Advancing carrot IPM: New tools for nematode and leafhopper control

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Factors Influencing Insect Pest Management

‘Environmental Concerns’

With increasing affluence domestically and globally, there are increasing concerns about pesticide usage and perceived environmental effects.

This has rapidly accelerated the shift to “softer” products and technologies – ‘sustainability’.
Factors Influencing Insect Pest Management

‘Food Safety’

Major food retailers are setting acceptable residue levels below those set by government regulatory agencies.

“No detectable residues” will be a competitive advantage for food retailers.

Older insecticides that do not meet these requirements are not being re-registered, resulting in increased use of novel Reduced-Risk (RR) insecticides
Improving Aster Yellows Management

The Challenge!

Increasing the sustainability, efficiency and profitability of carrot production...

- Synthetic pyrethroids represent the backbone of ALH and AY management ($42 - $60 acre)
- New registrations and delivery systems offer promising alternatives ($18 – $24 acre) – ‘Reduced-Risk’
**Aster yellows**

**Disease incidence:**
1% - 15% in intensively managed carrot fields

Likely 80-100% if not managed

**Variable symptoms:** *Above ground* – leaf yellowing and reddening, twisting, witches' brooming; *Below ground* – stunted and malformed roots, adventitious root growth

**Other crops affected:** Lettuce, celery, cilantro, canola, parsnip, potato
Vector: Aster leafhopper (ALH)

Adult

- *Macrosteles quadrilineatus* Forbes (Hemiptera: Cicadellidae)
- Approximately 4 mm long and weigh 1 mg (0.8 mg M; 1.2 mg F)
- Light greenish-yellow in color (seasonally variable)
- Widely distributed in the U.S.

Immature
Early season migration of the ALH from the Gulf-states to the Upper Midwest

Migratory behavior together with the mode of transmission makes possible the movement of AYp over great distances.
Carrot crop relative to ALH biology

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<tbody>
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<td>Carrot</td>
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<td>Planting</td>
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<td>Crop growth</td>
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<td>Harvest</td>
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Aster Leafhopper

Migratory | Local | 1st – 3rd Generation

Aster Leafhopper Management (Current)

Foliar insecticide applied when Aster Yellows Index (AYI) exceeds values of 50, 75 or 100:

- \[ \text{AYI} = \% \text{ALH infectivity} \times \# \text{ALH} / 100 \text{ sweeps} \]
Carrot crop relative to ALH biology

|-------|-----|------|------|--------|-------|------|
| Carrot
| Planting | Crop growth | Harvest |

Aster Leafhopper

Migratory

Local

1st – 3rd Generation

Foliar insecticide applications

($42-65 / Acre)

Aster Leafhopper Management (Current):

Synthetic pyrethroids - backbone of AY control programs
Improving Aster Yellows Management

The Challenge!

Increasing the sustainability, efficiency and profitability of carrot production...

- Synthetic pyrethroids represent the backbone of ALH and AY management ($42 - $60 acre)
- New registrations and delivery systems offer promising alternatives ($18 – $24 acre) – ‘Reduced-Risk’

- Can we improve our current management strategies?
- Do we have all the tools that we need to manage this disease?
Insecticides for Managing Carrot Pests

Recently Labeled in Wisconsin:

- **Actara** (thiamethoxam) – foliar
- **Platinum** (thiamethoxam) – in-furrow
- **Admire Pro, Alias, etc.** (imidacloprid) – in-furrow / foliar
- **Gaucho** (imidacloprid) – seed treatment
- **Sepresto 75 WS** (imidacloprid, clothianadin) – seed treatment

In the Pipeline:

- **FarMore DI400&500** (spinosad, thiamethoxam) – seed trt
- **Cruiser** (thiamethoxam) – seed trt
- **Benevia, Verimark** (cyantraniliprole) – in-furrow, foliar, seed
- **Entrust** (spinosad) – seed treatment
- **Avicta** (abamectin, thiamethoxam) – seed treatment
Systemic Neonicotinyl Insecticides

Beneficial Attributes

- **Broad spectrum**
  - Leafhoppers, aphids
- **Flexible**
  - Row mark, furrow, seed, layby
- **Long residual**
  - Rate dependent
- **Low toxicity**
  - “EPA classified Reduced-Risk (RR)”

Disadvantages

- **Same chemical class**
- **Resistance concerning**
Approach to deploying new insecticide tools

Identify periods of “high risk” for spread of AY
- Historical pest scouting records (Pest Pros, Inc.)

Target control to periods of higher risk for AYp spread
- Use new reduced risk insecticides

Can we reduce the number of applications by targeting times of higher AY risk – Treatment Window?

Can the higher cost of novel, reduced risk, and less broad spectrum insecticides be offset by using fewer applications?
Detection of seasonal trends in AY risk

Methods were modified from Nault et. al. (2009). Environ. Entomology 38(5):1347-1359.

Pest Pros Inc., Plainfield, WI 54966 (http://www.pestprosinc.com)

Our methods:

Sweep net and infectivity data averaged for each year, field, and date combination (7 and 14 years, respectively).

Data were standardized using random effects models and regression splines

Cubic polynomials were fit to the resulting “conditional” or “de-seasonalized” data (linear model)
Seasonal Trends: ALH Abundance

- Fit Random Effects model to data
- Model ‘Best Linear Unbiased Predictors’ vs. Julian date and fit cubic polynomial

Solve for $S = 0$

$X_1: 155$ (June 3)
$X_2: 216$ (August 3)
$X_3: 265$

Above average ALH catches between $X_1$ and $X_2$

“Risk Window”
Seasonal trends: ALH infectivity

Using similar methodology to examine ALH infectivity

Above average ALH infectivity

\[ X_1: 139 \text{ (May 18)} \]
\[ X_2: 197 \text{ (July 15)} \]
\[ X_3: 259 \]

“Risk Window”
# Defining the ‘Treatment Window’

*Can we reduce the number of applications by targeting times of higher AY risk – Treatment Window?*

*Can the higher cost of novel, reduced risk, and less broad spectrum insecticides be offset by using fewer applications?*

<table>
<thead>
<tr>
<th></th>
<th>Open</th>
<th>Close</th>
<th># Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Susceptible carrot</td>
<td>May 25</td>
<td>Sept. 1</td>
<td>100</td>
</tr>
<tr>
<td>Aster Leafhopper</td>
<td>June 7</td>
<td>August 1</td>
<td>55</td>
</tr>
<tr>
<td>ALH infectivity</td>
<td>May 18</td>
<td>July 15</td>
<td>58</td>
</tr>
<tr>
<td>Overlap</td>
<td>June 7</td>
<td>July 15</td>
<td>40</td>
</tr>
<tr>
<td>Resistant Carrot (High infectivity)</td>
<td>June 18</td>
<td>July 8</td>
<td>20</td>
</tr>
<tr>
<td>Susceptible Carrot (High infectivity)</td>
<td>June 7</td>
<td>August 7</td>
<td>61</td>
</tr>
</tbody>
</table>
Carrot crop relative to ALH biology


Carrot
- Planting
- Crop growth
- Harvest

Aster Leafhopper
- Migratory
- Local
- 1st – 3rd Generation

Foliar insecticide applications
($42-65 / Acre)

Risk window 45 Days – 85 DAP

Seed treatments or in-furrow insecticide applications
($18-24 / Acre)
Objective

To evaluate the efficacy of thiamethoxam (Platinum and Cruiser) when applied as in-furrow and seed treatment applications for managing aster leafhopper and Aster Yellows disease.
# Products Evaluated for Managing Aster Leafhopper and Aster Yellows Disease of Carrot in WI, 2011

<table>
<thead>
<tr>
<th>Product</th>
<th>Active Ingredient</th>
<th>Type*</th>
<th>Rate</th>
<th>Variety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Cruiser 5FS</td>
<td>thiamethoxam</td>
<td>ST</td>
<td>0.1 mg a.i. / seed</td>
<td>cv. ‘Enterprise’</td>
</tr>
<tr>
<td>Avicta</td>
<td>thiamethoxam &amp; abamectin</td>
<td>ST</td>
<td>0.1 mg a.i. / seed</td>
<td>cv. ‘Maverick’</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.016 mg a.i. / seed</td>
<td></td>
</tr>
<tr>
<td>Untreated</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Sepresto</td>
<td>clothianadin &amp; imidacloprid</td>
<td>ST</td>
<td>0.068 mg a.i. / seed</td>
<td>cv. ‘Maverick’</td>
</tr>
<tr>
<td>Sepresto / Votivo</td>
<td>clothianadin &amp; imidacloprid</td>
<td>ST</td>
<td>0.068 mg a.i. / seed</td>
<td>cv. ‘Maverick’</td>
</tr>
<tr>
<td></td>
<td><em>Bacillus firmus</em></td>
<td></td>
<td>0.023 mg a.i. / seed</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>1.5 X10³ cfu / seed</td>
<td></td>
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<tr>
<td>Vydate CLV</td>
<td>oxamyl</td>
<td>BR</td>
<td>2 gal / acre</td>
<td></td>
</tr>
<tr>
<td>Asana XL (Standard)</td>
<td>esfenvalerate</td>
<td>F</td>
<td>5 appl @ 8.0 fl oz/acre</td>
<td>cv. ‘Canada’</td>
</tr>
<tr>
<td>Platinum 75SG</td>
<td>thiamethoxam</td>
<td>IF</td>
<td>4.01 fl oz / acre</td>
<td></td>
</tr>
<tr>
<td>Platinum 75 SG &amp; Liquid Fertilizer</td>
<td>thiamethoxam</td>
<td>IF</td>
<td>4.01 fl oz / acre</td>
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*ST = seed treatment; IF = in furrow application; BR = broadcast at-plant
Large plot trials conducted on farm (~ 1/3 acre per trt x 3 trt x 3 locations; Many thanks to Miller Farms)

Data collected: Weekly ALH abundance, Nematode counts (2 dates), Disease ratings (2 dates), yields, and root quality assessment.
Mean Adult Aster Leafhoppers Captured / Sweep
Hancock, WI 2011

P = 0.0320    N=10

Mean adult ALH / 50 sweeps

Date

Trt
UTC
Sepresto
Sepresto/ Votivo

cv. ‘Maverick’
Mean Cumulative Adult Aster Leafhoppers
Captured / Sweep  Hancock, WI  2011

P < 0.0001    N=10

cv. ‘Maverick’
Mean Adult Aster Leafhoppers Captured / Sweep
Hancock, WI  2011

P= 0.0085    N=10

Mean adult ALH / 50 sweeps

cv. ‘Enterprise’
Mean Cumulative Adult Aster Leafhoppers Captured / Sweep  Hancock, WI 2011

P < 0.0001  N=10

cv. ‘Enterprise’
Cumulative adult ALH relate to yield: all locations combined

Data were centered for each location, treatment and block combination.

On average, an increase of 1 ALH resulted in a 0.3 T/A decrease in yield.

Trend was largely driven by data from a single location where there was more insect pressure throughout the season.
Mean Yield (Tons/Acre)  
Bayer - Nunhems Treatments  
Hancock, WI 2011

P = 0.6604  N = 10

Treatments:
- Untreated
- Sepresto
- Sepresto / Votivo
- HAI Field (Vydate)
Mean Yield (Tons/Acre) Syngenta Treatments Hancock, WI 2011

P = 0.4708 N = 10
Mean Counts Root Lesion Nematode
Bayer – Nunhems Treatments
Hancock, WI 2011

P = 0.0744    N=10

Treatments

Untreated
Sepresto
Sepresto / Votivo
HAI Field (Vydate)
Mean Adult ALH Numbers – Syngenta In-Furrow Treatments  Hancock, WI  2011

P< 0.0001    N=10  June 10 – Aug 29, 2011

Mean Adult ALH Numbers / Sweep

Treatments

Asana Standard
Platinum 75SG...
Platinum 75SG...

0 1 2 3 4 5 6

a  b  b
Mean Percent Symptomatic Plants
Syngenta In-Furrow Treatments
Hancock, WI 2011

P = 0.0186    N=10

Treatments

Asana Standard
Platinum 75SG...
Platinum 75SG...
Mean Yield (Tons/Acre)
Syngenta In-Furrow Treatments
Hancock, WI 2011

P = 0.0214    N=10

Treatments

Asana Standard
Platinum 75SG...
Platinum 75SG...
Overall summary: refining the AYI

Advance our basic understanding of the epidemiology of aster yellows in Wisconsin towards the development and implementation of a comprehensive management plan

- Incorporate biological information about the AY disease system improve on-farm AY management decisions
- Utilize available and emerging information and technologies in the context of management to:
  - I) Ensure AYP detection is accurate and reflects biology – Reduce unwarranted sprays
  - II) Identify trends in AY risk – Target control to high AY risk periods, offset high costs of new “softer” chemistries
  - III) Advance predictive tools to address sporadic risks – allows advanced preparation for ALH infestations to mitigate yield loss
Acknowledgements

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**Dept. of Entomology**

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**Carrot growers:**
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Shiprock Farms
Miller Farms
Patrykus Farms
Guth Farms
Kincaid Farms

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