Evaluation of Onion Soil Amendment to Control White Rot

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Allium White Rot

• Caused by the fungus *Sclerotium cepivorum*
• Leaves decay at the base, turn yellow, wilt, and collapse
• Fluffy mycelium on rotted roots and bulbs
• Watery, decayed bulbs
• Outer scales dry, shrink and crack
• Small sclerotia (0.02 inch, about the size of a poppy seed) form in and on the surface of affected bulb parts
White Rot Epidemiology

- Affects only *Allium* spp. (e.g. onion, garlic, leek, and shallot)
- Sclerotia from an initially high population may survive 20 to 30 years or more in soil without the presence of a host
- Easily spreads from plant to plant
- Fungus is favored by cool soils and is restricted above 75°F
- White rot can continue to decay infected bulbs in storage if humidity is not kept low
- Sclerotia germinate in to sulfur-containing root exudates from Alliums (C-C-C-S)
White Rot Management

- Cultural
  - Exclusion
  - Sanitation
- Chemical
  - Fungicides
  - Germination stimulants
**Sclerotia Germination Stimulants and Fungicides**

- Garlic juice, garlic oil, garlic powder, onion oil, onion compost
- Diallyl disulfide (DADS) mimics natural garlic and onion sulfur compounds and can reduce sclerotia populations by 80-98% (Coley-Smith, McDonald, Davis, Crowe)
- Alli-Up™
- DADS, combined with tebuconazole with or without penthiopyrad and/or fludioxonil, improves control and marketable yields (Ferry and Davis)
Onion Soil Amendment

- Produced by TOP Onions USA (Ontario, OR)
- Byproduct of onion oil distillation
- Onions are washed, ground, pressed and juice is distilled, separated, and purified
- di-1-propyl disulfide and other propyl sulfide compounds
- Available in large quantities
- Inexpensive
Onion Soil Amendment

• Water soluble
• pH: ~4.1
• Bacteria, yeasts, fungi
• 5.8% dry matter
  • 2.30% N
  • 0.78% P
  • 1.81% K
  • 36.0% C
  • 0.37% S
Materials and Methods

• 30’ x 10’ field plots were established in a previously infested field at COARC

• Soils were sampled from each plot prior to treatments to establish pre-treatment populations of white rot sclerotia

• Up to 50 sclerotia were tested for viability by plating on agar

• Mean initial sclerotia populations = 80 sclerotia/liter soil
  • Range = 73 to 110 sclerotia/liter soil
Materials and Methods

Treatment factors:

1. Onion soil amendment
   • (0-, 2-, and 5 gal/acre)

2. Tarp covering for 6 days after onion soil amendment application
   • (tarp and no tarp)

3. Tebuconazole applied in-furrow at planting
   • (0- and 20.5 gal/acre)

Treatments replicated 4 times

Plots were arranged in a split-split block design
Materials and Methods

• Onion soil amendment applications were performed on May 15 when the mean soil temperature at a 4 in depth was 62°F
• Applications were made using five XR Teejet 8008VS nozzles arranged on a boom mounted to a 4-wheeler
• Plots were irrigated after onion soil amendment applications and 6 mm clear polyethylene tarps were installed the following day
• Post-treatment soil samples were taken on June 25-26 and August 27 and assayed for white rot sclerotia
Materials and Methods

- Garlic was hand-planted on September 29 and 30, 2015
- Two rows per 36 inch bed at a spacing of approximately 15 plants per foot row
- Tebuconazole (20.5 oz/acre) was applied in a 4 to 6 inch band over the furrow in a total volume of 40 gal/acre
- Garlic emergence, white rot incidence and severity were determined on January 24 when plants were at the 3 to 4 leaf stage.
  - White rot severity was rated using a 0 to 5 scale: 0 = no symptoms; 1 = chlorosis on 1 to 2 leaves; 2 = chlorosis on 3 or more leaves; 3 = necrosis on 1 to 2 leaves; 4 = necrosis on 3 or more leaves; and 5 = dead plant
Results: Soil Assays

No. of viable sclerotia

- Nontreated Nontarped
- Nontreated Tarped
- 2 gal/acre Nontarped
- 2 gal/acre Tarped
- 5 gal/acre Nontarped
- 5 gal/acre Tarped

- Initial
- Mid-season
- Final
## Results: Germination and Disease Evaluations

<table>
<thead>
<tr>
<th>Onion</th>
<th>Fungicide</th>
<th>Tarp</th>
<th>Emergence (no. plants)</th>
<th>Incidence (%)</th>
<th>Severity (0-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Control</td>
<td>N</td>
<td>34</td>
<td>100</td>
<td>5.0</td>
</tr>
<tr>
<td>Control</td>
<td>Tebuconazole</td>
<td>N</td>
<td>55</td>
<td>78</td>
<td>2.4*</td>
</tr>
<tr>
<td>2 gal/acre</td>
<td>Control</td>
<td>N</td>
<td>34</td>
<td>99</td>
<td>4.6</td>
</tr>
<tr>
<td>2 gal/acre</td>
<td>Tebuconazole</td>
<td>N</td>
<td>57</td>
<td>75</td>
<td>2.1*</td>
</tr>
<tr>
<td>5 gal/acre</td>
<td>Control</td>
<td>N</td>
<td>38</td>
<td>100</td>
<td>4.6</td>
</tr>
<tr>
<td>5 gal/acre</td>
<td>Tebuconazole</td>
<td>N</td>
<td>55</td>
<td>70*</td>
<td>2.1*</td>
</tr>
<tr>
<td>Control</td>
<td>Control</td>
<td>Y</td>
<td>31</td>
<td>99</td>
<td>4.5</td>
</tr>
<tr>
<td>Control</td>
<td>Tebuconazole</td>
<td>Y</td>
<td>66*</td>
<td>60*</td>
<td>2.1*</td>
</tr>
<tr>
<td>2 gal/acre</td>
<td>Control</td>
<td>Y</td>
<td>34</td>
<td>95</td>
<td>4.6</td>
</tr>
<tr>
<td>2 gal/acre</td>
<td>Tebuconazole</td>
<td>Y</td>
<td>59*</td>
<td>73</td>
<td>2.3*</td>
</tr>
<tr>
<td>5 gal/acre</td>
<td>Control</td>
<td>Y</td>
<td>44</td>
<td>88</td>
<td>4.0</td>
</tr>
<tr>
<td>5 gal/acre</td>
<td>Tebuconazole</td>
<td>Y</td>
<td>62*</td>
<td>63*</td>
<td>2.4*</td>
</tr>
</tbody>
</table>

A * indicates a significant difference from the control (no onion soil amendment, no tebuconazole, and no tarp) using Dunnett’s test.
## Results: Yield

Yields were measured from 1 m² plots in August 2016

<table>
<thead>
<tr>
<th>Onion amendment</th>
<th>Fungicide</th>
<th>Tarp</th>
<th>Mean total bulbs (g)</th>
<th>Total yield (g)</th>
<th>Mean no. marketable bulbs</th>
<th>Marketable bulb yield (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Control</td>
<td>N</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Control</td>
<td>Tebuconazole</td>
<td>N</td>
<td>27.0</td>
<td>637.7</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>2 gal/acre</td>
<td>Control</td>
<td>N</td>
<td>10.0</td>
<td>210.6</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>2 gal/acre</td>
<td>Tebuconazole</td>
<td>N</td>
<td>28.8</td>
<td>602.4</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>5 gal/acre</td>
<td>Control</td>
<td>N</td>
<td>0.3</td>
<td>1.1</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>5 gal/acre</td>
<td>Tebuconazole</td>
<td>N</td>
<td>36.5</td>
<td>835.7</td>
<td>0.3</td>
<td>13.6</td>
</tr>
<tr>
<td>Control</td>
<td>Control</td>
<td>Y</td>
<td>11.8</td>
<td>198.1</td>
<td>0.3</td>
<td>10.3</td>
</tr>
<tr>
<td>Control</td>
<td>Tebuconazole</td>
<td>Y</td>
<td>24.5</td>
<td>411.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>2 gal/acre</td>
<td>Control</td>
<td>Y</td>
<td>0.8</td>
<td>9.6</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>2 gal/acre</td>
<td>Tebuconazole</td>
<td>Y</td>
<td>31.8</td>
<td>665.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>5 gal/acre</td>
<td>Control</td>
<td>Y</td>
<td>1.3</td>
<td>19.9</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>5 gal/acre</td>
<td>Tebuconazole</td>
<td>Y</td>
<td>29.0</td>
<td>459.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>
Conclusions

• A significant effect of onion soil amendment and/or tarping was not observed
• Higher rates of onion soil amendment and/or a different method of application may be more effective
• A significant ($P < 0.0001$) effect of tebuconazole was observed for garlic emergence, white rot incidence, and white rot severity based on ratings taken in January
• Four of the tebuconazole treatments exhibited greater total yields compared to the controls
• Marketable yields were negligible in all treatments
Pesticide Management Research Grant White Rot Project

- R. Wilson, T. Turini, J. Dung received a PMRG grant from the CA Department of Pesticide Regulation
- Compare highest possible rate of garlic juice, garlic oil and other products against DADS and Vapam
- IREC and Fresno test sites
- Field trials begin in 2016

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated Control</td>
<td>n/a</td>
</tr>
<tr>
<td>DADS</td>
<td>1 gal/A</td>
</tr>
<tr>
<td>Garlic Company Garlic Juice</td>
<td>max.appl.rate</td>
</tr>
<tr>
<td>Synthetic Garlic Oil Blend</td>
<td>2 gal/A</td>
</tr>
<tr>
<td>AITC (Dominus) test at IREC only</td>
<td>10-40 gal/acre</td>
</tr>
<tr>
<td>Vapam test at IREC only</td>
<td>50 gal/A</td>
</tr>
</tbody>
</table>
Very high ratings from the stakeholder review panel (93%)
Invited to submit a full proposal in March
Thank you for the letters of support!

Letters from Stakeholders and Industry Organizations

National Onion Association
California Garlic and Onion Research Advisory Board
Idaho-Eastern Oregon Onion Committee
Idaho Onion Growers’ Association
Jefferson County (OR) Seed Growers Association
Malheur County (OR) Onion Growers Association
New Mexico Dry Onion Commission
New York State Vegetable Growers Association
Pacific Northwest Vegetable Association

Crookham Company
McCain’s Foods USA Inc.
Nunhems/Bayer
Seminis/Monsanto

Individual Grower Letters
SCRI Grant Proposal: Managing Stakeholder-Prioritized Pest and Diseases Threatening the US Allium Industry

**Thrips and IYSV:**
- Washington State University: Hanu Pappu (Project Director), Tim Waters
- Cornell University: Brian Nault
- New Mexico State University: Chris Cramer
- USDA-ARS: Michael Havey
- Oregon State University: Stuart Reitz

**White Rot:**
- Oregon State University: Jeremiah Dung, Michael Qian
- University of California-ANR: Robert Wilson, Tom Turini

**Economics:**
- College of Idaho: Gina Greenway
Thrips and IYSV:

• Onion germplasm previously selected under thrips and IYSV pressures will be genetically characterized.

• A novel thrips-IYSV management program that combines host-plant tolerance, cultural control, and reduced-risk insecticides will be evaluated and implemented.

• Damage by thrips and IYSV will be assessed and bulb yields measured in field trials in New York (high organic soils) and Oregon/Washington (mineral soils), and compared to the standard approaches.
SCRI Grant Proposal: Managing Stakeholder-Prioritized Pest and Diseases Threatening the US Allium Industry

White Rot:

- Volatile sulfur compounds in garlic and onion will be characterized by M. Qian
- The efficacy of *Allium* sulfur compounds on sclerotia germination will be determined in the lab using soil treatments and filter-paper assays
- Effective dosages and potential synergistic effects of germination stimulants will be evaluated individually and in combinations
- Stimulants will be applied to replicated field trials with and without fungicides
SCRI Grant Proposal: Managing Stakeholder-Prioritized Pest and Diseases Threatening the US Allium Industry

Economic Analysis:

• The economic viability of management programs will be estimated

• Base-line data from existing commodity farm budgets will be used to compare the relative profitability and net economic returns of alternative approaches used to control these pests.

• Costs and economic benefits of management programs will be communicated to stakeholders.

Extension efforts in CA, OR, WA, ID, NM, NY
Acknowledgements

- Michael Qian, Fei He – OSU Food Science and Technology

- Technical assistance:
  - Dr. Jeness Scott
  - Rhonda Simmons
  - Hoyt Downing
  - Mitchell Alley

- Funding and in-kind support:
  - California Garlic and Onion Research Advisory Board
  - TOP Onions USA
  - Olam Spices and Vegetables
  - Bayer Crop Sciences
Questions and Discussion