Status of Brown Marmorated Stink Bug and Spotted Wing Drosophila in NY.

Empire Producers Expo
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Invasive Species

Our work specifically addressing the impact of important invasive insect pest species across the major commodities grown in the Northeast, specifically those impacting the Hudson Valley, has been conducted since 2010. Monitoring invasive insects is our primary concern to determine early emergence, presence and development. Intensive scouting is then conducted to validate the presence in agricultural crops. From these data we hope to construct developmental models to initiate management and keep the agricultural community apprised of county distribution, management timing and economic injury levels throughout the region.

The insects of greatest concern include:
- Spotted Wing Drosophila, Drosophila suzukii in small fruit, stone fruit and grape;
- 2013 Hudson Valley Spotted Wing Drosophila Pest Alert
- Brown Marmorated Stink Bug, Halyomorpha halys, causing economic injury to Hudson Valley tree fruit and pepper;
- Brown Marmorated Stink Bug Grower Alert
- Managing BMSB Using an Integrated Approach: Pheromone based mass trapping, treated netting, high intensity lighting, and
- Beauveria bassiana (Mycotrol-O GHA strain)
- African Fig Fly, Zaprionus indiana, in grape; causing injury to grape in New Jersey.
Agricultural Invasive Insect Pests

Native / invasive insects destroy about 13% of potential crop production yearly.

Represents $33 billion in U.S. crops (USBC, 2001).

• Approximately 40% of pests were introduced (Pimentel, 1993)

• $1.2 billion in pesticides are applied for all insect control yearly (Pimentel, 1997).

• Approximately $500 million/year applied against invasive insects

• Invasive insect pest cost: approx. $13.5 billion / year in the U.S.

1. Update on the environmental and economic costs associated with alien-invasive species in the United States. David Pimentel, Rodolfo Zuniga, Doug Morrison. 29 Dec. 2004 College of Agriculture and Life Sciences, Cornell University, Ithaca, NY 14850-0901, USA
### Agricultural Invasive Insect Pests Present

<table>
<thead>
<tr>
<th>Invasive Agricultural Pest (Accidental)</th>
<th>Description</th>
<th>Year</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Cydia pomonella</em></td>
<td>codling moth</td>
<td>1800</td>
<td>NY</td>
</tr>
<tr>
<td><em>Quadraspidiotus perniciosus</em></td>
<td>San Jose scale</td>
<td>1870</td>
<td>CA</td>
</tr>
<tr>
<td><em>Cacopsylla pyricola</em></td>
<td>pear psylla</td>
<td>1832</td>
<td>CT</td>
</tr>
<tr>
<td><em>Grapholita molesta</em></td>
<td>oriental fruit moth</td>
<td>1913</td>
<td>VA</td>
</tr>
<tr>
<td><em>Ostrinia nubilalis</em></td>
<td>European corn borer</td>
<td>1917</td>
<td>MA</td>
</tr>
<tr>
<td><em>Halyomorpha halys</em></td>
<td>brown marmorated stink bug</td>
<td>1996</td>
<td>PA</td>
</tr>
<tr>
<td><em>Drosophila suzukii</em></td>
<td>spotted wing drosophila</td>
<td>2008</td>
<td>CA</td>
</tr>
</tbody>
</table>

- **Brown Marmorated Stink Bug (BMSB)**
- **Spotted Wing Drosophila (SWD)**
Asian Invasive Brown Marmorated Stink Bug Spread in the US

Halyomorpha halys

Map showing the spread of the Asian invasive brown marmorated stink bug in the US, with a color-coded legend indicating the year of detection.
Urban mapping of BMSB (from Citizen Science submissions) showing population concentrations in 33 Counties of New York.

Confirmed Sightings of Brown Marmorated Stink Bug in NY by Zip Code
Eggs: Average 28/cluster; light green to white

1st instar: black & red; cluster near eggs

2nd instar: striped antennae

3rd instar: striped antennae and legs

4th instar: thoracic spur striped antennae & legs

5th instar: wing pads striped antennae & legs

BMSB Adults: red eyes, 4 cream colored dots on shoulders; banding on legs and antenna, smooth blunt shoulders. Banded abdomen; 14 -17 mm in length.
Adult BMSB

2 sets of 4 cream ‘dots’

Along the anterior edge of the abdomen and thorax
BMSB Bi-Voltinism
2 generations in the Mid-Hudson Valley of NY

Overwintering adult
28 eggs / cluster weekly; 200 / female

1st Generation

Combined 1st & 2nd Generations

May      June      July      August      September     Oct.

Presence

Intensified Feeding
Figure 1: Risk maps displaying the relative density of field, vegetable, and fruit crop hosts plants of BMSB throughout the United States.
Tree of Heaven, *A. altissima.*

Warwick, NY
September, 2012

![Graph showing total BMSB (Brown Marmorated Stink Bug) counts from 29 June to 9 August, 2012. The graph indicates significant activity from *A. altissima* and other species.](image)
Ag. Hosts of the Brown Marmorated Stink Bug

**Tree fruit** (apple, pear, peaches, cherry)

**Small fruit** (grape, bramble fruit)

**Vegetables** (tomato, pepper, sweet corn, Lima Beans, soybean)
The Stink Bug Complex In NYS Tree Fruit Mouthparts

• Stink bug species are both herbivorous and insectivorous.

• Mouthparts modified into a proboscis, sheathed within a modified labium, which is capable of piercing plant tissue and insect cuticle to remove liquids from their host.
The Brown Marmorated Stink Bug Complex In NYS Tree Fruit Feeding Injury

• The adult and nymph feed on tree fruit, vegetable, small fruit, grape and ornamental trees.

• Greatest tendency is to feed on developing seed of broadleaf plants, arboreal tree hosts.

• Stink bug feeding pierces the fruit skin leaving behind a feeding ‘hole’ in the center of a depression and at times a ‘feeding sheath’.
The Stink Bug Complex In NYS Tree Fruit
SB Feeding Injury

- Leaving behind dry cell walls that appear as corking when peeled.
**Hudson Valley Complex:**

**SB species of economic importance**

- **Brown Stink Bug, *Euschistus servus* (Say)**
  - Adult Stink bug damage
  - Breakdown:
    - GT
    - TC
    - P
    - Bloom
    - PF
    - 1C
    - 2C
    - 3C
    - 4C
    - 5C
    - 6C
    - 7C
    - 8C

- **Green Stink Bug, *Acrosternum hilare* (Say)**
  - Adult Stink bug damage
  - Breakdown:
    - GT
    - TC
    - P
    - Bloom
    - PF
    - 1C
    - 2C
    - 3C
    - 4C
    - 5C
    - 6C
    - 7C
    - 8C

- **Brown marmorated stink bug, *Halyomorpha halys* (Stål)**
  - Adult SB Presence
  - Adult & Nymph Stink bug damage
  - Breakdown:
    - GT
    - TC
    - P
    - Bloom
    - PF
    - 1C
    - 2C
    - 3C
    - 4C
    - 5C
    - 6C
    - 7C
    - 8C

**Adult Stink bug damage**
- 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

**Adult & Nymph Stink bug damage**
- 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
Establishing Brown Marmorated Stink Bug Presence In NYS: Agriculture Environment

- Standard use of Tedders trap and pheromone lures to determine presence / absence of BMSB
  - Black Tedders triangular station with cone trap and clear plastic collection jar
  - USDA #10 + MDT (methyl (E,E,Z)-2,4,6-decatrienoate)
  - Killing strip
  - Weed free base
The BMSB Presence in New York: Agriculture

• 2011: 70 Sites

• **MDT Lure** baited set out in NYS major agricultural regions
  – BMSB captured only in Marlboro, NY (Hudson Valley).

• 2012: 8 Sites

• **USDA #10 lure + MDT Lure**
  – BMSB in all lower and Mid-Hudson Valley trap Sites
  – 60+ / week one orchard site.
  – Severe tree fruit injury observed (>20%)
The BMSB Presence in New York: Agriculture

• 2013: 14 NYS Counties (≈40 traps)

• #10 lure +MDT Tedders traps captured higher numbers of adults earlier and in new areas of NYS:
  – 900+ / week in Marlboro, NY
  – New Ag. Sites Captures:
    – Western NY plus HV (May 7);
    – Long Island (May 15);
    – Capital District (Aug 19).

BMSB injury noted early in tree fruit in 2013, however, no economic injury was observed.
Results from #10 lure +MDT Tedders traps in agricultural sites. BMSB observed in 7 of 15 NY counties during the 2013 growing season.
BMSB Monitoring of 3 NY Orchards, 2013

Campbell Hall, NY

Milton, NY

Marlboro, NY
A strong edge effect was observed from wooded edge toward the interior of the block in Pink Lady harvested in early November.

Evaluation of 3600 fruit.

Along 30’ of border fruit 74-98% injury was assessed.

>21% injury was documented at packout.
Stink Bug injury to Golden Delicious
5 bins: Range from 38 – 57% damage
9 October, 2012; Milton, NY
What are the factors influencing the movement of BMSB to Ag Commodities in NYS

- **Population density** leading to reduced host viability
  - High overwintering and 1<sup>st</sup> generation BMSB can reduce host viability
  - 2<sup>nd</sup> generation move out of deciduous forest trees for lack of food resources

- **Climatic conditions**
  - Under drought conditions
    - Seed and plant tissue becomes stressed with reduced moisture
    - Seed of deciduous trees reduce moisture stores
    - BMSB will move from deciduous trees to crops as seed viability is reduced

- Can we use trap captures, rainfall & RH as predictors for BMSB movement to crops?
Factors Influencing BMSB Fruit Feeding
Rainfall & RH, Campbell Hall, NY

>21% Fruit Injury (N=3600) 2012

Total Rain (1.8 in.)

0.1% Fruit Injury (N=12,000) 2013

Total Rain (6.0 in.)

RH Hrs >= 90% (15 hrs.)

RH Hrs >= 90% (1122 hrs.)
## Insecticide Use

<table>
<thead>
<tr>
<th>Insecticide Group</th>
<th>Product</th>
<th>Active Ingredient</th>
<th>% Adult BMSB Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pyrethroid</td>
<td>Bifenture</td>
<td>bifenthrin</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Danitol</td>
<td>fenpropathrin</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Warrior II</td>
<td>lambda-cyhalothrin</td>
<td>73</td>
</tr>
<tr>
<td>Carbamate</td>
<td>Lannate</td>
<td>methomyl</td>
<td>92</td>
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<tr>
<td></td>
<td>Vydate</td>
<td>oxymyl</td>
<td>68</td>
</tr>
<tr>
<td>Neonicotinoid</td>
<td>Actara</td>
<td>thiamethoxam</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>Assail</td>
<td>acetamiprid</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>Calypso</td>
<td>thiacloprid</td>
<td>58</td>
</tr>
<tr>
<td>Pre-mix</td>
<td>Leverage 360</td>
<td>imidaclorpid and β-cyfluthrin</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Endigo</td>
<td>lambda-cyhalothrin and thiamethoxam</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Voliam Flexi</td>
<td>chlorantraniliprole and thiamethoxam</td>
<td>98</td>
</tr>
</tbody>
</table>

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.
BMSB Mgt. in Peaches at 10 d Intervals: Rutgers

Percent Injured Fruit

- Assail + Bifenture
- Perm-Upt + Assail
- Bifenture
- Danitol
- Endigo
- Voliam Flexi
- Voliam Xpress
- *Closer
- Lannate
- UTC

* Sulfoxaflor-Dow
Residual field bioassay of adult BMSB on treated foliage:

- **Four tree plots, 4 replicates** treated with the highest labeled rate of insecticides using tractor mounted airblast sprayer

- Foliage collected 24, 48 and 72 hours after application.

- 1st generation adults placed on portions of 4 leaves wrapped on the inside of a 1 oz. enclosed container.

- Adults were observed at 1 and 3 day intervals and evaluated as live, morabund or dead, held at 70°F.
BMSB Adult Exposure to Insecticide Residue of Apple Foliage
24h Old Residue @ 1 d

BMSB Adult Exposure to Insecticide Residue of Apple Foliage
24h Old Residue @ 3 d
BMSB Monitoring, Threshold and Application Strategy

- **Monitoring:**
  - **Trap:** Tedders + pheromones to detect BMSB along the orchard perimeter
  - **Scout:** If BMSB is captured in traps then scout perimeter orchard rows
  - **Threshold:** 1 BMSB observed within 100’ of perimeter scouting
  - **Application Strategy:** Perimeter orchard application using effective

- **Scouting:** Repeat scouting after 4d, using 1 BMSB threshold along perimeter orchard rows as a trigger for subsequent application.

- **Application Strategies:** Alternate row middle applications (ARM) at 7d

- **Monitoring:** Repeat perimeter scouting using 1 BMSB threshold

- **Application Strategies:** Use whole orchard application. Repeat sequence.
Spotted Wing Drosophila
*Drosophila suzukii*

- An invasive insect in the vinegar fly family. (Drosophilidae)
- It was observed in 2011 in the Midwest, East Coast and northern Hudson Valley with *economic losses* in raspberry.
- In 2012 we observed high levels of small fruit infestation across the Hudson Valley.
- In 2013, *earlier emergence* and increasing range of fruit infestation.
- Raspberry & blackberry 100% loss.
Current state level spotted wing drosophila in the United States.

Drosophila suzukii
spotted wing
Drosophila

- Known Ag hosts include: blackberries, raspberries, blueberries, strawberries, figs, cherries, thin skin grapes, peaches, apples, pears, nectarines, plums.

- California represents the largest acreage of these fruits nationwide.

- SWD was responsible for an average of 20% crop loss in CA, although near total infestations are possible.

- Range of fruit injury from egg laying and larval infestation in the Hudson Valley of NY by mid-August: 17%-100% injury
SWD – Key Characteristics

**Male**
- Black spot on wings
- 2 black combs on front legs

**Female**
- She inserts saw-like device (ovipositor) into fruits and lays eggs
Un-ripened blackberry infested with SWD eggs
2012

Key problem: SWD oviposits into pre-ripened fruit
Spotted Wing Drosophilada – Overwintering

SWD trap captures in Vineland, Ontario
- Highest numbers move toward the forest in the winter
Tartarian Honeysuckle (Lonicera tatarica)

An invasive shrub, Tartarian honeysuckle is a native of eastern Asia and was first introduced into North America as an ornamental in 1752. SWD was found to be highly attracted to the fruit, and infestations in L. tatarica were noticed before infestation in cultivars.
Tartarian Honeysuckle (Lonicera tatarica)
Tartarian Honeysuckle (*Lonicera tatarica*)
Fruit Infestation levels by location. Opacity of line indicates level of infestation.
As Tartarian Honeysuckle loses fruit, infestation increases in cultivars closest to forest edge.
As Tartarian Honeysuckle loses all fruit, Infestation in cultivars reaches higher levels.
Tartarian Honeysuckle berries maintained high levels of infestation until August 12, when the plants bordering the orchard no longer had fruit.

Infestation in the domestic cultivars increased as wild hosts disappeared.
Injury in blackberry crop:
- Clean crop up to mid-July
- 20% injury on 21 July
- 90% injury on 1 August
SWD Management

Adult Trapping: Yeast mixture, sugar, apple cider vinegar
   Adult captures provide early warning
   Begin management at 1st adult SWD?

Crop Monitoring: Assessment of fruit for eggs & larva

Cultural management of crop: Clean pick & removal of injured fruit

Maintain harvested fruit at 33F: ASAP

Insecticide frequency: 3-4 day program using best materials
   Alternate row middle vs full row

Insecticide class rotation: Resistance management 10d to 2 wks
SWD Management after 0.8” of Rainfall (R. Issacs, Univ. Mich)

<table>
<thead>
<tr>
<th>Material</th>
<th>Rate</th>
<th>% Control</th>
<th>% Control 0.8” rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mustang Max</td>
<td>4.0 oz./A</td>
<td>100</td>
<td>70-100</td>
</tr>
<tr>
<td>Assail 30SG</td>
<td>5.3 oz./A</td>
<td>60-100</td>
<td>20-45</td>
</tr>
<tr>
<td>Delegate 25WDG</td>
<td>4.5 oz./A</td>
<td>88-100</td>
<td>20-60</td>
</tr>
<tr>
<td>Malathion 8F</td>
<td>2.0 pts./A</td>
<td>70-100</td>
<td>8-45</td>
</tr>
</tbody>
</table>

Loss of SWD efficacy 1-3 days after rain
24 hrs post application rain event.
Stresses the need for retreatment of most insecticides.
## SWD Control in Mixed Small Fruit; Orange Co.

<table>
<thead>
<tr>
<th>Date</th>
<th>Material</th>
<th>Rate</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 June</td>
<td>Malathion 57</td>
<td>2 pts./A</td>
<td>Raspberry</td>
</tr>
<tr>
<td>1 July</td>
<td>Assail 30SG</td>
<td>5 oz./A</td>
<td>Raspberry</td>
</tr>
<tr>
<td>5 July</td>
<td>Malathion 57</td>
<td>2 pts./A</td>
<td>Raspberry</td>
</tr>
<tr>
<td>12 July</td>
<td>Delegate 25WDG</td>
<td>3 oz./A</td>
<td>Raspberry</td>
</tr>
<tr>
<td>14 July</td>
<td>Brigade</td>
<td>8 oz./A</td>
<td>Raspberry</td>
</tr>
<tr>
<td>19 July</td>
<td>Assail 30SG</td>
<td>5 oz./A</td>
<td>Raspberry</td>
</tr>
<tr>
<td>22 July</td>
<td>Danitol</td>
<td>16 oz./A</td>
<td>Raspberry</td>
</tr>
<tr>
<td>27 July</td>
<td>Mustang Max</td>
<td>4 oz./A</td>
<td>Raspberry</td>
</tr>
<tr>
<td>30 July</td>
<td>Assail 30SG</td>
<td>5 oz./A</td>
<td>Raspberry</td>
</tr>
</tbody>
</table>

6.31” Rainfall; 6 day application interval

| 5 August | Delegate 25WDG     | 3 oz./A | Raspberry |
| 19 August| Brigade            | 8 oz./A | Raspberry |
Orange County Fruit Infestation - 2013

Raspberry Management

6.31” Rainfall

Eggs/Larvae per Gram

Raspberry
Blackberry
House Blackberries
Blueberries
Cherry
Strawberry


Alternative Approaches to Conventional IPM

**Mycotrol-O** is a mycopesticide, employing a fungal pathogen (*Beauveria bassiana*) as a method of controlling *D. suzukii*.

- **OMRI approved**
- Strain GHA at a concentration of 10.9% or $2 \times 10^{10}$ viable spores per gram of active ingredient.

In laboratory studies, BotaniGard was applied to surface of blueberries in closed bioassay (one adult fly per berry, 10 replicates), adult fatality measured daily.
Mycotrol-O mycopesticide. (*Beauveria bassiana*) to control *D. suzukii*.

BotaniGard applied to surface of blueberries in closed bioassay (one adult fly per berry, 10 replicates). Adult mortality measured daily.
Mycotrol-O mycopesticide. (*Beauveria bassiana*) to control *D. suzukii*.

Advanced stage of fungal growth (~10 days of exposure).
Thanks to the staff at the HVL for all their support:

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