Cabbage Root Fly Control Strategies & Research in the Skagit Valley of Washington

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Cabbage maggot – *Delia radicum*
**Delia spp life cycle**

- **Root maggots overwinter in a puparium.**
- **3 Larval instars (3-5 weeks) damage - roots feeding, stem feeding, girdling at soil line.**
- **Adult root maggots resemble small houseflies. Crop invasion is likely from a nearby source.**
- **Delia species are multivoltine (3 – 5 generations/year).**
- **Egg clusters laid on soil near stem hatch in 3-7 days.**
Monitoring for Cabbage Maggot

• Yellow sticky traps - no relationship between traps and oviposition or damage (Blackshaw et al. 2012).
  * Yellow pan traps
  * Egg sampling
  * Sweep sampling – low, fast fliers

Yellow sticky cards attract pests and beneficials and dirt.
Wilting is an indication of maggot infestation but initial infestation is asymptomatic. Purple or red discolored cabbage plants can indicate presence of maggots.
Large maggot loads – generate slime from feeding which creates a protective encrusted cap, difficult for insecticides to penetrate. Adequate gallonage is required for efficacy.
Young larvae can feed inside the stem and move upward away from the soil or below the soil line. Only systemic products would be effective at this stage. Older 3rd instar larvae were never seen in the thin cabbage stems, due to their size. Older larvae have a tough cuticle and are more difficult to kill.
Infestation by cabbage maggot is dependent on many variables:
- Location of fields
- Cropping history
- Planting depth and angle
Our research was primarily focused on cabbage seed production – a biennial crop. Results are applicable to head cabbage.
Preliminary 2011 trials

Good efficacy:
Warrior II - lambda cyhalothrin
Regent - fipronil
Diazinon

35 ml field rate applied as a soil drench. Larvae were sieved from soil and scored dead/alive.

Infested cabbage were field collected and brought to lab.
Cabbage Seed Production

Open Nursery – 5 weeks of cabbage maggot pest pressure

Seedlings are transplanted in the fall, using a mechanical transplanter with application of transplant water containing diazinon or chlorantraniliprole.

5 and 12 DAP additional drench applications of chlorpyrifos or diazinon. Plants overwinter.

Seeds are sown into plug trays in August.

Seeds are harvested the following year.
Cabbage plants may outgrow maggot infestations but cabbage seed crops are biennial and infested plants are more vulnerable to frost damage.
WSU NWREC 2012
Cabbage Maggot Field Trials

Three experiments – random complete block design
Each plot -2 (10”) rows = 20 plants/plot
Cabbage Maggot preoviposition
~ 2 weeks in spring field trials

Developing eggs

Mature eggs
Evaluations

Spring field trials
Field analysis

Fall field trials
Microscopic analysis
(3 weeks after transplanting and 8 weeks after sowing).
3 insecticides are currently used:
2 organophosphates: diazinon and lorsban (chlorpyrifos)
Coragen (chlorantraniliprole)

**Objective** – to test new chemistries
- As replacements for the organophosphates
- Reduce potential for resistance development
- Promote the registration of new insecticides including experimental and combination treatments.

Field trials provided a comparison of:
5 seed treatments
2 tray drenches
2 granular baits
9 drenches (one foliar), representing 7 insecticide classes (IRAC).

Experimental design was set up to compare residual protection of the new products alongside industry standards.
Seed treatment technology

A – untreated cabbage seed
B – film coated (seed size shape unchanged)
C – pelletized (seed size increased, improved sowability)

+ seed treatments reduce amount of insecticide
+ provide systemic protection
+ target site of attack
- seed treatments have affected germination and seedling growth
Seed treatments trial #1  
(Evaluated 8 weeks after sowing date.)

*Pelletized by Skagit Seed Services, Mount Vernon

*FarMore 300 + Spinosad (3 fungicides; mefenoxam – Apron XL®, fludioxonil – Maxim 4FS® and azoxystrobin – Dynasty®)
*FarMore 300 + Cruiser (FarMore DI400, 0.1 mga/seed)
*FarMore 300 + Cruiser (HR 0.2mga/seed) + Spinosad (FarMore FI500)
*FarMore 300 + Cruiser (LR 0.1 mga/seed) + Spinosad

Sepresto 75WS (clothianidin 56.25% and imidacloprid 18.75% + Maxim)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean # Larvae</th>
</tr>
</thead>
<tbody>
<tr>
<td>FarMore 300 + Spinosad</td>
<td>1.25 c</td>
</tr>
<tr>
<td>FarMore 300 + Cruiser</td>
<td>1.75 bc</td>
</tr>
<tr>
<td>FarMore 300 + Cruiser (HR) + spinosad</td>
<td>2.25 bc</td>
</tr>
<tr>
<td>FarMore 300 + Cruiser (LR) + spinosad</td>
<td>5.00 abc</td>
</tr>
<tr>
<td>Sepresto (clothianidin + imidacloprid)</td>
<td>7.25 a</td>
</tr>
<tr>
<td>UTC</td>
<td>5.25 abc</td>
</tr>
</tbody>
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FarMore – Syngenta
Sepresto – Bayer CropScience
Results of seed treatments

• FarMore treatments performed better than Sepresto, the only treatment which fell below the untreated check.
• Seed treatments were located on the Eastern half of the field and did not receive the pest pressure experienced in the Western half of the field.
• Industry response – still interested if it will carry the seedlings through the open nursery phase.
• Sepresto seed treatment may be more efficacious for root attacking larval instars than stem boring early instar larvae. Clothianidin and imidacloprid may not be uptaken as rapidly as thiamethoxam which is 10x more soluble.
• in similar trials with onion maggot, seed required high loading rates for efficacy due to the minute amount of product and prolonged vulnerability from seed to bulb. Cabbage seed size is similarly small. In a cucurbit study thiamethoxam was effective up to the 2-leaf stage and inconsistent after that.
Split plot drench trial #2
Treatments applied 1 week following transplant water of Diazinon or Coragen.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean # Larvae</th>
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</thead>
<tbody>
<tr>
<td>Leverage 360</td>
<td>2.75a</td>
</tr>
<tr>
<td>Movento</td>
<td>3.25a</td>
</tr>
<tr>
<td>Endigo ZC</td>
<td>3.38a</td>
</tr>
<tr>
<td>Entrust</td>
<td>3.75a</td>
</tr>
<tr>
<td>UTC</td>
<td>3.25a</td>
</tr>
</tbody>
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Results
• No difference in the treatments
• Diazinon as a transplant water was more effective than Coragen.
• Experimental design - single treatment which did not mirror industry methods and data was not conclusive.
## Drench treatments trial #3

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean # Larvae</th>
<th>formulation/active ingredient(s)</th>
<th>Mean # Larvae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warrior II</td>
<td>0.25 b</td>
<td>Lambda cyhalothrin 22.8%</td>
<td></td>
</tr>
<tr>
<td>Movento (foliar)</td>
<td>1.50 ab</td>
<td>Spirotetramat 22.4%</td>
<td></td>
</tr>
<tr>
<td>Endigo ZC</td>
<td>1.75 ab</td>
<td>Lambda cyhalothrin 9.8% &amp; thiamethoxam 12.6%</td>
<td></td>
</tr>
<tr>
<td>Pyganic</td>
<td>2.25 ab</td>
<td>Pyrethrins 1.4%</td>
<td></td>
</tr>
<tr>
<td>Brigade</td>
<td>2.75 ab</td>
<td>Bifenthrin 10.0%</td>
<td></td>
</tr>
<tr>
<td>Trilogy</td>
<td>3.00 ab</td>
<td>Neem oil 70%</td>
<td></td>
</tr>
<tr>
<td>Verimark HR</td>
<td>3.25 ab</td>
<td>Cyantraniliprole 20%</td>
<td></td>
</tr>
<tr>
<td>Leverage 360</td>
<td>4.25 ab</td>
<td>Imidacloprid 21% &amp; beta-cyfluthrin 10.5%</td>
<td></td>
</tr>
<tr>
<td>Durivo</td>
<td>4.75 ab</td>
<td>Thiamethoxam 17.5% &amp; chlorantraniliprole 8.8%</td>
<td></td>
</tr>
<tr>
<td>UTC</td>
<td>1.75 ab</td>
<td></td>
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- Warrior II outperformed all other treatments.
- Addition of a pyrethroid to thiamethoxam improved performance (Endigo compared with Durivo).
- Chlorantraniliprole, industry standard, exhibited poor efficacy in these trials.
Tray Drench Application

Uniform broadcast high-volume, foliar spray, followed immediately by sufficient overhead irrigation to wash insecticide from foliage into potting media without causing it to drip from bottom of tray.

3 insecticides tested

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<tr>
<td>Admire Pro – (Bayer CropScience) imidacloprid 42.8%</td>
<td>5.25 abc</td>
</tr>
<tr>
<td>Verimark – (DuPont) cyazopyr 20%</td>
<td>5.25 abc</td>
</tr>
<tr>
<td>Coragen – (DuPont) chlorantraniliprole 18.4%</td>
<td>9.00 a</td>
</tr>
<tr>
<td>UTC</td>
<td>5.25 abc</td>
</tr>
</tbody>
</table>

• Application timing must meet prescribed REI
• Workers will be required to wear protective gloves.
Granular Baits
Certis markets a granular entrust (spinosad) 0.07%. New formulation has an external coating of entrust.
44#/Acre recommended rate.

Results
• Never dissolved – created a crust on soil surface.
• Eggs were seen in the granular bait in the field.
• New formulation slightly more effective than old formulation.
Edge effect influences oviposition sites and presence of cabbage maggot eggs stimulates oviposition by additional female flies.

Map of Autumn 2012 WSU NWREC field trials.
2013 Cabbage Maggot Research Plans

• Spring and fall trials anticipated.
• Laboratory trials with seedlings exposed to flies in a screened cage to determine efficacy of aged residues.
• Dermacore - DuPont (chlorantraniliprole 50% will be tested as a seed treatment) using broccoli seed.
• Stagger planting of seed treatments.
• Stagger field transplanting.
• Treatments will mirror industry standard with applications at 5 and 12 DAP.
• Lorsban will be added for comparison with Diazinon and Coragen.
• Most treatments will be repeated.
Research Funding provided by
Puget Sound Seed Growers Association
Washington State Commission on Pesticide Registration
Application of a pesticide to a crop or site that is not on the label is a violation of pesticide law and may subject the applicator to civil penalties up to $7,500. In addition, such an application may also result in illegal residues that could subject the crop to seizure or embargo action by WSDA and/or the U.S. Food and Drug Administration. It is your responsibility to check the label before using the product to ensure lawful use and obtain all necessary permits in advance.