Evaluation of Sclerotia Germination Stimulants for White Rot Control

California Garlic and Onion Symposium, 2017
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Acknowledgements

Collaborators:
• Robert Wilson – UC-ANR, IREC
• Tom Turini – UC-ANR, Fresno
• Michael Qian – OSU, Corvallis

Technical assistance:
• Jeness Scott
• Travis Klopp
• IREC and COARC Staff

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• CA Garlic and Onion Research Advisory Board
• CA Department of Pesticide Regulation
• The Garlic Company
• Olam Spices and Vegetables
• Isagro USA
Collaborative White Rot Research

• CAGORAB-funded projects:
  • Central OR microplot studies (Dung and Qian)
  • Fresno field research (Turini and Dung)
  • Characterization of stimulants (Qian et al.)

• CA Department of Pesticide Registration Grant (Wilson, Turini, Dung)

• Proposed projects:
  • New fungicides for white rot (Wilson and Dung)
  • Specialty Crops Research Initiative – proposal in preparation
White Rot 101

- 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)
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)
Central OR Microplot Studies

Objectives:

• Test different rates of garlic powder to reduce white rot
• Evaluate dimethyl disulfide (DMDS) and allyl isothiocyanate (AITC) for white rot control
Dimethyl Disulfide (DMDS)

- DMDS kills several soil pathogens and nematodes
- DMDS is a sulfur compound found in garlic that has been suggested to have sclerotial germination stimulant properties
- Paladin is a soil fumigant containing DMDS
- Not currently registered for use in CA
Allyl Isothiocyanate (AITC)

- Broad spectrum soil biofumigant produced by mustards
- Dominus is a biofumigant containing DADS
- Touted as safer and more environmental friendly fumigant than Telone and Vapam.
- Possible labeling for organic systems
Microplots were established in an infested field located at COARC.

- Round (24” diameter x 18” tall), bottomless nursery pots
- 6 replicates

Treatments applied on 4-21-16
Materials and Methods - Central OR Microplot Studies

- Treatments applied at a depth of six inches
- Garlic powder treatments were sprinkled and incorporated by hand
- DADS, DMDS, and AITC treatments were applied using a CO₂ backpack sprayer
- Irrigated (0.5”) after treatments
- Tarped treatments (DMDS and AITC) were covered with white, 6-mil poly film and removed 18 days later
Materials and Methods - Central OR Microplot Studies

- Soil cores sampled prior to treatment (April 20) and 3 months after treatment (July 21)
- Sclerotia recovered via wet-sieving and sucrose flotation
- Sclerotia counted and tested for viability by plating
# Results - Central OR Microplot Studies

<table>
<thead>
<tr>
<th>Germination stimulant</th>
<th>Rate</th>
<th>Pre-treatment</th>
<th>Post-treatment</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-treated control</td>
<td>NA</td>
<td>53.3</td>
<td>51.3</td>
<td>0.3%</td>
</tr>
<tr>
<td>DADS</td>
<td>1 gal/A</td>
<td>56.0</td>
<td>6.0</td>
<td>91.8% *</td>
</tr>
<tr>
<td>Garlic powder</td>
<td>100 lb/A</td>
<td>50.7</td>
<td>7.3</td>
<td>83.7% *</td>
</tr>
<tr>
<td>Garlic powder</td>
<td>75 lb/A</td>
<td>45.3</td>
<td>20.0</td>
<td>54.0% *</td>
</tr>
<tr>
<td>Garlic powder</td>
<td>60 lb/A</td>
<td>39.3</td>
<td>19.3</td>
<td>45.8% *</td>
</tr>
<tr>
<td>Dimethyl disulfide</td>
<td>51.3 gal/A</td>
<td>52.0</td>
<td>51.3</td>
<td>2.0%</td>
</tr>
<tr>
<td>Dimethyl disulfide (tarped)</td>
<td>51.3 gal/A</td>
<td>40.0</td>
<td>38.7</td>
<td>1.7%</td>
</tr>
<tr>
<td>Allyl isothiocyanate (tarped)</td>
<td>40 gal/A</td>
<td>30.7</td>
<td>29.3</td>
<td>3.2%</td>
</tr>
</tbody>
</table>
Conclusions - Central OR Microplot Studies

• A significant effect of DADS and garlic powder was observed
• Higher rates (≥100 lb/acre) or repeated applications of (this) garlic powder would be required to reduce sclerotia to acceptable levels
• DMDS and AITC were not effective; however, efficacy may depend on application methods (e.g. shank injection may be more effective)
• Garlic (15 cloves/microplot) was planted on Oct. 3, 2016
• White rot and yield will be evaluated in 2017
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 began 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>
### Materials and Methods – CA DPR

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated Control</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Vapam</td>
<td>75 gal/A</td>
<td>Fall</td>
</tr>
<tr>
<td>DADS</td>
<td>1 gal/A</td>
<td>Spring</td>
</tr>
<tr>
<td>Garlic Juice (100% v/v)</td>
<td>100 gal/A</td>
<td>Spring</td>
</tr>
<tr>
<td>Garlic Juice (100% v/v)</td>
<td>100 gal/A</td>
<td>Spring &amp; Fall</td>
</tr>
<tr>
<td>Sigma Garlic Oil</td>
<td>2 gal/A</td>
<td>Spring</td>
</tr>
<tr>
<td>Sigma Garlic Oil</td>
<td>2 gal/A</td>
<td>Spring &amp; Fall</td>
</tr>
<tr>
<td>Dominus</td>
<td>10 gal/A</td>
<td>Fall</td>
</tr>
<tr>
<td>Sigma Garlic Oil &amp; Dominus</td>
<td>2 gal/A &amp; 10 gal/A</td>
<td>Spring &amp; Fall</td>
</tr>
</tbody>
</table>
Materials and Methods – CA DPR

• Main plots 12’ x 60’
• Subplots: Tebuconazole (20.5 oz/A)
• Stimulant treatments applied 5-9-16
• Soil sampled before and 3 months after stimulant treatments
Results – CA DPR

No. sclerotia

Pre-treatment

Post-treatment

Non-treated control
DADS (spring)
Garlic Company Garlic Juice (spring)
Garlic Juice (spring & fall)
Sigma Garlic Oil Blend (spring)
Sigma Garlic Oil Blend (spring & fall)
Vapam (fall)
Dominus-AITC (fall)
Spring Garlic Oil (spring) + Dominus (fall)
Conclusions and Next Steps...

• DADS significantly reduced sclerotia numbers by 60%
• Spring application of garlic oil significantly reduced sclerotia counts by 59% in one treatment
• Additional sclerotia germination stimulants, Vapam, and Dominus were applied in September 2016.
• Onions will be planted in spring 2017.
• Fungicide treatments will be applied in-furrow in a split-block design
• Plots will be evaluated for sclerotia populations, disease severity, and yield at harvest.
Proposed Fungicide Evaluations (PI: Rob Wilson)

• In 2016, Bayer released Velum (fluopyram) products labeled for disease and nematode control
• Similar chemistries, such as Luna and Fontelis, have activity on white rot
• We would like to revisit testing fluopyram at a much higher use rate compared to the Luna products that were tested in the past
• Syngenta and DuPont also have new SDHI fungicides slated for registration that we would also like to test for white rot control
• **Objective:** Evaluate the efficacy of new SDHI fungicides for suppression of white rot including fluopyram (formulated as Velum Prime), solatenol, and unregistered compounds
Very high ratings from the stakeholder review panel

Invited to submit a full proposal in March

Thank you for the letters of support!
Garlic Seed Harvest in Culver, OR (2016)