Management of Fusarium Basal Rot of Onion

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Fusarium basal rot of onion
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- *Fusarium oxysporum* f. sp. cepae
- Worldwide in onion production regions
- Soilborne, fairly persistent
- Only *Allium* spp. are susceptible
- Affects onion at any growth stage
- Progresses in storage (not between bulbs)
- Survives >4 yrs in soil: residues, chlamydospores
- Seedborne?
- Spread: soil, seed/sets/transplants, water
- Favorable conditions:
  - warm soils (>80°F, rarely at <60°F)
  - moist soils
  - injured roots/basal plate (e.g., maggot)
Fusarium oxysporum f. sp. cepae

Macroconidia, microconidia, chlamydospores
**Fusarium oxysporum f. sp. cepae**

- Genetic variation (Swift et al. 2002; Galván et al. 2008; Southwood et al. 2012; Taylor et al. 2016; Armitage et al. 2018)
  - 7 vegetative compatibility groups (VCGs): VCG 0420 - 0426
  - 4 single member VCGs: SMV 7 - 10
  - Some non-pathogenic isolates of *F. oxysporum* closely related to *Foc*
- Variation in virulence
- 2 mating types (*MAT1-1* & *MAT1-2*)
- Inform onion breeding efforts

Southwood et al. 2012
Fusarium basal rot: Management

- Rotation of 4+ years: Pathogen & saprophyte on organic matter
- Cold storage of bulbs (<40°F)
- Chemical control:
  - Fungicide seed treatments (FRAC Groups 1 & 3)
    - Limited duration of efficacy
    - Primarily limits impact of seedborne, not soilborne, inoculum
  - Bulb dips & dust treatments
    - Sintahehu et al. (2011): Shallot bulbs dipped in prochloraz, tebuconazole, carbendazim, mancozeb: Prochloraz & carbendazim reduced Fusarium basal rot incidence (40 & 43%), increased yield (42-45%)
    - Naik & Burden (1981): Bulb treatment with benomyl reduced basal rot by 77%, increased yield 106%
  - Soil treatments
    - Tebuconazole, carbendazim, thiophanate-methyl reported to reduce losses but not registered in most countries/states for this use (de Visser et al. 2006)
  - Soil fumigation
    - Metam sodium
    - Telone C-17 or C-35
    - Application method – shanked vs. chemigated?
Application of a pesticide to a crop or site that is not on the label is a violation of pesticide law and may subject the applicator to civil penalties.

In addition, such an application may also result in illegal residues that could subject the crop to seizure or embargo action.

It is your responsibility to check the label before using any product to ensure lawful use, and obtain all necessary permits in advance.
## Fumigation for Fusarium basal rot

Schwartz (1986): Shanked Telone C-17 or Vapam in (Colorado)

<table>
<thead>
<tr>
<th>Site, treatment, rate</th>
<th>Plant stand/A</th>
<th>Pink root severity</th>
<th>Fusarium basal rot incidence (%)</th>
<th>Yield (cwt/A)</th>
<th>Fumigation cost/A</th>
<th>Net return/A ($5/cwt)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kersey Site ‘White Sweet Spanish PRR’</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telone C-17 24 gpa</td>
<td>80,275</td>
<td>Light</td>
<td>13.8</td>
<td>570</td>
<td>$282</td>
<td>$428</td>
</tr>
<tr>
<td>Control</td>
<td>68,825</td>
<td>Moderate</td>
<td>23.2</td>
<td>428</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>LSD (P = 0.05)</td>
<td>NS</td>
<td>-</td>
<td>NS</td>
<td>66</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Olathe Site ‘Brown Beauty’</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telone C-17 30 gpa</td>
<td>69,000</td>
<td>Light</td>
<td>27.2</td>
<td>480</td>
<td>$351</td>
<td>$1,249</td>
</tr>
<tr>
<td>Vapam 60 gpa</td>
<td>54,000</td>
<td>Light</td>
<td>55.4</td>
<td>212</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Control</td>
<td>53,800</td>
<td>Moderate</td>
<td>56.4</td>
<td>160</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LSD (P = 0.05)</td>
<td>8,500</td>
<td>-</td>
<td>15.0</td>
<td>165</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

- Telone C-17 reduced pink root severity (moderate to light), Fusarium basal rot incidence (10-28%), increased marketable yield (33-198%)
- Sumner et al. (1997) in GA: Chloropicrin most effective, metam sodium & Telone C-17 were less efficacious, methyl bromide or Telone alone were ineffective
Fumigation with metam sodium?

Historically, metam sodium has never effectively reached all three pests (weed seed, nematodes, soilborne pathogens) in a single application (Kyle Coleman, NovaSource)
On chemigated fields, metam readings in shank traces were 2-5x higher than between shanks, even in sand (800+ readings, WA)

Kyle Coleman, NovaSource
Metam sodium fumigation
Summary points – Kyle Coleman, NovaSource

• Metam has **very low vapor pressure**, making vertical and lateral movement difficult. Ground preparation, moisture, and product placement are important.

• **Chemigation:** Most metam is located in the top 4 inches of soil

• **Ground-applied metam:** Product moves 6 inches above and below the injection point, assuming ground is moist and ripped below the injection point.
  
  – With single level injection by ground, the top 4 inches can be difficult to reach.

• Because readings are typically gone after 48 hours in warm weather, **pre-irrigation is an excellent practice.**
Fusarium basal rot: Management (ctd)

• Resistant or tolerant cultivars
  • Variation in virulence among isolates, variation in onion germplasm
  • Screening/breeding efforts:
    – Early programs: Retig et al. (1970) in WI, Sokhi et al. (1974) in India, ...
    – A. fistulosum, A. roylei, & A. galanthum = potential introgression to A. cepa
    – Private breeding programs

• Manage root/bulb feeding insects (e.g., maggot)
• Avoid excessive N fertilization, excessive soil moisture, minimize stress
• Sanitation, avoid moving soil from infested fields (machinery, shoes, ...
Fusarium basal rot: Management (ctd)

- Organic amendments, e.g., biofumigant & other cover crops, alfalfa, vetch, etc. (de Visser et al. 2006; Ozer et al. 2002)

![Graph showing the incidence of Fusarium basal rot of onion in soil amended with stalks of different plants in two sites.](image)

In incidence of Fusarium basal rot of onion in soil amended with stalks of different plants in two sites (Ozer et al. 2002. Phytoparasitica 30:429-433)
Fusarium basal rot: Management (ctd)

- Fusarium basal rot risk assessment:
  - Soil/seed/seedling testing? Soil bioassay ineffective (de Visser et al. 2006)

Figure 13-45. *Fusarium oxysporum.*
A – B: Macroconidia; C – D: Microconidia; E – F: Microconidia in situ on CLA. A – D, scale bar = 25 µm; E – F, scale bar = 50 µm.

Leslie et al., 2006
Identification of pathogenic strains of *Fusarium oxysporum*

Koch’s postulates

- Consistently isolate fungus from symptomatic plants
- Describe fungus in culture
- Inoculate healthy plants of same species/cultivar
- Reproduce same symptoms as on original plants
- Re-isolate fungus from inoculated plants
- Verify characteristics of isolates = original isolates

Time-consuming & very tedious!
Identification of pathogenic strains of *Fusarium oxysporum* f. sp. *cepaе*

Molecular methods of identification

• DNA-based assays (polymerase chain reaction = PCR)
  - Relatively rapid
  - Can be quite costly
  - Cannot differentiate DNA from live vs. dead cells

• Adele McLeod, South Africa: Molecular method(s) of identifying *F. oxysporum* f. sp. *cepaе*, VCGs (Southwood et al. 2012)

• Genetic variation among onion isolates, screening onion germplasm for resistance (Galván et al. 2008, Netherlands)

• John Clarkson, UK: Identified pathogenicity factors, developed DNA primers based on onion pathogenicity genes (not yet available) (Taylor et al. 2016, Armitage et al. 2018)
Fusarium wilt in spinach seed crops

Fusarium oxysporum f. sp. spinaciae
Soil bioassay for spinach Fusarium wilt


(vs. a real-time PCR assay: Okubara et al. 2013. Plant Dis. 97:927-937)
Risk assessment: Spinach Fusarium wilt soil bioassay

A. 2009–10 bioassay

B. 2010–11 bioassay

Also screen spinach parent lines for susceptibility to Fusarium wilt
### Multiple regression analyses (121 fields)

| pH       | Buffer pH | NO₃ | NH₄⁺ | P   | K   | Ca  | Mg  | S   | B   | Fe  | Mn  | Zn  | Cu  | CEC | OM  | EC  | Spinach rotation duration | % sand, silt, and clay | F. oxysporum, V. dahliae |
|----------|-----------|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---------------------------|-------------------------|-------------------------|

#### Susceptible inbred:

\[ Y = -0.4556 - 0.0172(\text{rotation}) + 0.0854(\text{NH}_4^+ - \text{N}) - 0.3875(\text{soil pH}) + 0.4037(\text{buffer pH}) + 0.0056(\text{sand}) + 0.0245(\text{clay}) \]

\( R^2 = 0.3396 \text{ at } P < 0.0001 \)

#### Moderate inbred:

\[ Y = 1.0777 - 0.0136(\text{rotation}) + 0.0005(\text{V. dahliae}) + 0.0563(\text{NH}_4^+ - \text{N}) - 0.1528(\text{soil pH}) + 0.0045(\text{clay}) \]

\( R^2 = 0.3213 \text{ at } P < 0.0001 \)

#### Resistant inbred:

\[ Y = 0.6161 - 0.0094(\text{rotation}) + 0.0498(\text{NH}_4^+ - \text{N}) + 0.0003(\text{K}) - 0.0947(\text{soil pH}) \]

\( R^2 = 0.2415 \text{ at } P < 0.0001 \)
Fusarium wilt risk assessment:
Spinach Fusarium wilt bioassay vs. soil testing for
*Fusarium oxysporum*

A) Area-under-disease-progress-curve (AUDPC) for severity of wilt rated weekly from 21-42 days after planting on a 0-5 scale (5 = all plants dead)

2018

Fungal counts (CFU/gram of soil)

2018

*Fusarium oxysporum*
Fusarium basal rot of onion: Summary

- Don’t cut onion rotations short (ideally 4+ years)
  - Longer rotations for fields with history of onion Fusarium basal rot
- Avoid moving soil from infested fields on equipment
- Incorporate organic matter (cover crops, residues of non-host crops)
- Select cultivars with partial resistance/tolerance (ask seed reps)
- Minimize stress, don’t over-fertilize or irrigate excessively
- Use cold storage for bulbs
- Soil fumigation: Follow shank and/or chemigation recommendations for accurate placement throughout the top 6-10”
- If you get your soil tested for Fusarium or F. oxysporum, use caution in interpreting results for risk prediction