Detection and characterization of CMV in snap beans, peppers, and aphids

Midwest Food Processors Association
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# Relative Importance of the Snap Bean Crop; Great Lakes Region

<table>
<thead>
<tr>
<th>Processing snap bean:</th>
<th>Acreage</th>
<th>Value (million $)</th>
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</thead>
<tbody>
<tr>
<td>Wisconsin</td>
<td>73,500</td>
<td>36.6</td>
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<tr>
<td>New York</td>
<td>22,200</td>
<td>15.1</td>
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<tr>
<td>Ontario, Canada</td>
<td>20,000</td>
<td>N/A</td>
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<tr>
<td>Michigan</td>
<td>19,000</td>
<td>9.8</td>
</tr>
<tr>
<td>Illinois</td>
<td>15,800</td>
<td>6.8</td>
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<tr>
<td>Pennsylvania</td>
<td>10,900</td>
<td>6.7</td>
</tr>
<tr>
<td>Total (U.S.)</td>
<td>169,200</td>
<td>97.3</td>
</tr>
</tbody>
</table>

| Fresh-market snap bean:     |         |                   |
| New York                    | 10,700  | 48.1              |
| Total (U.S.)                | 104,700 | 324.1             |

NASS (2007)
Processing Snap Bean
Production Intervals in Wisconsin

<table>
<thead>
<tr>
<th>Date</th>
<th>Planting</th>
<th>Harvesting</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/5</td>
<td></td>
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<tr>
<td>5/19</td>
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<tr>
<td>6/2</td>
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<tr>
<td>6/16</td>
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<td>6/16</td>
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<td>6/30</td>
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<tr>
<td>7/14</td>
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<td>7/14</td>
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<td>7/28</td>
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<td>8/11</td>
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<td>8/25</td>
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<tr>
<td>9/8</td>
<td></td>
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<tr>
<td>9/22</td>
<td></td>
<td></td>
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<tr>
<td>10/6</td>
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</tbody>
</table>

Date

Logos of Del Monte Foods, Seneca, Lakeside Foods, and Hartung Brothers.
Virus Infections
Intervals of Risk in Wisconsin

Early Planted
Late Planted
Middle Planted
Symptom Development

Date
Yield Reduction Attributed to Viruses

cv. ‘Goldmine’

Nault 2006
New Insect Vector, Soybean aphid

*Aphis glycines*, soybean aphid

Lee 2002

2005 Distribution
Emerging Bean Viruses: The problem (2007)

Wisconsin Snap Bean Survey, 2007

- **Central Sands**: 93.2%
  - CMV: 1.3%
  - AMV: 0.5%
  - BCMV: 11.1%
  - BYMV: 2.7%
  - ClYVV: 90.2%
- **New Richmond**: 80.5%
- **Spring Green**: 90.2%
  - CMV: 78.3%
  - AMV: 11.1%
  - BCMV: 0.5%
  - BYMV: 2.7%
- **Door Co.**: 80.5%

CMV – Bell pepper

CMV – Jalapeno, mature leaf

CMV – Jalapeno fruit
Hypothesis I. Long Distance Transport

Viruliferous Soybean Aphids

Colder, Dry Air

Warm, Moist Air

North Dakota

South Dakota

Minnesota

Wisconsin

Michigan

Ohio

Indiana

Kentucky

Iowa

Missouri

Nebraska

Kansas
Long Distance Transport

Viruliferous Soybean Aphids

CMV-infected aphid
Non-infected aphid
Hypothesis II. Long Distance Aphid Dispersal: Local Inoculum
Epidemiology of CMV

- Affects a number of important vegetable and ornamental plants (tomato, cucumber, squash, pepper, snap beans)

- Is transmitted non-persistently by several aphid vectors and through seed.

- Very broad host range (> 1,000 spp.) and can overwinter in several perennial weed species
Research Objectives

- Compare the genetic structure of CMV isolates collected from (1) infected crops (beans and peppers), (2) dispersing aphids, and (3) potential reservoir hosts.

Goal: Identify the primary reservoir hosts of CMV in and around selected snap bean fields and to determine those species, or set of species, which have the greatest epidemiological importance.

Goal: Accurately determine periods of elevated risk for CMV transmission and develop disease management strategies to limit spread of the viral pathogen.
I. Genetic Structure of CMV

- CMV is tripartite, + sense RNA, with 5 ORF’s

  RNA1 (3.4 Kb)

  RNA2 (3.1 Kb)

  RNA3 (2.2 Kb)

- ORF 2b involved in grouping by host association
I. Characterizing CMV host association

- Determine similarity / dissimilarity of CMV isolates 1) within a field (snap beans) and 2) among affected fields (regional).

![Map of Wisconsin with marked regions]

- **Central Sands**, **Ripon Plain**, **Lakeshore**, **Spring Green**
I. CMV host association: Virus types

- 4 primary inoculum sources (host types)

Seneca Foods, Buttercup Ave., Adams County:
I. CMV host association: Virus types

- Hartung Bros, Hwy 14., Dane County:

- 3 primary inoculum sources (host types)
I. CMV host association: Virus types

- Del Monte Foods, Hwy 73, Green Lake County:

  - 2 primary inoculum sources (host types)
I. CMV host association: Virus types

- Lakeside Foods, Hwy. 42, Manitowoc County:
  - 3 primary inoculum sources (host types)
II. Characterizing CMV host – vector(s) associations

- Weekly captures of dispersing aphid species.

- D. Voegtlin, Illinois Natural History Survey

Regional Soybean Aphid Suction Trap Network

*Acyrthosiphon pisum*  
*Acrythosiphon pisum*  
*“Pea aphid”*

*Aphis craccivora*  
*Aphis craccivora*  
*“Black legume aphid”*

*Aphis glycines*  
*Aphis glycines*  
*“Soybean aphid”*

*Aphis gossypii*  
*Aphis gossypii*  
*“Cotton-melon aphid”*

*Aphis helianthi*  
*Aphis helianthi*  
*“Sunflower or dogwood aphid”*

*Aphis nasturtii*  
*Aphis nasturtii*  
*“Buckthorn-potato aphid”*

*Aphis spiraecola*  
*Aphis spiraecola*  
*“Spiraea aphid”*

*Brachycerda helichrysi*  
*Brachycerda helichrysi*  
*“Leaf curling plum aphid”*

*Lipaphis pseudobrassicae*  
*Lipaphis pseudobrassicae*  
*“Turnip aphid”*

*Macrosiphum euphorbiae*  
*Macrosiphum euphorbiae*  
*“Potato aphid”*

*Rhopalosiphum insertum*  
*Rhopalosiphum insertum*  
*“Apple grass aphid”*

*Rhopalosiphum maidis*  
*Rhopalosiphum maidis*  
*“Corn leaf aphid”*

*Rhopalosiphum padi*  
*Rhopalosiphum padi*  
*“Bird cherry-oat aphid”*

*Schizaphis graminum*  
*Schizaphis graminum*  
*“Greenbug”*

*Sitobion avenae*  
*Sitobion avenae*  
*“English grain aphid”*

*Therioaphis trifolii*  
*Therioaphis trifolii*  
*“Spotted Alfalfa aphid”*
## II. Characterizing CMV host – vector(s) associations

### Seasonal detection / transmission efficiencies (2008):

<table>
<thead>
<tr>
<th>Aphid Species</th>
<th>Estimated Transmission (Gildow et al. 2008)</th>
<th>Seasonal Detection</th>
<th>Host Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean aphid (<em>A. glycines</em>)</td>
<td>60%</td>
<td>36.3%</td>
<td></td>
</tr>
<tr>
<td>Spotted alfalfa aphid (<em>T. trifolii</em>)</td>
<td>58%</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Pea aphid (<em>A. pisum</em>)</td>
<td>42%</td>
<td>8.1%</td>
<td></td>
</tr>
<tr>
<td>Corn leaf aphid (<em>R. maidis</em>)</td>
<td>30%</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Green peach aphid (<em>M. persicae</em>)</td>
<td>6%</td>
<td>--</td>
<td></td>
</tr>
</tbody>
</table>

CMV detections in individual *A. glycines*

370 bp →

* * * * * * * *
III. Accurate identification of CMV inoculum sources

- Mueller and Gratton (2008)
- Rist and Lorbeer (1989, 1991)
- Bruckart and Lorbeer (1976)

<table>
<thead>
<tr>
<th>Plant Species</th>
<th>Estimated Infection (Field Surveys)</th>
<th>Host Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>alfalfa ((M. sativa))</td>
<td>0.4% ((N=1,340))</td>
<td></td>
</tr>
<tr>
<td>white clover ((T. repens))</td>
<td>0.7% ((N=540))</td>
<td></td>
</tr>
<tr>
<td>Kura clover ((T. repens X hybriduum))</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>eastern black nightshade ((S. ptycanthum))</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>milkweed ((Asclepias spp.))</td>
<td>18.2% ((N=650))</td>
<td></td>
</tr>
</tbody>
</table>
Project Goals / Expected Outcome

- Improve our understanding of the epidemiology of CMV

- Determine which vector, or set of vectors, contribute to disease cycles.

- To accurately identify the primary reservoir hosts of CMV in and around affected snap bean fields and determine those species, or set of species, which have the greatest epidemiological importance.
Managing Aphid Transmitted Viruses

**Solutions for some vegetable crops**

- Prevent aphids from landing on crop
  - reflective mulches (e.g., pepper)
  - row covers

- Manipulate immigrating aphid populations
  - border crop or barrier crop

- Separate crop from virus source
  - distance
  - time

- Resistant varieties

- Interfere with aphid’s ability to transmit virus
  - mineral and stylet oils (e.g., pepper and snap beans)
Minimizing Current Season Infection: Timely and Improved Oil Applications

- Selection of light, ‘white’ mineral oils
  - quality and concentration
  - (e.g. Aphoil or JMS Stylet Oil)
  - plant development
  - 4 – 5 days risk periods

- Selective feeding blockers:
- Systemic Acquired Resistance (SAR’s):
  - plant activators
  - defensive proteins
  - modified fertilizers
Managing Aphid Transmitted Viruses: Elevated Risk of Spread

- Crop protection during periods of greatest risk
Acknowledgements

Hartung Brothers
Seneca Foods
Lakeside Foods
Del Monte Foods
Midwest Food Processors Association

QUESTIONS?