Update on White Rot Control with Fungicides in the San Joaquin Valley

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White Rot of Garlic (and other Alliums)

*Sclerotium cepivorum*
Sclerotia
Sclerotia

- Survive for decades
- Moved with garlic planting material or with soil
- Very few in soil can cause damage to Alliums
Central San Joaquin Valley

13,000 acres with *Sclerotium cepivorum*
Control

- Sanitation
- Sclerotia-germinating stimulant 90-99% effective.
- Some fungicides applied at planting reduce disease severity.
Many of the treatments to be discussed are not currently labeled uses

- Carefully read the current product label before writing any pesticide recommendation.
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (T/A)</th>
<th>Disease from 5/6/04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planted, Untreated Control</td>
<td>4.5 e</td>
<td>4.0 a</td>
</tr>
<tr>
<td>Botran (foliar)</td>
<td>5.1 de</td>
<td>4.5 a</td>
</tr>
<tr>
<td>Pristine (foliar)</td>
<td>5.3 de</td>
<td>4.0 a</td>
</tr>
<tr>
<td>Switch (foliar)</td>
<td>5.4 de</td>
<td>3.8 ab</td>
</tr>
<tr>
<td>Rovral (in furrow)</td>
<td>5.9 cd</td>
<td>3.6 ab</td>
</tr>
<tr>
<td>Pristine (foliar – HIGH RATE)</td>
<td>6.8 bc</td>
<td>2.9 bc</td>
</tr>
<tr>
<td>Botran (in furrow)</td>
<td>7.2 ab</td>
<td>2.1 cd</td>
</tr>
<tr>
<td>Switch (in furrow)</td>
<td>7.7 ab</td>
<td>2.4 cd</td>
</tr>
<tr>
<td>Folicur (seed treatment)</td>
<td>8.4 a</td>
<td>2.0 cd</td>
</tr>
</tbody>
</table>

Foliar treatments were applied on 3/5/04, 3/17/04, 3/25/04, 4/7/04, and 4/16/04.
### Fungicide Comparison 2004-05 Shannon Mueller

<table>
<thead>
<tr>
<th>Material</th>
<th>Rate</th>
<th>Ap</th>
<th>Yield</th>
<th>Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevate (fenhexamid)</td>
<td>1.5 lb/A</td>
<td>Foliar</td>
<td>5.4 f</td>
<td>7.2 a</td>
</tr>
<tr>
<td>Botran (dicloran)</td>
<td>1 pint/A</td>
<td>Drip</td>
<td>5.5 f</td>
<td>6.7 ab</td>
</tr>
<tr>
<td>Rovral (iprodione)</td>
<td>4 pints/A</td>
<td>Drip</td>
<td>5.6 f</td>
<td>6.1 abcde</td>
</tr>
<tr>
<td>Elevate (fenhexamid)</td>
<td>1.5 lb/A</td>
<td>Foliar</td>
<td>5.8 f</td>
<td>6.9 ab</td>
</tr>
<tr>
<td>Untreated Control</td>
<td>--</td>
<td>--</td>
<td>6.0 ef</td>
<td>6.9 ab</td>
</tr>
<tr>
<td>Pristine</td>
<td>18.5 oz/A</td>
<td>Drip</td>
<td>6.0 ef</td>
<td>6.5 abc</td>
</tr>
<tr>
<td>Endura (boscalid)</td>
<td>6.8 oz/A</td>
<td>Drip</td>
<td>6.1 def</td>
<td>6.3 abcd</td>
</tr>
<tr>
<td>Folicur (tebuconazole)</td>
<td>20.5 fl oz/A</td>
<td>Drip</td>
<td>6.4 cdef</td>
<td>6.2 abcd</td>
</tr>
<tr>
<td>Omega (fluazinam)</td>
<td>0.6 pints/A</td>
<td>In furrow</td>
<td>6.9 bcdef</td>
<td>5.9 bcde</td>
</tr>
<tr>
<td>Botran (dicloran)</td>
<td>2 pints/A</td>
<td>Drip</td>
<td>7.0 bcdef</td>
<td>6.1 abcde</td>
</tr>
<tr>
<td></td>
<td>1 pint/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thiophanate methyl</td>
<td>13 lbs/A</td>
<td>Drip</td>
<td>7.7 abcde</td>
<td>5.9 bcde</td>
</tr>
<tr>
<td>Switch (fludioxinil + cyprodinil)</td>
<td>14 oz/A</td>
<td>In furrow</td>
<td>7.8 abcde</td>
<td>4.9 ef</td>
</tr>
<tr>
<td>Scholar (fludioxinil)</td>
<td>8 oz/A</td>
<td>In furrow</td>
<td>7.9 abcd</td>
<td>5.1 def</td>
</tr>
<tr>
<td>Botran (dicloran)</td>
<td>102 oz/A</td>
<td>In furrow</td>
<td>8.2 abc</td>
<td>5.7 bcde</td>
</tr>
<tr>
<td>Folicur (tebuconazole)</td>
<td>20.5 oz/A</td>
<td>In furrow</td>
<td>8.7 ab</td>
<td>4.1 f</td>
</tr>
<tr>
<td>Pristine</td>
<td>18.5 oz/A</td>
<td>In furrow</td>
<td>8.9 a</td>
<td>5.4 cde</td>
</tr>
<tr>
<td>Folicur (tebuconazole)</td>
<td>20.5 fl oz/A</td>
<td>In furrow</td>
<td>9.2 a</td>
<td>3.9 f</td>
</tr>
<tr>
<td></td>
<td>5.8 fl oz/A</td>
<td>2 Foliar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endura (boscalid)</td>
<td>6.8 oz/A</td>
<td>In furrow</td>
<td>9.4 a</td>
<td>5.1 def</td>
</tr>
</tbody>
</table>

**Foliar: 3/11/05 and 3/31/05. 50 gpa and 20 psi.**

**Drip injected: 3/11/05: repeated for Botran on 4/8, 4/25, 5/3, and 5/18/05.**
Fungicide In furrow Comparison, 2005-06
Shannon Mueller
above ground disease severity

[Bar chart showing comparison of fungicide treatments with 'Endura', 'Folicur', 'Cannonball', 'Omega', 'Topsin M', and 'Untreated' categories.]
Fungicide In furrow Comparison, 2005-06
Shannon Mueller

yield (tons/a)

Endura
Folicur
Cannonball
Omega
Topsin M
Untreated
Drip: Fungicide Comparison, 2005-06
Shannon Mueller

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fresh Wt (t/A)</th>
<th>Disease rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botran 2 pts/A</td>
<td>4.42</td>
<td>6.00</td>
</tr>
<tr>
<td>Endura 6.8 oz/A</td>
<td>4.97</td>
<td>5.77</td>
</tr>
<tr>
<td>Untreated</td>
<td>5.24</td>
<td>5.90</td>
</tr>
<tr>
<td>LSD</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

Drip injected on 4/28/06 and 5/11/06.
2007-2008 Objectives

• To evaluate white rot management programs (combining furrow/multiple drip applications)
• To compare performance of fungicides
• To assess activity of biological control agents against white rot
• To assess the effect of a soil surfactant soil adjuvant (Watermaxx II) on fungicide performance.
Fresno County Research
2003-2007
(Shannon Mueller: UCCE, Fresno)

• At Planting Fungicide Applications
  – At planting, Folicur, Endura, Scholar, Switch and Botran reduced disease severity and increased yield

• Drip applications (2005-06) not effective
Fresno Co., CA White Rot Trials, 2007-2008

• Evaluation of at-planting applications combined with drip applications

• Chemical/biological control agent efficacy comparison
Cultural Details

Location: *S. cepivorum* infested field in Fresno Co. (114 sclerotia/kg soil sampled 27 Sep 2007).

California Late garlic was planted in 2 seed lines per 40” beds on 20 Nov 2007.
Application Details

• At planting application
  – CO$_2$-pressurized backpack sprayer
  – 25 gallons of water per acre
  – 30 psi.

• All drip applied materials were pumped into the 1-2 inch deep drip line over 45 minutes.
Monitoring

• OnSet temperature recorder was placed in field with sensors buried to depths of 2.5, 5, 7.5 and 10 inches
Soil Temperatures at Fresno Co. White Rot Trial

Date

degrees Fahrenheit
45  50  55  60  65  70  75  80  85

Sensor depth
- 2.5 inch
- 5.0 inch
- 7.5 inch
- 10 inch

Optimum temperature for infection: 60-65°F
Temp range: 50-75°F
Monitoring

- OnSet temperature recorder was placed in field with sensors buried to depths of 2.5, 5, 7.5 and 10 inches
- Fifty garlic cloves were collected from buffers (untreated) on 7 and 14 Feb and surface sterilized and incubated in moist chambers at 72°F
Garlic Clove Collection and Incubation

- 7 Feb collection: *S. cepivorum* grew from 2/50 cloves
- 14 Feb collection: *S. cepivorum* grew from 1/50 cloves
Monitoring

• OnSet temperature recorder was placed in field with sensors buried to depths of 2.5, 5, 7.5 and 10 inches
• Fifty garlic cloves were collected from buffers (untreated) on 7 and 14 Feb and surface sterilized and incubated in moist chambers at 72°F
• Above ground symptoms were rated (0-10 scale) on 23 Apr and 14 May.
Monitoring

- OnSet temperature recorder was placed in field with sensors buried to depths of 2.5, 5, 7.5 and 10 inches.
- Fifty garlic cloves were collected from buffers (untreated) on 7 and 14 Feb and surface sterilized and incubated in moist chambers at 72°F.
- Above ground symptoms were rated (0-10 scale) on 23 Apr and 14 May.
- Twenty-five ft of each plot was harvested on 22 - 23 Aug, weighed and re-weighed on 3 Sep.
At Planting Treatments

1. Folicur 20.5 oz
2. Cannonball 8.0 oz
3. Contans 4 lbs/a
4. Cannonball 8.0 oz + Botran 5F 102 oz
5. Untreated control
## Drip Applied Treatments

<table>
<thead>
<tr>
<th>Application dates</th>
<th>15 Feb</th>
<th>7 Mar</th>
<th>27 Mar</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cannonball 8.0oz</td>
<td>Folicur 20.5 oz</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Cannonball 8.0oz</td>
<td>Folicur 20.5 oz</td>
<td>Endura 6.8 oz</td>
</tr>
<tr>
<td>3</td>
<td>Folicur 20.5 oz</td>
<td>Cannonball 8.0oz</td>
<td>Endura 6.8 oz</td>
</tr>
<tr>
<td>4</td>
<td>Untreated control</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


## Five Replication Split-Plot Experimental Design

<table>
<thead>
<tr>
<th></th>
<th>REP 1</th>
<th>REP 2</th>
<th>REP 3</th>
<th>REP 4</th>
<th>REP 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>10'</td>
<td>Drip 4</td>
<td>Drip 2</td>
<td>Drip 1</td>
<td>Drip 3</td>
<td>Drip 4</td>
</tr>
<tr>
<td>IF 5</td>
<td>IF 3</td>
<td>IF 2</td>
<td>IF 3</td>
<td>IF 5</td>
<td>IF 4</td>
</tr>
<tr>
<td>IF 2</td>
<td>IF 5</td>
<td>IF 4</td>
<td>IF 2</td>
<td>IF 1</td>
<td>IF 3</td>
</tr>
<tr>
<td>IF 4</td>
<td>IF 2</td>
<td>IF 1</td>
<td>IF 5</td>
<td>IF 1</td>
<td>IF 2</td>
</tr>
<tr>
<td>IF 1</td>
<td>IF 4</td>
<td>IF 3</td>
<td>IF 4</td>
<td>IF 2</td>
<td>IF 1</td>
</tr>
<tr>
<td>IF 3</td>
<td>IF 1</td>
<td>IF 5</td>
<td>IF 1</td>
<td>IF 5</td>
<td>IF 4</td>
</tr>
</tbody>
</table>

| 10' | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
Programs Trial: In furrow
Above-ground symptom severity, 23 Apr

Cannonball 8.0 oz + Botran 5F 3.2 qts
Folicur 20.5 oz
Cannonball 8.0 oz
Untreated control
Contans 4 lbs

P=0.05
Programs Trial: In furrow
Above-ground symptom severity, 14 May

P=0.05
Programs Trial: In furrow
fresh weights (tons/acre)

P=0.05
## Programs Trial: drip applied treatments

<table>
<thead>
<tr>
<th>Date of application and materials applied</th>
<th>Severity (0-10)</th>
<th>Weights (tons/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15 Feb 7 Mar 27 Mar</td>
<td>23 Apr 14 May</td>
</tr>
<tr>
<td>Cannonball 8.0oz Folicur 20.5 ozxxxxxx</td>
<td>2.52 3.00</td>
<td>4.63 3.82</td>
</tr>
<tr>
<td>Cannonball 8.0oz Folicur 20.5 oz Endura 6.8 oz</td>
<td>2.40 3.28</td>
<td>4.26 3.82</td>
</tr>
<tr>
<td>Folicur 20.5 oz Cannonball 8.0oz Endura 6.8 oz</td>
<td>2.24 3.00</td>
<td>4.43 3.91</td>
</tr>
<tr>
<td>Untreated control</td>
<td>2.40 3.28</td>
<td>4.07 3.83</td>
</tr>
<tr>
<td>LSD$_{0.05}$</td>
<td>NS NS</td>
<td>NS NS</td>
</tr>
</tbody>
</table>
At Planting Efficacy Trial

1. Moncut (flutolanil: Gowan) 2.86 lbs
2. Folicur 20.5 fl oz fp/a with WatermaxxII (soil adjuvant: Western Farm Service) 2 qts
3. Cannonball 50WP 8.0 oz fp/a with WatermaxxII 2 qts
4. Contans (Coniothyrium minitans) 2 lbs
5. Contans 4 lbs
6. Contans 8 lbs
7. Endura 6.8 oz
8. Glomes intrardices (Reforestation Technologies International) 30.0 lbs
9. Cannonball 50WP (fludioxonil: Syngenta) 4.0 oz
10. Cannonball 50WP (fludioxonil: Syngenta) 8.0 oz
11. Folicur (tebuconizole: Bayer) 20.5 fl oz
12. Untreated control
Efficacy Comparison
Above-ground symptom severity, 23 Apr

- Endura 6.8 oz
- Folicur 20.5 oz
- Cannonball 8.0 oz + WatermaxxII 2 qts
- Folicur 20.5 oz + WatermaxxII 2 qts
- Cannonball 4.0 oz
- Moncut 2.86 lbs
- Glomes intrardices 30.0 lbs
- Contans 4 lbs
- Contans 2 lbs
- Contans 8 lbs
- Untreated control
Efficacy Comparison In Furrow
Fresh Weights (tons/acre)

- Endura 6.8 oz
- Folicur 20.5 oz
- Cannonball 8.0 oz + WatermaxxII 2 qts
- Folicur 20.5 oz + WatermaxxII 2 qts
- Cannonball 4.0 oz
- Moncut 2.86 lbs
- Glomes intrardices 30.0 lbs
- Contans 4 lbs
- Contans 2 lbs
- Contans 8 lbs
- Untreated control
Summary

- At planting application were effective, but drip applications did not reduce disease severity or increase yield – infection had occurred at time of first application.
- Endura, Folicur, and Cannonball applied at planting resulted in increased yields.
- Under the conditions of this study, biological control agents were not effective against white rot, but may show efficacy if applied the season before planting a susceptible crop.
- The use of soil adjuvant (Watermaxx II) with Folicur or Cannonball did not result in a detectable reduction of disease or increase in yields as compared with Folicur or Cannonball alone, under the conditions of this study.
Acknowledgements

- CGORAB
- Larry Schwankl – UC, Kearney Ag Center
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- Richard Molinar – UCCE, Fresno
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- Sentient Dehydrated Flavors
- Advan
- BASF
- Bayer
- Gowan
- Syngenta
- Western Farm Service
- Western Forestation Technologies
2007-08 Fresno Co. white rot trial report

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