Update on Soilborne Disease Management and Fumigation Trials

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The goal of today’s presentation is to provide an update on current soilborne disease research in red raspberry

- Outline
  - Background
  - Project 1 – Root and Crown Inoculum Removal
  - Project 2 – Alternative Fumigation Strategies
  - Future projects
  - Questions and discussion
Industry Challenges

- Improved soilborne disease management is a research priority.
- Growers primarily pre-plant fumigate to manage:
  - Root lesion nematode (*Pratylenchus penetrans*; RLN)
  - Phytophthora root rot (*Phytophthora rubi*)
  - Others?

Images: D. Wixted
Images: forestpathology.cfans.umn.edu
Despite Fumigation, Soilborne Diseases are Still a Challenge for Raspberry Growers

- Changes in land management
- Loss of traditional soil fumigants
- Increasing restrictions on fumigant usage
- Application methods need optimization
- Questions about “replant disease complex” and what to target
One of the **primary goals** of the Small Fruit Horticulture (SFH) program is to develop improved horticultural tools for soilborne disease management in red raspberry.

Improved soilborne disease management is a shared goal and offers excellent opportunity for collaboration.

**Diverse approach:**
- Application and management of cover crops
- Improved understanding soil microbial ecology and “replant disease”
- Removal of root and crown inoculum
- Alternative fumigants and methods of fumigation
Project 1 – Root and Crown Inoculum Removal
Why Root and Crown Removal?

- Large amounts of root and crown material remain in fields prior to fumigation and replanting.
- Soil fumigants are unable to penetrate undecomposed plant material.
- Remaining plant material could serve as a source of inoculum for soilborne diseases and pests.
Goals of Root Removal Project

- **Short Term** – Evaluate and demonstrate the efficacy of raspberry root inoculum removal as a pre-plant management technique for enhancing soilborne disease suppression
- **Long Term** – Develop practical tools for the integrated management of soilborne pathogens and pests
- Three experiments
Experiment 1

- **Objective:** Compare three root removal devices for speed and efficacy of root removal in two commercial fields
- **Devices tested includes:**
  - Lundby plant lifter
  - Beach cleaner
  - Potato harvester
## Experiment 1 - Results

<table>
<thead>
<tr>
<th>Device</th>
<th>Speed (mph)</th>
<th>Percent of root and crown material removed$^z$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant lifter</td>
<td>0.25</td>
<td>98</td>
</tr>
<tr>
<td>Beach cleaner</td>
<td>0.37</td>
<td>91</td>
</tr>
<tr>
<td>Potato harvester</td>
<td>1.0</td>
<td>96</td>
</tr>
</tbody>
</table>

$^z$Determined by measuring the amount of removed root/crown material within a 4 ft$^3$ (0.1 m$^3$) of soil.
Volume of Material Removed

Amount of root material removed (left) and remaining (right) in a 4 ft³ plot.
Experiment 2

- **Objective**: Evaluate the effects of root removal on:
  1) RLN, *Pythium*, and *Fusarium*
  2) Raspberry plant growth, development, and yields

- Initiated in a ‘Chemainus’ field replanted to ‘Meeker’ in Aug. 2014 in Whatcom County, WA
Experiment 2 – Approach

- Split plot experiment
  - Main plot: Fumigation, with or without using Telone® C-35 at 32 gal/acre
  - Split plot: Root removal (with or without removal, using a Lundby plant lifter)
  - Replicated six times
  - Main plots were 100 x 30 ft and the split plots 15 x 30 ft in size
- Data collected include: changes in soilborne disease [RLN, and Fusarium and Pythium (proxies for P. rubi)], plant growth, and yield
Experiment 2 – Recap of 2015 Results

1) Colonization rates of root material (> 5 mm) by Fusarium and Pythium were the same six weeks after fumigation (i.e., colonization was not impacted by fumigation)

2) Soil populations of Fusarium and Pythium were the same by planting time in Spring 2015

3) RLN populations returned to pre-fumigation levels by Aug. 2015; no treatment differences

4) No differences were observed in plant growth in 2015
**Experiment 2 – 2016 Results**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Primocane no.</th>
<th>Primocane height (cm)</th>
<th>Primocane diameter (cm)</th>
<th>Yield (lbs/30 ft)(^z)</th>
<th>Average berry size (g)(^y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fumigated, no root removal (control)</td>
<td>17(^x)</td>
<td>184.9</td>
<td>0.93</td>
<td>2.27</td>
<td>3.0</td>
</tr>
<tr>
<td>Fumigated, roots removed</td>
<td>17</td>
<td>189.2</td>
<td>0.92</td>
<td>2.25</td>
<td>2.9</td>
</tr>
<tr>
<td>Not fumigated, no root removal</td>
<td>15</td>
<td>171.7</td>
<td>0.91</td>
<td>1.96</td>
<td>2.8</td>
</tr>
<tr>
<td>Not fumigated, roots removed</td>
<td>15</td>
<td>174.1</td>
<td>0.90</td>
<td>2.00</td>
<td>2.9</td>
</tr>
<tr>
<td><strong>P-value</strong></td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

\(^z\)Yield was averaged from four machine harvests on June 15, 20, 29, and July 7, 2016.

\(^y\)Determined from two 10-berry samples per plot on June 20 and July 7, 2016.

\(^x\)Alpha (\(\alpha\)) = 0.05; NS denotes not statistically significant.
Experiment 2 – 2016 Results

- Overtime, fumigated plots had less RLN
- No differences in *Fusarium* and *Pythium* populations
- Visual differences in plant vigor were observed between fumigated and non-fumigated plots
Experiment 3

- **Objective**: Evaluate the effects of root removal on:
  1) *P. rubi, Fusarium*, and *Pythium* (also RLN)
  2) Raspberry plant growth, development, and yields

- Initiated in a ‘Meeker’ field replanted to ‘Meeker’ in Aug. 2015 in Whatcom County, WA
Experiment 3 – Approach

- Randomized complete block design
  - Two treatments: root removal vs. no removal
  - Replicated four times
  - Entire field fumigated with Telone® C-35 at 35 gal/acre
  - Plots were 60 x 30 ft in size
- Data collected include: changes in soilborne diseases (P. rubi, Fusarium, and Pythium), RLN, plant growth, and yield
Experiment 3 – 2016 Results

- No differences in primocane number, height, diameter, nor vigor
- Fumigation did not reduce *Fusarium* or *Pythium* in large or small root debris
- Fumigation initially reduced soil *Fusarium* populations, but not *Pythium*
- Still generating *P. rubi* data
- Few populations of RLN/g root
- Overall, little effect of root removal
Project 1 – Take Home Messages

- Root and crown inoculum removal is **not effective** in current fumigation systems
- Broadcast fumigation with Telone® C-35, untarped, is leading to **poor suppression** of RLN, *Fusarium*, and *Pythium*
- Observed fumigation bump in Experiment 2; soil microbial ecology being sequenced by Dr. Cedar Hesse
Project 2 – Alternative Fumigation Strategies
Project 2 – Introduction

- Standard fumigation with Telone® C-35 produces variable suppression of RLN and other soilborne diseases
- Tarping should improve fumigation efficacy, but is seldom practiced
- Preliminary trials with Dominus® biofumigant and Telone® C-35 + Vapam® have shown promise
- High populations of RLN have been observed in winter cover crop roots
Project 2 – Objectives

- **Experiment 1** - Determine if alternative fumigant products and fumigation practices improve management of RLN, *Fusarium*, and *Pythium*.

- **Experiment 2** - Evaluate if modified winter cover cropping practices reduce the potential for cover crop roots to serve as a bridge for RLN (*not covered today due to time*).
Experiment 1 – Approach

- Randomized complete block design
- Four treatments, each applied to single-row plots
- Replicated four times
- Treatments applied Fall of 2015 and include:
  1) Telone® C-35 (control)
  2) Telone® C-35 + tarp
  3) Telone® C-35 + Vapam®
  4) Dominus® biofumigant
## Experiment 1 – 2016 Results

<table>
<thead>
<tr>
<th>Treatment</th>
<th>RLN in wheat roots (Pp g/root)</th>
<th>RLN in raspberry roots collected in June (Pp g/root)</th>
<th>RLN in raspberry roots collected in July (Pp g/root)</th>
<th>Primo. no.</th>
<th>Primo. height (cm)</th>
<th>Primo. diameter (cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telone® C-35 (control)</td>
<td>122 a&lt;sup&gt;y,x&lt;/sup&gt;</td>
<td>22</td>
<td>10</td>
<td>9</td>
<td>52.8</td>
<td>0.89</td>
</tr>
<tr>
<td>Telone® C-35 + tarp</td>
<td>0 b</td>
<td>34</td>
<td>11</td>
<td>10</td>
<td>53.1</td>
<td>0.92</td>
</tr>
<tr>
<td>Telone® C-35 + Vapam®</td>
<td>15 b</td>
<td>33</td>
<td>3</td>
<td>10</td>
<td>55.9</td>
<td>0.91</td>
</tr>
<tr>
<td>Dominus® biofumigant</td>
<td>407 a</td>
<td>28</td>
<td>11</td>
<td>10</td>
<td>53.0</td>
<td>0.91</td>
</tr>
</tbody>
</table>

P-value 0.00185 NS NS NS NS NS

<sup>z</sup>Scale: 1=poor vigor/weak; 3=moderate vigor; 5=excellent vigor.

<sup>y</sup>Mean separation in columns by least significant difference, \( P < 0.05 \); means with the same letter are not different and NS denotes not statistically significant.

<sup>x</sup>RLN populations in wheat and July raspberry roots were transformed by taking the square root of the response variable; data presented in original units.
Experiment 1 – 2016 Results

- Soilborne disease data indicate root debris were not penetrated by fumigants, regardless of treatment.
- Tarped treatment was more effective on *Fusarium* than *Pythium* soil populations, but were the same by spring 2016.
- Fall RLN populations in raspberry roots were relatively low (12 - 41 RLN/g root), suggesting treatments *may have been* effective for RLN.
Summary of Projects

- Results are preliminary
- Further data need to be collected from two projects and synthesized
- However, preliminary results demonstrate variable nature of fumigation efficacy
- There are opportunities to improve upon the current soilborne disease management systems
- Tarping and Telone® + Vapam® cap treatments appear promising
Future Work and Activities

- Additional fumigation trails
- Applying for USDA specialty crop block grant (PI Grünwald)
- Testing alternative winter cover crops that are potential non-host for RLN; cover crops being studied include:
  1) Black oats
  2) Tall Fescue ‘Jesup MaxQ®’
  3) Rye ‘Wheeler’
  4) Winter wheat ‘Bobtail’
  5) No cover crop
Acknowledgements

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Thank you!
Any Questions?

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