Reduced Risk Insecticides Through Drip Irrigation Delivery Systems

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Vegetable Production in Wisconsin

- Important production state nationally: ranked 2\textsuperscript{nd} in total processing production

- Good crop climate also limits pests

- Production linked historically to canning industry

- Recent increase in fresh market
## Wisconsin Vegetable Production Statistics (Wis. Ag. Stats. 2008)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Nat. Rank</th>
<th>Acres</th>
<th>% of U.S.</th>
<th>$ Value (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major crops</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potatoes</td>
<td>3</td>
<td>64,500</td>
<td>6</td>
<td>$242</td>
</tr>
<tr>
<td>Sweet corn (Proc)</td>
<td>1</td>
<td>88,900</td>
<td>21</td>
<td>$81</td>
</tr>
<tr>
<td>Sweet corn (Fresh)</td>
<td>--</td>
<td>7,700</td>
<td>--</td>
<td>$14</td>
</tr>
<tr>
<td>Snap beans</td>
<td>1</td>
<td>82,300</td>
<td>38</td>
<td>$62</td>
</tr>
<tr>
<td>Peas</td>
<td>3</td>
<td>40,200</td>
<td>21</td>
<td>$20</td>
</tr>
<tr>
<td><strong>Minor crops</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cucumbers (pickles)</td>
<td>4</td>
<td>7,100</td>
<td>8</td>
<td>$9</td>
</tr>
</tbody>
</table>
| **Small-acreage fresh market production continues to expand. Anecdotal statistics estimate ca. 1,900 small-acreage producers that grow over 50 crops in Wisconsin**
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 (bio-pesticides).
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
‘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.
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
Drip Application for Insect Control (Cucurbits, Fruiting Vegetables, Brassicas)

- Why use drip irrigation for insecticide applications?
- What insects are controlled with drip application?
- Regulations and tips for best results of drip chemigation.
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
Limitations of Spraying Insecticides

- Weather conditions
  - Wind
  - Rain
  - Wash-off
- Re-entry intervals
- Pre-harvest intervals
Advantages of Drip 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
Why use drip irrigation for insecticide application?

What insects are controlled with drip irrigation applications?

Regulations and tips for best results of drip chemigation.
What Insecticides Can Be Applied in Drip Irrigation Systems

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

<table>
<thead>
<tr>
<th>Neonicotinoids</th>
<th>Diamides</th>
<th>Carbamates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admire</td>
<td>Coragen</td>
<td>Vydate</td>
</tr>
<tr>
<td>Platinum</td>
<td>Synapse</td>
<td></td>
</tr>
<tr>
<td>Venom</td>
<td>**HGW86</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Durivo</td>
<td></td>
</tr>
</tbody>
</table>
## MoA Classification Chart
### Insecticide Resistance Action Committee (IRAC)

<table>
<thead>
<tr>
<th>Mode of Action</th>
<th>Group</th>
<th>Chemical group</th>
<th>Chemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetylcholine esterase inhibitors</td>
<td>1A</td>
<td>Carbamates</td>
<td>Carbaryl (Seven) Methomyl (Lannate) Oxamyl (Vydate)</td>
</tr>
<tr>
<td>Sodium channel modulators</td>
<td>3A</td>
<td>Pyrethroids</td>
<td>Bifenthrin (Brigade) Zeta-cypermethrin (Mustang Max) Lamda-cyhalothrin (Warrior) Esfenvalerate (Asana) Fenpropathrin (Danitol) Permethrin (Ambush)</td>
</tr>
<tr>
<td>Nicotinic acetylcholine receptor agonist/antagonists</td>
<td>4A</td>
<td>Neonicotinoids</td>
<td>Acetamiprid (Assail) Dinotefuran (Scorpion) Imidaclorpid (Admire, Provado) Thiamethoxam (Actara, Platinum)</td>
</tr>
<tr>
<td>Ryanodine receptor modulator</td>
<td>28</td>
<td>Diamides</td>
<td>Chlorantraniliprole (Coragen) Flubendiamide (Synapse)</td>
</tr>
</tbody>
</table>
Thiamethoxam & Imidacloprid

- **Platinum 75SG – Admire Pro**
  - Brassicas, Cucurbitis, Fruiting Veg, Leafy Veg, Potato

- **Spectrum of Activity**
  - Cucumber beetles, squash bug, flea beetle, seed maggots, & CPB
  - Suppression of aphids, thrips, whiteflies

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

- **Coragen 1.67SC**
  - Brassicas, Cucurbits,
  - Fruiting Veg, Leafy Veg, Potato

- **Spectrum of Activity**
  - Lepidopterans, some beetles (CPB)
  - Whitefly suppression at higher rates

- **Systemic activity**
  - Labeled for foliar and drip irrigation application
Flubendiamide

- Synapse 24WG
  - Brassicas, Cucurbits, Fruiting Veg, Leafy Veg

- Spectrum of Activity
  - Lepidopterans

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

- **Durivo 1.67SC**
  - 2:1 mixture of thiamethoxam & chlorantraniliprole
  - Brassicas, Cucurbits, Fruiting Veg, Leafy Veg

- **Spectrum of Activity**
  - Lepidopterans, leafhoppers, cucumber beetle
  - Aphids, Beetles, Plant & Stink Bug, Thrips, Mealybug, Whitefly

- Drip application only, 1 application/year.
- 5-day REI for honeybees.
Drip Irrigation of Insecticides
# Potato Insect Pest Management

Drip Irrigation Injection Trials, HAES 2010

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Insecticide</th>
<th>Rate</th>
<th>Application Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>chlorantraniliprole (Coragen®)**</td>
<td>5.5 &amp; 3.0 fl oz / A</td>
<td>Foliar</td>
</tr>
<tr>
<td>2</td>
<td>Imidacloprid (AdmirePro®)</td>
<td>3.5 &amp; 3.5 fl oz / A</td>
<td>Injection</td>
</tr>
<tr>
<td>3</td>
<td>Imidacloprid (AdmirePro®)</td>
<td>2.5 &amp; 3.8 fl oz / A</td>
<td>Foliar</td>
</tr>
<tr>
<td>4</td>
<td>Imidacloprid (AdmirePro®)</td>
<td>5.0 &amp; 3.7 fl oz / A</td>
<td>Injection</td>
</tr>
<tr>
<td>5</td>
<td>thiamethoxam (Platinum®)</td>
<td>1.5 &amp; 3.0 fl oz / A</td>
<td>Foliar</td>
</tr>
<tr>
<td>6</td>
<td>thiamethoxam (Platinum®)</td>
<td>1.67 &amp; 1.0 fl oz / A</td>
<td>Injection</td>
</tr>
<tr>
<td>7</td>
<td>Dinotefuran (Scorpion®)</td>
<td>6.0 &amp; 6.0 fl oz / A</td>
<td>Injection</td>
</tr>
<tr>
<td>8</td>
<td>chlorantraniliprole + thiamethoxam (Durivo®)**</td>
<td>6.0 &amp; 7.0 fl oz / A</td>
<td>Injection</td>
</tr>
<tr>
<td>9</td>
<td>Untreated Control</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**Note: not currently registered**
Colorado Potato Beetle Control (2010 - Potato)

Larvae / 10 plants

2, injections (2 and 16 June) - HAES

- Coragen (8.5 oz)
- Admire Pro (8.7 oz)
- Platinum (2.67 oz)
- Scorpion (12 oz)
- Durivo (13.0 oz)
- Control
Potato Leafhopper Control (2010 - Potato)

2, injections (2 and 16 June) - HAES

- Coragen (8.5 oz)
- Admire Pro (8.7 oz)
- Platinum (2.67 oz)
- Scorpion (12 oz)
- Durivo (13.0 oz)
- Control

Adult PLH / 10 plants
Potato Aphid Control (2010 - Potato)

2, injections (2 and 16 June) - HAES

- Coragen (8.5 oz)
- Admire Pro (8.7 oz)
- Platinum (2.67 oz)
- Scorpion (12 oz)
- Durivo (13.0 oz)
- Control

Adult PA / 10 plants
## Cucumber Insect Pest Management Drip Irrigation Injection Trials, HAES 2010

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Insecticide</th>
<th>Rate</th>
<th>Application Type</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>chlorantraniliprole (Coragen®)**</td>
<td>5.5 &amp; 3.0 fl oz / A</td>
<td>Injection</td>
</tr>
<tr>
<td>2</td>
<td>Imidacloprid (AdmirePro®)</td>
<td>5.5 &amp; 5.0 fl oz / A</td>
<td>Injection</td>
</tr>
<tr>
<td>3</td>
<td>thiamethoxam (Platinum®)</td>
<td>2.67 &amp; 1.0 fl oz / A</td>
<td>Injection</td>
</tr>
<tr>
<td>4</td>
<td>dinotefuran (Scorpion®)</td>
<td>5.5 &amp; 5.0 fl oz / A</td>
<td>Injection</td>
</tr>
<tr>
<td>5</td>
<td>Untreated Control</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**Note: not currently registered**
Cucumber Beetles: Damage

- Defoliation
- Pollination Interference
- Feeding Scars
- Rindworms
Striped Cucumber Beetle Control (2010 - Cucumber)

2, injections (18 May and 4 June) - HAES
Cucumber Beetles – Bacterial Wilt

- Most damage is from bacterial wilt, *Erwinia tracheiphila*

- Closely associated with beetle, vectored via posterior-station

- No cure for bacteria, control through vector

- Susceptibility:

  Melons (not watermelon) > cucumbers > butternut and Hubbard squash

Avoidance of bacterial wilt is accomplished through effective cucumber beetle control.
Limiting Bacterial Wilt
(2010 - Cucumber)

Mean Percent Symptomatic Plants

- Control
- Scorpion (10.5 oz)
- Platinum (3.67 oz)
- Admire Pro (10.5 oz)
- Coragen (8.5 oz)

2, injections (19 May and 4 June) - HAES
**Tomato Fruitworm Damage**

**Occurrence**

- 2nd generation only – Aug/Sept

**Damage**

- Small larvae feed on leaves
- Larger bore into fruit
- Develop internally
- Infested fruit may color early or rot
- Major pest in CA and FL
Tomato Insect Pest Management
Drip Irrigation Injection Trials, HAES 2010

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<td>Imidacloprid (AdmirePro®)</td>
<td>5.0 &amp; 5.5 fl oz / A</td>
<td>Injection</td>
</tr>
<tr>
<td>3</td>
<td>thiamethoxam (Platinum®)</td>
<td>2.67 &amp; 1.0 fl oz / A</td>
<td>Injection</td>
</tr>
<tr>
<td>4</td>
<td>dinotefuran (Scorpion®)</td>
<td>5.0 &amp; 5.5 fl oz / A</td>
<td>Injection</td>
</tr>
<tr>
<td>5</td>
<td>Untreated Control</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**Note: not currently registered**
Tomato Fruitworm Control (2009 - Tomato)

2, injections (29 July and 12 August) - AAES

% Damage

- Coragen (8.5 oz)
- Admire Pro (10.5 oz)
- Platinum (3.67 oz)
- Scorpion (10.5 oz)
- Control
** ONLY when the plants have green fruit and an average of 1 infested plant (larvae or fresh feeding damage) per 40 plants
** Monitor for damage carefully when trap catches exceed 7 moths per trap per week
# Drip Insecticide Program on Fruiting Vegetables

<table>
<thead>
<tr>
<th>Time</th>
<th>Insecticide (PHI)</th>
<th>Rate/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-plant transplant</td>
<td>AdmirePro (21)</td>
<td>0.44 oz / 10,000 plants</td>
</tr>
<tr>
<td>28 days after planting*</td>
<td>Coragen + Admire Pro or...</td>
<td>3.5 - 5 oz/acre</td>
</tr>
<tr>
<td></td>
<td>Platinum (30)</td>
<td>7 - 10.5 oz/acre</td>
</tr>
<tr>
<td></td>
<td>or</td>
<td>5 - 11 oz/acre</td>
</tr>
<tr>
<td></td>
<td>Durivo (30)</td>
<td>10 - 13 oz/acre</td>
</tr>
</tbody>
</table>

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

**Season scouting program to determine need for supplemental insecticide sprays should focus on thrips, mites and possibly stink bugs.
## Drip Insecticide Program on Brassicas

<table>
<thead>
<tr>
<th>Time</th>
<th>Insecticide (PHI)</th>
<th>Rate/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-plant transplant</td>
<td>AdmirePro (21)</td>
<td>0.44 oz / 10,000 plants</td>
</tr>
<tr>
<td>14-21 days after planting</td>
<td>Coragen (14)</td>
<td>3.5 - 5 oz/acre</td>
</tr>
<tr>
<td>30 days after planting*</td>
<td>Coragen + Admire Pro or…</td>
<td>3.5 - 5 oz/acre</td>
</tr>
<tr>
<td></td>
<td>Platinum (30)</td>
<td>7 - 10.5 oz/acre</td>
</tr>
<tr>
<td></td>
<td>or Durivo (30)</td>
<td>5 - 11 oz/acre</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 - 13 oz/acre</td>
</tr>
</tbody>
</table>

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

**Season scouting program to determine need for supplemental insecticide sprays should focus on thrips, mites and possibly stink bugs.
Drip Insecticide Program on Cucurbits

<table>
<thead>
<tr>
<th>Time</th>
<th>Insecticide (PHI)</th>
<th>Rate/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-plant transplant</td>
<td>AdmirePro (21)</td>
<td>0.44 oz / 10,000 plants</td>
</tr>
<tr>
<td>14 - 21 days after planting*</td>
<td>Coragen + Admire Pro or... Platinum (30)</td>
<td>3.5 - 5 oz/acre 7 - 10.5 oz/acre 5 - 11 oz/acre 10 - 13 oz/acre</td>
</tr>
<tr>
<td>28 - 35 days after planting*</td>
<td>Coragen (14)</td>
<td>3.5 - 5 oz/acre</td>
</tr>
</tbody>
</table>

*Application of AdmirePro, Platinum or Durivo must be timed to not violate PHI.

**Season scouting program to determine need for supplemental insecticide sprays should focus on thrips, mites and possibly stink bugs.
Drip Application for Insect Control

- Why use drip irrigation for insecticide application?
- What insects are controlled with Drip Application?
- Regulations and tips for best results of drip chemigation.
Drip Application System Requirements of Injection of Insecticides (READ LABEL)

- Check valve, vacuum relief valve, and low pressure drain.
- Automatic, quick closing check valve in injection pipeline.
- Solenoid-operated valve on intake side of injection pump.
- Interlocking controls to shut off injection pump when water pump stops.
- Irrigation or water pump must contain pressure switch to stop water pump when pressure drops.
ATCP 29 Rule, Pesticide Use and Control, Revised September 2009. ATCP 29.54 Chemigation.

http://datcp.state.wi.us/cp/consumerinfo/cp,cp_laws/pesticides/pesticide_use.pdf
Example Fertigation – Chemigation Assembly

www.agriculturesolutions.com

www.amiad.com/filters
Example Fertigation – Chemigation Assembly

http://www.reinders.com/rescomirr
Example Backflow Prevention

‘Air Gap’

‘Backflow Preventer’
For Best Results with Drip-Applied Insecticides

- Repair all leaks before chemigating.
- Before injection of insecticide begins, system must be fully pressurized.
- Minimum injection time should be time for water to move from injection point to most distant emitter.
- Water solubility and soil texture affects movement in soil, and timing of injection.
  - Low solubility = limited movement
  - High solubility = readily moves in soil
## Water Solubility of Insecticides Registered for Drip Chemigation

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Water solubility (g/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coragen (chlorantraniliprole)</td>
<td>0.001</td>
</tr>
<tr>
<td>Imidacloprid (AdmirePro)</td>
<td>0.58</td>
</tr>
<tr>
<td>Platinum (thiamethoxam)</td>
<td>4.1</td>
</tr>
<tr>
<td>Venom (dinotefuran)</td>
<td>39.83</td>
</tr>
<tr>
<td>Vydate (oxamyl)</td>
<td>229.0</td>
</tr>
</tbody>
</table>
Conclusions

- Drip application of insecticides offers several advantages over foliar application, including safety, flexibility and longer residual control.

- Combinations of several insecticides with different MoA can achieve broad spectrum insect control.

- Be sure irrigation system is legal for chemigation, and provides uniform distribution of water.
Future Research

- Refine rates, delivery systems, and integrated control programs for cucurbit pest management.

- Investigate new chlorantraniliprole and cyantraniliprole technologies, especially as drip injection delivery.

- Repeat experiments in 2010 to confirm proportions of native bee species present in cucurbit production.
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Grower / Cooperators
Hancock Agri Experiment Station
Arlington Agri Experiment Station
Jack Buchanon, Hancock, WI

QUESTIONS