Epidemiology and management of Fusarium wilt of lettuce

Alex Putman, Ph.D.
Assistant Cooperative Extension Specialist
Dept. of Microbiology & Plant Pathology

aiputman@ucr.edu
951-522-9556

UC RIVERSIDE UNIVERSITY OF CALIFORNIA

November 18, 2021
Monterey 2021 Pest Management Meeting

University of California
Agriculture and Natural Resources

Plant Disease

Susceptible host

Favorable environment

Virulent pathogen

Stunting, wilting

Yellowing/death of outer leaves

Collapse; Interior rot, reddish discoloration

Occurs in patches year to year that expand

Fusarium oxysporum f. sp. *lactucae*

- Disease-causing ability is host specific
  - *F. oxysporum* f. sp. *lactucae* will only cause disease of lettuce
  - f. sp. = “special form”
- Can grow and reproduce on:
  - Plants on which it cannot cause disease
  - Resistant cultivars of its host plant
- There are many *F. oxysporum* f. sp. ____ of other hosts
  - Also, there are probably many *F. oxysporum* populations that are non-pathogenic

You have…	Can it cause disease on…?		Can it grow on roots of…?	
	Lettuce	Strawberry	Lettuce	Strawberry
 Lettuce Fusarium wilt	YES	no	YES	? (probably)
	Fusarium oxysporum f. sp. *lactucae*			
 Strawberry Fusarium wilt	no	YES	YES	YES
	Fusarium oxysporum f. sp. *fragariae*			

Henry et al. 2019 10.1094/PHYTO-11-18-0418-R

Fusarium thrives in soil

Maryani et al. 2019 Studies in Mycology

G. Holmes, Cal Poly SLO, Bugwood.org

Structures are produced in abundance in diseased tissue and are added to the soil

Fusarium thrives in soil

Maryani et al. 2019 Studies in Mycology

G. Holmes, Cal Poly SLO, Bugwood.org

A teaspoon of soil can contain hundreds of resting spores

Fusarium is spread via infested soil

Three Primary Factors Affecting Fusarium wilt

- Pathogen density in soil (of resting spore)
- Temperature
- Host susceptibility

Pathogen density in soil

- Things that increase pathogen density
  - History of lettuce crops
  - History of Fusarium wilt of lettuce
    - more severe = bigger increase
  - Susceptible lettuce cultivars with or without disease

Table 1. Colonization of the root cortex of six lettuce cultivars by *Fusarium oxysporum* f. sp. *lactucae*

			Pathogen level in plant (CFU/g)	
Cultivar	**Type**	**Susceptibility**	**All Plants**	**Symptomless Plants**
King Henry	Romaine	Low	43 a	45
Caesar	Romaine	Low	62 a	97
Red Rossa	Leaf	Low	145 ab	82
Lolla Rossa	Leaf	Low	229 ab	191
Green Forest	Romaine	Low	789 b	614
Salinas	Crisphead	Intermediate	14591 c	1866

Scott et al. 2014 10.1111/ppa.12135

Pathogen density in soil

- Things that <u>likely</u> increase <u>OR</u> maintain pathogen density:
  - Rotation with spinach**, cauliflower, broccoli

    **Spinach was extensively and frequently colonized

  - Wild lettuce relatives (not tested): prickly lettuce (*Lactuca serriola*)

Note: Few rotation crops have been tested

Scott et al. 2014 10.1111/ppa.12135

Pathogen density in soil

- Things that decrease pathogen density
  - Solarization: 30 days in summer
    - Tested in Yuma in July-August, where soil temp at 2 in. averaged 116°F
  - Fallow (Yuma): estimated half-life (time for population to decline by 50%) is 6 months
    - Declined by 99.5% after 34 months

- Things that slow introduction and spread
  - Sanitation: Prevent movement of soil from fields with Fusarium wilt history
    - Any and all: equipment, foot traffic

Matheron and Porchas 2010 10.1094/PDIS-04-10-0296
Scott et al. 2012 10.3733/ca.v066n01p20

Temperature

- Usually prevalent in early planting windows
  - Yuma: disease much less severe for Oct./Dec. plantings compared to Sept.

Table 2. Incidence of Fusarium wilt at crop maturity for lettuce cultivars grown in all three plantings in 2002 or 2003 in a field naturally infested with *Fusarium oxysporum* f. sp. *lactucae*

	Plants dead or diseased (%)[x]		Mean soil temp (°C)[y]	
Planting time[z]	2002	2003	2002	2003
September	92.3 a	74.2 a	24	28
October	15.1 b	5.1 b	15	14
December	2.0 c	0.7 b	14	14

[X] Average of 7 (2002) and 16 (2003) cultivars

[Y] Depth of 10 cm

[Z] Planting dates in: 2002, Sept 7, Oct 17,Dec 6; 2003, Sept 3, Oct 21, Dec 18

Matheron et al. 2005 10.1094/PD-89-0565

Temperature

- Usually prevalent in early planting windows
  - Yuma: disease much less severe for Oct./Dec. plantings compared to Sept.

- Difference in planting date of as little as 1 week can reduce disease (field trials, Davis)

Paugh and Gordon 2019 10.1094/PDIS-09-18-1614-RE

Temperature

- Growth chamber experiment maintained on a day/night cycle of 73/64°F
- Treatments consisted of removing plants to another growth chamber at 91/73°F for one week at two, three, or four weeks after transplant

Table 3. Effect of 1-week exposure to high temperature on severity of Fusarium wilt and dry weight of two lettuce cultivars

		Above-ground disease severity		Below-ground disease severity	
Cultivar	**Treatment[u]**	**Mean ± SE[v]**	**RE ± 95% CI[w]**	**Mean ± SE[x]**	**RE ± 95% CI[y]**
Sidewinder	Control	1.3 ± 0.1	0.38 ± 0.06 b	1.5 ± 0.1	0.34 ± 0.06 b
Sidewinder	Week 2	1.7 ± 0.1	0.64 ± 0.07 a	2.2 ± 0.1	0.64 ± 0.05 a
Sidewinder	Week 3	1.6 ± 0.1	0.62 ± 0.06 a	2.0 ± 0.1	0.55 ± 0.05 ab
Sidewinder	Week 4	1.2 ± 0.1	0.37 ± 0.06 b	1.8 ± 0.1	0.46 ± 0.06 b
Steamboat	Control	1.2 ± 0.1	0.42 ± 0.06 b	1.8 ± 0.2	0.32 ± 0.07 c
Steamboat	Week 2	1.6 ± 0.1	0.53 ± 0.07 ab	3.0 ± 0.1	0.62 ± 0.06 a
Steamboat	Week 3	1.6 ± 0.1	0.59 ± 0.07 a	2.9 ± 0.1	0.59 ± 0.06 ab
Steamboat	Week 4	1.3 ± 0.1	0.46 ± 0.06 ab	2.4 ± 0.1	0.48 ± 0.06 b

Paugh and Gordon 2019 10.1094/PDIS-09-18-1614-RE

Temperature

- Strongly favored by warm to hot temperatures
  - Daytime highs above 77F likely increases disease risk
  - Key window: 20 to 25 days after transplant
    - Unknown if this can be applied to seeded crops

Table 3. Effect of 1-week exposure to high temperature on severity of Fusarium wilt and dry weight of two lettuce cultivars

		Above-ground disease severity		Below-ground disease severity	
Cultivar	**Treatment[u]**	**Mean ± SE[v]**	**RE ± 95% CI[w]**	**Mean ± SE[x]**	**RE ± 95% CI[y]**
Sidewinder	Control	1.3 ± 0.1	0.38 ± 0.06 b	1.5 ± 0.1	0.34 ± 0.06 b
Sidewinder	Week 2	1.7 ± 0.1	0.64 ± 0.07 a	2.2 ± 0.1	0.64 ± 0.05 a
Sidewinder	Week 3	1.6 ± 0.1	0.62 ± 0.06 a	2.0 ± 0.1	0.55 ± 0.05 ab
Sidewinder	Week 4	1.2 ± 0.1	0.37 ± 0.06 b	1.8 ± 0.1	0.46 ± 0.06 b
Steamboat	Control	1.2 ± 0.1	0.42 ± 0.06 b	1.8 ± 0.2	0.32 ± 0.07 c
Steamboat	Week 2	1.6 ± 0.1	0.53 ± 0.07 ab	3.0 ± 0.1	0.62 ± 0.06 a
Steamboat	Week 3	1.6 ± 0.1	0.59 ± 0.07 a	2.9 ± 0.1	0.59 ± 0.06 ab
Steamboat	Week 4	1.3 ± 0.1	0.46 ± 0.06 ab	2.4 ± 0.1	0.48 ± 0.06 b

Paugh and Gordon 2019 10.1094/PDIS-09-18-1614-RE

Host Resistance and Pathogen Races

- Four races of *F. oxysporum* f. sp. *lactucae* have been identified worldwide
  - 1: Japan
    - Taiwan, Iran
    - Europe (Italy, Portugal, Spain)
    - South America (Brazil)
    - North America (Florida, California, Arizona)
  - 2: Japan
  - 3: Japan, Taiwan
  - 4: Netherlands
    - Belgium
    - United Kingdom
    - Italy
    - Ireland

Host Resistance and Pathogen Races

- Wide variation exists among lettuce types
  - Crisphead, butterhead: generally highly susceptible
  - Romaine, leaf: generally less susceptible
- High level of resistance
  - Romaine: Costa Rica No. 4, Caesar, King Henry, Slugger, King Louie, and Valmaine
  - Leaf: Lolla Rossa, Red Rossa
- Moderate resistance
  - Crisphead: Chouya No. 37, Shinano Hope, Salinas, Salinas 88, and Calmar

Compounding Interactions

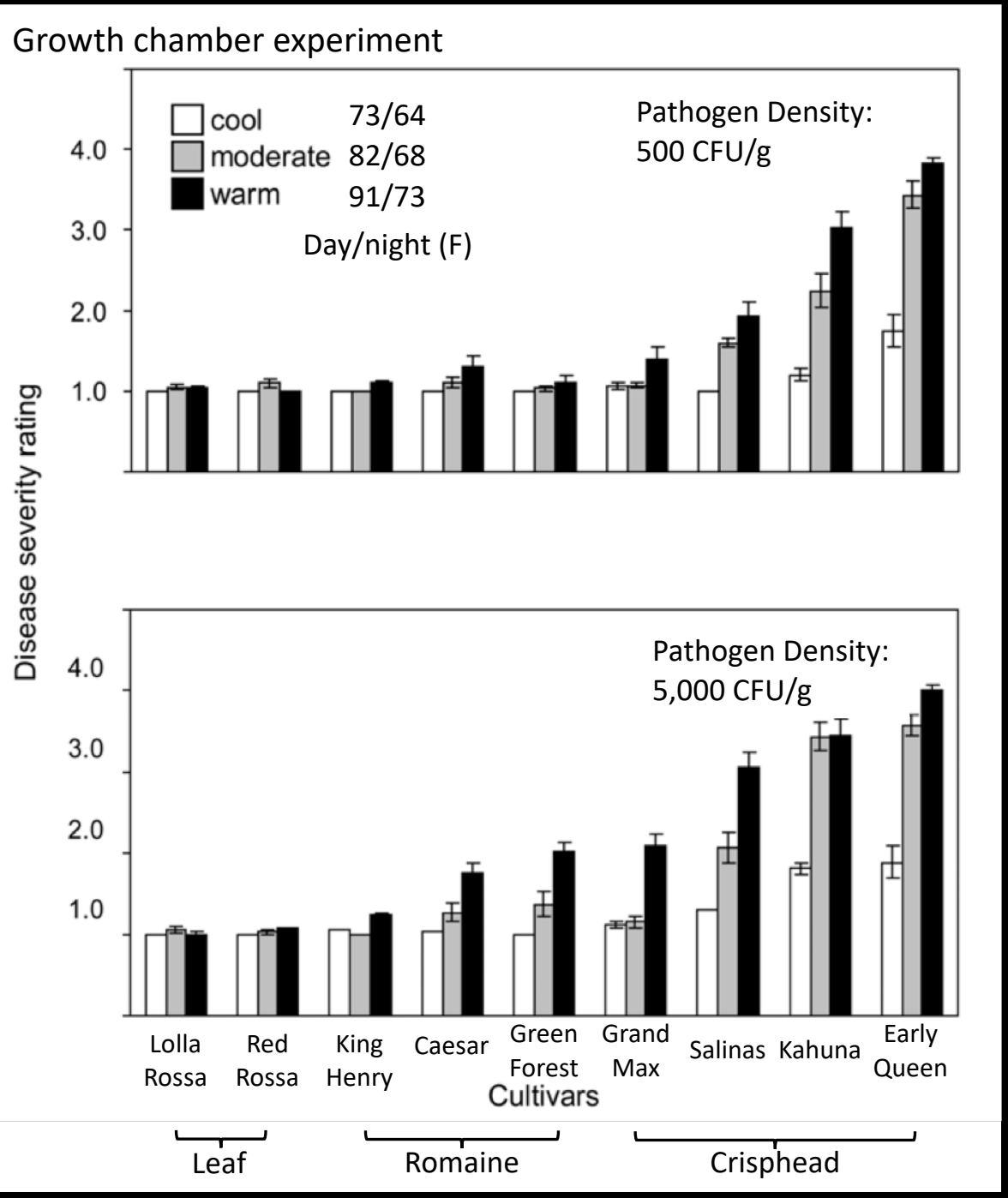
Host: susceptible

If both pathogen inoculum and temperature are highly favorable, "resistant" cultivar can get disease

Environment: temperature

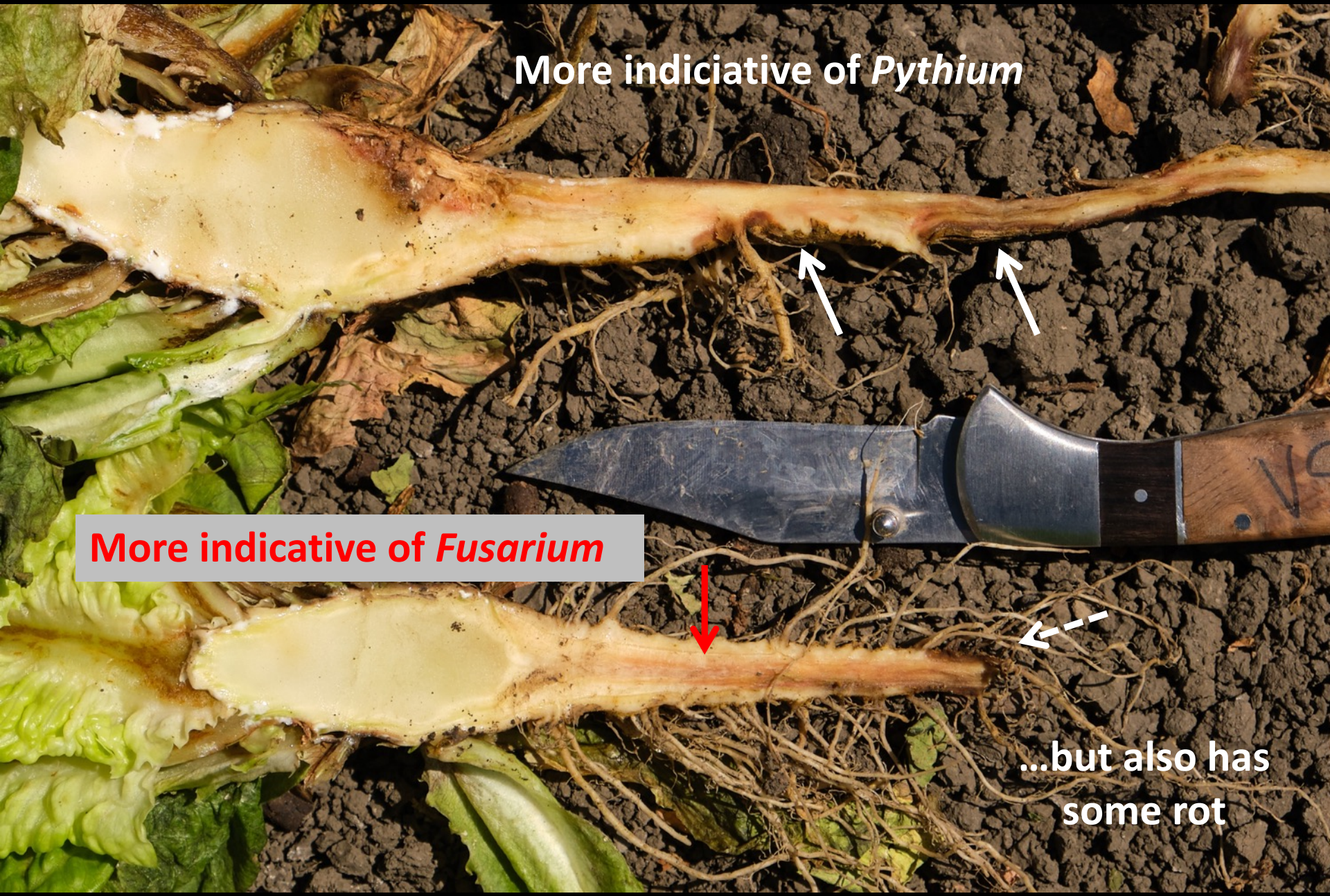
Pathogen: inoculum density

Compounding Interactions



If both pathogen inoculum and temperature are highly favorable, a less susceptible cultivar can get disease

Scott et al. 2010 10.1094/PDIS-94-1-0013



Gonzales 10/12/21 - Romaine

New Developments

- Severe losses in planting windows outside the typical high Fusarium risk periods
- Severe losses on cultivars that previously performed well: for example, Romaine and leaf types
- Possible causes:
  - Change in pathogen population?
  - Build up of pathogen inoculum?

We Are Looking for Fusarium wilt Samples!

951-522-9556; aiputman@ucr.edu