

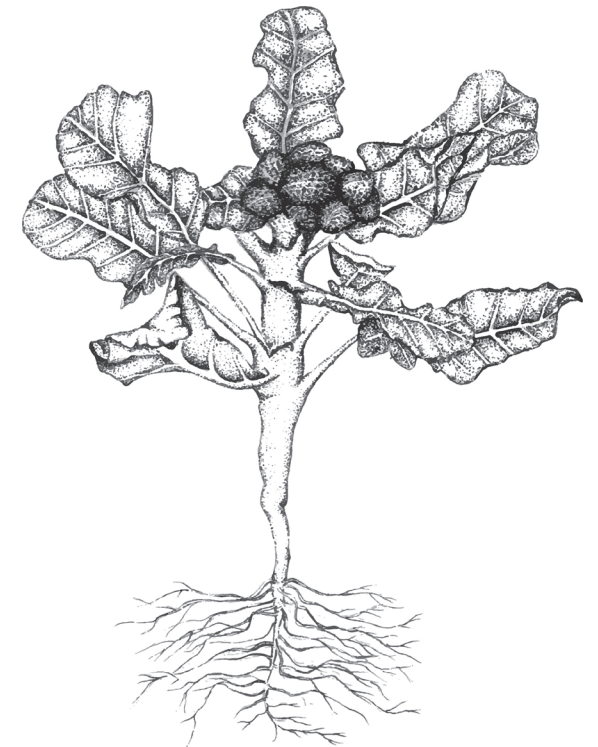
Understanding the *F.o. fragariae* life cycle for improved management decisions



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Annual Fumigants and Alternatives Meeting

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Fusarium wilt of strawberry:

Causal agent: *Fusarium oxysporum* f. sp. *fragariae*

- Host specific type of *Fusarium oxysporum*
- *F.o. fragariae* is not known to cause disease on other plant species
- Three genetically distinct lineages exist in CA



Henry et al., 2017

Prevention is the best management strategy



Management options for Fusarium wilt of strawberry

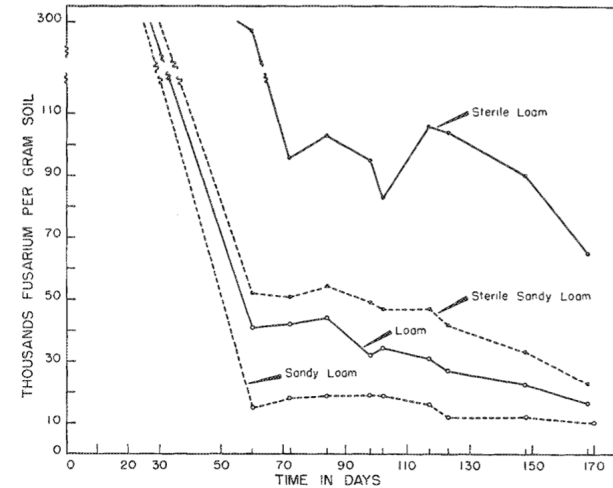
1. Plant resistant cultivars
 - Continued strawberry production
 - Yield penalty under high inoculum
2. Fumigation or Anaerobic Soil Disinfestation (ASD)
 - Significant disease reduction
 - Does not eradicate the pathogen
3. Crop rotation
 - Can be profitable, or cost very little
 - Requires time



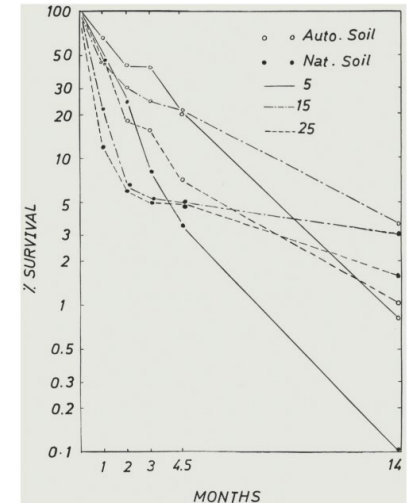
Survival of *Fusarium oxysporum* in soil

- Soil populations of *Fusarium oxysporum* decrease substantially within 1-3 years
- Factors affecting rate of decline:
 - Microbial activity
 - Moisture
 - Temperature
 - Soil physical characteristics
 - Texture
 - Electrical conductivity (salinity)
 - Etc.
- ...in the absence of a plant host or some soil amendments

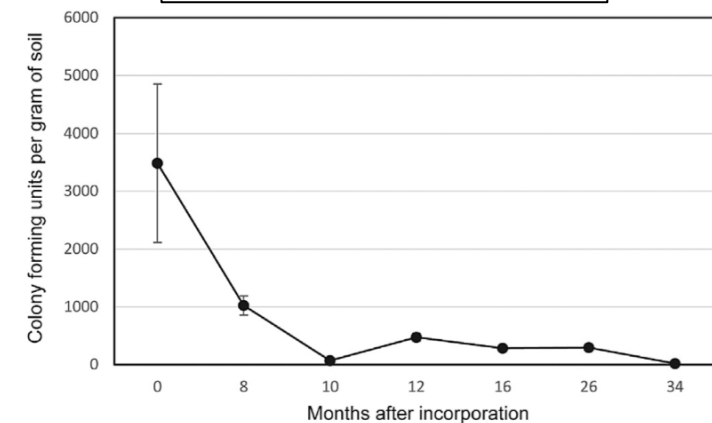
Stover, 1956



Snyder and Hansen, 1973



Gordon and Koike, 2015



Rotation crops



Spinach



Wheat



Raspberry



Strawberry:



San Andreas
(resistant)

Albion
(susceptible)

Broccoli



Lettuce

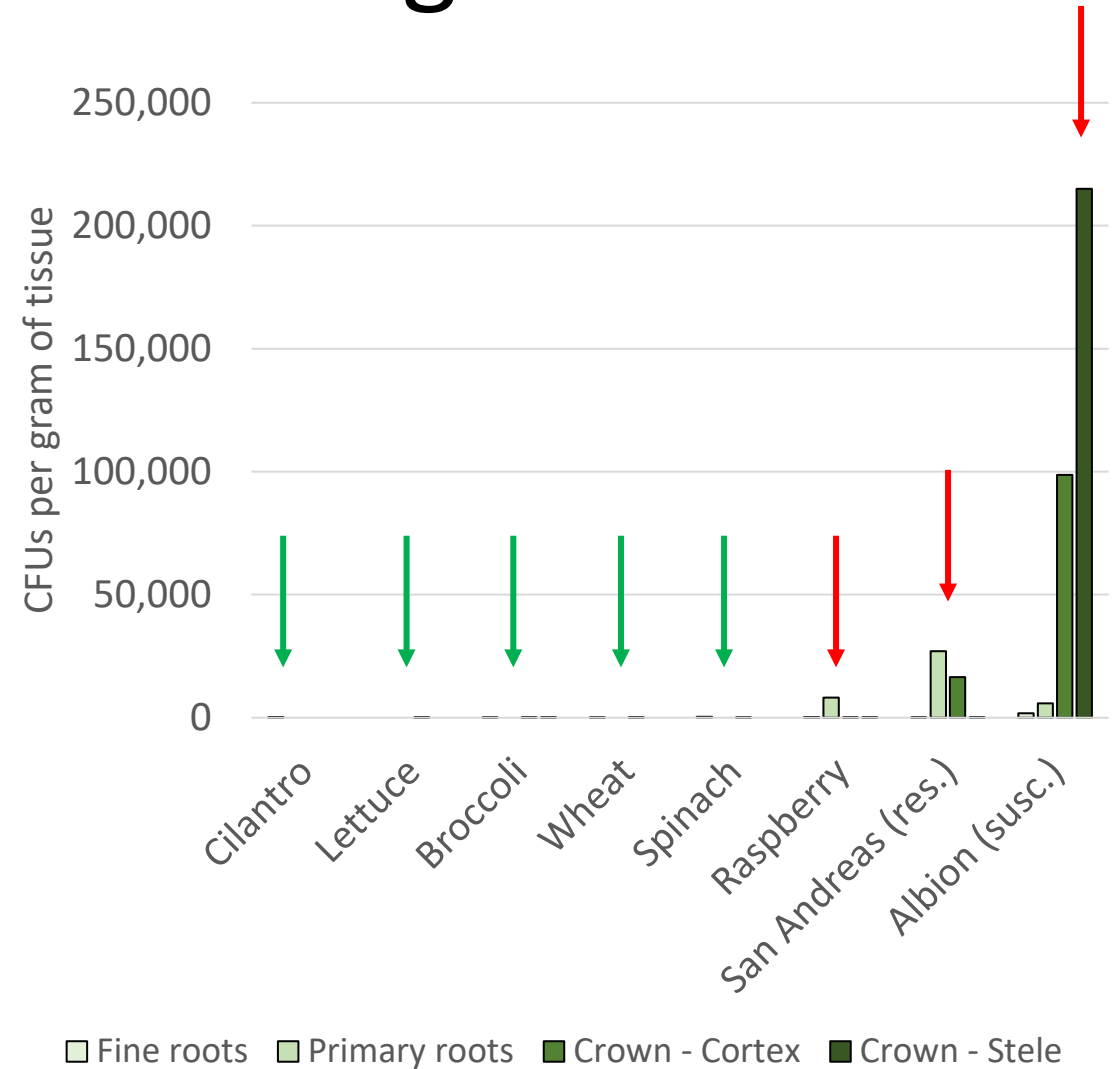


Cilantro



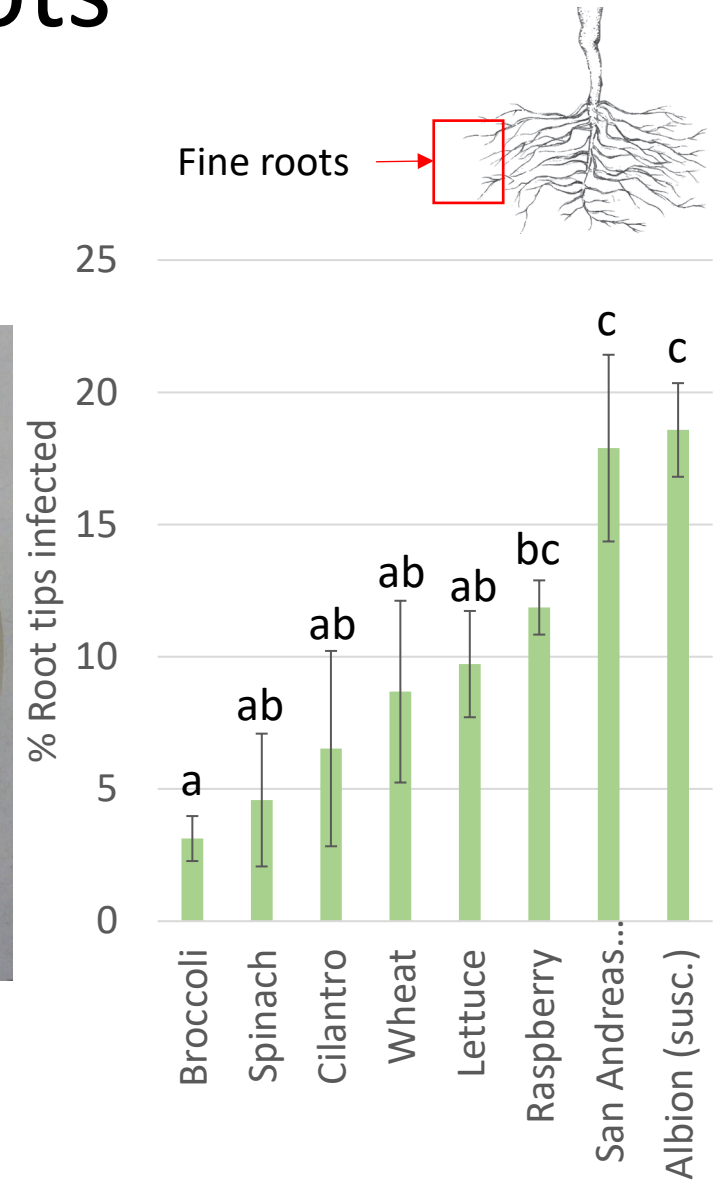
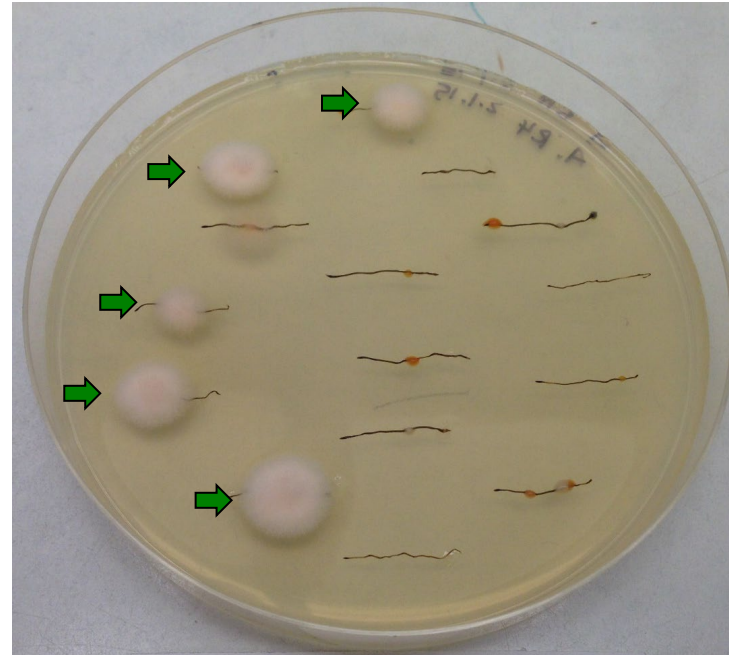
Population growth on living tissues

- Soil: high *F.o. fragariae* population
- Assayed 4 plant tissues for the pathogen
- Very low population growth detected on tissues of rotation crops
- Exception: Raspberry primary roots

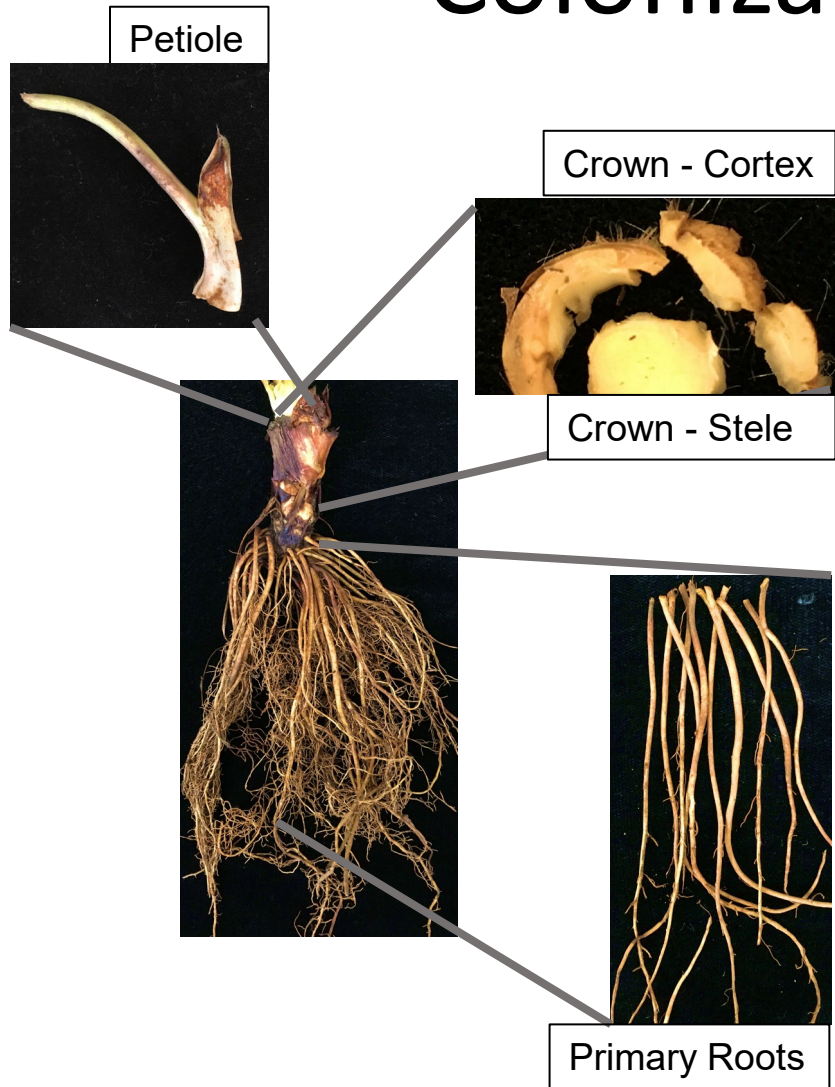


Infection rate of fine roots

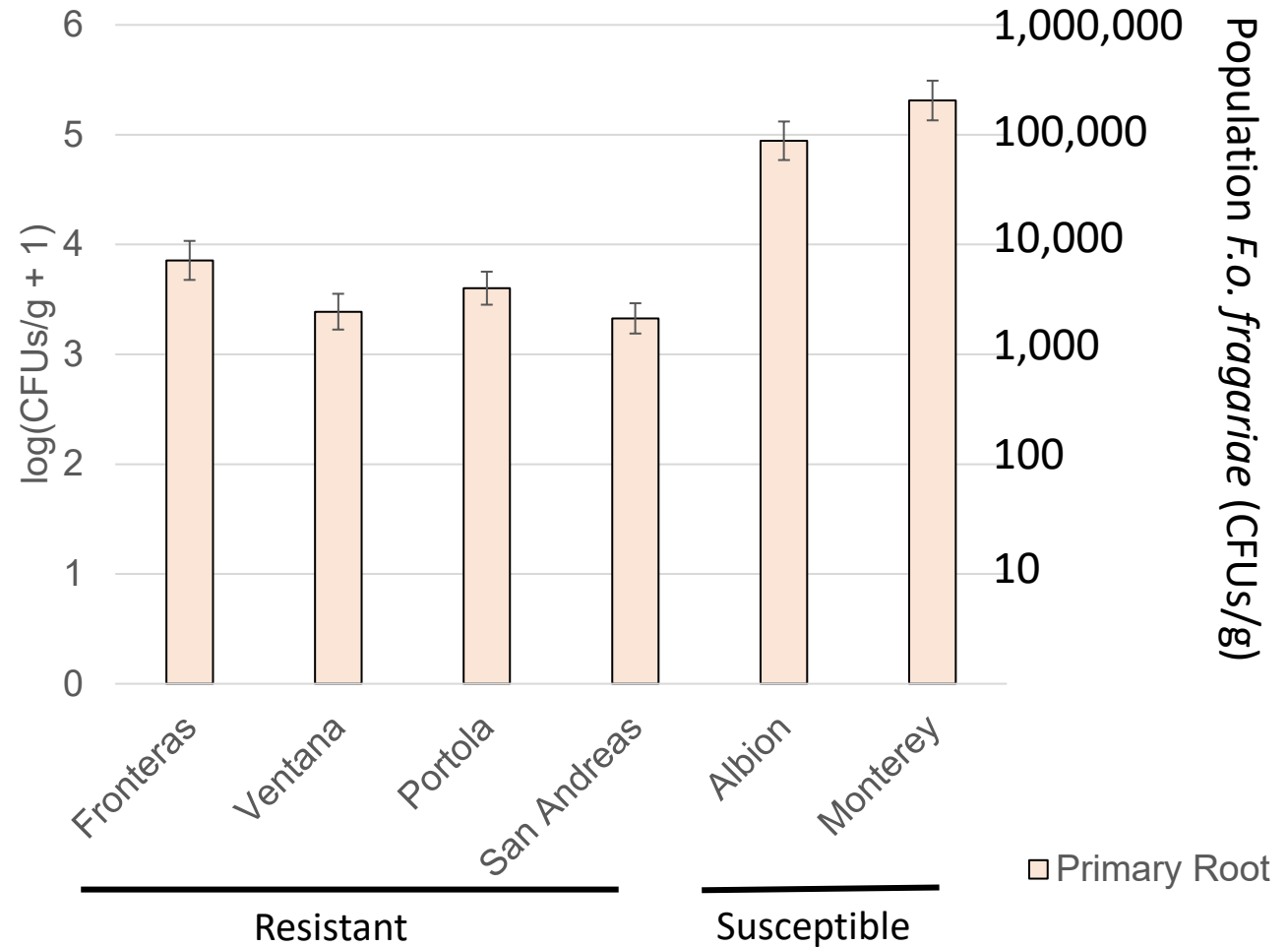
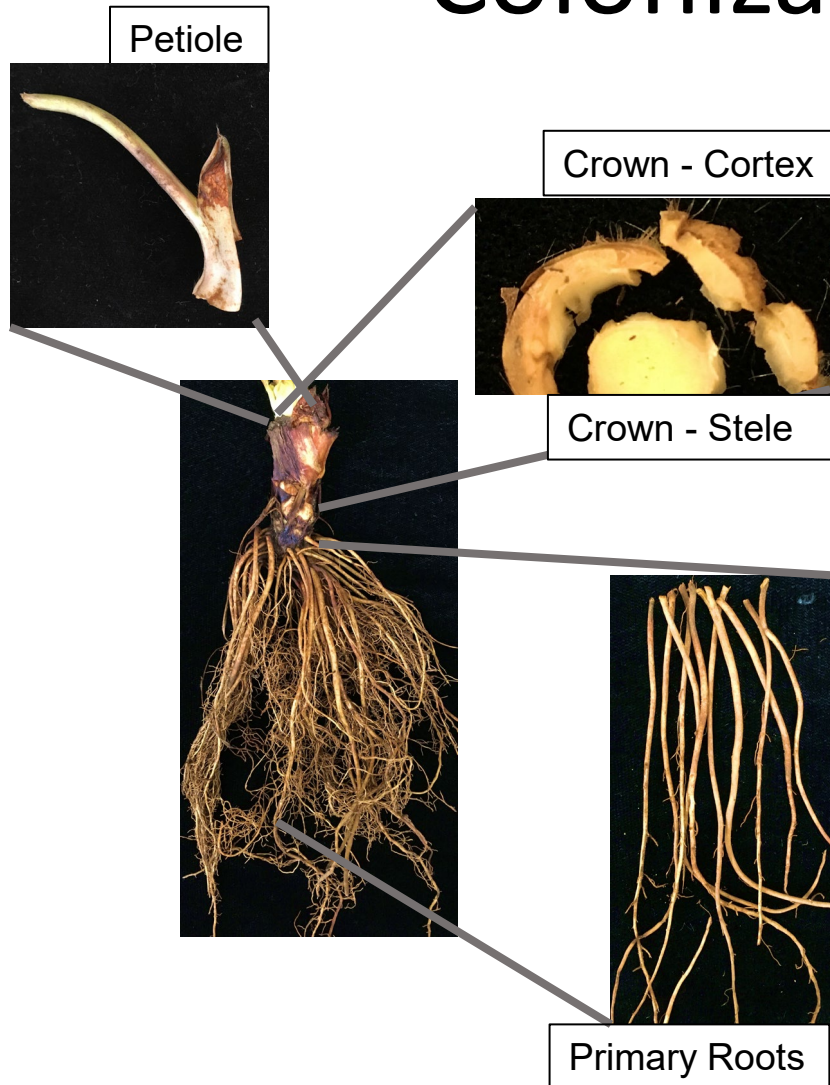
- Fine roots most likely to encounter *F.o. fragariae*
- All crops sustained infections
- Resistant/susceptible strawberries, and raspberry not significantly different



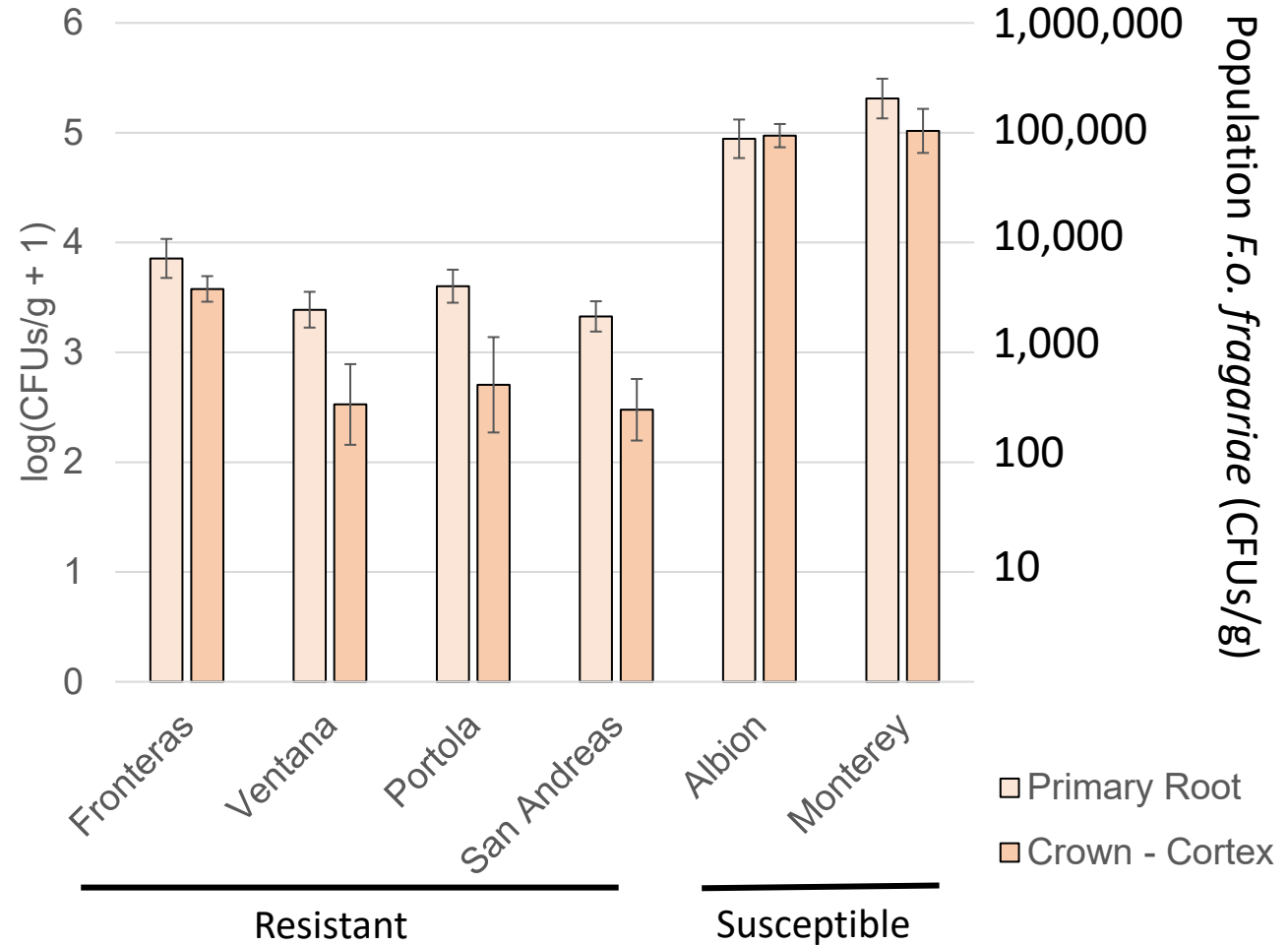
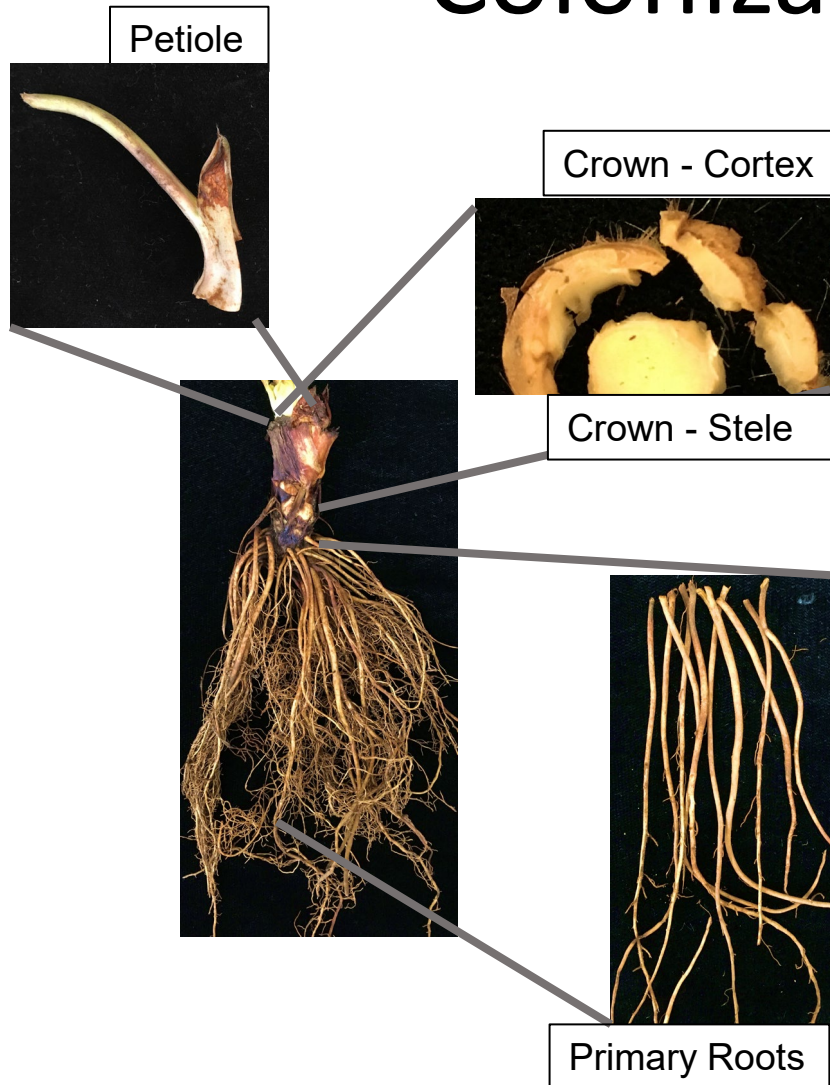
Colonization of resistant cultivars



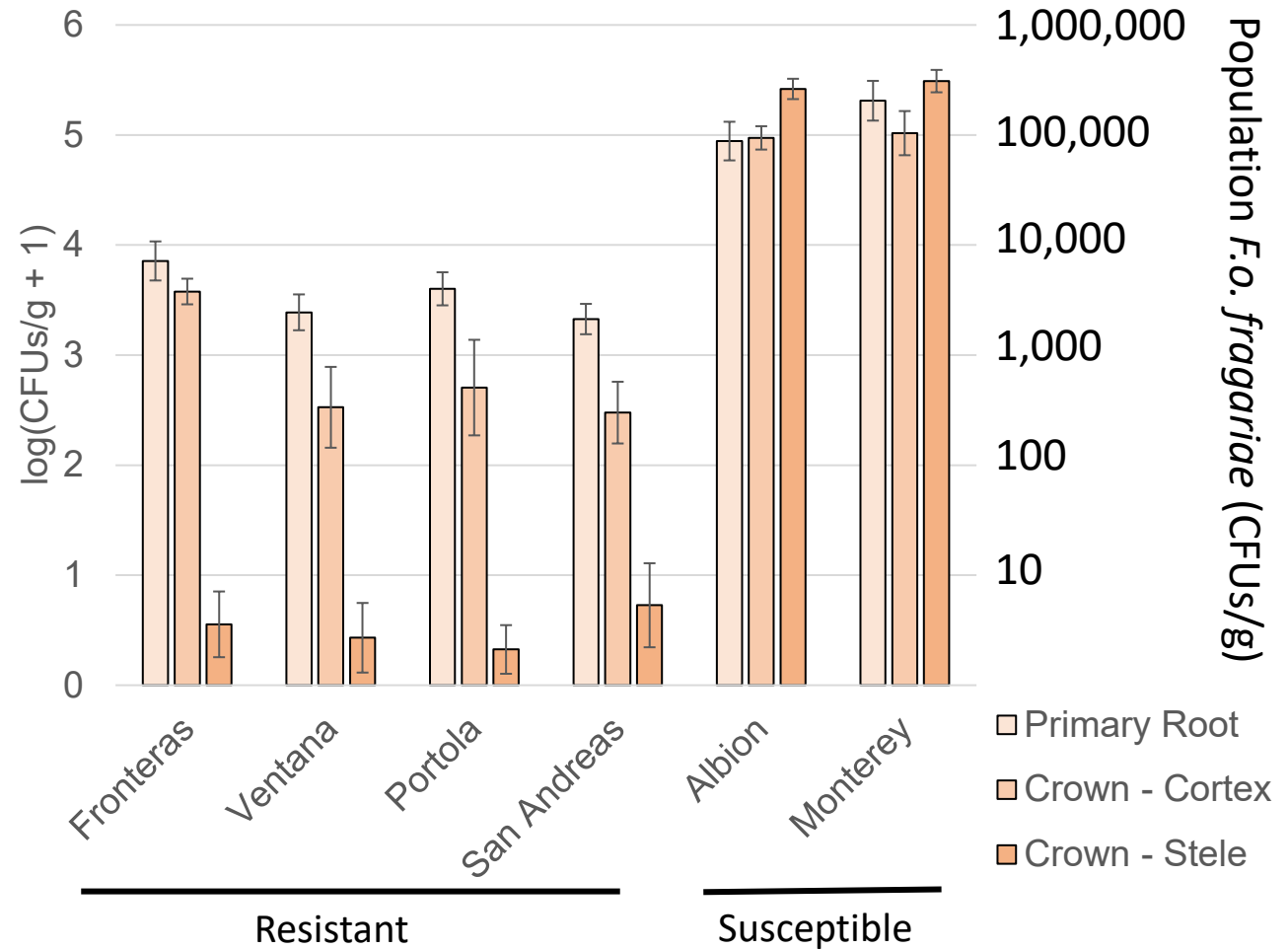
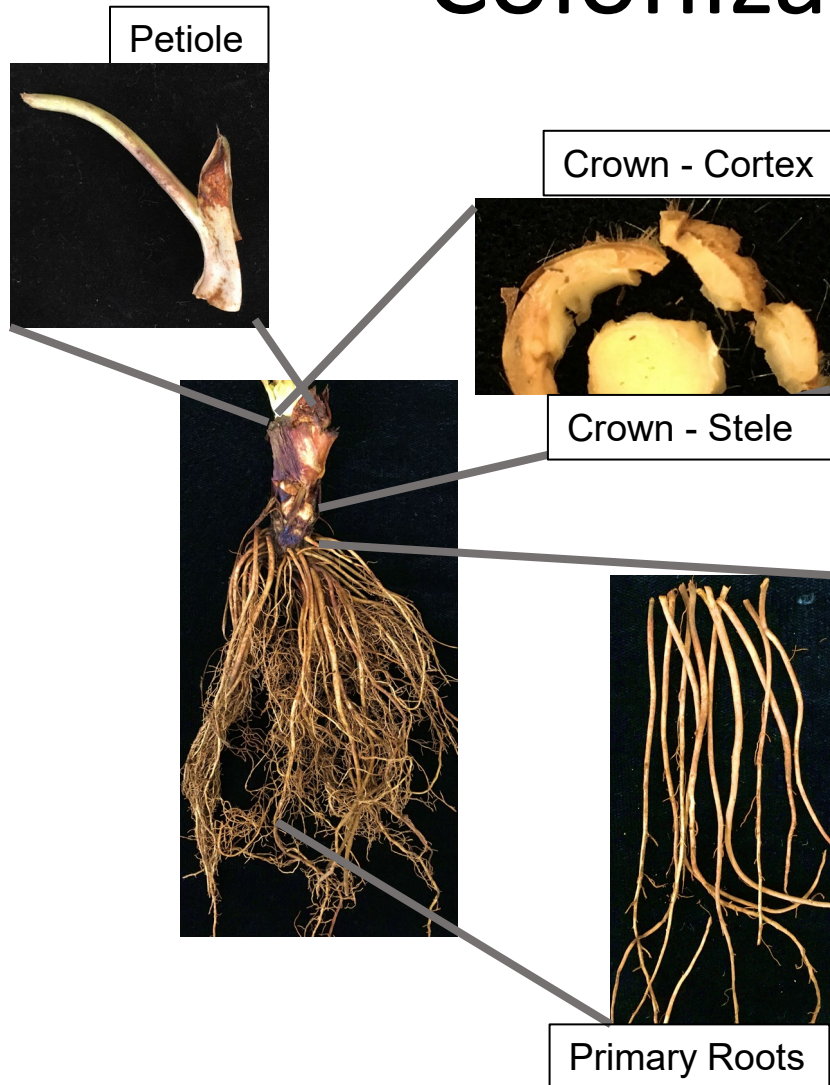
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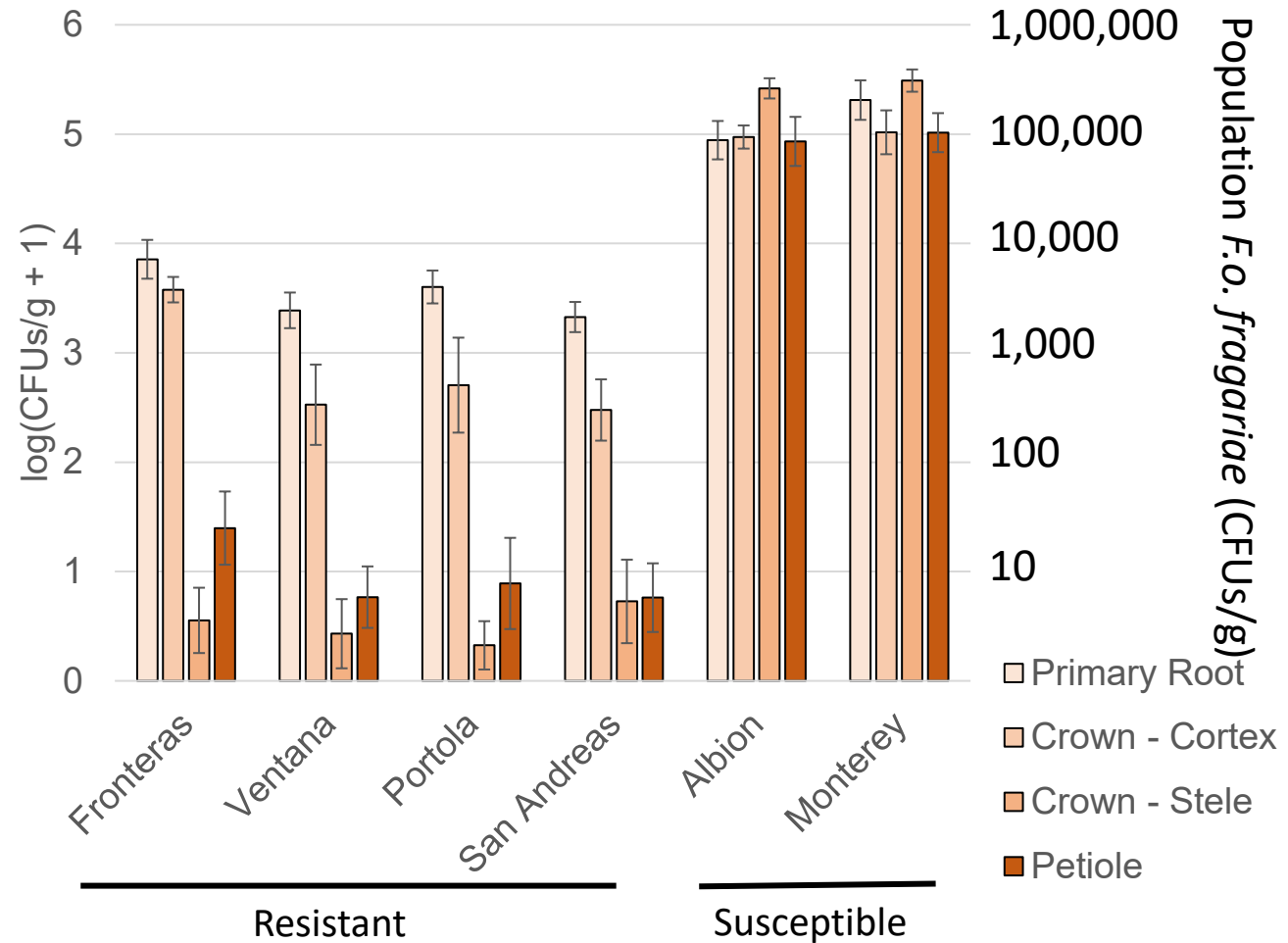
Petiole

Crown - Cortex

Crown - Stele

Primary Roots

- Resistant cultivars can become highly colonized by *F.o. fragariae*
- Infection does not extend into vascular tissue
- Susceptible: vascular tissue as the highest population of *F.o. fragariae*
- Some resistant cultivars may have larger *F. fragariae* populations than others

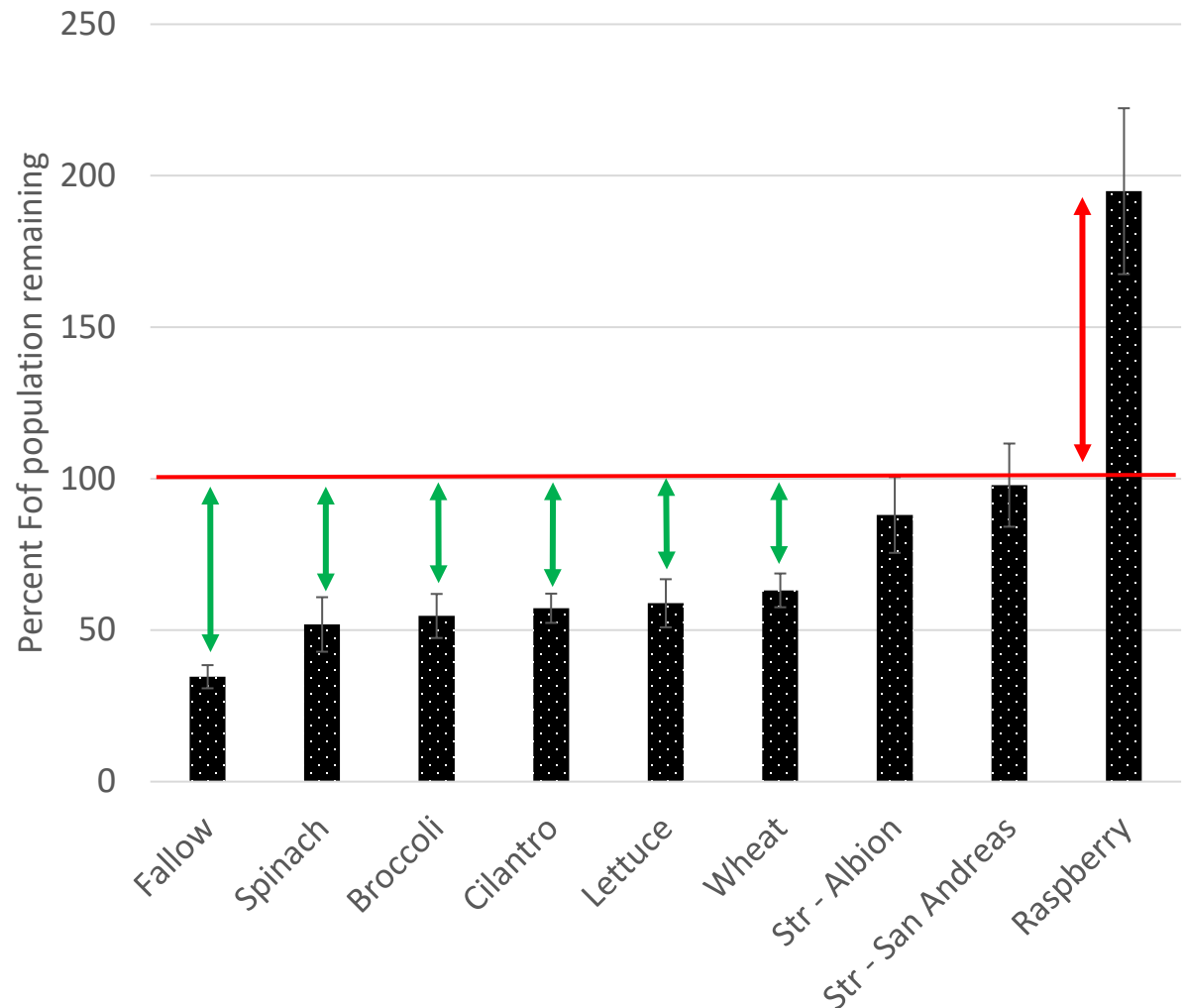


Change in soil *F.o. fragariae* populations 6 months post tillage

- Experiment:
 - Field soil infested with *F.o. fragariae*
 - Crops grown for 6 weeks
 - Included fallow (no crop) treatment
 - Tilled into soil
 - Soil population of *F.o. fragariae* measured:
 - Before tillage
 - 6 months post tillage
- How did populations change after 6 months?

Change in soil *F.o. fragariae* populations 6 months post tillage

- Raspberry significantly increased Fof population
 - No symptoms present
- Net decrease in soil *F.o. fragariae* population after vegetable crops and wheat
- Fallow: consistently lowest population



The *F.o. fragariae* life cycle: Growth on a **symptomatic** host

The **symptomatic host**, which are susceptible strawberry cultivars, are planted in *F.o. fragariae* infested soil.

1



Symptomatic hosts:

- *F.o. fragariae* susceptible strawberry cultivars:
 - Albion
 - Monterey
 - Benicia
 - Camarosa
 - Grenada
 - Sweet Anne
 - Etc.

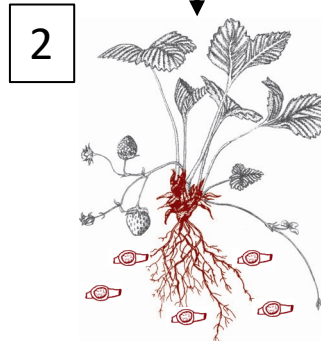
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Growing season

F.o. fragariae grows to **high** populations on plant tissues.



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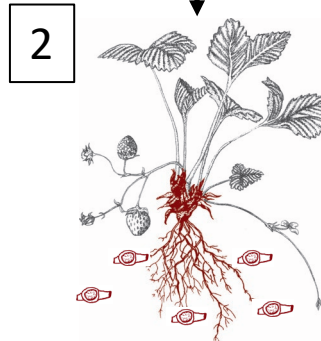
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Tillage

3a Total *F.o. fragariae* population is now larger.



Symptomatic hosts:

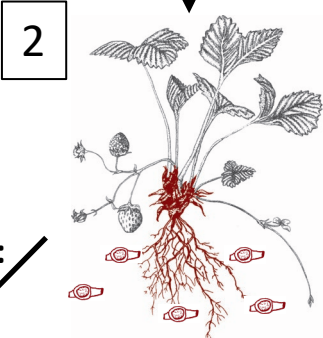
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Symptomatic hosts:

- *F.o. fragariae* susceptible strawberry cultivars:
 - Albion
 - Monterey
 - Benicia
 - Camarosa
 - Grenada
 - Sweet Anne
 - Etc.

Removed plants:



Crop debris removal:

Soil population of *F.o. fragariae* may be less than if plants were tilled into field.

3b

Remaining soil population:



Tillage

3a

Total *F.o. fragariae* population is now larger.



The *F.o. fragariae* life cycle: Growth on a **reservoir** host

A **reservoir** host, such as resistant strawberry cultivars, are planted in *F.o. fragariae* infested soil.



Reservoir hosts:

- *F.o. fragariae* resistant strawberry cultivars
- Raspberry
- Other crops in Rosaceae?

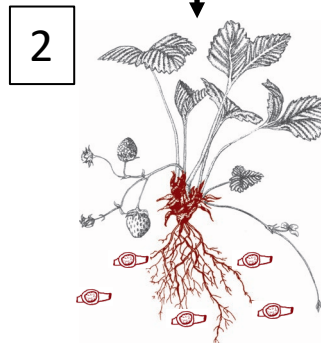
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Growing season

F.o. fragariae grows to **moderate** populations on plant tissues.



Reservoir hosts:

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The *F.o. fragariae* life cycle: Growth on a **reservoir** host

A **reservoir** host, such as resistant strawberry cultivars, are planted in *F.o. fragariae* infested soil.



Growing season

F.o. fragariae grows to **moderate** populations on plant tissues.



Tillage

3 Pathogen population remains equal to the start of season or increases.

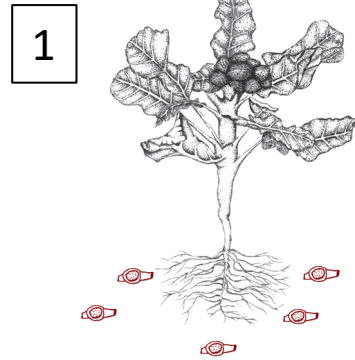


Reservoir hosts:

- *F.o. fragariae* resistant strawberry cultivars
- Raspberry
- Other crops in Rosaceae?

The *F.o. fragariae* life cycle: Growth on a **weak** host

A **weak host** (such as broccoli) is planted in *F.o. fragariae* infested soil.

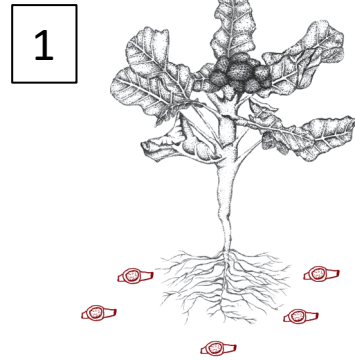


Weak hosts:

- Broccoli
- Spinach
- Lettuce
- Cilantro
- Wheat

The *F.o. fragariae* life cycle: Growth on a **weak** host

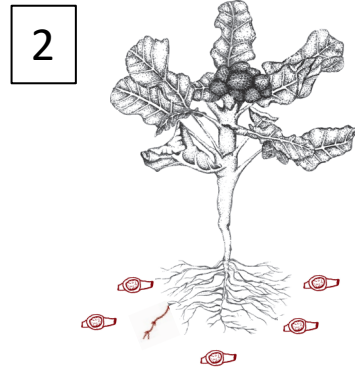
A **weak host** (such as broccoli) is planted in *F.o. fragariae* infested soil.



Growing season



F.o. fragariae grows **very little** on plant tissues.

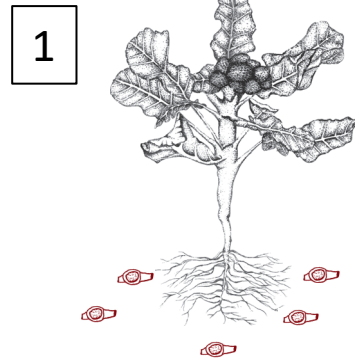


Weak hosts:

- Broccoli
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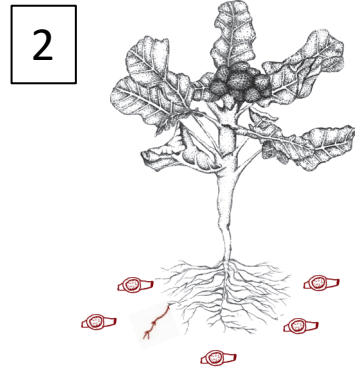
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A **weak host** (such as broccoli) is planted in *F.o. fragariae* infested soil.



Growing season

F.o. fragariae grows **very little** on plant tissues.



Tillage

3

There is a net reduction in the pathogen population in the soil



Weak hosts:

- Broccoli
- Spinach
- Lettuce
- Cilantro
- Wheat

Change in soil *F.o. fragariae* populations 6 months post tillage

- Categories of interaction with *F.o. fragariae*:

- **Symptomatic hosts**

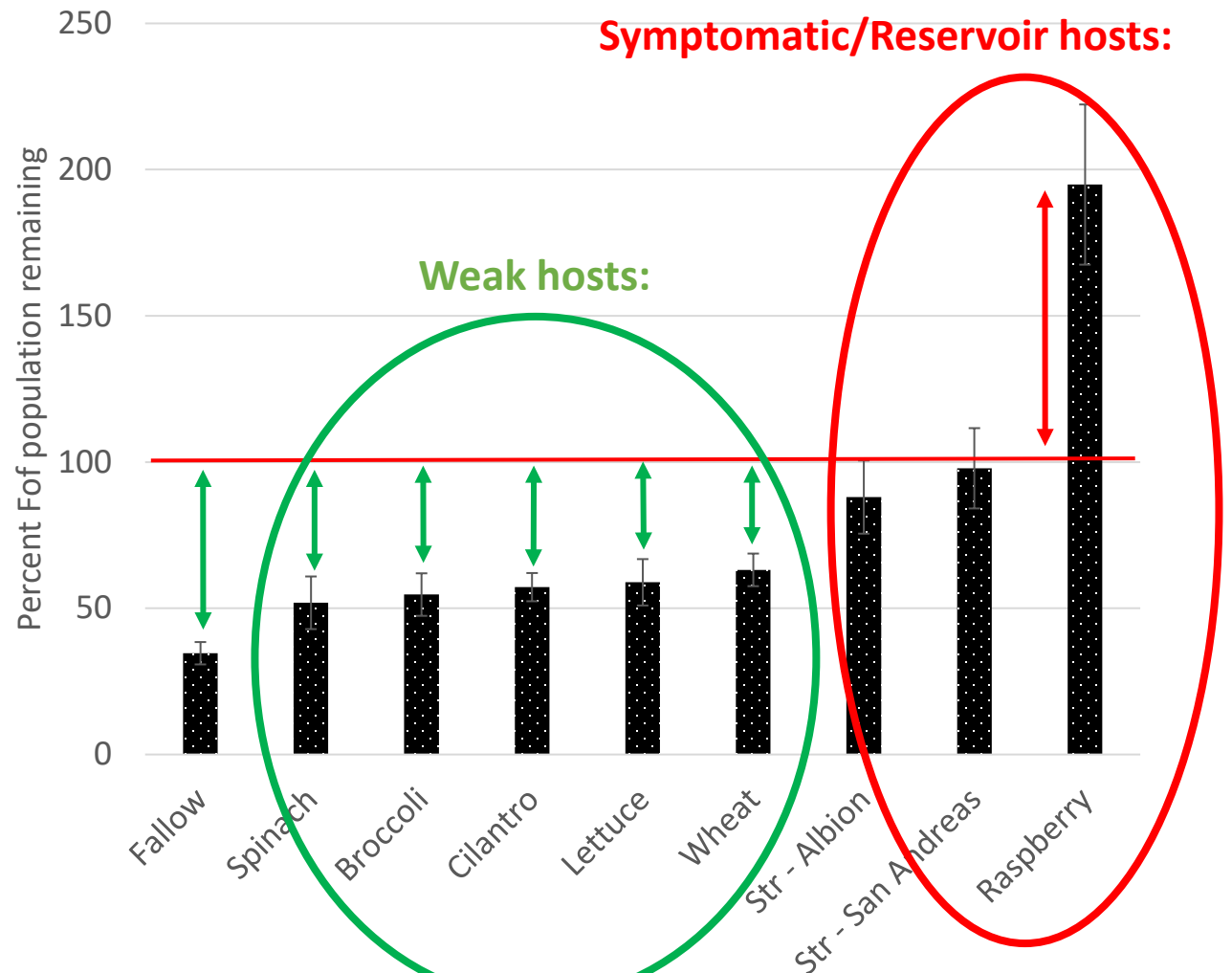
- Susceptible strawberry cultivars

- **Reservoir hosts**

- Resistant strawberry cultivars
- Raspberry
- Other Rosaceae?

- **Weak hosts**

- All annual vegetable crops tested
- Wheat



Future research

- Survival in soil over longer periods of time
 - 1-3 years
- End of season management:
 - Symptomatic debris removal
 - Crop termination
- Assess *F.o. fragariae* population growth on:
 - Blackberry
 - Soil amendments:
 - Compost
 - Others?



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