Lettuce drop: Current and future management considerations

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Sclerotinia drop on lettuce

*Sclerotinia minor* and *Sclerotinia sclerotiorum*
Disease cycle for Sclerotinia drop begins and ends with sclerotia

- **S. minor**: 0.5 - 2.0 mm long
- **S. sclerotiorum**: 2.0 to 20.0 mm long
Disease cycle: *Sclerotinia minor*
Disease cycle: *Sclerotinia sclerotiorum*
Airborne spores of *S. sclerotiorum*
Requirements for aerial spore production and infection by *S. sclerotiorum*

**Aerial spore production**
- Sclerotia in the top 2 inches of soil
- Wet soil
- Soil temperatures from 46 - 61°F

**Aerial spore infection of lettuce**
- Presence of free water on leaves
- Senescent plant tissue
2010 Sclerotinia aerial infection outbreak
Field temperature and moisture data*:

- **Nov 26-30**
  - 2010: 5 days with low below 40°F (32-38°F)
  - 2007, 08, 09: No days with low below 40°F
  - 2006: One day with low below 40°F (35°F)

- **December**
  - 2010: 14 days (all consecutive) with RH ≥ 90% (92-100%)
  - 2009: 5 days (2 consecutive) with RH ≥ 90% (90-95%)
  - 2008: 12 days (7 consecutive) with RH ≥ 90% (91-100%)
  - 2007: 8 days (3 consecutive) with RH ≥ 90% (91-97%)
  - 2006: 1 day with RH ≥ 90% (94%)

*Yuma Valley AZMET station
2010 Sclerotinia aerial infection outbreak

Requirements for aerial spore production and infection by *S. sclerotiorum*

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- Sclerotia in the top 2 inches of soil
- Wet soil
- Soil temperatures from 46 - 61°F

**Aerial spore infection of lettuce**
- Presence of free water on leaves
- Senescent plant tissue
Most Sclerotinia drop on lettuce in Arizona is initiated by direct germination of sclerotia.

- Direct germination of sclerotia favored by wet soil at temperatures ranging from 50 to 75°F.

![S. minor](image1.png)  ![S. sclerotiorum](image2.png)
More abundant production of sclerotia (10 to 100X) by *S. minor* compared to *S. sclerotiorum*
Summary of differences between *Sclerotinia minor* and *S. sclerotiorum*

- Size of sclerotia
- Abundance of sclerotia
- Ability of *S. sclerotiorum* to produce aerial spores
  - When this occurs, entire fields can be infected and destroyed
At the end of the crop, sclerotia mixed back into soil to await the next lettuce crop
Management of Sclerotinia drop

The target of disease control efforts are the sclerotia.

Sclerotia allow the pathogens to carry over in soil from one lettuce crop to another.

Disease management tools

– Cultural
– Biological
– Chemical
Cultural disease management tools

- Do nothing
  - Population of sclerotia will decline over time
- Soil solarization
  - Sclerotia in nonsolarized furrows will not be affected
- Summer soil flooding for 3-4 weeks
Effect of soil temperature and moisture on viability of *Sclerotinia* sclerotia

- Irrigated soil
- Nonirrigated soil
Effect of soil temperature on viability of sclerotia of *S. minor*

Summary of 3 trials. Soil irrigated every 1-2 wk, depending on the trial. Sclerotia at 0 and 2 inch depth.
Effect of soil temperature on viability of sclerotia of *S. sclerotiorum*

<table>
<thead>
<tr>
<th>Duration</th>
<th>Soil Temperature</th>
<th>Percentage of sclerotia that did not germinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 weeks</td>
<td>79°F</td>
<td></td>
</tr>
<tr>
<td>4 weeks</td>
<td>79°F</td>
<td></td>
</tr>
<tr>
<td>6 weeks</td>
<td>79°F</td>
<td></td>
</tr>
<tr>
<td>8 weeks</td>
<td>79°F</td>
<td></td>
</tr>
<tr>
<td>2 weeks</td>
<td>90°F</td>
<td></td>
</tr>
<tr>
<td>4 weeks</td>
<td>90°F</td>
<td></td>
</tr>
<tr>
<td>6 weeks</td>
<td>90°F</td>
<td></td>
</tr>
<tr>
<td>8 weeks</td>
<td>90°F</td>
<td></td>
</tr>
</tbody>
</table>

Summary of 3 trials. Soil irrigated every 1-2 wk, depending on the trial. Sclerotia 0 and 2 inch depth.
Effect of soil moisture on viability of sclerotia of *S. minor*

Summary of 3 trials. Soil irrigated every 1-2 wk, depending on the trial. Sclerotia 0 – 2 inches deep. Mean soil temp. 90°F for irrigated and 102°F for nonirrigated soil.
Effect of soil moisture on viability of sclerotia of *S. sclerotiorum*

Summary of 3 trials. Soil irrigated every 1-2 wk, depending on the trial. Sclerotia 0 – 2 inches deep. Mean soil temp. 90°F for irrigated and 102°F for nonirrigated soil.
Effect of soil flooding on viability of Sclerotinia sclerotia
Effect of summer soil flooding on viability of sclerotia

- **Sclerotinia minor**
  - 1 week
  - 2 weeks
  - 3 weeks
  - 4 weeks

- **Sclerotinia sclerotiorum**
  - 1 week
  - 2 weeks
  - 3 weeks
  - 4 weeks

Percentage of sclerotia that did not germinate
Sclerotinia drop management tools

- Cultural
- Biological
- Chemical
Management of Sclerotinia drop with biofungicides

Evaluating efficacy
<table>
<thead>
<tr>
<th>Product</th>
<th>Active ingredient</th>
<th>Source</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actinovate</td>
<td><em>Streptomyces lydicus</em></td>
<td>Natural Industries</td>
<td>At seeding, after thinning</td>
</tr>
<tr>
<td>Contans</td>
<td><em>Coniothyrium minitans</em></td>
<td>SipcamAdvan</td>
<td>At seeding, after thinning</td>
</tr>
<tr>
<td>Endura</td>
<td><em>Boscalid</em></td>
<td>BASF</td>
<td>At seeding, after thinning</td>
</tr>
<tr>
<td>Humega 81</td>
<td><em>Bacillus amyloliquefaciens</em></td>
<td>BioFlora</td>
<td>At seeding, +14 and 28 days</td>
</tr>
<tr>
<td>Humega S</td>
<td><em>B. amyloliquefaciens, B. megaterium, B. subtilis</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sil-Matrix</td>
<td>Potassium silicate</td>
<td>Certis USA</td>
<td>At seeding, +6 times</td>
</tr>
<tr>
<td>SoilGard</td>
<td><em>Gliocladium virens</em></td>
<td>Certis USA</td>
<td>At seeding, after thinning</td>
</tr>
<tr>
<td>Tenet</td>
<td><em>Trichoderma asperellum T. gamsii</em></td>
<td>SipcamAdvan</td>
<td>At seeding, after thinning</td>
</tr>
</tbody>
</table>
Percent lettuce drop control

2010 biofungicide trial

Contans
Endura
Actin. / End. + Actin.
Actin. / End.
Humega 81
Actinovate
SoilGard
SilMATRIX
Tenet
Humega S

Percent disease control

S. minor
S. sclerotiorum
Sclerotinia drop management tools

- Cultural
- Biological
- Chemical
Management of Sclerotinia drop with conventional chemistries

Evaluating efficacy
Growth stages of crisphead lettuce and occurrence of Sclerotinia drop

- **Seedling**: 20–36 days
- **First true leaf**: 14–28 days
- **Thinning**: 14–28 days
- **Rosette**: 14–28 days
- **Early-heading**: 10–26 days
- **Mid-heading**: 16–30 days
- **Mature head**: 16–30 days
Chemical disease management

**Traditional application timing:** Applied to bed and base of plants to prevent germination of sclerotia at or near soil surface

- Immediately after thinning and cultivation
- At rosette stage (2-3 weeks after thinning)
Relative efficacy of products for management of lettuce drop caused by each species of Sclerotinia

Each value is the mean from 4 trials, with 2 applications of each product per trial
Field trial protocol 2010-11 field trial
Evaluation of new chemistries

- Lettuce seeded on raised beds in double rows, 12 inches apart
- At thinning, sclerotia produced in the laboratory were spread on the surface of each 25-ft-long plot between the rows of lettuce seed and mixed into the top 2-inches of soil
  - 2100 sclerotia of *S. minor*, 800 of *S. sclerotiorum* per plot
  - Five replicate plots per treatment
Field trial protocol (continued)

- First application of products after thinning
- Field irrigated by sprinkler irrigation to germinate seed, then furrow irrigated for remainder of trial
- One subsequent application of products 2 weeks after thinning
- At crop maturity, the number of dead plants per plot due to *Sclerotinia* infection was recorded
## Products tested in 2010-11 lettuce drop trial

<table>
<thead>
<tr>
<th>Trade name</th>
<th>Active ingredient</th>
<th>Source</th>
<th>FRAC #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contans</td>
<td>Coniothyrium minitans</td>
<td>Sipcam/Advanc</td>
<td></td>
</tr>
<tr>
<td>Endura</td>
<td>Boscalid</td>
<td>BASF</td>
<td>7</td>
</tr>
<tr>
<td>Rovral</td>
<td>Iprodione</td>
<td>Bayer</td>
<td>2</td>
</tr>
<tr>
<td>SoilGard</td>
<td>Gliocladium virens</td>
<td>Certis</td>
<td></td>
</tr>
<tr>
<td>Switch</td>
<td>Cyprodinil + fludioxonil</td>
<td>Syngenta</td>
<td>9+12</td>
</tr>
<tr>
<td>Cannonball</td>
<td>Fludioxonil</td>
<td>Syngenta</td>
<td>12</td>
</tr>
<tr>
<td>Fontelis</td>
<td>Pentiopyrad</td>
<td>DuPont</td>
<td>7</td>
</tr>
<tr>
<td>Omega</td>
<td>Fluazinam</td>
<td>Syngenta</td>
<td>29</td>
</tr>
<tr>
<td>Experimental</td>
<td>--------</td>
<td>-------------</td>
<td>------</td>
</tr>
<tr>
<td>S-2200</td>
<td>--------</td>
<td>-------------</td>
<td>------</td>
</tr>
</tbody>
</table>

Registered on lettuce
Lettuce drop control: *S. minor* 2010 trial

Two applications: at thinning and 2 wk later

- Fontelis
- S-2200
- Omega*
- Contans
- Endura
- Experimental
- Cannonball
- V-10135
- Rovral
- SoilGard
- Switch

* Percent disease control

*LSD = 17*

* Omega applied only after thinning*
Lettuce drop control: *S. sclerotiorum* 2010

Two applications: at thinning and 2 wk later

Contans

S-2200

Endura

SoilGard

Fontelis

Switch

Omega*

Experimental

Cannonball

Rovral

* Percent disease control

LSD = 16

* Omega applied only after thinning
Lettuce drop control: *S. minor*

Two year average

Percent disease control

- **Endura**
- **Fontelis**
- **Cannonball**
- **Rovral**
Lettuce drop control: *S. sclerotiorum*

Two year average

<table>
<thead>
<tr>
<th>Product</th>
<th>Percent Disease Control</th>
</tr>
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<tbody>
<tr>
<td>Cannonball</td>
<td>52%</td>
</tr>
<tr>
<td>Endura</td>
<td>49%</td>
</tr>
<tr>
<td>Rovral</td>
<td>40%</td>
</tr>
<tr>
<td>Fontelis</td>
<td>35%</td>
</tr>
</tbody>
</table>
Future research

Examine alternate methods of application with the goal of maximizing control of Sclerotinia drop
- Application at seeding vs. at thinning
- Incorporation into soil vs. application to soil surface
- Single compared to multiple applications
Thank you for your attention