

Soil-Borne Diseases of Pistachio

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Soil-borne diseases:

- Phytophthora root and crown rots
- Verticillium wilt
- Armillaria root rot
- Rhizoctonia seedling blight
- Current research on soil borne diseases

The relative importance of soil-borne diseases has varied with changes in choice of rootstocks.

- Root asphyxiation or “Wet feet” (abiotic disorder)

Root asphyxiation or “Wet feet” is common in pistachio orchards due to overwatering or poor soil management and is often confused with soil borne diseases like Phytophthora root rot

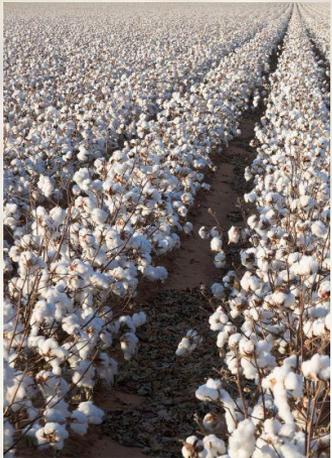
Verticillium wilt:

- Historically, the most destructive disease of pistachio in California
- The development of resistant rootstocks (PGI and UCB-1) has solved the Verticillium wilt problem of pistachio in California
- Still observed sporadically in the southern half of the San Joaquin Valley



Verticillium wilt:

- Soilborne fungus: *Verticillium dahliae*
- Wide host range: over 300 plant species
- Common crops affected in CA include: cotton, tomato, pepper, potato, strawberry
- Non-cultivated plants, weeds also serve as hosts



Verticillium wilt:



Pictures courtesy of S. Koike

Verticillium wilt: Almond

- All rootstock cultivars susceptible
- Flagging, shepherd hook, vascular streaking
- Trees over 5 years old are rarely affected by the disease



Verticillium wilt:

- Symptom development on portion of the tree
- Dead leaves remain attached to the tree
- The whole tree may die
- *Pistacia atlantica* is highly susceptible



Verticillium wilt:



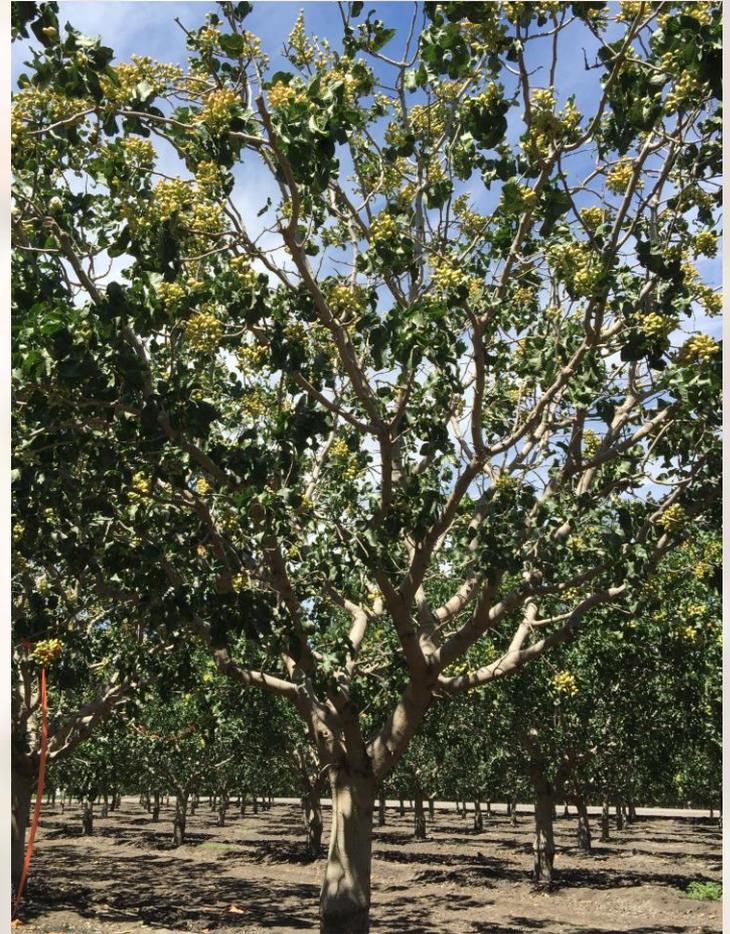
Verticillium wilt:

- In locations where highly susceptible crops were grown previously (cotton, pepper, tomato, strawberries, etc...)
- Cool spring weather, mild summer and most soils favor the disease
- Hot San Joaquin Valley summer temperatures apparently slow or inhibit *Verticillium*
- Over irrigation when temperatures are cool will increase Verticillium wilt
- Stressed trees are more vulnerable
- Trees of all ages are susceptible to the disease



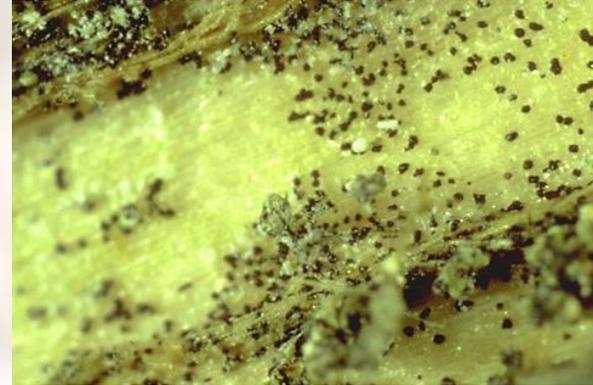
Verticillium thin leaf:

- Symptoms develop slowly over several years and are characterized by a slow loss of vigor and a reduction in growth and yield.
- A gradual thinning of the leaf canopy occurs: “see-through” symptom
- Diagnosis is more difficult



Verticillium wilt:

- Survive in the soil as microsclerotia
- Microsclerotium: hard dark resting body of certain fungi, consisting of a mass of hyphal threads
- Persist in soil for long periods.
- Survive on weed hosts



Disease cycle:

- Microsclerotia germinate in the presence of root exudates
- The pathogen invades the cortical cells of young roots, then the current year's xylem vessels
- It produces conidia that are transported into the tree trunk
- Colonization of the xylem results in disruption of water and nutrient transport



Verticillium wilt:

■ **Management:**

- Avoid planting in soils with history of susceptible crops
- Avoid inter-cropping your pistachios with a susceptible host crop
- Submit samples to commercial lab for analysis: # microsclerotia/g soil
- For almond/pistachio, three microsclerotia per gram of soil is considered high risk
- Reduce inoculum: flooding fallow field, solarization, fumigation, growing grass crops for several seasons
- Minimizing tree stress through maintenance of soil fertility and soil moisture will help trees tolerate the disease and encourage their recovery, but do not over-irrigate
- Potassium deficiency increases tree loss due to Verticillium at low inoculum levels
- Use of resistant/tolerant rootstocks (PGI, UCB-1)

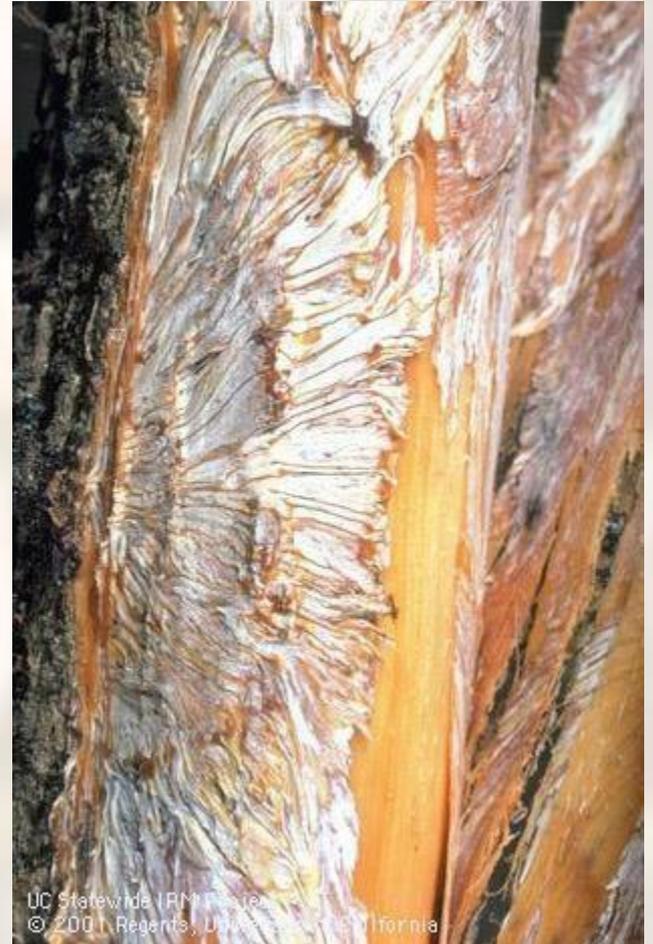
Armillaria root rot:

- Soil borne pathogen
- *Armillaria mellea* or the oak root fungus
- Basidiomycetes (mushroom)
- Orchards planted where oak trees once grew can be severely damaged
- Plants along streams and river get more affected
- Rare in pistachio



Armillaria root rot:

- The presence of mycelial plaques is sufficient to confirm the disease
- Plaques are white, fan-shaped sheets of fungal mycelium and occur between the bark and wood
- Symptoms are reduced growth, yellowing of leaves, defoliation
- The disease progress to adjacent tree
- The fungus survives on dead roots
- Control is difficult and consist of removing infected roots from soil before new planting



Rhizoctonia seedling blight:

- 1995: found in a nursery in CA where it resulted in the death of over 10,000 rootstock seedlings
- Leaves turn brown, wilted, and hanged to shoots
- Brown cortical lesions develop on roots
- Seedlings are stunted, blighted, and die
- *P. atlantica*, *P. integerrima*, and UCB-1 were all similarly infected
- The disease has not been observed on planted trees in an orchard



Phytophthora diseases:

- Soil borne pathogens
- Fungus-like organisms
- Oomycetes: water molds
- Water spores: zoospores – they can swim
- Favored by standing water in the orchard
- Root rot
- Crown rot
- Trunk canker

Phytophthora diseases:

- Many *Phytophthora* spp. are present in canal and river water
- Generally introduced to orchards irrigated from these sources
- To date, *Phytophthora* has not been found in well water
- Historically not so common on pistachio trees in California
- Increasing cases in the last few years

Phytophthora root rot: Symptoms

- Affects small roots, kill feeder roots and reduces the uptake of water and nutrients causing trees to slowly decline



Phytophthora root and crown rots: Symptoms



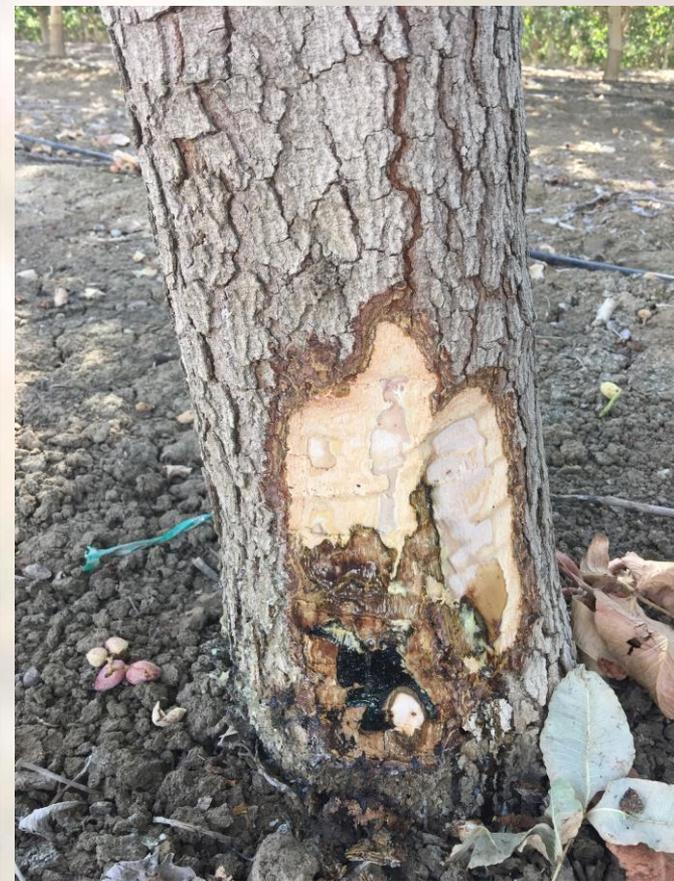
Picture courtesy of E. Fichtner

Phytophthora crown rot: Symptoms

- Affects the tree trunk at or near the ground level; girdling of trees; relatively fast decline



Phytophthora crown rot: Symptoms



Phytophthora crown rot: Symptoms

- Occurrence of concentric growth rings below the bark



Aerial Phytophthora or trunk canker:

- Mainly a problem in sprinkler-irrigated pistachio orchards



Phytophthora root and crown rots: Species diversity

- *Phytophthora parasitica*
- *Phytophthora cactorum*

Historically...

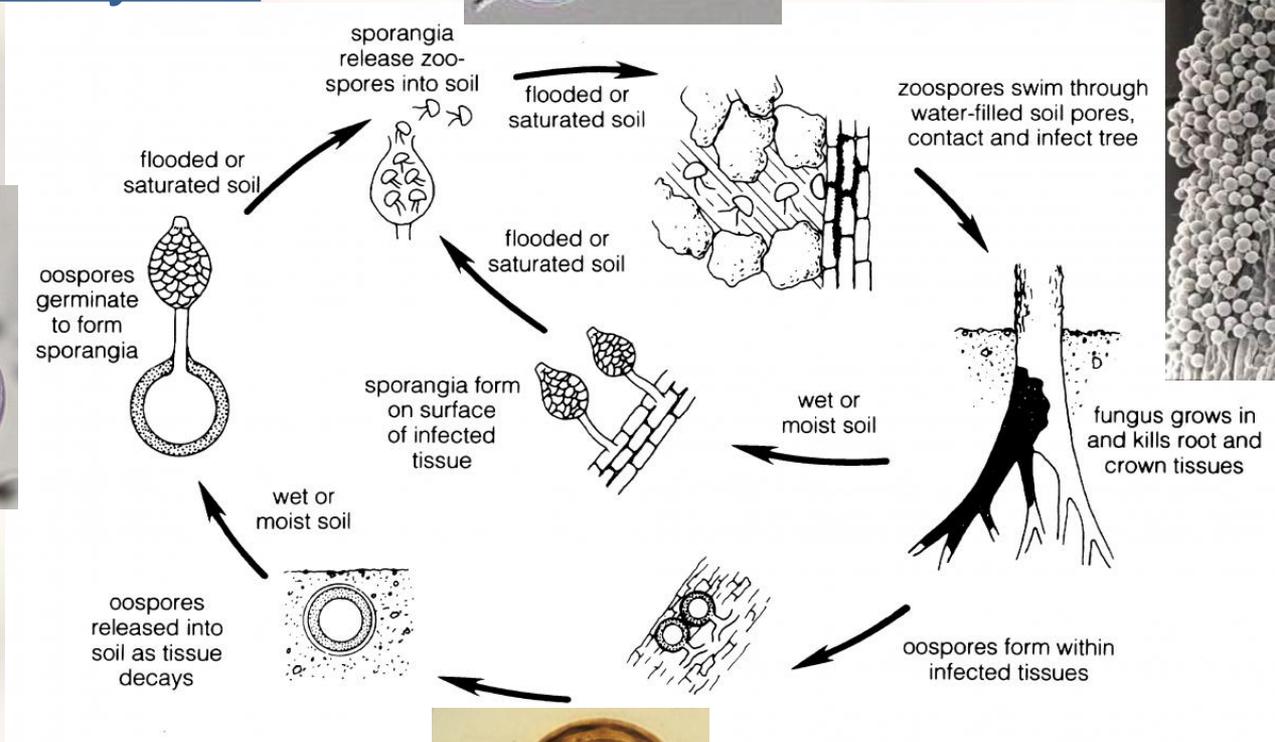
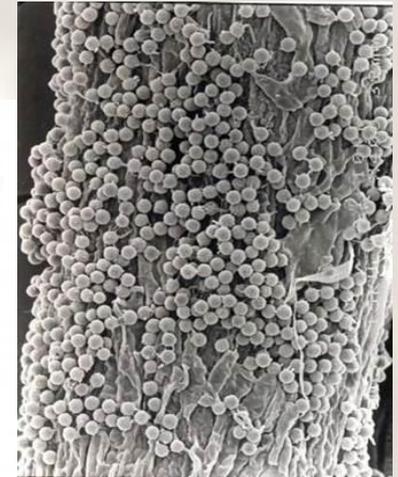
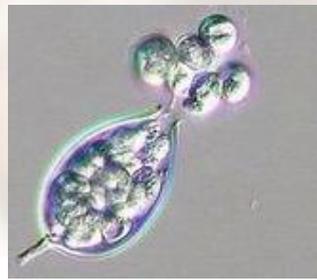
- *Phytophthora niederhauserii*
- *Phytophthora cinnamomi*
- *Phytophthora taxon walnut*

Found in commercial orchards 2015-2016

- *Phytophthora parsiana*
- *Phytopythium helicoides*

Recently found in potted pistachio plants in research plots (E. Fichtner et al. 2015, 2016)

Phytophthora disease cycle:



Phytophthora diseases:

Favored by:

- Prolonged periods of high soil moisture
- 24 hours soil saturation period
- Low spots in the orchard
- Soil with poor water infiltration/drainage (heavy soil, hardpan)
- Irrigation from surface water
- Flood irrigation systems
- Alternating cycles of wet and dry soil also exacerbate Phytophthora root rots



Picture courtesy of E. Fichtner

Phytophthora disease management:

- Water management is the basis for control of *Phytophthora* root and crown rot
- Shortening irrigation time
- Improving water penetration
- Planting on berms
- Avoid to wet soil longer than 24 hours at a time.
- The relative susceptibility of pistachio rootstocks to *Phytophthora* species is unknown.
- Avoid puddling forming around the crown. This is especially important where irrigation water is taken from canals or rivers that may be contaminated with *Phytophthora*.
- Sprinklers should be set to avoid water hitting the tree
- No chemicals are registered for control of this disease on pistachios

Root asphyxiation: “Wet feet”

- Frequently misdiagnosed as Phytophthora root or crown rot



Root asphyxiation: “Wet feet”

- Overall symptoms similar to Phytophthora diseases.
- More common issue in the field than Phytophthora
- *Pistachio* trees are drought tolerant: deep rooted, can survive in extremely dry conditions
- Less tolerant to soils with high moisture



Root asphyxiation: “Wet feet”

- Roots need oxygen to grow and to absorb nutrients
- Too much water eliminates air space in soil and around roots
- In water-saturated soil, the oxygen content is low; without oxygen, roots cannot respire properly and cannot take up water and nutrients
- Anaerobic conditions: bad smell
- Trees declining slowly and may die

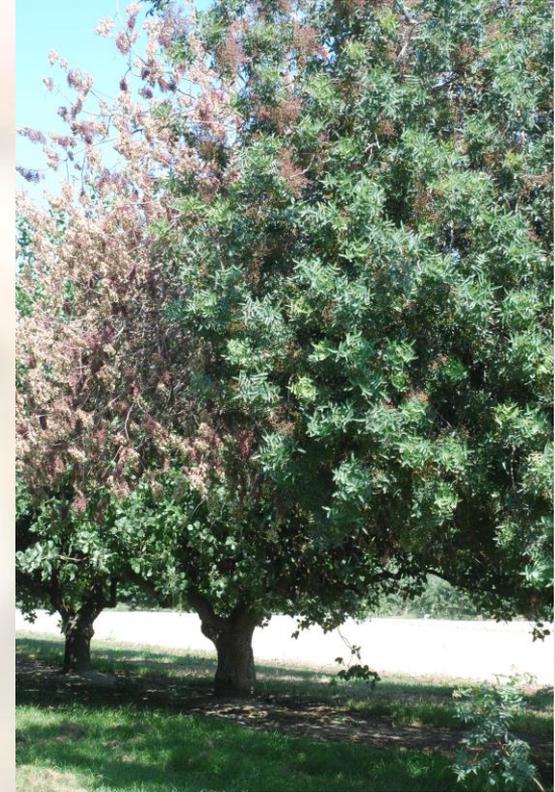


Root asphyxiation: “Wet feet”

- Low spots, heavy loam or clay, soil overly wet, etc...
- End of the row
- Fields with poor water infiltration/drainage



Root asphyxiation: “Wet feet”



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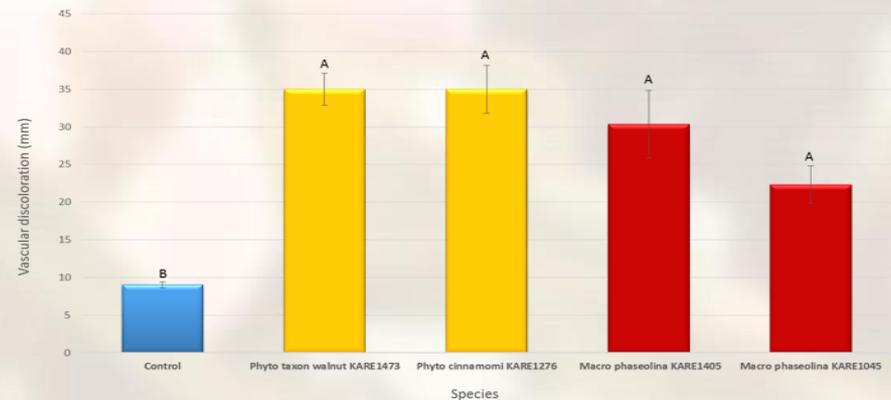
Secondary pathogens:

- Plant stresses may allow “secondary pathogens” to become virulent and destructive of pistachio trees



Current research:

- We currently investigate the biology of fungi such as *Fusarium* spp. or *Macrophomina phaseolina* isolated rather commonly from declining pistachio trees
- We are also testing various rootstock tolerance to soil-borne diseases



Lesion size produced by *Phytophthora taxon walnut*, *Phytophthora cinnamomi* and *Macrophomina phaseolina* on pistachio Rootstock 3 months after inoculation

Thank you!

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