Fusarium wilt of lettuce in Arizona

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Fusarium wilt of lettuce
Fusarium wilt (root rot) of lettuce:

- 1955 - First found on lettuce in Japan
- 1990 - USA; California; Fresno County (Huron)
- 1995 - Iran
- 1998 - Taiwan
- 2001 - USA; Arizona; 6 fields
- 2002 - Italy
Fusarium wilt of lettuce in Yuma

- 2001 - *Fusarium oxysporum* was recovered from lettuce in 6 different fields
- 2002 - 11 new fields
- 2003 - 10 new fields (includes one site in Bard, CA)
- 2004 - ??
Yuma County fields containing *Fusarium oxysporum f. sp. lactucae*
**Fusarium oxysporum**

- Comprises 40 to 70% of the total *Fusarium* population in soil
- Very active saprophyte (nonpathogenic phase).
- When pathogenic, it primarily causes symptoms of wilt and sometimes root rot
- There are over 100 different formae speciales of *Fusarium oxysporum*
What is a formae specialis?

- This is a sub-species categorization based on physiological or biochemical characteristics, particularly with respect to pathogenicity and host range.
- The full name for the lettuce pathogen is *Fusarium oxysporum* f.sp. *lactucae*. 
Fusarium oxysporum

A = mycelium growing on agar
B = macroconidia
C = microconidia
D = chlamydospores + macroconidia
How do you know if you have *Fusarium oxysporum f. sp. lactucae* in your field?
Symptoms of Fusarium wilt on lettuce
Symptoms of Fusarium wilt on lettuce

• **Seedling stage**
  – Death of some plants
  – Red streak through the cortex of the crown and upper root

• **Older plants**
  – Brown streaks in the vascular system of the crown
  – Reddish brown discoloration of the crown and upper root cortex
In 1993, Hubbard and Gerik published the results of their work with the lettuce *Fusarium* pathogen in California.

- The pathogen grows between 46 and 89 F, with optimum growth at 82 F.
- Lettuce is not susceptible to any of the *Fusarium* wilt pathogens from other crops, such as cotton, melon and tomato.
- Seedling inoculation tests revealed that several lettuce cultivars were susceptible to the pathogen, with Salinas showing the most disease tolerance.
On other crops, Plant resistance or genetic tolerance is most often used to manage wilt diseases caused by *Fusarium oxysporum*
Lettuce cultivar evaluation trials

- Trials conducted in a field with a history of Fusarium wilt of lettuce
- Lettuce cultivars planted at three different planting dates
- The replicate plot size was two beds 150 ft. in length, with 4 replicate plots per cultivar arranged in a randomized complete block design
- Disease development was monitored from thinning until plant maturity
Incidence of Fusarium wilt at first, second and third disease rating date

<table>
<thead>
<tr>
<th></th>
<th>First</th>
<th>Second</th>
<th>Third</th>
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<tbody>
<tr>
<td>Sep planting</td>
<td>20</td>
<td>60</td>
<td>100</td>
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<tr>
<td>Oct planting</td>
<td>20</td>
<td>10</td>
<td>20</td>
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<tr>
<td>Dec planting</td>
<td>20</td>
<td>10</td>
<td>20</td>
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</table>
Incidence of Fusarium wilt at crop maturity at different planting dates

![Bar chart showing incidence of Fusarium wilt at crop maturity at different planting dates. The chart compares the 2002 season (blue) and the 2003 season (red) with three planting dates: Sep 7 or 3, Oct 17 or 21, and Dec 6 or 18. The peak incidence is observed in Sep 7 or 3, with lower incidence in Oct 17 or 21 and minimal incidence in Dec 6 or 18.](chart_image)
Soil temperature during time intervals between disease ratings

<table>
<thead>
<tr>
<th>Planting date</th>
<th>Final disease incidence (%)</th>
<th>Soil temp (F): Seeding to first rating</th>
<th>Soil temp (F): First to second rating</th>
<th>Soil temp (F): Second to third rating</th>
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<tbody>
<tr>
<td>2002-03</td>
<td></td>
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<tr>
<td>Sep 7</td>
<td>97</td>
<td>82</td>
<td>75</td>
<td>70</td>
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<tr>
<td>Oct 17</td>
<td>37</td>
<td>68</td>
<td>57</td>
<td>50</td>
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<td>Dec 6</td>
<td>2</td>
<td>54</td>
<td>59</td>
<td>64</td>
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<td>2003-04</td>
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<tr>
<td>Sep 3</td>
<td>80</td>
<td>90</td>
<td>82</td>
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<td>Oct 21</td>
<td>7</td>
<td>66</td>
<td>52</td>
<td>53</td>
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<td>Dec 18</td>
<td>1</td>
<td>54</td>
<td>53</td>
<td>64</td>
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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>
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<tr>
<td>Romaine</td>
<td>34</td>
<td>8</td>
<td>0.2</td>
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<tr>
<td>Green leaf</td>
<td>74</td>
<td>2</td>
<td>0.1</td>
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<tr>
<td>Red leaf</td>
<td>67</td>
<td>1</td>
<td>5.2</td>
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<tr>
<td>Butterhead</td>
<td>88</td>
<td>1</td>
<td>0.3</td>
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Lettuce cultivar susceptibility to Fusarium wilt

2-year average - First planting

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<tr>
<td>ROMAINE</td>
<td>BOS 9021</td>
<td>Clemente</td>
<td>Coastal Star</td>
<td>Conquistador</td>
<td>Darkland COS</td>
<td>DF 7</td>
<td>Fresheat</td>
<td>Green Forest</td>
<td>Green Towers</td>
<td>King Louie</td>
<td>Paragon PIC</td>
<td>Robusto</td>
<td>Slugger</td>
<td>Triton</td>
<td>Marin (GL)</td>
<td>North Star (GL)</td>
<td>Optima (B)</td>
<td>Red Tide (RL)</td>
<td>Two Star (GL)</td>
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Percentage of plants dead or stunted

0 20 40 60 80 100
Lettuce cultivar evaluation trial:
Head lettuce: first planting
Lettuce cultivar evaluation trial: Romaine vs. head lettuce
Green leaf  Red leaf  Head
Second planting – Head lettuce

Susceptible cultivar

Tolerant cultivar
Second planting – romaine, leaf lettuce
On other crops, Plant resistance or genetic tolerance is most often used to manage wilt diseases caused by *Fusarium oxysporum*
On other crops, plant resistance or genetic tolerance is most often used to manage wilt diseases caused by *Fusarium oxysporum*.

What else can be done to combat Fusarium wilt of lettuce?
Evaluation of selected fungicides against Fusarium wilt of lettuce

Three products
• Pristine (boscalid + pyraclostrobin)
• Scholar (fludioxonil)
• Topsin M (thiophanate methyl)
were applied to beds after seeding Lighthouse and before first irrigation, then again 4 wk later.

This experiment was conducted at each of the three planting dates during the 2003-04 season.
Evaluation of selected fungicides against Fusarium wilt of lettuce

The three products
Pristine (boscalid + pyraclostrobin)
Scholar (fludioxonil)
Topsin M (thiophanate methyl)
had no effect on disease development in the September, October or December lettuce plantings
Soil flooding and soil solarization have reduced the population of some fungal plant pathogens in earlier studies.
Soil flooding and soil solarization trials

Soil infested with *Fusarium oxysporum* f. sp. *lactucae* was placed in 5-gallon buckets and treated as described below.

- No treatment of soil (the control)
- Soil flooded for 15, 30, 45 or 60 days
- Soil thoroughly irrigated, then covered with a clear plastic film for 15, 30, 45 or 60 days.

Lettuce seedlings then were transplanted into soil from each treatment and observed for symptoms of Fusarium wilt.
Fusarium soil flooding trial
Fusarium soil solarization trial
Soil temperatures for treatments of Fusarium infested soil in 2003

From Jul 22 to Sep 22, 2003

<table>
<thead>
<tr>
<th>Soil treatment</th>
<th>Mean temp (F)</th>
<th>Temperature range (F)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>At the 2-inch depth</strong></td>
<td></td>
<td></td>
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<tr>
<td>Dry soil</td>
<td>98</td>
<td>68-132</td>
</tr>
<tr>
<td>Flooded soil</td>
<td>88</td>
<td>68-106</td>
</tr>
<tr>
<td>Solarized soil</td>
<td>109</td>
<td>77-142</td>
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<tr>
<td><strong>At the 9-inch depth</strong></td>
<td></td>
<td></td>
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<tr>
<td>Dry soil</td>
<td>95</td>
<td>86-108</td>
</tr>
<tr>
<td>Flooded soil</td>
<td>90</td>
<td>80-100</td>
</tr>
<tr>
<td>Solarized soil</td>
<td>102</td>
<td>86-118</td>
</tr>
</tbody>
</table>
Foliar symptom rating after treatment of soil infested with *Fusarium oxysporum f. sp. lactucae*

**Rating scale:**
- 0 = no apparent disease.
- 1 = slight to moderate stunting.
- 2 = Severe stunting and yellowing.

<table>
<thead>
<tr>
<th>Condition</th>
<th>F(15)</th>
<th>F(30)</th>
<th>F(45)</th>
<th>F(60)</th>
<th>S(15)</th>
<th>S(30)</th>
<th>S(45)</th>
<th>S(60)</th>
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<td>Check (Dry soil)</td>
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<td>Flooded soil (days)</td>
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<td>Solarized soil (days)</td>
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</tbody>
</table>
Root symptom rating after treatment of soil infested with *Fusarium oxysporum f. sp. lactucae*

**Rating scale:**

- **0** = no discoloration of root cortex.
- **1** = slight to moderate yellowing.
- **2** = Slight to moderate red streaking.
- **3** = Necrotic cortex tissue.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Check</th>
<th>F(15)</th>
<th>F(30)</th>
<th>F(45)</th>
<th>F(60)</th>
<th>S(15)</th>
<th>S(30)</th>
<th>S(45)</th>
<th>S(60)</th>
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<tr>
<td>Dry soil</td>
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<td>Flooded soil (days)</td>
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<td>Solarized soil (days)</td>
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Plant fresh weight (g) after treatment of soil infested with *Fusarium oxysporum f. sp. lactucae*
Plants from soil flooding and solarization trial

Disease rating of 3

Disease rating of 2

Disease rating of 1

Disease rating of 0
Management considerations for fields infested with *Fusarium oxysporum f. sp. lactucae*

- Prevent the spread of soil from contaminated to “clean” fields by workers and equipment
  - This may be especially difficult when crops other than lettuce are grown
- Selection of appropriate planting time and lettuce cultivar
Management considerations for fields not infested with *Fusarium*

- The vast majority of lettuce production fields (99%) in Yuma County are not yet known to contain the lettuce *Fusarium* pathogen
- In these fields, take every precaution to prevent the introduction of the pathogen
- Use normal criteria for selection of planting time and lettuce cultivar