Fusarium Wilt of Leafy Greens: Managing a Challenging Disease

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Fusarium wilt

Caused by the soil-borne fungus

*Fusarium oxysporum*
Fusarium oxysporum

Mycelium

Macrospores

Microspores

Chlamydospores & macrospores
Characteristics of *Fusarium oxysporum*

- Some members of this group only live on dead plant tissue (not plant pathogens).

- Those that are plant pathogens also can live on dead plant tissue when host plant is not available.
  - Enables the pathogen to remain in the soil indefinitely.
Characteristics of *Fusarium oxysporum*

Those that are plant pathogens are specific for certain plant hosts and are known as ‘forma speciales’ or special forms.

There are over 100 different special forms of *Fusarium oxysporum*, each usually with a specific host on which they can cause disease.

- *Fusarium oxysporum* f. sp. *asparagii* (asparagus)
- *Fusarium oxysporum* f. sp. *melonis* (muskmelon)
Leafy green *Fusarium* pathogens

- *Fusarium oxysporum* f. sp. *spinaciae* (spinach)
- *Fusarium oxysporum* f. sp. *erucae* (arugula)
- *Fusarium oxysporum* f. sp. *conglutinans* (lamb’s lettuce)
- *Fusarium oxysporum* f. sp. *lactucae* (lettuce)
Fusarium wilt development

- Fungus invades plants through roots
- Grows in plant xylem, which transports water and nutrients from roots to foliage
- Xylem becomes obstructed and plant wilts and dies
- Older plants may survive but are often stunted
- Infected plants usually show reddish-brown discoloration in cortex
Symptoms of Fusarium wilt on lettuce
How do you know if *Fusarium oxysporum* f. sp. *lactucae* (*Fol*) is in a lettuce field?
Fusarium wilt, Sclerotinia drop or Botrytis gray mold?
Worldwide occurrence of Fusarium wilt of lettuce

- 1955 Japan
- 1990 U.S. (California; Fresno County)
- 1995 Iran
- 1998 Taiwan
- 2000 Brazil
- 2001 U.S. (Arizona; Yuma County)
- 2002 Italy
Races of *Fusarium oxysporum f. sp. lactucae*

- Races 1, 2, 3: Japan
- Race 1: Brazil, Iran, Italy, Taiwan, United States

Question: How did the pathogen travel across continents?
Races of *Fusarium oxysporum* f. sp. *lactucae*

- Races 1, 2, 3: Japan
- Race 1: Brazil, Iran, Italy, Taiwan, United States

**Question:** How did the pathogen travel across continents?

Italian researchers confirmed that *Fusarium oxysporum* f. sp. *lactucae* is seed-transmitted.
Lettuce fields found to contain *Fusarium oxysporum f. sp. lactucae*

Fields containing the pathogen (2001 to 2003)
- 26 in Yuma County
- 2 in Imperial County (Bard Valley)
Lettuce fields found to contain *Fusarium oxysporum* f. sp. *lactucae*

Current recorded sites containing the pathogen:
- 50 in Yuma County
- 3 in Imperial County (Bard Valley)
Disease management considerations: Plant resistant cultivars

The primary management tool for Fusarium wilt on most hosts is to plant resistant cultivars

- Resistance in crisphead cultivars not yet commercially available
- Some romaine cultivars have tolerance to the Fusarium pathogen
Lettuce cultivar evaluation trial: Romaine vs. head lettuce
Romaine cultivar susceptibility to Fusarium wilt
2-year average, early September planting

- Slugger
- King Louie
- BOS 9021
- Fresheart
- Triton
- Green Towers
- Clemente
- DF-7
- Darkland COS
- Robusto
- Paragon PIC
- Green Forest
- Conquistador
- Coastal Star

Percentage of plants with Fusarium wilt
Disease management considerations: Sanitation

- Minimize movement of pathogen from infested to noninfested fields
  - Anything that moves infested soil or plant material can spread the pathogen
  - Seed bed preparation activities, cultivation and harvesting operations
    - Contaminated irrigation pipe, workers shoes, tractors and other farm equipment
  - Sanitation practices need to be implemented even when lettuce is not planted in the field
Disease management considerations: Crop rotation

The Fusarium wilt lettuce pathogen
- can colonize living tomato, cantaloupe, watermelon, and cotton plants without causing disease symptoms
- can grow on dead organic matter such as crop waste
Disease management considerations: Chemical treatment

At seeding application of thiophanate-methyl, fludioxonil, or boscalid+ pyraclostrobin had no effect on disease development
Disease management considerations:

Chemical treatment

At seeding application of thiophanate-methyl, fludioxonil, or boscalid+ pyraclostrobin had no effect on disease development.

In one trial, preplant application of Vapam (30-60 gal/acre) reduced disease incidence at maturity by 44% for a susceptible crisphead cultivar.
Disease management considerations: Cultural practices

- Grow lettuce at a time less favorable for development of Fusarium wilt
  - Most lettuce plants with Fusarium wilt have been found from October to December
- These fields were seeded from September through early October
Incidence of Fusarium wilt at crop maturity at different planting dates

Crisphead lettuce

- 2002 season
- 2003 season

<table>
<thead>
<tr>
<th>Planting date</th>
<th>2002 season</th>
<th>2003 season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sep 7 or 3</td>
<td>90%</td>
<td>30%</td>
</tr>
<tr>
<td>Oct 17 or 21</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>Dec 6 or 18</td>
<td>2%</td>
<td>1%</td>
</tr>
</tbody>
</table>
Incidence of Fusarium wilt at crop maturity at different planting dates

Mean soil temperature at the 4 inch depth from seeding to time of first disease rating

- Sep 7 or 3: 82°F
- Oct 17 or 21: 68°F, 66°F
- Dec 6 or 18: 54°F (2002 season), 54°F (2003 season)

Crisphead lettuce
Effect of planting date and lettuce type on incidence of Fusarium wilt (2 years)

<table>
<thead>
<tr>
<th>Lettuce type</th>
<th>September planting</th>
<th>October planting</th>
<th>December planting</th>
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<tbody>
<tr>
<td>Crisphead</td>
<td>94</td>
<td>30</td>
<td>1.3</td>
</tr>
<tr>
<td>Romaine</td>
<td>34</td>
<td>8</td>
<td>0.2</td>
</tr>
<tr>
<td>Green leaf</td>
<td>74</td>
<td>2</td>
<td>0.1</td>
</tr>
<tr>
<td>Red leaf</td>
<td>67</td>
<td>1</td>
<td>5.2</td>
</tr>
<tr>
<td>Butterhead</td>
<td>88</td>
<td>1</td>
<td>0.3</td>
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Disease management considerations

Soil solarization
2005 field soil solarization trial
Fusarium wilt at crop maturity
Soil temperatures recorded in 2006 trial at a depth of 2 inches

<table>
<thead>
<tr>
<th>Bed condition</th>
<th>Mean soil temp (°F)</th>
<th>Temperature range (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not solarized</td>
<td>Solarized</td>
</tr>
<tr>
<td>Preshaped</td>
<td>102</td>
<td>116</td>
</tr>
<tr>
<td></td>
<td>Not solarized</td>
<td>Solarized</td>
</tr>
<tr>
<td></td>
<td>80-122</td>
<td>82-149</td>
</tr>
</tbody>
</table>

Solarization performed during July and August
Soil temperature (°F) in a solarized bed

<table>
<thead>
<tr>
<th>Soil depth (inches)</th>
<th>July 20, 3:00 p.m.</th>
<th>July 22, 8:00 a.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>153 104</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>146 109</td>
<td>143 100 145 98</td>
</tr>
<tr>
<td>3</td>
<td>131 100</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>124 100</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>118 100</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>113 101</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>109 102</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>108 102</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>104 102</td>
<td>104 103 104 102</td>
</tr>
</tbody>
</table>
2006 field soil solarization trial
Fusarium wilt at crop maturity
Crisphead lettuce

Not solarized

Solarized
2006 field soil solarization trial
Fusarium wilt at crop maturity
Green leaf

Not solarized

Solarized
2006 field soil solarization trial
Fusarium wilt at crop maturity
Romaine

Not solarized

Solarized
Reduction of lettuce *Fusarium* wilt incidence due to soil solarization

In plots planted to a susceptible crisphead lettuce cultivar

<table>
<thead>
<tr>
<th>Year</th>
<th>% Disease reduction</th>
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<tbody>
<tr>
<td>2004</td>
<td>42</td>
</tr>
<tr>
<td>2005</td>
<td>81</td>
</tr>
<tr>
<td>2006</td>
<td>98</td>
</tr>
<tr>
<td>2007</td>
<td>67</td>
</tr>
</tbody>
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Review of lettuce Fusarium wilt management considerations:

- **Resistant cultivars:** Some tolerant romaine, crisphead not there yet
- **Sanitation:** Avoid moving infested soil or plant material to noninfested fields
- **Crop rotation:** too long to be feasible
- **Chemical treatment:** more work needed
- **Cultural practices:** avoid September and early October planting dates
- **Solarization:** can significantly reduce disease