0.5348	0.5348	0.1093	<.0001

Means followed by the same letter are not significantly different by Steel-Dwass Method at α=0.05 Apples were rated on Oct.12, 2017. BMSB survival were recorded 7 days after exposure to the fruit.

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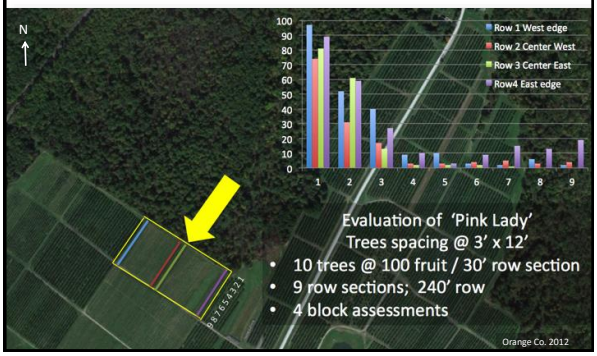
A Behaviorally Based Approach To Managing The Invasive Brown Marmorated Stink Bug (BMSB), *Halyomorpha Halys*

- Behaviour of the BMSB is **migratory,** from wodland to orchard. As populations increase in the crop, residual aggregation pheremone provides the insect with guidence to repetitvely return to previously infested tree.



92

A Behaviorally Based Approach To Managing The Invasive Brown Marmorated Stink Bug (BMSB), *Halyomorpha Halys*

In a 2016 study, **a <u>single wooded perimeter orchard application at trap threshold of 10 adults/trap/wk,</u>** was made along the SE edge in one of two, 5-acre orchard blocks, using 12.8 fl. oz. of Bifenture EC / A.

- Both blocks received three applications of Assail 30SG in 14d intervals at 6.0 oz./A.
- 100 Red Delicious fruit samples were harvested and assessed from 5 trees fruit in four quadrants.
- **Border management was shown to be highly effective in reducing both insecticide use and SB injury.**

Liberty Orchard, Highland, NY, 2016

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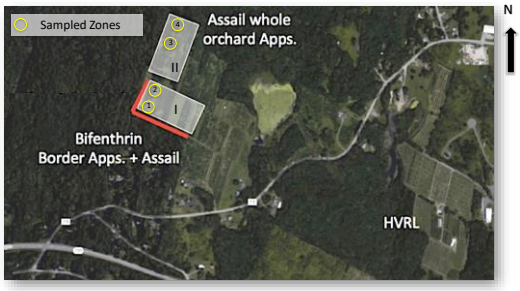
A Behaviorally Based Approach To Managing The Invasive Brown Marmorated Stink Bug, *Halyomorpha Halys*



Liberty Orchard, Highland, NY, 2016

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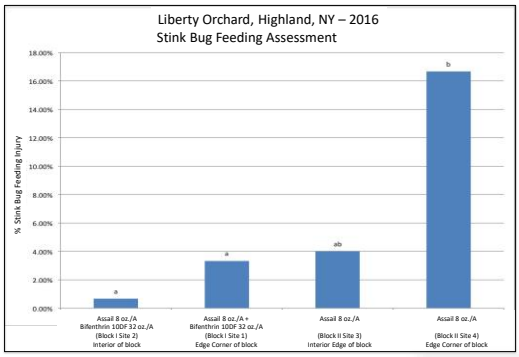

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Brown Marmorated Stink Bug Management

- Aspects of BMSB Ecology & Biology
- Agricultural Monitoring / Scouting
- Stink Bug Injury Diagnostics
- Insecticide Efficacy Studies
- Novel / Innovation Mgt. Research
- **Biological Control**

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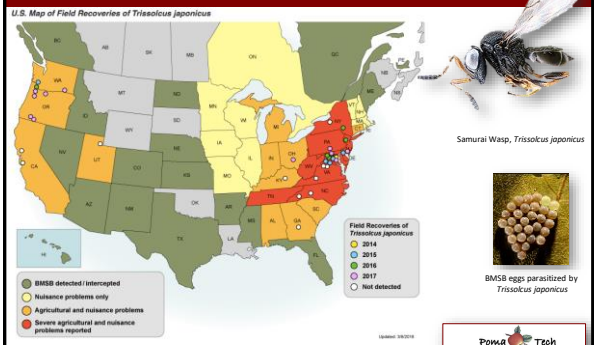
Adventive Populations of *Trissolcus japonicus* Field Recovery Sites of *T.j.* in the US



Samurai Wasp, *Trissolcus japonicus*

BMSB eggs parasitized by *Trissolcus japonicus*

Samurai wasp in 12 States & Washington DC by 2019.

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Biological Control Redistribution of *Trissolcus japonicas in NYS*

***Trissolcus japonicus* Samurai Wasp**

Samurai Wasp, *Trissolcus japonicus*

- Adventive wasp, discovered in HV of NYS in Sept. of 2016 & 2017
- Developed Colony for redistribution from 2018-2021
- 155 release sites established.
- Recapture of *T.j.* in 20% of surveyed sites from 2018-2021

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Biological Control Redistribution of *Trissolcus japonicas in NYS*

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- Captured in HV of NYS in Sept. of 2016 & 2017
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- Recapture of *T.j.* in 20% of surveyed sites from 2018-2021

BMSB Oviposition
1st Gen. June – late July
2nd Gen Late July – Sept.

T.j. Oviposition
1st Gen. June – late July
2nd Gen Late July – Sept

T.j. Emergence
3-7 generations
1st Gen. June
High population in Sept.

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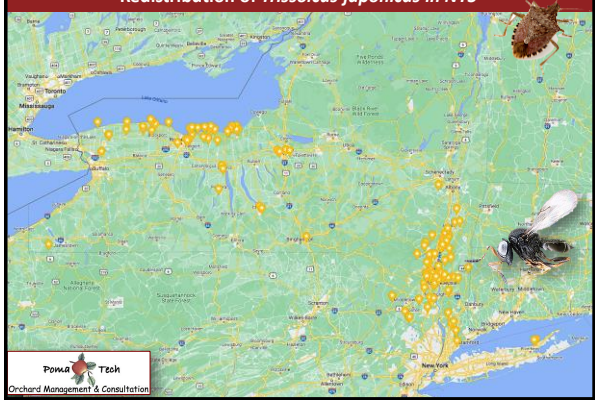
Biological Control Redistribution of *Trissolcus japonicas in NYS*



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Biology and Management of Thrips in Stone Fruit

- **Thrips Ecology & Biology**
- **Agricultural Monitoring / Scouting**
- **Management**

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Thrips (Thysanoptera)
Biology, Ecology and Management in Stone Fruit

- **Thrips:** Generally the insect either plant tissue feeders **or** are predatory, are beneficial in crops, feeding on other thrips species or arthropods.
- **Thrips act as vectors** for the tospoviruses, impatiens necrotic spot virus (INSV) and tomato spotted wilt virus (TSWV) in the greenhouse.
- Two types of injury to apricot, peach, plum, nectarine caused by Thrips: **Silvering and Russetting**
- **Western flower thrips:** *Frankliniella occidentalis* is native to the US. They are a common pest of several hundred plants and crops including peaches, nectarines, plums and apple.
- **Eastern flower thrips:** *Frankliniella tritici*, and WFT are indistinguishable and found in the NE. Adults are slender and yellowish, with short antennae; the wings are long and narrow, and held over the abdomen. Larvae are smaller and wingless, but otherwise resemble adults.

Thrips feeding on developing fruit to cause russetting

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Thrips (Thysanoptera)
Biology, Ecology and Management in Stone Fruit

- In years of hot dry weather populations can increase dramatically (2022) .
- Resulting injury is primarily from feeding injury early in fruit development,.
- Western flower thrips can be seen as a pest in peach during **late season feeding**, which results in **"silvering"**. The feeding results in defuzzing of peaches leading up to harvest.
- **Silvering** damage stands out on highly colored fruit. Thrips can be found inside the shucks of nectarines and plums during the growing season causing blotches in plum and crescent-shaped scars in nectarines.

Thrips feeding on developing nectarines fruit to cause silvering

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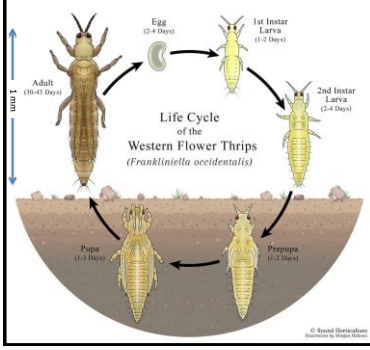
Thrips Biology in Stone Fruit



The insect overwinters as adults in weeds.

Adults are approximately 1 mm in length, have two pairs of wings folded along the back covering a striped abdomen.

In spring, the adults fly to flowering plants and eventually onto developing fruit.

Several generations of Western flower thrips are produced per year.

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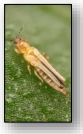
Thrips Monitoring in Stone Fruit

Spring



Bloom Sampling: Adult Threshold. Collect flowers from 10 to 12 trees at each of three to four sites per orchard, and looking at the blooms against a light yellow surface to determine abundance of adults.

PA extension guidelines recommend **treatment if adults infest more than five per 50 blooms**

Larval Threshold: The presence of larvae is determined by dissecting at least 50 blooms per orchard. **Begin treatment if larvae are present.**

Summer

First fruit ripening. Count the number of adult thrips on 10 fruits at each of five sites per orchard. Sample fruit from the ends of branches in the lower third of the canopy.

Threshold: Five adult thrips per 50 fruits and the presence of silvering may indicate a damaging population.

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Thrips Management in Stone Fruit

Control of western flower thrips

- **Preventing growth of weedy areas** in and adjacent to orchards. Controlling weed growth suppresses thrips buildup, reducing migration into orchards.
- Pennslyvania Extension guidelines recommend **Proper thinning to reduce the amount of protected feeding sites between fruit.**
- **Reducing the amount of clover in row middles.**
- **Not mowing** adjacent fields or weedy row middles **during bloom or harvest.**
- **Avoiding the use carbaryl**, ineffective against western flower thrips. Often increases the amount of injury occurring during harvest by killing late season beneficials.

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Thrips Management in Stone Fruit

Crop and Pest Management Guidelines
A Cornell Cooperative Extension Publication
Cornell Cooperative Extension

HOME > CORNELL GUIDELINES > 2022 TREE FRUIT TABLE OF CONTENTS > 14 PEACHES AND NECTARINES > 14.1 INSECTICIDES AND FUNGICIDES FOR PEACHES AND NECTARINES > PETAL FAL

Petal Fall — Peach & Nectarine

Pest	IRAC & FRAC	Product	Rates	PHI (days)	REI (hrs)	Efficacy
Western flower thrips	4A	*†Actara 25WDG	4.5-5.5 oz/acre	14	12	Moderate
	5	Delegate 25WG	4.5-7 oz/acre	1	4	High
	5	§Entrust 2SC	4-8 fl oz/acre 1.3-2.7 fl oz/100 gal water	1	4	High
	5	§Entrust 80WP	1.25-2.5 oz/acre 0.42-0.83 oz/100 gal water	1	4	High
	3A/28	*†Besiege	6-12 fl oz/acre	14	24	Moderate
	4A/3A	*†Endigo ZC	5-5.5 fl oz/acre	14	24	Moderate
	4A/28	*†Voliam Flexi WDG	6-7 oz/acre	14	12	Moderate

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Thrips Management in Stone Fruit

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Additional Summer Sprays — Peach & Nectarine

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Thrips Management in Stone Fruit

Crop and Pest Management Guidelines
A Cornell Cooperative Extension Publication

Cornell Cooperative Extension

Petal Fall — Apricots

Pest	IRAC & FRAC	Product	Rates	PHI (days)	REI (hrs)	Efficacy
Western flower thrips	5	Delegate 25WG	4.5-7 oz/acre	14	4	High
	5	§Entrust 2SC	4-8 fl oz/acre 1.3-2.7 fl oz/100 gal water	14	4	High
	5	§Entrust 80WP	1.25-2.5 oz/acre 0.42-0.83 oz/100 gal water	14	4	High
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Thrips Management in Stone Fruit

Crop and Pest Management Guidelines
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Cornell Cooperative Extension

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Thank you

Questions??

E-mail: pjjentsch24@gmail.com

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