Managing Soilborne Diseases Through Removal of Root Inoculum in Red Raspberry

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Red Raspberries in Washington

- Washington is the largest national producer of processed red raspberries
- In 2014, 73 million pounds of fruit were harvested from 9,700 acres
- Valued at ~$60.9 million in 2014
- Depending on year, 59-88% of total US red raspberry acreage is in Washington

Source: NASS, 2015 and WRRC, 2015
Industry Challenges

- Fields that used to remain in production for 15-20+ years are now being renovated and replanted every 5-8 years.
- Land suitable for red raspberry is limited, so production is often continuous and crop rotation seldom used.
- Soils are typically fumigated prior to replanting.
Soil Fumigation in Red Raspberry

- Preplant fumigation in fall or spring
- Fumigants typically applied by commercial applicators
- Most fumigants are deep-shanked and injected into the soil at depths of 12-18 inches; untarped
- Primary fumigant products:
  - Telone® C-35 - 1,3-dichloropropene (63.4%) + chloropicrin (34.7%)
  - Vapam® - metam sodium (42%)
Despite Fumigation, Soilborne Disease Management is Still a Major Challenge for the Red Raspberry Industry

- Changes in land management
- Loss of traditional soil fumigants
- Increasing restrictions on fumigant usage
- Application methods need optimization
- Concerns over soil quality, especially soil biology
- Poor understanding of “replant disease”
Soilborne Pathogens and Pests

- **Phytophthora rubi**
  - Oomycete – “water molds”
  - Causal agent of Phytophthora root rot
  - Oospores and mycelia can persist in soils for years
  - Infection of root tissue damages root systems

- **Pratylenchus penetrans**
  - Root-lesion nematode
  - Migratory endoparasite with broad host range
  - High populations can cause root dieback, stunting, and increase the potential for synergistic disease complexes
SFH Research Goals

- 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:**
  - Alternative fumigants and methods of fumigation
  - Application and management of cover crops
  - Improved understanding soil microbial ecology and “replant disease”
  - Removal of root and crown inoculum
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.
Plant Material Remaining in Field Prior to Fumigation
Goals of Root Removal Project

- **Short Term** – Evaluate and demonstrate the efficacy of raspberry root inoculum removal as a pre-plant management technique for reducing soilborne pathogen and pest populations
- **Long Term** – Develop practical tools for the integrated management of soilborne pathogens and pests
- Two experiments
Experiment 1

- **Objective**: Compare three root removal devices for speed and efficacy of root removal in two commercial fields.
- Economic analysis with Mrs. Galinato.
- Devices tested includes:
  - Lundby plant lifter
  - Beach cleaner
  - Potato harvester
Evaluated Tools for Raspberry Root Removal

- Lundby Plant Lifter
- Beach Cleaner
- Potato Harvester

Video: https://www.youtube.com/watch?v=vnN0h8JrOA4
## 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.
Amount of root material removed (left) and remaining (right) in a 4 ft$^3$ plot.
Experiment 2

- **Objective**: Evaluate the effects of root removal on:
  1) Populations of soilborne pathogens and pests
  2) Raspberry plant growth, development, and yields

- Initiated in a ‘Cheminus’ 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 to be collected includes: changes in soilborne disease (*Fusarium* and *Pythium*, proxies for *P. rubi*) and *P. penetrans* populations, plant growth, and yield
Experiment 2 – Preliminary Results

Changes in *P. penetrans* populations over time, 2015.

Populations returned to pre-fumigation levels by Aug. 2015.
Experiment 2 – Preliminary Results

Changes in *Pythium* populations as a result of root removal and fumigation treatments, 2015. Results similar for *Fusarium*.

*Figure courtesy of Dr. Weiland*
Experiment 2 – Preliminary Results

Changes in *Fusarium* populations in root material ≥ 5 mm in diameter over time, 2015. Results similar for *Pythium*.

*Figure courtesy of Dr. Weiland*
Experiment 2 – Preliminary Results

- No differences in cane number per hill nor cane height as of June 2015
- Re-evaluate in 2016
Next Steps for Root Removal Projects

- Continue monitoring
- Collect first set of yield data
- Repeat experiment in a field site infested with *P. rubi*
Root removal generates a large amount of waste…

Is composting a viable disposal method for removed root/crown material?
Composting Experiment

- Tissue culture ‘Meeker’ plants were grown in compost, with and without roots
- Removed roots were composted and screened for *P. penetrans*, *Fusarium*, and *Pythium* via a greenhouse bioassay
- Composting reduced pests and pathogens to undetectable levels
- Economic viability?
Thoughts Moving Forward…

- Conventional fumigation = unsatisfactory results
- Concerns that overwintering cover crops may serve as a bridge for *P. penetrans*
- Trials with biofumigants (Dominus®) and metam sodium show promise
- New research funded by WSDA SCBG address these timely concerns
Acknowledgements

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- Tim Purcell, Trident Agricultural Products
- Whatcom Farmers Co-op
- Northwest Center for Small Fruits Research
Thank you for your attention!

Any questions?

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