How to Keep Worms Out of Sweet Corn Ears

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Ohio State University
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Topics

• Life cycles & management
• Insecticide use
  – Emphasis on best timing
  – During silking vs before silking
  – Main/late season corn vs early season corn
  – Conventional vs organic options
• How to monitor pests
Caterpillars in Sweet Corn

• Key pests; can ruin the crop
• Pest management is complex
  – Several insect species
  – Sequential plantings
• The need to control them varies through the season
  – No control
  – Low intensity control
  – High intensity control
# Caterpillar Species Mix

<table>
<thead>
<tr>
<th></th>
<th>June</th>
<th>July</th>
<th>Aug./Sep.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Corn Earworm</strong></td>
<td>-/*</td>
<td>-/*</td>
<td>***</td>
</tr>
<tr>
<td><strong>European Corn Borer</strong></td>
<td>**</td>
<td>-</td>
<td>**</td>
</tr>
<tr>
<td><strong>Fall Armyworm</strong></td>
<td>-</td>
<td>-/*</td>
<td>**</td>
</tr>
</tbody>
</table>
Life Cycle

Caterpillar (Larva)

Egg

Pupa

Moth (Adult)
Sweet Corn Development

- Seedling
- Whorl stage
- Emerging tassel stage **
- Fresh silk ***
- Dry silk
Control of Caterpillars During Silking in Main Season & Late Season Corn

** Spray interval

** Coverage of ear zone

* Choice of insecticide
### Relative importance of pests during silking

<table>
<thead>
<tr>
<th>Rank</th>
<th>Pest</th>
<th>Spray Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Corn earworm</td>
<td>2-6 d</td>
</tr>
<tr>
<td>2</td>
<td>Eur. corn borer</td>
<td>5-7 d</td>
</tr>
<tr>
<td>3</td>
<td>Fall armyworm</td>
<td>5-7 d</td>
</tr>
<tr>
<td>4</td>
<td>Sap beetles</td>
<td>4-5 d</td>
</tr>
<tr>
<td>5</td>
<td>Silk clip. beetles</td>
<td>(1 spray)</td>
</tr>
</tbody>
</table>
Difference in ‘Worm’ Invasion

- **Corn earworm**
- **European corn borer**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Corn earworm</th>
<th>European corn borer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg location</td>
<td>silks</td>
<td>ear leaf</td>
</tr>
<tr>
<td>Egg hatch</td>
<td>2-3 days</td>
<td>3-5 days</td>
</tr>
<tr>
<td>Source</td>
<td>migratory</td>
<td>local</td>
</tr>
</tbody>
</table>

Source: migratory vs. local
### Insecticides During Silking

<table>
<thead>
<tr>
<th>Moths active?</th>
<th>Corn</th>
<th>Eur. corn</th>
<th>Insecticide need to control larvae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moths active?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Earworm</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Borer</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Corn**
- **Eur. corn**

- More intensive
- Less intensive
- None
1. Corn earworm
Trap to Monitor Corn Earworm

- Pheromone lure
- Attracts male moths
- Highly effective
**Corn Earworm Insecticide SPRAY SCHEDULE Based on Scentry Pheromone Trap & Maximum Daily Air Temperature**

<table>
<thead>
<tr>
<th>Number moths per trap</th>
<th>Spray interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;80 F</td>
</tr>
<tr>
<td>Per day</td>
<td>Per 5 d</td>
</tr>
<tr>
<td>&lt; 0.2</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>0.2-0.5</td>
<td>1.0-2.5</td>
</tr>
<tr>
<td>0.5-1</td>
<td>2.5 - 5</td>
</tr>
<tr>
<td>1 - 13</td>
<td>5 - 65</td>
</tr>
<tr>
<td>&gt;13</td>
<td>&gt;65</td>
</tr>
</tbody>
</table>
2. European corn borer
European Corn Borer & Sweet Corn

- Moths active:
  - 1\textsuperscript{st} flight:
    - Late May to late June
    - Most eggs on whorls
    - Move to tassel to ear
    - Control \underline{before} silking

  - 2\textsuperscript{nd} flight:
    - Late July to late August
    - Most eggs near ear
    - Control \underline{during} silking

- Monitor moths with pheromone traps
European corn borer: generations per year

• 2 generations
  – when summer has average temperatures (60% of years in Ohio)

• 3 generations
  – when summer has high temperatures (40% of years)
European Corn Borer on Sweet Corn

- Spray during silking if moths active (> 1 moth per night = 7 moths per week in pheromone trap)
- 1st spray when 10-20% of plants silking
- Spray every 5 - 7 days
  - 5-day during peak egg hatch
  - 5-day when temperatures hot (>80 F)
3. fall armyworm
Fall Armyworm During Silking

- Pheromone trap
  - All-green unitrap
- Spray every 5-7 days during silking if more than 3 moths per week in trap

fall armyworm moth
4. beetles
Dusky Sap Beetle

- Adults & larvae in kernels
- Often follow caterpillars
- Can infest uninjured ears
- Eggs hatch in 2-3 days
- Larvae feed for 14 days, first on silks or frass, then kernels
Sap Beetle Management

• Scout (examine ears)
  – 50 ears in small plantings (<2A)
  – 100 ears in large plantings (≥2A)
  – Record # infested with adult or larval sap beetles

• Action threshold
  – Treat every 4-5 days during silking if sap beetles in >10% of ears
Silk-Clipping Beetles

- Several species:
  - Japanese beetle
  - corn rootworm beetles
    - western
    - southern
    - northern

- Treat once, early-silk, if:
  - >2 Jap. beetles per ear or
  - >5 rootwm beetles per ear
Managing Worms
Before Silking
Managing European Corn Borer First Generation & Fall Armyworm

- **Q**: Do you have equipment to apply granules to whorl stage corn?
  - If answer is **YES**, then scout at whorl stage
  - If answer is **NO**, then delay scouting until emerging-tassel stage
Whorl Stage Corn

• Scout (examine plants)
  – 50 plants in small plantings (<2A)
  – 100 plants in large plantings (>2A)
  – Record # with fresh feeding:
    • Big holes, messy = fall armyworm
    • Small holes, tidy = European corn borer
Whorl Stage Corn

• Action thresholds:
  – Treat with spray or granules if fall armyworm on >15% of plants
  – Treat with granules if European corn borer on >30% of plants
Emerging-Tassel Stage

• Scout (examine plants)
  – 50 plants in small plantings (<2A)
  – 100 plants in large plantings (>2A)
  – Record # with fresh feeding damage

• Action threshold
  – Spray if fall armyworm and/or European corn borer on >10% of plants
Caterpillar Control in EARLY Corn

**Step 1)** if threshold exceeded:

1 application of granules to **whorls**

*OR*

1 spray application to **emerging tassels**

**Step 2)** spray on silking ears:

1 spray at early silk, *2*nd spray 5-7 days later if **corn borer** flight not over

*OR*

Spray every 2-6 days if **corn earworm** active
Insecticide Issues

- Coverage
- Choice of product
  - Conventional alternatives
  - Organic alternatives
- Rates
- Mixtures
- Application method
Spray Coverage

• Direct spray to ear zone
• Drop nozzles effective
## Insecticides on Sweet Corn

<table>
<thead>
<tr>
<th></th>
<th>Eur. corn borer</th>
<th>Corn earworm</th>
<th>Fall armyworm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mustang</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Capture</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Baythroid</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Warrior</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>SpinTor</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Pounce</td>
<td>G</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Asana</td>
<td>F</td>
<td>G</td>
<td>P</td>
</tr>
<tr>
<td>Larvin</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Penncap-M</td>
<td>G</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>Lannate</td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Sevin</td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Diazinon</td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>B.t.</td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>
B.t. on Sweet Corn

• **Whorl stage:**
  - Granules or spray
  - Target corn borer (1\textsuperscript{st} gen.) & fall armyworm

• **Silking**
  - Spray
  - Target corn borer (2\textsuperscript{nd} gen.) & corn earworm & fall armyworm
B.t. vs Conventional?

Sweet corn in Minnesota (Hutchison et al. 1992)
4 sprays, earworm & borer; harvest 12 Sept.

<table>
<thead>
<tr>
<th>Product &amp; relative rate</th>
<th>% marketableable ears</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pounce (mid)</td>
<td>79 a</td>
</tr>
<tr>
<td>Ambush (mid)</td>
<td>66 abcd</td>
</tr>
<tr>
<td>Javelin (high)</td>
<td>66 abcd</td>
</tr>
<tr>
<td>MVP (mid)</td>
<td>64</td>
</tr>
<tr>
<td>abcde</td>
<td></td>
</tr>
<tr>
<td>Penncap-M (min)</td>
<td>51 abcdefgh</td>
</tr>
<tr>
<td>Asana (max)</td>
<td>46 bcdefgh</td>
</tr>
<tr>
<td>Penncap (&lt;min)</td>
<td>42</td>
</tr>
<tr>
<td>cdefgghi</td>
<td></td>
</tr>
<tr>
<td>Penncap (&lt;min) + Javelin (low)</td>
<td>41 defghi</td>
</tr>
<tr>
<td>Lannate (max)</td>
<td>37 efgh</td>
</tr>
<tr>
<td>Untreated</td>
<td>15</td>
</tr>
</tbody>
</table>
Organic Alternative for Earworm & Borer on Sweet Corn: B.t. + Oil
(Ruth Hazzard, Univ. Mass.)

• Hand-held ‘Zea-later’ applicator
  – Johnny’s Selected Seeds, $79
• Mix:
  – 900 ml food-grade corn oil
  – Lecithin 5% (emulsifier)
  – 28.6 grams DiPel DF (B.t.)
  – 100 ml water
• Treat once, 5 days after silking begins
• Squirt 0.5 ml. of oil mix into each ear tip
Corn earworm =
tomato fruitworm

• Normal year in Ohio:
  – Large number of moths arrive in late summer from South
  – Pyrethroids work well

• In September 2004:
  – Average number of moths arrived
  – Larvae NOT susceptible to pyrethroids (Warrior, Baythroid)
Corn earworm = tomato fruitworm

- What to expect in 2005?
- Known to not overwinter well here
- Problem could re-occur
- Growers should have alternative insecticide
Corn earworm = tomato fruitworm

- Pyrethroid alternatives:
  - **Sweet corn**
    - SpinTor
    - Larvin
    - Lannate
  - **Tomato**
    - SpinTor
    - Proclaim
    - Avaunt
    - Intrepid
### Insecticide Rates?

Sweet corn in Wisc., 1999 (Wedberg & Jensen):

<table>
<thead>
<tr>
<th>Treatment, rate/A</th>
<th># infested ears per 25 ears</th>
<th>(3 applications)</th>
<th>w/ borer</th>
<th>w/ earworm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capture, 2.6 oz (mid)</td>
<td>1.5 a</td>
<td>1.5 a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capture, 2.1 oz (min)</td>
<td>0.8 a</td>
<td>2.2 a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warrior, 3.2 oz (mid)</td>
<td>1.5 a</td>
<td>2.0 a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warrior, 2.6 oz (min)</td>
<td>0.2 a</td>
<td>4.5 abc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SpinTor, 6 oz (max)</td>
<td>1.5 a</td>
<td>2.2 a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SpinTor, 3 oz (min)</td>
<td>1.0 a</td>
<td>3.5 abc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pounce, 8 oz (max)</td>
<td>1.5 a</td>
<td>4.2 abc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pounce, 6 oz (mid)</td>
<td>3.0 a</td>
<td>4.8 abc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baythroid, 2.8 oz (max)</td>
<td>0.2 a</td>
<td>5.8 abcd</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baythroid, 1.6 oz (min)</td>
<td>2.0 a</td>
<td>8.0 bcd</td>
<td></td>
<td></td>
</tr>
<tr>
<td>untreated check</td>
<td>8.8 b</td>
<td>5.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Conclusion:

• For European corn borer:
  – low rates fine

• For corn earworm
  – higher rates better
**Insecticide Combinations?**

Sweet corn in Virginia, 1999 (Nault & Speese)

<table>
<thead>
<tr>
<th>Treatment, rate/A; 4 applications</th>
<th>No. larvae per ear</th>
<th>earworm</th>
<th>borer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warrior, 3.8 oz (max) alone</td>
<td>0.04 c</td>
<td>0.09 b</td>
<td></td>
</tr>
<tr>
<td>Baythroid, 2.8 oz (max) alone</td>
<td>0.05 bc</td>
<td>0.05 c</td>
<td></td>
</tr>
<tr>
<td>Penncap-M, 1 qt (min)</td>
<td>0.03 c</td>
<td>0.02 c</td>
<td></td>
</tr>
<tr>
<td>+Warrior, 1.6 oz (&lt;min)</td>
<td>0.13 b</td>
<td>0.02 c</td>
<td></td>
</tr>
<tr>
<td>Penncap-M, 1 qt (min) +Baythroid, 0.8 oz (&lt;min)</td>
<td>0.38 a</td>
<td>0.26 a</td>
<td></td>
</tr>
<tr>
<td>Untreated check</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Insecticide Application Options for Sweet Corn

• Old way
  – Foliar spray
    • High clearance boom sprayer (High Boy)
    • Airblast sprayer

• New ways
  – Chemigation via overhead irrigation
  – Commercial seed treatment
    • Gaucho, Cruiser, Poncho
  – Transgenic BT corn
    • ‘Attribute’
‘Attribute’ BT Sweet Corn

- **European corn borer:**
  - Excellent control

- **Corn earworm:**
  - Adequate protection if population low
  - Supplement with insecticide if corn earworm population high
    - Spray at 75% fresh silk
    - 2\textsuperscript{nd} spray 4 days later
Monitoring
Traps for Corn Earworm & European Corn Borer

- **Set up:**
  - At edge of corn field
  - **CEW:** best near fresh-silking corn
  - **ECB:** over long grass is best; not over bare soil

- **Maintenance:**
  - Check 2 to 3 times per week; count target moths
  - Replace lure every 2 or 4 weeks (as per manufacturer)
Pheromone Lures for European Corn Borer

Two lure types available:

• ‘Iowa’ strain:
  – Also known as ‘Z’-strain
  – Best for Ohio

• ‘New York’ strain:
  – Also known as ‘E’-strain
  – Not needed in Ohio
Traps for Corn Earworm & European Corn Borer

Suppliers:

- **Great Lakes IPM** (Vestaburg, Mich.)
- **Gempler’s** (Belleville, Wisconsin)
- **Salem Fruit Growers Co-op** (Salem, Ohio)
## Traps for Corn Earworm or European Corn Borer

<table>
<thead>
<tr>
<th>Trap</th>
<th>Lures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manufacturer:</strong></td>
<td><strong>Scentry</strong></td>
</tr>
<tr>
<td><strong>Life span:</strong></td>
<td>2 - 4 yrs</td>
</tr>
<tr>
<td><strong># per season:</strong></td>
<td>1 (minimum)</td>
</tr>
<tr>
<td></td>
<td>2 (preferred)</td>
</tr>
<tr>
<td><strong>Cost:</strong></td>
<td>@$48 - 75*</td>
</tr>
<tr>
<td></td>
<td>$8 - 13 (for 5)</td>
</tr>
</tbody>
</table>

*plus optional spare tops @$17 - 24*