

Fusarium Wilt of Leafy Greens: Managing a Challenging Disease

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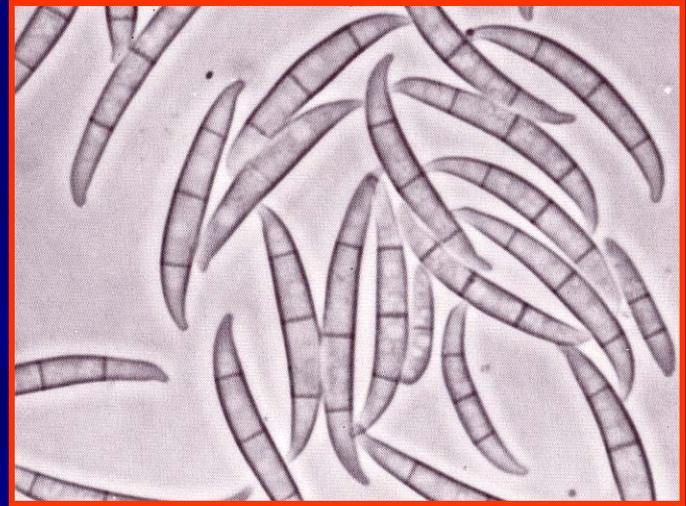
Fusarium wilt

- Caused by the soil-borne fungus
Fusarium oxysporum

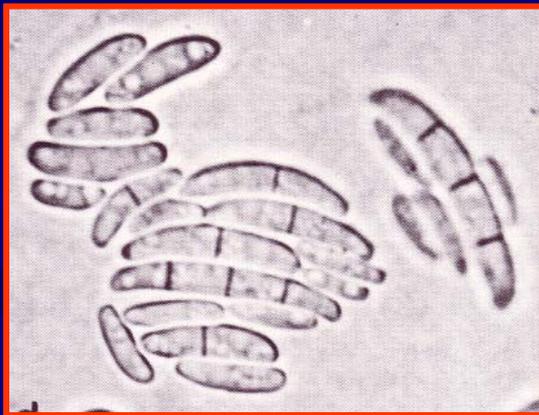
Fusarium oxysporum



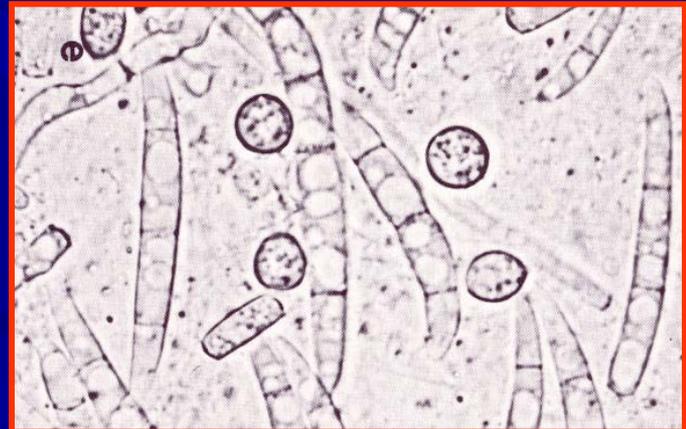
Mycelium



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)



Spinach



Arugula



Lamb's lettuce



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?

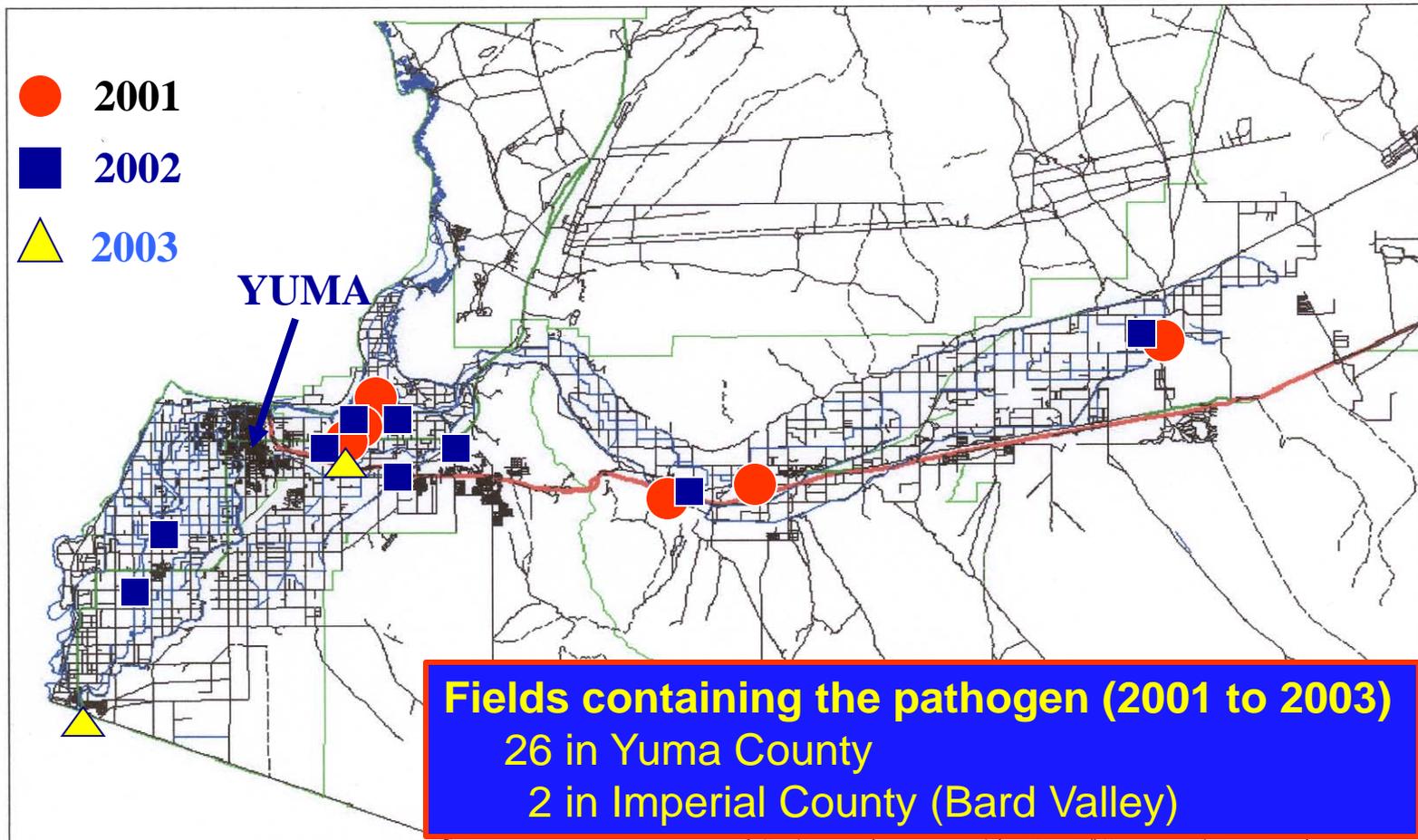
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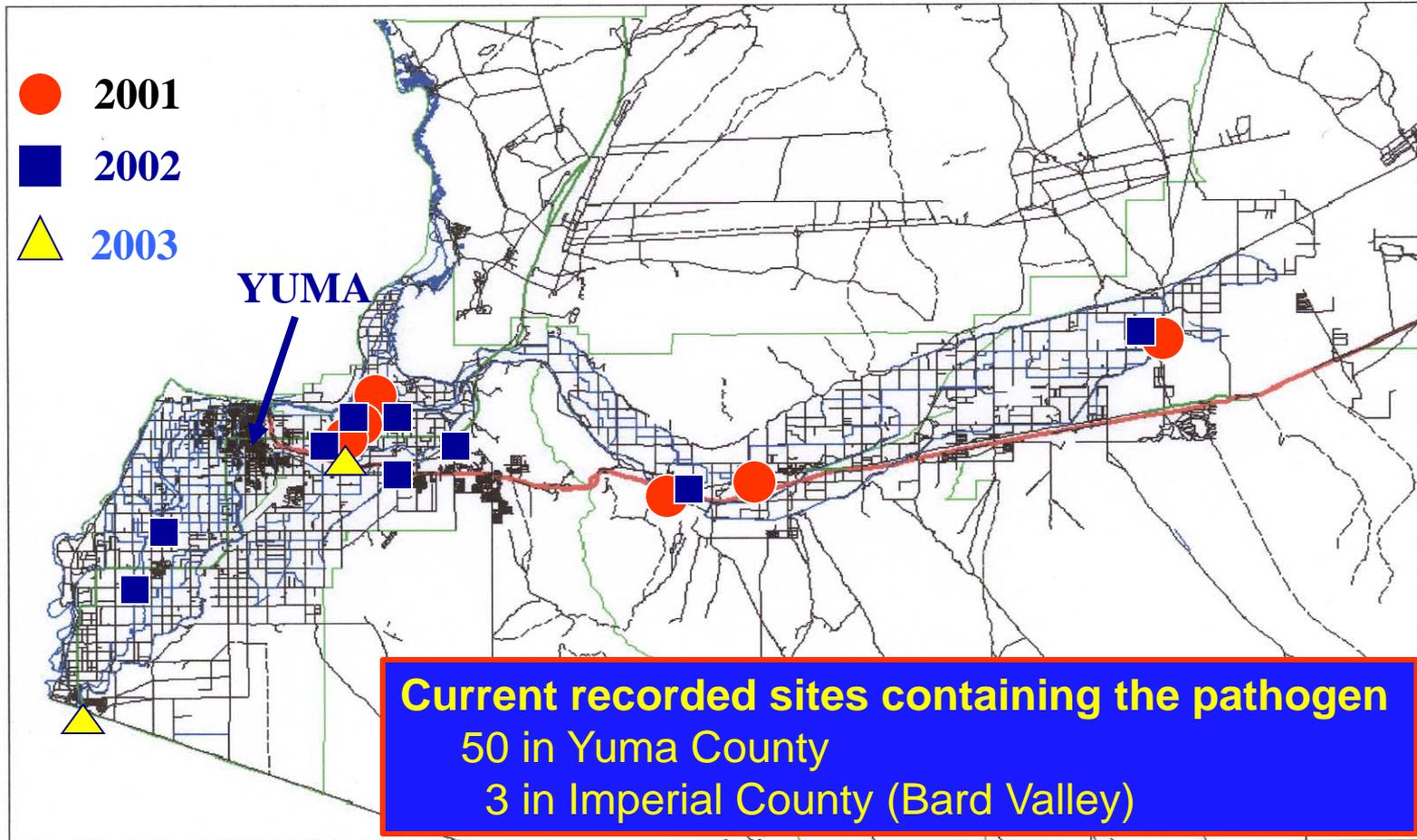
Italian researchers confirmed that *Fusarium oxysporum* f. sp. *lactucae* is seed-transmitted

Lettuce fields found to contain *Fusarium oxysporum* f. sp. *lactucae*



10 miles

Lettuce fields found to contain *Fusarium oxysporum* f. sp. *lactucae*



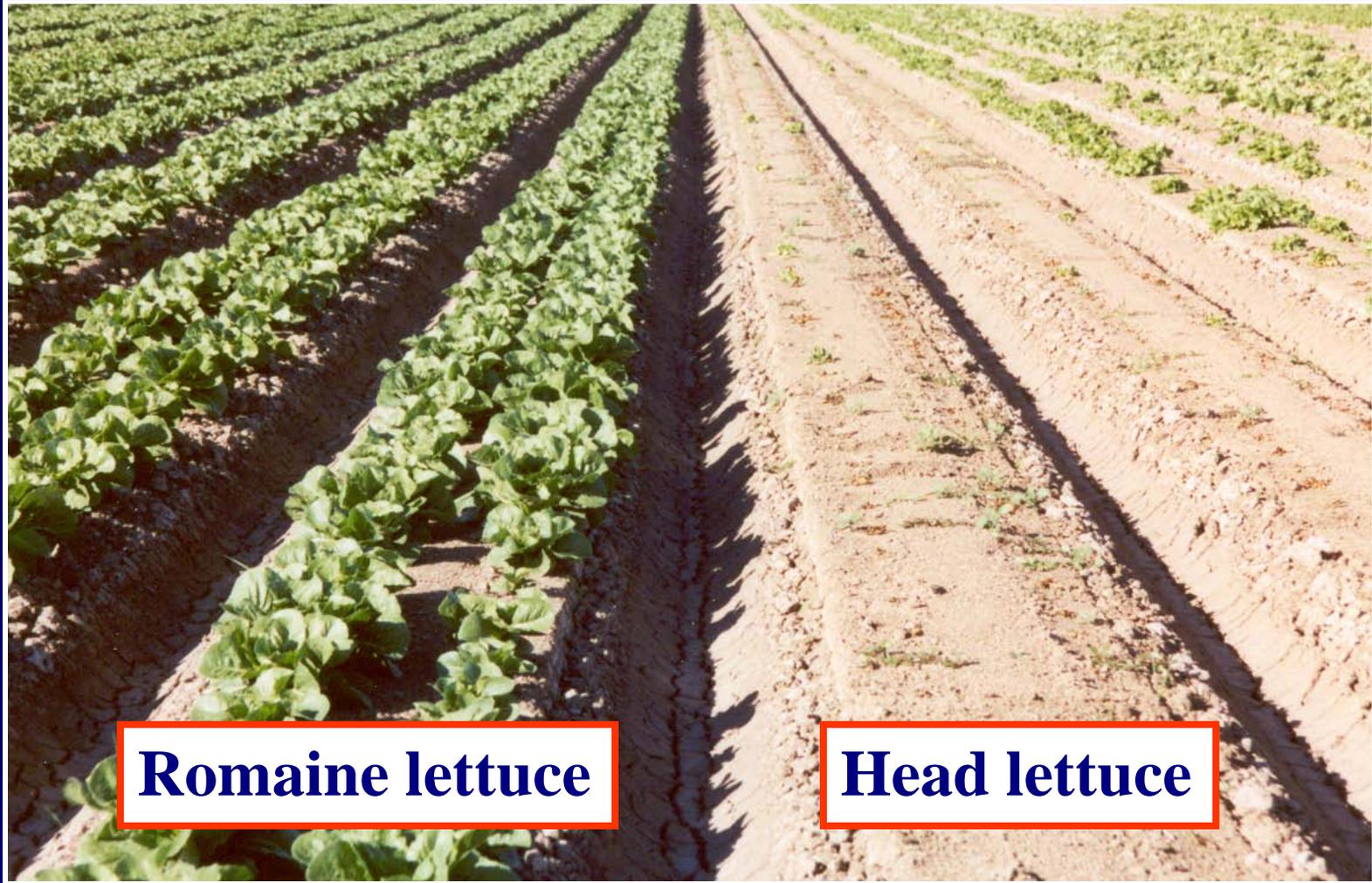
10 miles

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

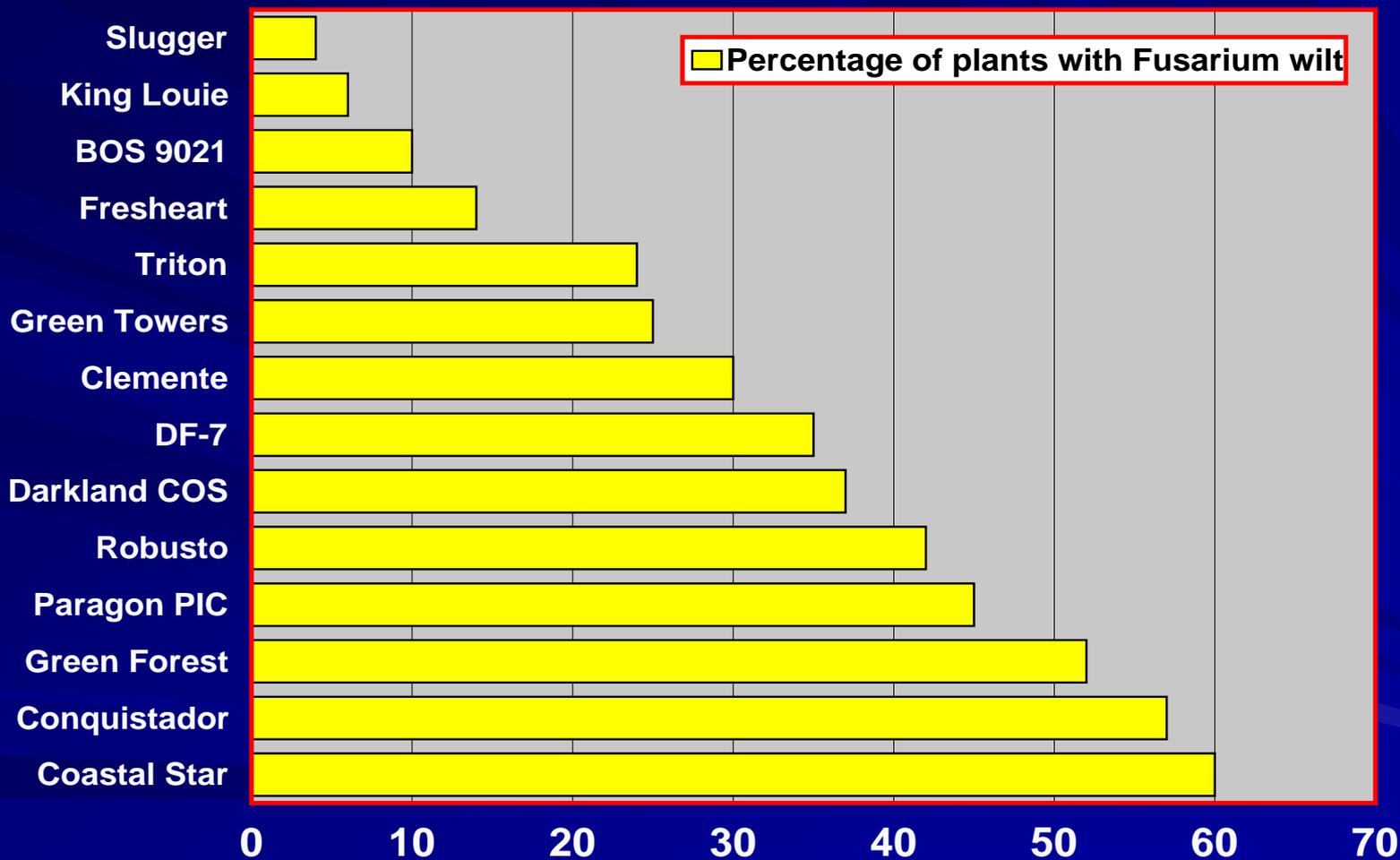


Romaine lettuce

Head lettuce

Romaine cultivar susceptibility to Fusarium wilt

2-year average, early September planting



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 a 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

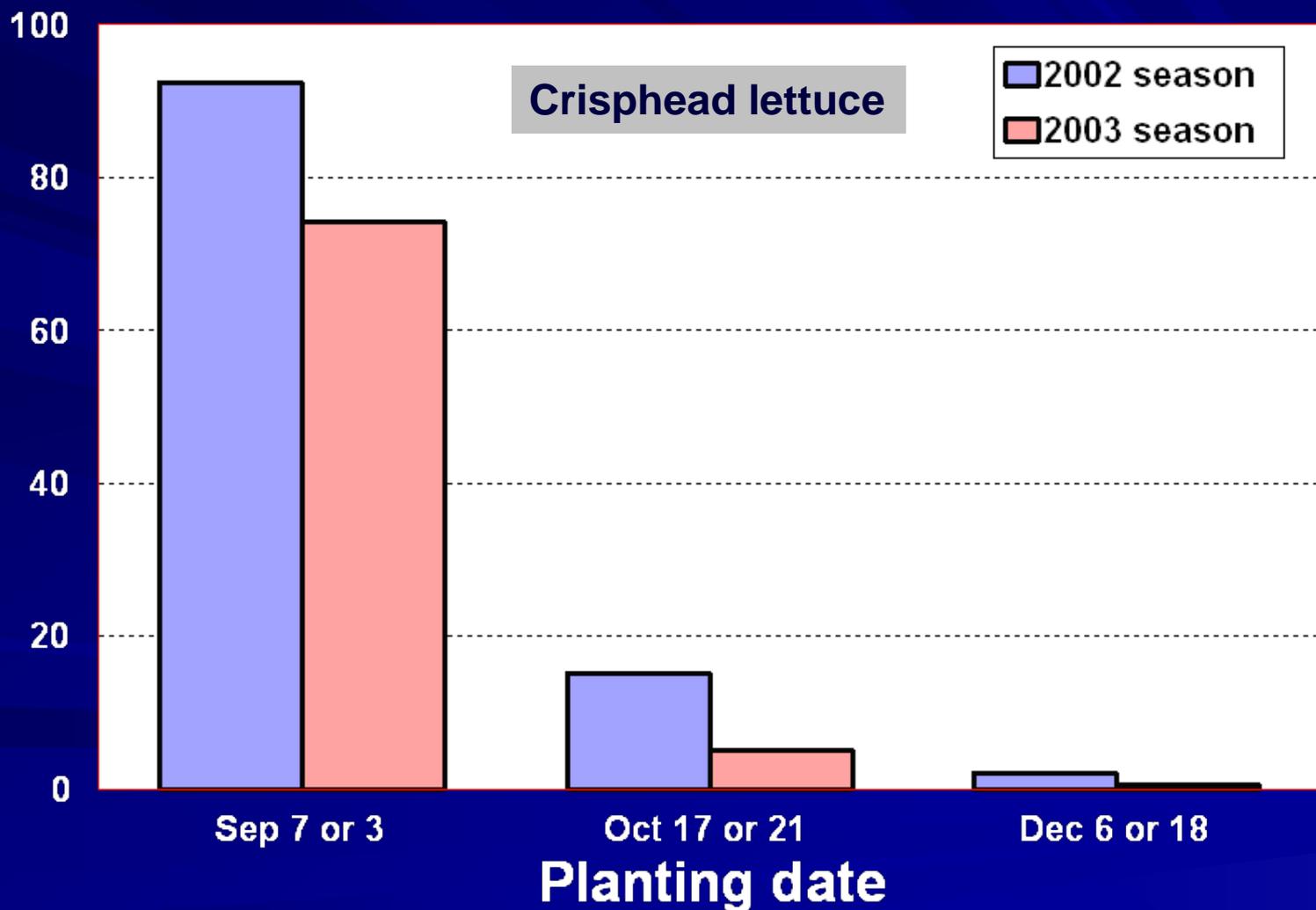
- At seeding application of thiophanate-methyl, fludioxonil, or boscalid+ pyraclostrobin had no effect on disease development
- In one trial, preplant application of Vapam (30-60 gal/acre) reduced disease incidence at maturity by 44% for a susceptible crisphead cultivar

Disease management considerations:

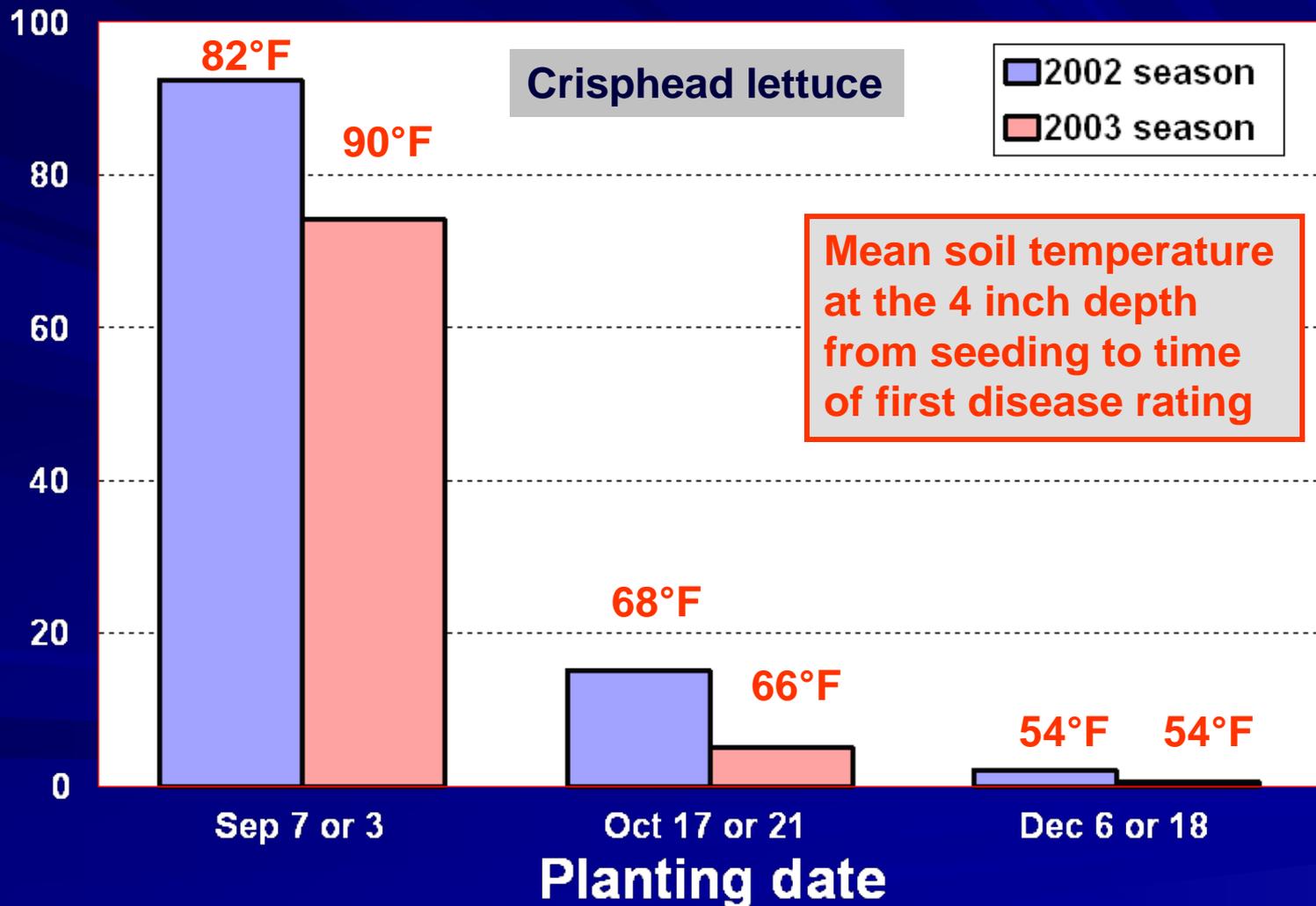
Cultural practices

- 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



Incidence of Fusarium wilt at crop maturity at different planting dates



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

Lettuce type	September planting	October planting	December planting
Crisphead	94	30	1.3
Romaine	34	8	0.2
Green leaf	74	2	0.1
Red leaf	67	1	5.2
Butterhead	88	1	0.3

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

Bed condition	Mean soil temp (°F)		Temperature range (°F)	
	Not solarized	Solarized	Not solarized	Solarized
Preshaped	102	116	80-122	82-149

Solarization performed during July and August

Soil temperature (°F) in a solarized bed

Soil depth
(inches)

July 20, 3:00 p.m.

July 22, 8:00 a.m.

1

153 104

2

146 109

143 100

145 98

3

131 100

4

124 100

5

118 100

6

113 101

7

109 102

8

108 102

9

104 102

104 103

104 102

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

Year	% Disease reduction
2004	42
2005	81
2006	98
2007	67

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