Co-Application of the Diamide Insecticides in Processing Snap Beans

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Goal. “Enhanced potential for improved efficiency, productivity, and profitability for the vegetable production and processing industry based on an improved understanding of the role of consumer markets”

Approach. “Beginning with the market, work with growers, processors, and distributors to explore how to generate market rewards through science-based sustainability that is measurable and profitable”
Project Objectives

**Objective 1.** Identify consumer preferences and willingness to pay for sustainably produced and processed vegetables and quantify market segments.

**Objective 2:** Create and test sustainability assessment tools and sustainability metrics for commercial vegetable growers.

**Objective 3:** Validate and improve the relationship between practice-based sustainability assessments and environmental and economic outcomes at the farm scale in each region.

- Implement sustainable practices to identify opportunities for improved water, nitrogen, and pesticide use efficiency at the field and farm level (Bland, Colquhoun, Mitchell, Ruark).

- Refine sustainable production practices to reduce environmental and economic risk (Bland, Colquhuon, Hutchison, Groves, Gevens, Nault, Ruark).

**Objective 4:** Build critical mass of support for sustainably grown and processed vegetables.
Factors Influencing Insect Pest Management

‘Food Safety and Residues’

– 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).
Neonicotinoid Insecticides in the News

**Neonicotinoid Insecticides in the News**

**Are Neonicotinoids Killing Bees?**
A Review of Research into the Effects of Neonicotinoid Insecticides on Bees, with Recommendations for Action

- **About Pesticides**
- **Neonicotinoid Insecticides**
- **Neonicotinoid Insecticides in the News**

**Integrated Crop Management**
Insecticidal Seed Treatments can Harm Honey Bees

**France Plans Ban on Seed Treatment, Escalating Bee Issue**
Syngenta’s ‘Dark day for French and European agriculture’

**Neonicotinoids**
Neonicotinoids are a relatively new class of the chemistry to control insects. They are now widely used because they are persistent and systemic in plant tissues. Most field crops in Iowa have a neonicotinoid seed treatment.

**Neonicotinoids are extremely toxic to bees.** Lethal LD50 rates (the dose at which half of the exposed population dies) for clothianidin are 22-44 nanograms per bee for direct contact and 2-3.7 nanograms per bee for oral ingestion. In other words, a single corn kernel would contain a 1,260 times rate of neonicotinoid seed treatment containing enough active ingredient to kill over 50,000 honey bees.

There has been an increased public awareness of pollinator health and the decline of bees in North America. Researchers have identified multiple contributing factors for the honey bee decline, including Varroa mites, disease-causing pathogens, habitat loss, maitnenance, the intensity of migratory pollination services and pesticides (Fig. 1).
Key findings include:

**Parasites and Disease Present Risks to Honey Bees:**
The parasitic Varroa mite and new virus species have been found in the U.S. and several of these have been associated with Colony Collapse Disorder (CCD).

**Increased Genetic Diversity is Needed:**
Genetic variation improves bees' thermoregulation, disease resistance and worker productivity.

**Poor Nutrition Among Honey Bee Colonies:**
Bees need better forage and a variety of plants to support colony health.

**Need for Improved Collaboration and Information Sharing:**
Best Management Practices associated with bees and pesticide use, exist, but are not widely or systematically followed by members of the crop-producing industry.

**Additional Research is Needed to Determine Risks Presented by Pesticides:**
The most pressing pesticide research questions relate to determining actual pesticide exposures and effects of pesticides to bees in the field.
Rich Hatfield, a biologist with the Xerces Society, estimates that over 50,000 bumble bees were killed, likely representing more than 300 wild colonies. “Each of those colonies could have produced multiple new queens that would have gone on to establish new colonies next year. This makes the event particularly catastrophic.”
Annual Changes in Crop Uses in the U.S.


Annual Changes in Crop Uses in the U.S.


Annual Changes in Crop Uses in the U.S.


Major Snap Bean Pests in Midwest

- Seedcorn Maggot (SCM)
- Potato Leafhopper (PLH)
- European corn borer (ECB)
Seedcorn Maggot, *Delia platura* (Meigen)

- Found in northern temperate regions worldwide (35-60° N)
- Saprophagous, but also feeds on plants (polyphagous)
- Life cycle is 18 – 60 d
- Three generations/year
- Overwinters as puparium in soil
Seedcorn maggot damage
Insecticides Evaluated as Seed Treatments for Seed Maggot Control in Snap Bean

<table>
<thead>
<tr>
<th>Product</th>
<th>Active Ingredient</th>
<th>Rate</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lorsban 50WP</td>
<td>chlorpyrifos</td>
<td>62 g ai/100 kg seed</td>
<td>Organophosphate</td>
</tr>
<tr>
<td>Cruiser 5FS</td>
<td>thiamethoxam</td>
<td>50 g ai/100 kg seed</td>
<td>Neonicotinoid</td>
</tr>
<tr>
<td>*Entrust</td>
<td>spinosad</td>
<td>0.5 mg ai/seed</td>
<td>Spinosyn</td>
</tr>
</tbody>
</table>

* Product NOT labeled as seed treatment on snap bean or sweet corn; Registered now as Regard™ by Syngenta for seed treatment purposes (OMRI approved?).
Seed Maggot Control in Snap Bean

‘Hystyle’ planted 27 May 2008; Data taken 16 dap; Arlington, WI

- **Untreated**: a
- **Lorsban**: b
- **Cruiser 5FS**: b
- **Entrust**: b

*P* < 0.0001, *n* = 6
Insecticides Evaluated as Seed Treatments for Seed Maggot Control in Sweet Corn

<table>
<thead>
<tr>
<th>Product</th>
<th>Active Ingredient</th>
<th>Rate</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cruiser 5FS</td>
<td>thiamethoxam</td>
<td>0.25 mg ai/seed</td>
<td>Neonicotinoid</td>
</tr>
<tr>
<td>Poncho 600</td>
<td>clothianidin</td>
<td>0.25 mg ai/seed</td>
<td>Neonicotinoid</td>
</tr>
<tr>
<td>*Entrust</td>
<td>spinosad</td>
<td>0.25 mg ai/seed</td>
<td>Spinosyn</td>
</tr>
</tbody>
</table>

* Product NOT labeled as seed treatment on snap bean or sweet corn; Registered now as Regard™ by Syngenta for seed treatment purposes (OMRI approved?).
Seed Maggot Control in Sweet Corn

‘Incredible SE’ planted 27 May 2005; Data taken 13 dap; Batavia, NY

Mean Damaged Seedlings (%)

- Untreated
- Cruiser 5FS
- Poncho 600

0 10 20 30 40

P<0.0001 n = 6

Incredible SE planted 27 May 2005; Data taken 13 dap; Batavia, NY

P<0.0001 n = 6

Cornell University
Summary
Seedcorn maggot control with new seed treatments

Snap bean

- **Cruiser 5FS** controlled seedcorn maggot (and PLH!)
- **Entrust** controlled seedcorn maggot (will **Regard™** become available in future?)

Sweet corn

- **Poncho 600** controlled seedcorn maggot
- **Cruiser 5FS** controlled seedcorn maggot
- **Entrust** controlled seedcorn maggot (will **Regard™** become available in future?)
Processing Snap Bean: European Corn Borer, Pest Phenology

Redrawn with permission, Brian Flood Del Monte Foods
**European Corn Borer Lifecycle**

**Eggs**
- Laid in masses (20-50)
- Black dots at hatch, 5-7 days

**Larva**
- Overwinter in corn stalks
- 5 instars (2-4 weeks)\(^{1}\)st and 2\(^{nd}\) external.

**Adult**
- 2 normal flight peaks June-Aug (1400 DD\(_{50}\) and 1733 DD\(_{50}\))

**Pupa**
- Inside stems 10-14 days
European Corn Borer: Snap bean damage

- Small larvae external
- Damage marginal
- Pods preferred if present
- Serious problem
- Later instars bore into stems
- Plants easily compensate
- Rejection threshold 1/1000
Insecticides for Managing Snap Bean Pests

Recently Labeled in Wisconsin:

- **Radiant SC** (spinetoram) - foliar
- **Coragen 1.67 SC** (chlorantraniliprole) – foliar
- **Blackhawk** (spinosad) – foliar
- **Beseige** (chlorantraniliprole + lambda-cyhalothrin) - foliar (aka. Voliam Xpress)
- **Belt SC** (flubendiamide) – foliar
- **Entrust SC** (spinosad) – foliar
- **Movento** (spirotetramat) – foliar
- **Transform WG** (sulfoxaflor) – foliar
- **Sivanto 200SL** (flupyradifurone) - foliar

In the Pipeline or in Review:

- **Exirel, Verimark** (cyantraniliprole) – 2015/16
Objectives

• Compared ECB control with chlorantraniliprole, cyantraniliprole, and bifenthrin at three different phenological stages of snap bean development (i.e., bud, bloom, pod formation) to determine the duration of residual activity for each insecticide under field conditions in snap bean.

• Co-applied cyantraniliprole and bifenthrin insecticides with either herbicides or fungicides at similar crop stages to determine if tank mixing cyantraniliprole and bifenthrin with common agrochemicals would reduce ECB control.
Anthranillic Diamide Insecticides

- **Active ingredients**: rynaxypyr (aka chlorantraniliprole) and cyazypyr (aka cyantraniliprole).

- **Class**: anthranilic diamide (IRAC MoA Class 28)

- **Mode of action**: ryanodine receptor modulator
  - Systemic activity
  - Most effective through ingestion
  - Insects stop feeding, become paralyzed and die within 1 to 3 days
  - Applied to soil at planting, drip chemigation and foliar spray (seed treatment)
  - Exceptionally long residual control – xylem mobile
  - Active against Lepidopterans, Coleoptera, and Hemiptera
Can Timing of Insecticide Application be Improved for ECB Control

Current Recommendations for ECB Control

Planting (May 31) ➔ Spray (July 16) ➔ Harvest (Aug. 3)

Bud  Bloom  Pin

Alternative Timing for ECB Control?

Planting (May 31) ➔ Co-apply with herbicide (July 2) ➔ Harvest (Aug. 3)

Bud  Bloom  Pin
Can Timing of Insecticide Application be Improved for ECB Control

Current Recommendations for ECB Control

Planting (May 31) → Spray (July 16) → Harvest (Aug. 3)

Bud Bloom Pin

Alternative Timing for ECB Control?

Planting (May 31) → Co-apply with fungicide (July 10)? → Harvest (Aug. 3)

Bud Bloom Pin
Can Timing of Insecticide Application be Improved for ECB Control

Current Recommendations for ECB Control

Alternative Timing for ECB Control?
## Agro-Chemicals Evaluated in Field Experiments 2012-2014, Plover, WI and Geneva, NY

<table>
<thead>
<tr>
<th>Type</th>
<th>Study years&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Application timing&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Trade name</th>
<th>Active ingredient (AI)</th>
<th>Chemical group</th>
<th>Rate (ac&lt;sup&gt;-1&lt;/sup&gt;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insecticides</td>
<td>2012, 2013, 2014</td>
<td>bud (R5), bloom (R6), pod formation (R7)</td>
<td>Brigade® 2EC</td>
<td>bifenthrin</td>
<td>pyrethroid</td>
<td>6.4 fl oz</td>
</tr>
<tr>
<td></td>
<td>2012</td>
<td>bud (R5), bloom (R6), pod formation (R7)</td>
<td>Coragen®</td>
<td>chlorantraniliprole rynaxypyr</td>
<td>diamide</td>
<td>5.0 fl oz</td>
</tr>
<tr>
<td></td>
<td>2012, 2013, 2014</td>
<td>bud (R5), bloom (R6), pod formation (R7)</td>
<td>Exirel®</td>
<td>cyantraniliprole cyazypyr</td>
<td>diamide</td>
<td>10.2 fl oz</td>
</tr>
<tr>
<td></td>
<td>2012, 2013, 2014</td>
<td>bud (R5), bloom (R6), pod formation (R7)</td>
<td>Exirel®</td>
<td>cyantraniliprole</td>
<td>diamide</td>
<td>13.5 fl oz</td>
</tr>
<tr>
<td>Herbicides</td>
<td>2013, 2014</td>
<td>bud (R5)</td>
<td>Basagran®</td>
<td>bentazon</td>
<td>benzothiadiazinone</td>
<td>1.5 pts</td>
</tr>
<tr>
<td></td>
<td>2013, 2014</td>
<td>bud (R5)</td>
<td>Reflex®</td>
<td>fomesafen</td>
<td>diphenylether</td>
<td>1.0 pt</td>
</tr>
<tr>
<td>Fungicides</td>
<td>2013, 2014</td>
<td>bloom (R6)</td>
<td>Topsin® M WSB</td>
<td>thiophanate-methyl</td>
<td>thiophanate</td>
<td>1.5 lb</td>
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<tr>
<td></td>
<td>2013, 2014</td>
<td>pod formation (R7)</td>
<td>Bravo Weather Stik®</td>
<td>chlorothalonil</td>
<td>chloronitrile</td>
<td>2.5 pt</td>
</tr>
</tbody>
</table>

<sup>a</sup> Chlorantraniliprole was only included in the 2012 small plot study. Co-applications were only tested in 2013 and 2014.

<sup>b</sup> Applications were timed at specific phenological stages of bean maturation.
Infested 10 plant row with ~ 500 ECB larvae
# Mean Percent Plant and Pod Damage, 2012

Treated at 3 crop development stages, Plover, WI

<table>
<thead>
<tr>
<th>Phenological stage</th>
<th>Insecticide</th>
<th>Plant damage</th>
<th>Pod damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>untreated</td>
<td>-</td>
<td>18.5±5.2 a</td>
<td>8.7±2.5 a</td>
</tr>
<tr>
<td>bud</td>
<td>bifenthrin (6.4 fl oz/ac)</td>
<td>9.0±6.4 b</td>
<td>2.6±1.2 bc</td>
</tr>
<tr>
<td></td>
<td>chlorantraniliprole (5.0 fl oz/ac)</td>
<td>4.1±3.3 bc</td>
<td>1.9±1.1 bc</td>
</tr>
<tr>
<td></td>
<td>(aka. rynaxypyr) - Coragen 1.67SC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>cyantraniliprole (10.2 fl oz/ac)</td>
<td>1.0±0.7 c</td>
<td>0.7±0.3 bc</td>
</tr>
<tr>
<td></td>
<td>(aka. cyazypyr) – Exirel 10OD</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>cyantraniliprole (13.5 fl oz/ac)</td>
<td>0.8±0.5 c</td>
<td>0.6±0.2 c</td>
</tr>
<tr>
<td></td>
<td>(aka. cyazypyr) – Exirel 10 OD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bloom</td>
<td>bifenthrin (6.4 fl oz/ac)</td>
<td>0.7±0.4 c</td>
<td>1.4±0.4 bc</td>
</tr>
<tr>
<td></td>
<td>chlorantraniliprole (5.0 fl oz/ac)</td>
<td>0.0±0.0 c</td>
<td>0.0±0.0 c</td>
</tr>
<tr>
<td></td>
<td>(aka. rynaxypyr) - Coragen 1.67SC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>cyantraniliprole (10.2 fl oz/ac)</td>
<td>0.1±0.1 c</td>
<td>0.2±0.1 c</td>
</tr>
<tr>
<td></td>
<td>(aka. cyazypyr) – Exirel 10OD</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>cyantraniliprole (13.5 fl oz/ac)</td>
<td>0.0±0.0 c</td>
<td>0.1±0.1 c</td>
</tr>
<tr>
<td></td>
<td>(aka. cyazypyr) – Exirel 10 OD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pod formation</td>
<td>bifenthrin (6.4 fl oz/ac)</td>
<td>0.0±0.0 c</td>
<td>0.0±0.0 c</td>
</tr>
<tr>
<td></td>
<td>chlorantraniliprole (5.0 fl oz/ac)</td>
<td>0.0±0.0 c</td>
<td>0.3±0.1 c</td>
</tr>
<tr>
<td></td>
<td>(aka. rynaxypyr) - Coragen 1.67SC</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>cyantraniliprole (10.2 fl oz/ac)</td>
<td>0.0±0.0 c</td>
<td>0.0±0.0 c</td>
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<td></td>
<td>(aka. cyazypyr) – Exirel 10OD</td>
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<tr>
<td></td>
<td>cyantraniliprole (13.5 fl oz/ac)</td>
<td>0.0±0.0 c</td>
<td>0.0±0.0 c</td>
</tr>
<tr>
<td></td>
<td>(aka. cyazypyr) – Exirel 10 OD</td>
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<td></td>
</tr>
</tbody>
</table>
### Mean Percent Plant and Pod Damage, 2013-14 Tank Mixes at 2 development stages, NY

<table>
<thead>
<tr>
<th>Vegetative stage</th>
<th>Insecticide</th>
<th>Plant damage</th>
<th>Pod damage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2013(^b)</td>
<td>2014(^c)</td>
</tr>
<tr>
<td>untreated(^a)</td>
<td>-</td>
<td>63.5±9.8 a</td>
<td>13.3±3.8 a</td>
</tr>
<tr>
<td>bud (herbicide)</td>
<td>bifenthrin (6.4 fl oz/ac)</td>
<td>22.1±10.1 ab</td>
<td>11.3±3.5 a</td>
</tr>
<tr>
<td></td>
<td>cyantraniliprole (10.2 fl oz/ac) (aka. cyazypyr) – Exirel 10OD</td>
<td>19.4±7.5 ab</td>
<td>6.9±2.2 ab</td>
</tr>
<tr>
<td></td>
<td>cyantraniliprole (13.5 fl oz/ac) (aka. cyazypyr) – Exirel 10 OD</td>
<td>20.5±2.0 ab</td>
<td>9.6±6.4 a</td>
</tr>
<tr>
<td>bloom (fungicide)</td>
<td>bifenthrin (6.4 fl oz/ac)</td>
<td>12.5±3.9 bc</td>
<td>1.2±1.2 bc</td>
</tr>
<tr>
<td></td>
<td>cyantraniliprole (10.2 fl oz/ac) (aka. cyazypyr) – Exirel 10OD</td>
<td>1.5±1.1 c</td>
<td>1.4±0.7 bc</td>
</tr>
<tr>
<td></td>
<td>cyantraniliprole (13.5 fl oz/ac) (aka. cyazypyr) – Exirel 10 OD</td>
<td>1.7±1.3 c</td>
<td>1.0±0.7 bc</td>
</tr>
<tr>
<td>pod formation (insecticide)</td>
<td>bifenthrin (6.4 fl oz/ac)</td>
<td>7.7±3.4 bc</td>
<td>0.0±0.0 c</td>
</tr>
<tr>
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<td>cyantraniliprole (10.2 fl oz/ac) (aka. cyazypyr) – Exirel 10OD</td>
<td>0.8±0.8 c</td>
<td>3.8±2.2 b</td>
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<tr>
<td></td>
<td>cyantraniliprole (13.5 fl oz/ac) (aka. cyazypyr) – Exirel 10 OD</td>
<td>0.5±0.5c</td>
<td>1.1±1.1 bc</td>
</tr>
</tbody>
</table>
Percent Snap Bean Stems Damaged by European Corn Borer

Plover, WI 2013

- Mean percent ECB damaged stems
- Treatments:
  - In-furrow
  - Liq Fert Pre-Mix
  - Foliar

- P = 0.032  N=4

- Statistical analysis showing differences among treatments.
Percent Snap Bean Pods Damaged by European Corn Borer

Plover, WI 2013

Mean percent ECB damaged pods

Treatments

- In-furrow
- Liq Fert
- Pre-Mix
- Foliar

Untreated
Verimark 6.5
Verimark 10
Verimark 6.5
Verimark 10
Brigade 5

P < 0.001  N=4
Summary

• Diamide insecticides (e.g. Coragen & Exirel) appear to have very good activity against ECB when applied as a foliar.

• Co-application of diamides with fungicides (bloom) had no antagonistic effects and were similar in performance to current foliar recommendations (pod-formation).

• Cyantraniliprole (aka. cyazypyr) was effective against ECB when applied as a in-furrow and as a liquid fertilizer pre-mix applications.
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