Insect Pest Management
Cabbage Growers Meeting

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Bear Creek, WI

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Wisconsin Specialty Crop Industries (Wis. Ag. Stats. 2006 - 08)

Keene and Mitchell, 2010

<table>
<thead>
<tr>
<th>Total Economic Activity</th>
<th>Total Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetable &amp; Fruit Production</td>
<td>$1,092</td>
</tr>
<tr>
<td>Potatoes</td>
<td>$349</td>
</tr>
<tr>
<td>Cranberries</td>
<td>$300</td>
</tr>
<tr>
<td>Sweet Corn</td>
<td>$83</td>
</tr>
<tr>
<td>Green Beans</td>
<td>$63</td>
</tr>
<tr>
<td>Green Peas</td>
<td>$26</td>
</tr>
<tr>
<td>Carrots, Cucumbers &amp; Onions</td>
<td>$28</td>
</tr>
<tr>
<td>Ginseng</td>
<td>$16</td>
</tr>
<tr>
<td>Specialty Crop Processing</td>
<td>$5,268</td>
</tr>
<tr>
<td><strong>Total Impact</strong></td>
<td><strong>$6,360</strong></td>
</tr>
</tbody>
</table>

*Production estimates based on 2006-2008 average farmgate values; processing estimates based on 2007 Economic Census values. Note: Sum of impacts may not equal total impact due to rounding.*

**Total Economic Impact**

Specialty crop production and processing together account for about $6.4 billion in economic activity (3% of Wisconsin’s overall economy) and nearly 35,000 jobs (1% of jobs statewide), including both indirect and induced impacts.
Wisconsin Specialty Crops: Cranberry

The total impact of Wisconsin’s cranberry production averages $300 million each year in economic activity and roughly 3,400 jobs statewide.

### Impact of Cranberry Production in Wisconsin

(Economic activity in $ millions per year)

<table>
<thead>
<tr>
<th></th>
<th>Direct</th>
<th>Indirect</th>
<th>Induced</th>
<th>Total</th>
<th>Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Activity</td>
<td>$199</td>
<td>$55</td>
<td>$46</td>
<td>$300</td>
<td>1.51</td>
</tr>
<tr>
<td>Jobs</td>
<td>2,300</td>
<td>700</td>
<td>400</td>
<td>3,400</td>
<td>1.48</td>
</tr>
</tbody>
</table>

1. Production estimates based on 2006-2008 average farmgate values.
2. Note: Sum of impacts may not equal total impact due to rounding.

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Based on 2006-2008 average values.

Keene and Mitchell, 2010
Wisconsin Specialty Crops: Potato

The total impact of Wisconsin’s potato production is estimated at $349 million annually in economic activity and over 2,770 jobs statewide.

<table>
<thead>
<tr>
<th>Impact of Potato Production(^1) in Wisconsin</th>
<th>Economic activity in $ millions per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Activity</td>
<td>Direct ($240)</td>
</tr>
<tr>
<td>Jobs</td>
<td>1,620 (Jobs)</td>
</tr>
</tbody>
</table>

\(^1\)Production estimates based on 2006-2008 average farmgate values.
Note: Sum of impacts may not equal total impact due to rounding.

Keene and Mitchell, 2010
Factors Influencing Insect Pest Management
‘Water Quantity and Quality’

• Decreasing availability of water for agriculture

  - Agriculture is the overwhelming user of fresh water.
  - Increasing urban demand will drive irrigation efficiency.

• **Drip irrigation, micro-sprinklers, hydroponics.**

• **Targeted application of water increases opportunity to use irrigation as a delivery system.**
Factors Influencing Insect Pest Management

‘Environmental Concerns’

– With increasing affluence reaching the developing world, there will be increasing concerns about pesticide usage and perceived environmental effects.

– This will accelerate the shift to “softer” products and technologies.
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 insecticides (reduced-risk & bio-pesticides).
Ethics Review of Chlorpyrifos Worker Exposure (2008):

- Monitor exposure of agricultural workers who reenter treated fields with Lorsban “Time-Limited Re-Registration Eligibility Decision (RED)”

- Concerns (RED) based on ecological risk studies widespread presence of organophosphate residues in agricultural and urban dominated waterways.
Diazinon AG600 WBC

Re-Registration Eligibility Decisions (2012-13)

- Organophosphate insecticide currently labeled in cole crops used as a broadcast and transplant water application (cabbage maggot).

- Re-registration Eligibility Decisions (RED) concerning diazinon, restrictions were placed on all indoor and outdoor residential uses (2004). Pending reviews for this active ingredient opened in 2008 (http://www.epa.gov/oppsrdrd1/registration_review)

- Projected RED registration review timeline resolved by 2012-13 under section 4(g)(2)(A) of FIFRA.

- Concerns (RED) based on ecological risk studies widespread presence of organophosphate residues in agricultural and urban dominated waterways.
Control practices utilize insecticide sprays (Group 3, IRAC, MoA Classification http://www.irac-online.org/)

- backbone of low-cost registrations which are relied upon to target caterpillar complex

Section 4 of FIFRA, US EPA continues to re-evaluate existing Reregistration Eligibility Decisions (RED) for the synthetic pyrethroid class under section 4(g)(2)(A) of FIFRA.

- highly lipophilic strongly adsorb to sediments
- wide spectrum of activity
- acute oral neurotoxicity to mammals
- chronic effects as endocrine disruptors
- mutagenic and carcinogenic.
1) Key insect pests of cole crops and new insecticide products

2) Reduced-risk drench and foliar plant protectants

3) New pest potential
Wisconsin Vegetable Pest Management

Options for Insect Pest Management – *More than ever before!*

- Cultural controls
- Host plant resistance
- Transgenic plants
  - IR traits
- Natural enemies
- Reduced-Risk Chemical Insecticides
- Baits and baiting systems
- Population disruption
- Entomopathogens

Vegetable IPM
Cole Crop Insect Control

Many crops with same insect pest complex

Head crops
Cabbage

Cauliflower

Broccoli

Also: Brussels sprouts, Kale, Kohlrabi, Collards, Mustard greens, Chinese cabbage, etc.

Root crops – Turnips, Radish, Rutabaga, etc.
Insect Pest Complex

Key Pests - Lepidoptera

Diamond back moth

Imported cabbage worm

Cabbage looper

Sporadic Pests

Cabbage maggot

Flea beetle

Cabbage aphid
# Calendar of Cabbage Insect Pests

<table>
<thead>
<tr>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Key Pests:**
- Imported cabbage worm
- Diamondback moth
- Cabbage Looper

**Intermittent Pests:**
- Cabbage Maggot
- Flea beetle
- Thrips
Managing Insects on Cole Crops

★★Excellent example of potential for biological control ★★
(Mahr et. al. NCR 471)

History of problem
- Direct damage to marketable product by key pests
  - Worms on heads
  - Maggots on roots
- Multiple insecticide applications used
- Resistance developed as threat to production

Solution
- IPM implementation based on biological control of key pests
- Pesticides switched to specific, ‘soft’ materials to preserve natural control
Naturally Occurring Parasitization of Lepidoptera

Diamondback moth 70-90%

Imported cabbage worm 30-60%

Cabbage looper 10-30%

Diadegma insulare

Cotesia glomerata

Pteromalus puparium

Trichogramma

Copidosoma floridanum
Key Pests of Cole Crops

- Complex of 3 lepidopteran species
- All feed on marketed crop
- Need to identify species but can treat as a complex

Diamondback moth
Cabbage looper
Imported cabbage worm
Diamondback moth life cycle

**Adult**
- Small night flyer, short fast flights
- ½”, wings have diamond pattern
- Can monitor with pheromone trap

**Eggs**
- Small, hard to see
- Laid close to veins

**Larvae**
- 4-5 instars up to ¾” long
- 2-3 weeks
- Cigar shaped, pointed at ends
- ‘wiggle’ when touched
- Spin thread and hang

**Pupa**
- Usually on underside of leaves
- Neatly spun pupal case
Diamondback moth

Occurrence
- Does not overwinter in Wisconsin
- Blown in on wind or imported on plants
- 4-8 generations per year

Damage
- ‘Window pane’ feeding, may also deform heads
- 1st instar mine in leaf
- Damage usually early-mid season (June/July)
- Resistance to many insecticides
- Major problem worldwide
Imported Cabbage Worm life cycle

**Adult**
- White, day flying butterfly

**Eggs**
- Laid single on undersurface
- White, turning yellow at hatch
- Cigar shaped

**Larvae**
- 5 instars; 3-4 weeks
- Velvety green with yellow dorsal line
- Slow moving
- Up to 1 ½ inches in length

**Pupa**
- Distinctive angular shape
- Usually on plant debris/old leaves
Imported Cabbage Worm

**Occurrence**
- Overwinters as pupae in Wisconsin
- 3 generations per year, 1st on weeds

**Damage**
- Usually most damaging species in Wisconsin
- Large holes in leaves and heads
- Often extensive frass
- Peak damage mid-season (June/July)
Cabbage Looper life cycle

Adult
- Large, night flying moth
- Hour glass marks

Eggs
- Laid singly on undersurface
- White, turning tan at hatch
- Round shaped

Larvae
- 5 instars; 4-5 weeks
- Green with white stripe
- Loop when moving
- Up to 2 inches in length

Pupa
- Roughly spun silk cocoon
- Underside of old leaves or on debris
Cabbage Looper

**Occurrence**
- Does not overwinter, adults blow in (June/July)
- 2 generations per year, persisting in late season

**Damage**
- Damage usually late season
- Extensive leaf holes and head damage
Managing the Lep. Complex

Cultural
- Use clean transplants

Biological
- Good complex of parasites
  - Diamondback moth: 70-90% parasitized
  - Imported Cabbage worm: 30-60%
  - Cabbage looper: 10-30%
- Multiple species
Putting together a biologically-based management program for cole crops

3 requirements

1. Existing or obtainable natural enemies for key pests
2. Pest specific insecticides to conserve natural enemy control
3. Non-disruptive controls for sporadic pests
2. Pest Specific Insecticides for Key Pests

- Control lepidoptera at thresholds when needed
- Conserve beneficial organisms
- Bt or Spintor

<table>
<thead>
<tr>
<th>Crop</th>
<th>Growth stage</th>
<th>Threshold (% infestation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabbage</td>
<td>Seed bed</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>Transplant-cupping</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>Cupping-early head</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>Mature head</td>
<td>10%</td>
</tr>
<tr>
<td>Broccoli/cauliflower</td>
<td>Seed bed</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>Transplant-first curd</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>Curd present</td>
<td>10%</td>
</tr>
</tbody>
</table>
Key Pest of Root Crops

Cabbage Maggot Life Cycle

**Adult**
- Small grey/black fly
- Similar to housefly

**Eggs**
- Small, white
- Laid in soil at base of plants

**Larvae**
- White, legless maggots
- 4 instars; up to 1/4”
- 3-4 weeks per generation
- 3 generations per year

**Pupa**
- Brown, oval shaped
- In or close to the roots
Seed (cabbage) maggot, Host range

- Wide host range
- Can develop on organic matter

**Crop Susceptibility**

<table>
<thead>
<tr>
<th>High</th>
<th>Moderate</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cucurbits (squash, cucumber, melon)</td>
<td>Peas</td>
<td>Corn</td>
</tr>
<tr>
<td>Beans (lima, snap)</td>
<td>Beans (soy, kidney)</td>
<td></td>
</tr>
<tr>
<td>Brassica roots (radish)</td>
<td>Brassica (cabbage, broccoli, cauliflower)</td>
<td></td>
</tr>
<tr>
<td>Onion (dry bulb)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Seed maggots: Seedling damage

**Occurrence**

- Overwinter in soil as pupa
- Adults emerge in spring
- 4-5 generations/year. 2\textsuperscript{nd} adult peak in May/June is usually most serious

**Damage**

- Tunnel germinating seeds
- Severely distort plant.
- Cool weather, delays plant emergence increases severity
Cabbage Maggot Life Cycle

**Occurrence**
- Overwinters in soil as pupa
- Adults emerge in spring
- 3 flight peaks
- First peak is most serious and occurs at 300 heat units or when lilacs bloom (May)

**Damage**
- Larvae tunnel on root surface
- May be secondary rot
- Major importance on root crops
- Causes wilting, death on head crops
Cabbage Maggot Management

**Cultural**
- Rotate crop away from overwintering site (1/4-1/2 mile)
- Prevent egg laying with barrier, row cover
- Predict egg laying with heat units (300 HU with 43°F base)
- Plant early or late to avoid eggs = fly free periods

**Biological**
- Some egg predation by beetles

**Chemical**
- At-plant drench and broadcast applications
- Experimental seed treatments in review (e.g. spinosad)
Sporadic Pests of Cole Crops

Flea beetle (several species)

Appearance
- Small, shiny black beetles
- Hind legs enlarged for jumping
- Overwinter as adults
- 2 generations per year

Damage
- Adults chew small circular holes
- Can kill small plants
- Larvae in soil are not damaging
Flea Beetle Management

**Cultural**
- Exclude adults with row cover
- Attract adults to alternate trap crop (Indian mustard)
- Avoid early planting

**Biological**
- No effective controls

**Chemical**
- Serial applications of spinosad (Radiant)
- **DO NOT** disrupt biological controls for lepidoptera
Sporadic Pests of Cole Crops

Cabbage aphids

Appearance
• Grey, waxy covered aphids in dense colonies
• Multiple generations

Damage
• Feeding results in leaf distortion
• Head malformation can occur
• Dense colonies disfigure heads
• Contamination of produce is common
Cabbage Aphid Management

Cultural
   – None available except exclusion

Biological
   – Parasites and predators are effective

Chemical
   – Neem extracts (Aza-Direct, Azatin)
   – Insecticidal soap may suppress colonies
Cabbage Aphid Natural Controls
1) Key insect pests of ginseng and new insecticide products

2) Reduced-risk drench treatment and foliar plant protectants

3) New pests and approaches
What Insecticides Can Be Applied as At-Plant Drench Applications

- Must move systemically through plant.
- Label must specifically state that product can be applied via drip irrigation

### Neonicotinoids
- Admire
- Platinum
- Scorpion

### Diamides
- Coragen
- Synapse
- **HGW86

### Durivo
Pesticide Drift

- Amount of pesticide lost due to drift estimated at 5 to 65%.
- Less than 0.1% of pesticide reaches target insect.
- Consequences of pesticide drift
  - Exposure of humans
  - Exposure of water resources
  - Exposure of wildlife
Advantages of Drench Application of Insecticides

- Reduced risk to environment and farm workers
  - Drift to non-target areas is eliminated
  - Farm workers do not come into contact with residues on exterior of plant
  - Beneficial organisms not directly exposed

- Longer residual activity
  - Not subject to loss from rain and UV light
  - Not subject to plant growth dilution effects

- More cost-effective
Thiamethoxam & Imidacloprid

- Platinum 75SG – Admire Pro
  - Brassicas

- Spectrum of Activity
  - Flea beetle, seed maggots, & aphids
  - Suppression of thrips

- Systemic activity
  - Labeled for foliar and drip irrigation application
Chlorantraniliprole (Rynaxypyr)

- **Coragen 1.67SC**
  - Brassicas

- **Spectrum of Activity**
  - Lepidopterans, DBM, ICW, CL
  - Aphid suppression at higher rates

- **Systemic activity**
  - Labeled for foliar and drench application
Flubendiamide

- Synapse 24WG
  - Brassicas

- Spectrum of Activity
  - Lepidopterans

- Application methods
  - Foliar and only overhead sprinkler irrigation
Chlorantraniliprole + Thiamethoxam

- Durivo 1.67SC
  - 2:1 mixture of thiamethoxam & chlorantraniliprole
  - Brassicas

- Spectrum of Activity
  - Lepidopterans, leafhoppers, Aphids, Seed maggots, Plant & Stink Bug, and Thrips

- Drip application only, 1 application/year.
- 5-day REI for honeybees.
### Cabbage Pest Management; At-Plant Drench and Foliar Trials, Arlington Ag Exp Station 2009

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Insecticide</th>
<th>Rate</th>
<th>Application Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Untreated control</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>thiamethoxam (Platinum® 75SG)</td>
<td>3.75 fl oz / A</td>
<td>Drench</td>
</tr>
<tr>
<td>3</td>
<td>thiamethoxam + chlorantraniliprotein (Durivo®)</td>
<td>4.01 fl oz / A</td>
<td>Drench</td>
</tr>
<tr>
<td>4</td>
<td>thiamethoxam + chlorantraniliprotein (Durivo®)</td>
<td>10.0 fl oz / A</td>
<td>Drench</td>
</tr>
<tr>
<td>5</td>
<td>clothianadin ** (Belay® 5FS)</td>
<td>13.5 fl oz / A</td>
<td>Drench</td>
</tr>
<tr>
<td>6</td>
<td>clothianadin ** (Belay® 5FS)</td>
<td>10.0 fl oz / A</td>
<td>Drench</td>
</tr>
<tr>
<td>7</td>
<td>cyazypyr** (DPX-HGW86 20SC)</td>
<td>12.0 fl oz / A</td>
<td>Drench</td>
</tr>
<tr>
<td>8</td>
<td>cyazypyr** (DPX-HGW86 20SC)</td>
<td>11.0 fl oz / A</td>
<td>Drench</td>
</tr>
<tr>
<td>9</td>
<td>rynaxypyr (Coragen® 1.67SC)</td>
<td>13.5 fl oz / A</td>
<td>Drench</td>
</tr>
<tr>
<td>10</td>
<td>rynaxypyr (Coragen® 1.67SC)</td>
<td>3.5 fl oz / A</td>
<td>Drench</td>
</tr>
<tr>
<td>11</td>
<td>chlorpyrifos (Lorsban® 4E)</td>
<td>5.0 fl oz / A</td>
<td>Drench</td>
</tr>
<tr>
<td>12</td>
<td>chlorpyrifos (Lorsban® 4E)</td>
<td>2.75 fl oz / 1,000'</td>
<td>Drench</td>
</tr>
</tbody>
</table>

**Note: not currently registered**
Transplant Direct Damage 2009

Planting Date 20 May – AAES
Stand counts June 3 & 10

P < 0.0001
Early Season Insect Control
ICW & DBM, 2009

Planting Date 20 May – AAES
Stand counts July 2, 9, & 16 (57 DAP)

Mean Larvae / Plant

UTC | Platinum 3.75 | Platinum 4.0 | Durivo 10.0 | Durivo 13.5 | Belay 10.0 | Belay 12.0 | HGW86 11.0 | HGW86 13.5 | Coragen 3.5 | Coragen 5.0 | Lorsan 2.75 / K

P < 0.0001  Imported cabbage worm

P = 0.0073  Diamondback moth
Early Season Infestation Estimates, 2009

Planting Date 20 May – AAES
Stand counts July 16 (57 DAP)

P < 0.0001

20% Defoliation Threshold
Early Season Insect Control
ICW, DBM & CL 2009

Planting Date 20 May – AAES
Stand counts July 29, Aug 5 and 12 (84 DAP)

Mean Larvae / Plant

P = 0.0236
Imported cabbage worm

P = 0.0331
Diamondback moth

P = 0.0674
Cabbage Looper
Mid-Season Infestation Estimates, 2009

Mean Percent Infestation / Plot

- UTC
- Platinum 3.75
- Platinum 4.0
- Durivo 10.0
- Durivo 13.5
- Belay 10.0
- Belay 12.0
- HGW86 11.0
- HGW86 13.5
- Coragen 3.5
- Coragen 5.0
- Lorsan 2.75

Planting Date 20 May – AAES
Stand counts Aug 12 (84 DAP)

P < 0.0001

10% Defoliation Threshold
## Drench Insecticide Program on Brassicas

<table>
<thead>
<tr>
<th>Time</th>
<th>Insecticide (PHI)</th>
<th>Rate/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>At-plant drench</td>
<td>AdmirePro (21)</td>
<td>4.4 – 10.5 fl oz / acre</td>
</tr>
<tr>
<td>35 days after planting</td>
<td>Coragen (14)</td>
<td>3.5 - 5 fl oz/acre</td>
</tr>
<tr>
<td>42 - 50 days after planting*</td>
<td>Coragen + Admire Pro (21) or...</td>
<td>3.5 - 5 fl oz/acre</td>
</tr>
<tr>
<td></td>
<td>Platinum (30) or...</td>
<td>4.4 - 10.5 fl oz/acre</td>
</tr>
<tr>
<td></td>
<td>Durivo (30)</td>
<td>5 - 11 fl oz/acre</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 - 13 fl oz/acre</td>
</tr>
</tbody>
</table>

*Application of AdmirePro, Plantinum or Durivo must be timed to not violate PHI (X).

**Season scouting program to determine need for supplemental insecticide sprays.
Cabbage IPM; Drench and Foliar Trials, 2010

- **Radiant™ (spinetoram)**
  - MoA group 5
  - Use rate 6 – 8 fl oz / ac (foliar)
  - Lepidopterans and flea beetles

- **Rimon 0.83 EC (novaluron):**
  - MoA Group 15
  - Use rate 6 – 12 fl oz / ac (foliar)
  - Control of immature insects and eggs

- **Capture 1.5G & Brigade 2SC** (bifenthrin):
  - MoA Group 3
  - Use rate 5.12 – 6.4 fl oz / ac (foliar)
  - Control of Lepidopterans, flea beetles, seed maggots

**Currently Registered**
Cabbage IPM; Drench and Foliar Trials, 2010

- **Voliam Flexi® (chlorantraniliprole + thiamethoxam)**
  - MoA groups 28 + 4A
  - Use rate 4 oz / ac
  - Control of Lepidopterans, aphids, thrips, and flea beetles

- **Voliam Xpress® (lambda-cyhalothrin + chlorantraniliprole)**
  - MoA groups 3 + 28
  - Use rate 6 – 9 fl oz / ac
  - Control of Lepidopterans, aphids, thrips, and flea beetles

- **Endigo® ZC (lambda-cyhalothrin + thiamethoxam)**
  - MoA groups 3 + 4A
  - Use rate 4.0 – 4.5 fl oz / ac
  - Control of Lepidopterans, aphids, thrips, and flea beetles
Cabbage IPM; Drench and Foliar Trials, 2010

- **Coragen™ (rynaxypyr)**
  - Anthranillic diamide (MoA group 28)
    - Use rate 3.5 – 5.0 fl oz / ac
    - DuPont Funded 2011 (USA – 11 – 870)
    - Lepidopterans

- **DPX-HGW86 (cyazypyr)**
  - Anthranillic diamide (MoA group 28)
    - Use rate 6.5-13.5 fl oz / ac (OD foliar)
    - DuPont Funded 2011 (USA – 11- 758)
    - Lepidopterans, flea beetles, and thrips

* Water soluble, systemically mobile insecticides
* Not currently registered
# Reduced Risk Foliar Options-Cabbage 2010 - New Registrations

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate</th>
<th>ICW&lt;sup&gt;1&lt;/sup&gt; (Aug 7, 14, 21)</th>
<th>DM&lt;sup&gt;1&lt;/sup&gt; (Aug 7, 14, 21)</th>
<th>CL&lt;sup&gt;1&lt;/sup&gt; (Aug 7, 14, 21)</th>
<th>% Defoliation (Aug 28)</th>
<th>Thrips (Aug 21)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td></td>
<td>7.9</td>
<td>18.2</td>
<td>4.7</td>
<td>78.2</td>
<td>4.4</td>
</tr>
<tr>
<td>DPX-HGW86 100 OD**</td>
<td>3.38 oz/a</td>
<td>3.7</td>
<td>4.9</td>
<td>1.5</td>
<td>4.2</td>
<td>3.8</td>
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<td>DPX-HGW86 100 OD**</td>
<td>6.76 oz/a</td>
<td>0.9</td>
<td>2.1</td>
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<td>DPX-HGW86 100 OD**</td>
<td>10.1 oz/a</td>
<td>0.3</td>
<td>0.9</td>
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<td>DPX-HGW86 100 OD**</td>
<td>13.5 oz/a</td>
<td>0.4</td>
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<td>Coragen 1.67 SC</td>
<td>3.45 oz/a</td>
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<td>Coragen 1.67 SC</td>
<td>5.06 oz/a</td>
<td>0.1</td>
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<td>Coragen 1.67 SC</td>
<td>7 oz/a</td>
<td>0.03</td>
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<td>Vollam Flexi 40 WG</td>
<td>4 oz/a</td>
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<td>Vollam Xpress 1.25 ZC</td>
<td>7 oz/a</td>
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<td>Endigo 2.06 ZC</td>
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<td>Belay 2.13 SC**</td>
<td>3 fl oz/a</td>
<td>4.7</td>
<td>14.3</td>
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<td>Scorpion 35 SL</td>
<td>2 fl oz/a</td>
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<td>12.3</td>
<td>109.8</td>
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<td>Scorpion 35 SL</td>
<td>2.75 fl oz/a</td>
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<td>84.3</td>
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<td>Actara 25 WDG</td>
<td>3 oz wt/a</td>
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<td>12.2</td>
<td>38.4</td>
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<td>Warrior II</td>
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<td>Hero</td>
<td>8 fl oz/a</td>
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<tr>
<td>Rimon 0.83 EC</td>
<td>9 fl oz/a</td>
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<td>3.0</td>
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<td>Rimon 0.83 EC</td>
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<td>LSD</td>
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<td>6.42</td>
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</tr>
</tbody>
</table>

<sup>1</sup> 2X applications, spaced 7 days
Mean number larvae / 5 plants

** Not currently registered for use
Cabbage Pest Management Development and Defoliation Thresholds

- 20% vegetative-cupping and < 10% head formation

Need to protect potato crop from CPB for 10-12 weeks

Drench systemic

Planting

Harvest


- RR-Foliar (65-75 dap)
- Cabbage lopper
- Diamondback moth
- Imported Cabbageworm

Cabbage Crop
Mode of Action Classification

IRAC
Insecticide Resistance Action Committee

The Key to Resistance Management

More information on IRAC and the Mode of Action Classification is available from:
www.irac-online.org or enquiries@irac-online.org
Presentation Outline

1) Key insect pests of cole crops and new insecticide products

2) Reduced-risk drench and foliar plant protectants

3) New pest potential
Swede Midge

- First identified in Ontario, Canada in 2000 and in the United States in 2004 in Niagara County, New York.
- Widespread throughout New York State and the provinces of Ontario and Quebec, Canada.

Adult midge

Larva (maggot)
Swede Midge: Hosts & Damage

- Swede midge appears to feed only on plants in the Brassicaceae (cabbage or mustard family).

- Common pest of cruciferous vegetable crops (e.g. broccoli, Brussels sprouts, cabbages, cauliflower, collards, kale, radishes, rutabaga, and turnips) often causing severe losses.
Swede Midge Distribution 2009

*Not all counties have been surveyed for swede midge. For example, in New York, detection survey work was discontinued after 2007. It is very likely that swede midge occurs in other counties within these states and within other states.*

*Swede midge has also been detected in other Canadian provinces beyond the boundary of this map.*
If you see (suspect) a Swede Midge

- **Contact your County Extension Educator at** [http://www.csrees.usda.gov/Extension/](http://www.csrees.usda.gov/Extension/)

- **Midges that are suspected to be the Swede Midge should be sent for positive identification. Samples from Wisconsin will be processed for free at UW; please send suspect samples to:**

  Attn: Swede Midge Reports  
  Phil Pelleterri and Pest Diagnostic Clinic  
  Department of Entomology, Rm. 240  
  1630 Linden Drive,  
  University of Wisconsin  
  Madison, WI 53706

- **DO NOT ship live insects. Please place dead insects in a leak-proof, crush-proof container** (e.g., plastic medicine bottle or film canister).

- **Additional details regarding submitting insect specimens are available at:** [http://www.entomology.wisc.edu/diaglab/entodiag.html#submit](http://www.entomology.wisc.edu/diaglab/entodiag.html#submit)
Start with Clean Transplants

- Using plug or bare root transplants that are grown in an area where swede midge does not occur provides the best opportunity for starting with clean transplants that are free of swede midge infestation.
Best Management Practices

Chemical Control:
- Should not be relied upon as a rescue strategy, because under very high pressure (i.e. 100 SM/trap/day) chemical control fails
- Can be very effective when SM populations are moderate
- Admire Pro applied to the soil as a drench has provided the most consistent control of swede midge
- No OMRI listed insecticides controlled swede midge
- Rotate chemical classes for resistance management
- Read labels carefully!
### Best Management Practices

**Chemical Control:**

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Active ingredient</th>
<th>Label Availability</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Neonicotinoids (systemic):</strong></td>
<td></td>
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<tr>
<td>Assail 70WP/30SG</td>
<td>acetamiprid</td>
<td>National</td>
<td>foliar</td>
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<tr>
<td>Admire Pro</td>
<td>Imidacloprid</td>
<td>National</td>
<td>soil</td>
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<tr>
<td>Provado 1.6</td>
<td>imidacloprid</td>
<td>National</td>
<td>foliar</td>
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<tr>
<td>Durivo</td>
<td>Chlorantraniliprole + thiamethoxam</td>
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</tr>
<tr>
<td><strong>Pyrethroids:</strong></td>
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<tr>
<td>Warrior with Zeon Technology</td>
<td>Lambda-cyhalothrin</td>
<td>National</td>
<td>foliar</td>
</tr>
<tr>
<td><strong>Organophosphates (OPs):</strong></td>
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</tr>
<tr>
<td>Lorsban 75WP</td>
<td>chlorpyrifos</td>
<td>National</td>
<td>foliar</td>
</tr>
</tbody>
</table>
Best Management Practices

Monitor for Swede Midge Using Pheromone Traps:
Phero Net (http://www.phero.net)
Swede Midge Monitoring

Place traps 1 foot above ground
Replace lures every 3 weeks
Replace sticky liners 1-3x per week
Adult swede midge on sticky cards
Best Management Practices

Field Sanitation

- Keep cruciferous fields and fields rotated out of crucifers free of cruciferous weeds:
  - Shepard’s purse
  - Field pepperweed
  - Wild mustard
  - Field pennycress
  - Wormseed mustard
  - Marsh yellowcress

- Weeds may sustain a SM population from season to season, but they are not their preferred host
Best Management Practices

- **Choose Tolerant Crops:**
  - Most tolerant: Green and red cabbage
  - Most susceptible: Collards, Chinese broccoli (gai lan), broccoli, Brussels sprouts, cauliflower, and Chinese cabbage (choy sum)

- **Choose Tolerant Varieties**
  - Broccoli cv. Everest and Triathlon are less susceptible compared to the highly susceptible Paragon, (U of Guelph)
  - More research required...

- **Field Selection**
  - Up from prevailing winds
  - Avoid sheltered areas
Best Management Practices

Knowledge is Your Best Defense!

- Early detection and management is key to keeping SM below economical levels

- Be proactive in minimizing introduction and development of swede midge
  - Use clean transplant seedlings
  - Timely post harvest crop destruct
  - Crop rotation
  - Make sure you know how to identify SM damage!
Acknowledgements

Great Lakes Kraut

Larsen Coop

Participating Growers

Allied Crop Protection Industries

University of Wisconsin-Madison

Vegetable Crop Entomology

http://www.entomology.wisc.edu/vegento/