



Symptoms and signs of soilborne pathogens of vegetables

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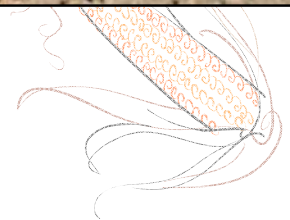
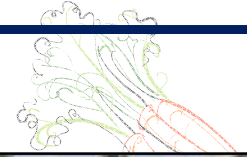


James A. LaMondia

The Connecticut Agricultural
Experiment Station

Project LNE10-296

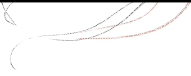
General field symptoms



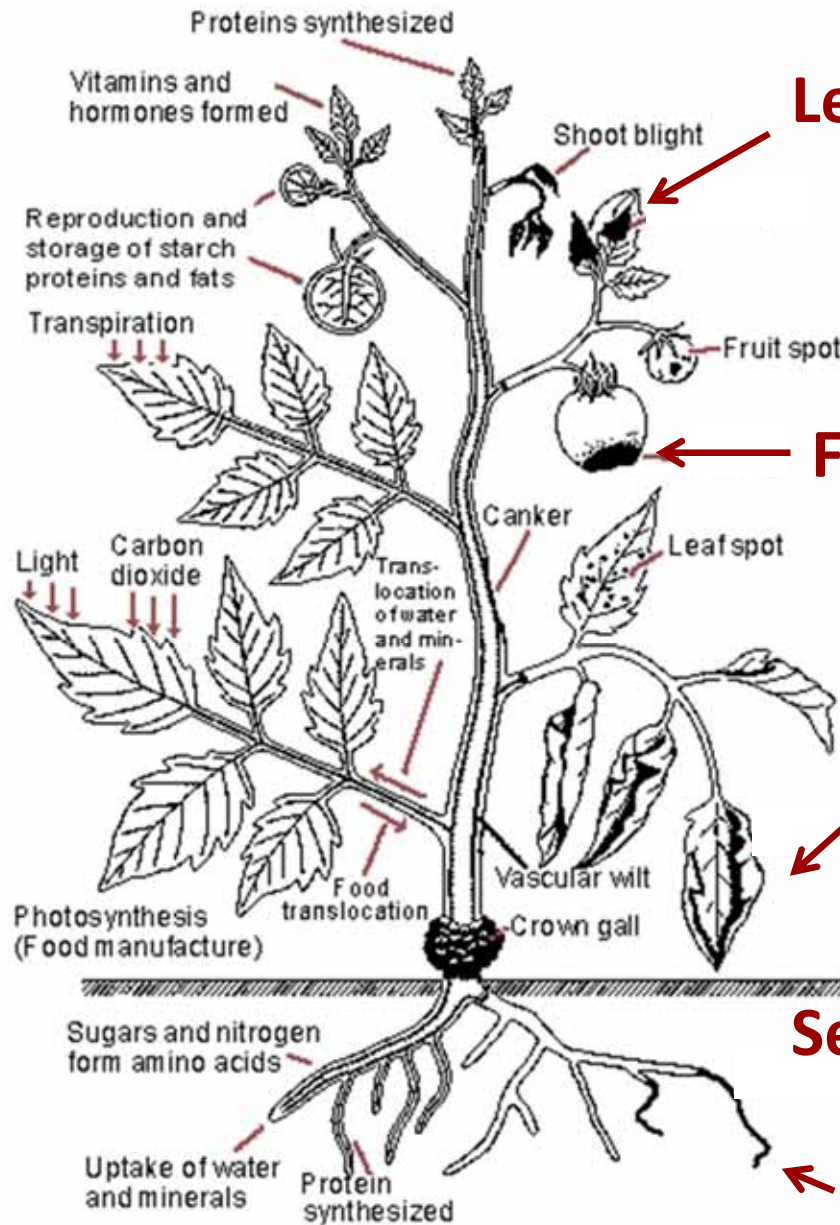
Patches and uneven distribution of less vigorous plants



General yellowing and wilting



General symptoms of soilborne pathogens



Leaf blights



Fruit rots



Wilts and stunting



Seed decay



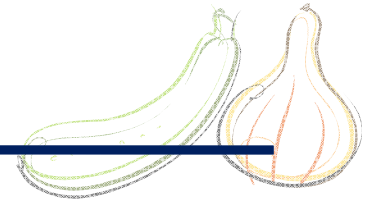
Root rots



Damping-off

(Modified from Agrios, G.N. 1997. Plant Pathology (4th ed.). Academic Press, NY, NY.)

Specific soilborne pathogens



Fusarium

Oomycete
pathogens

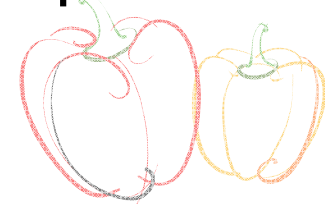
Sclerotinia



Disease
complexes

Basic lifecycle/sources of pathogen

Favorable environmental conditions



Diagnostic symptoms/signs

Streptomyces

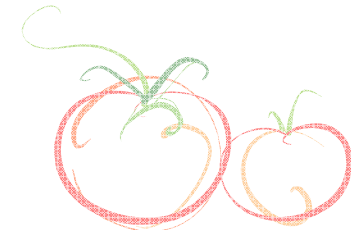
Host range



Verticillium

Other unique characteristics

Plasmodiophora



Rhizoctonia

Nematodes



Phytophthora fruit rot (*Phytophthora capsici*)



Phytophthora blight (*Phytophthora capsici*)



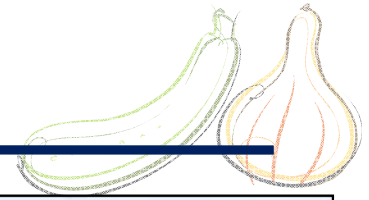
- ➔ Oomycete water-mold pathogen
- ➔ Major disease of pepper and cucurbit crops as well as eggplant, tomato and beans
- ➔ **Symptoms include:** damping-off, root and crown rots, stem and fruit rots
- ➔ Favorable environmental conditions: **warm and wet**



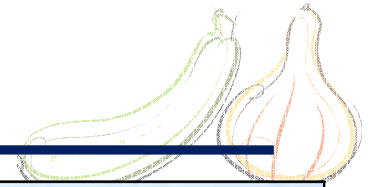
Phytophthora blight on pepper



Phytophthora blight on snap bean



Phytophthora blight on snap bean



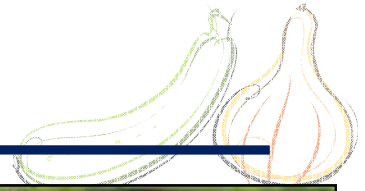
**2009 – Wet summer; June 6.3 in &
July 11.2 in. rain**



Phytophthora blight on snap bean



Phytophthora blight on snap bean

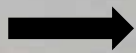


Phytophthora blight on snap bean

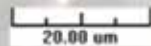
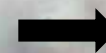


Phytophthora capsici

20 to 40 zoospores per sporangia



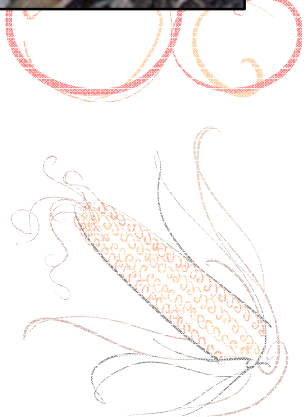
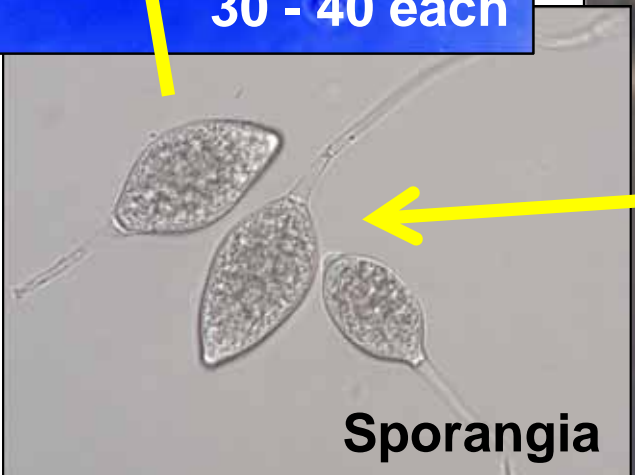
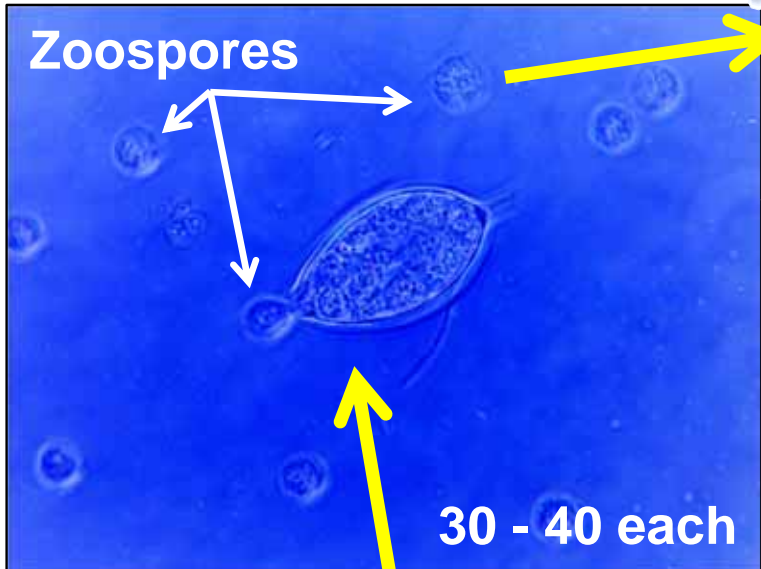
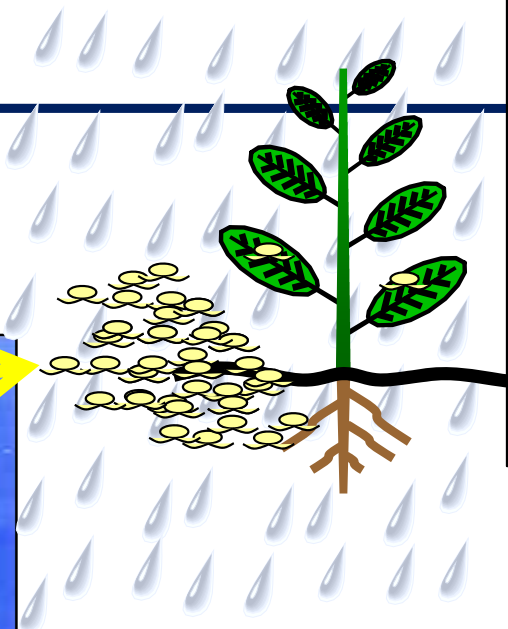
Sporangia



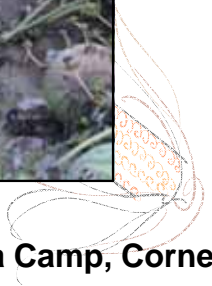
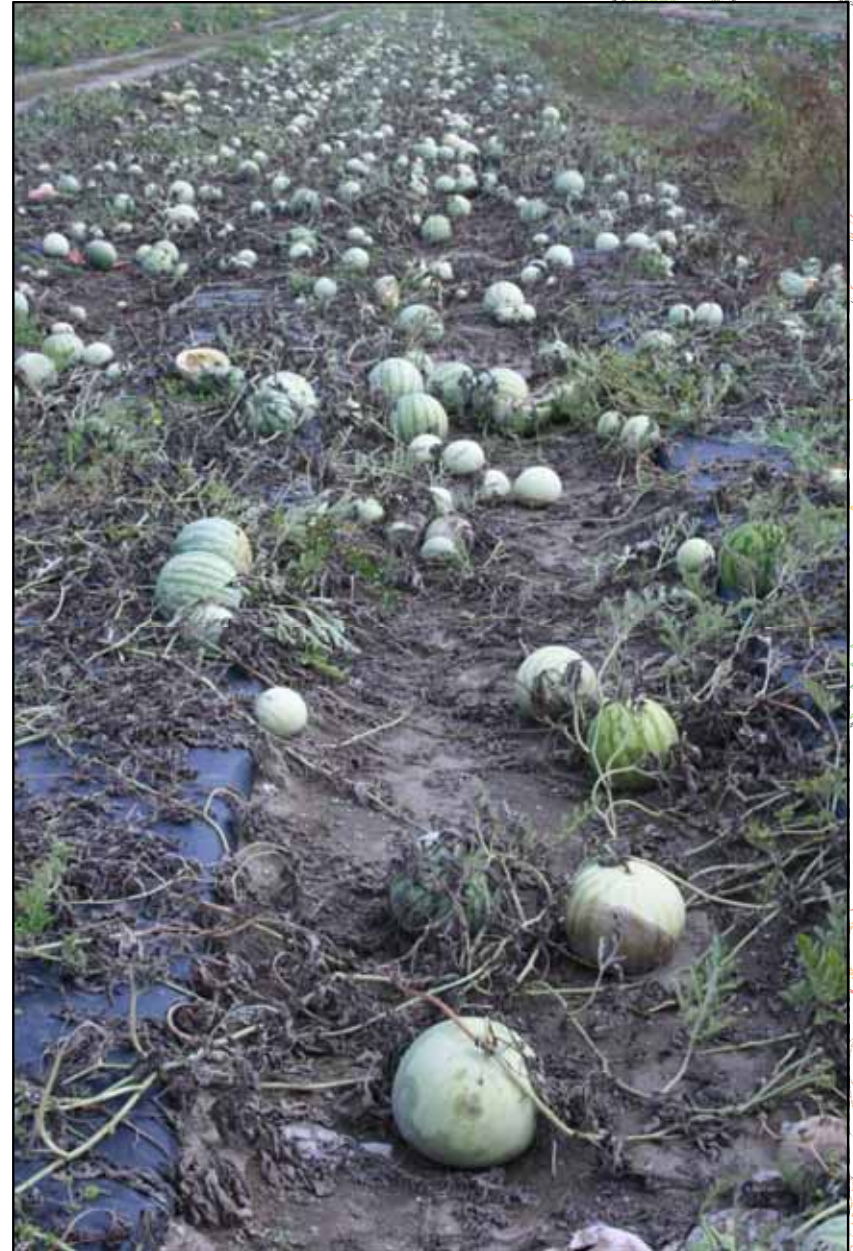
Zoospore →

How does Phytophthora blight spread?

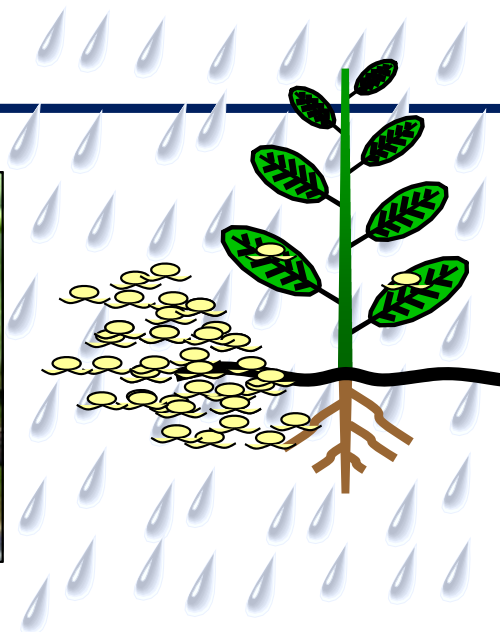
Optimum temp 75 to 91°F
Saturated soils



Before & after tropical storm Lee and Hurricane Irene

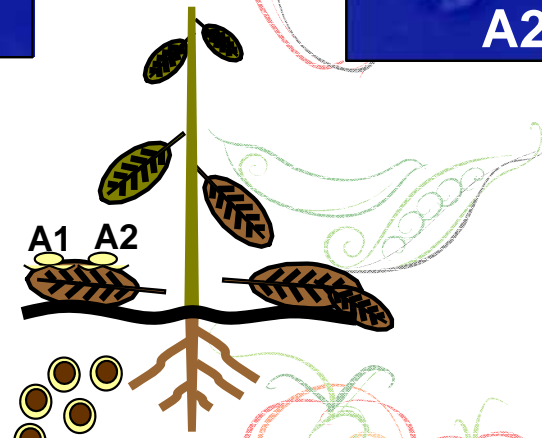
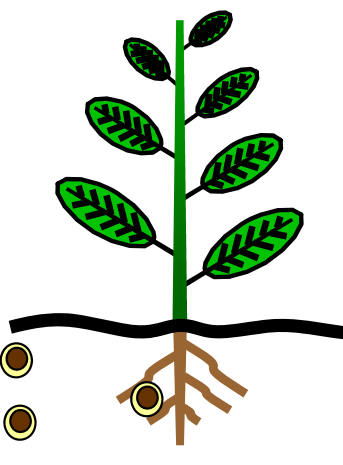


How does Phytophthora blight survive?



A1

A2

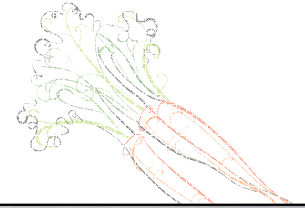


Germinating oospores



Oospores

Buckeye rot on tomato (*Phytophthora parasitica*)



- ➔ Develops on fruit touching the ground
- ➔ **Concentric rings** alt. light and dark
- ➔ Initially fruit are firm but become **soft and rotted**
- ➔ Favored by high relative humidity, wet soils and warm temps



M. McGrath

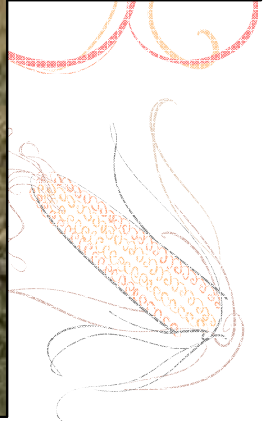


Pythium root rot on bean



Pythium root rot (*Pythium* spp.)

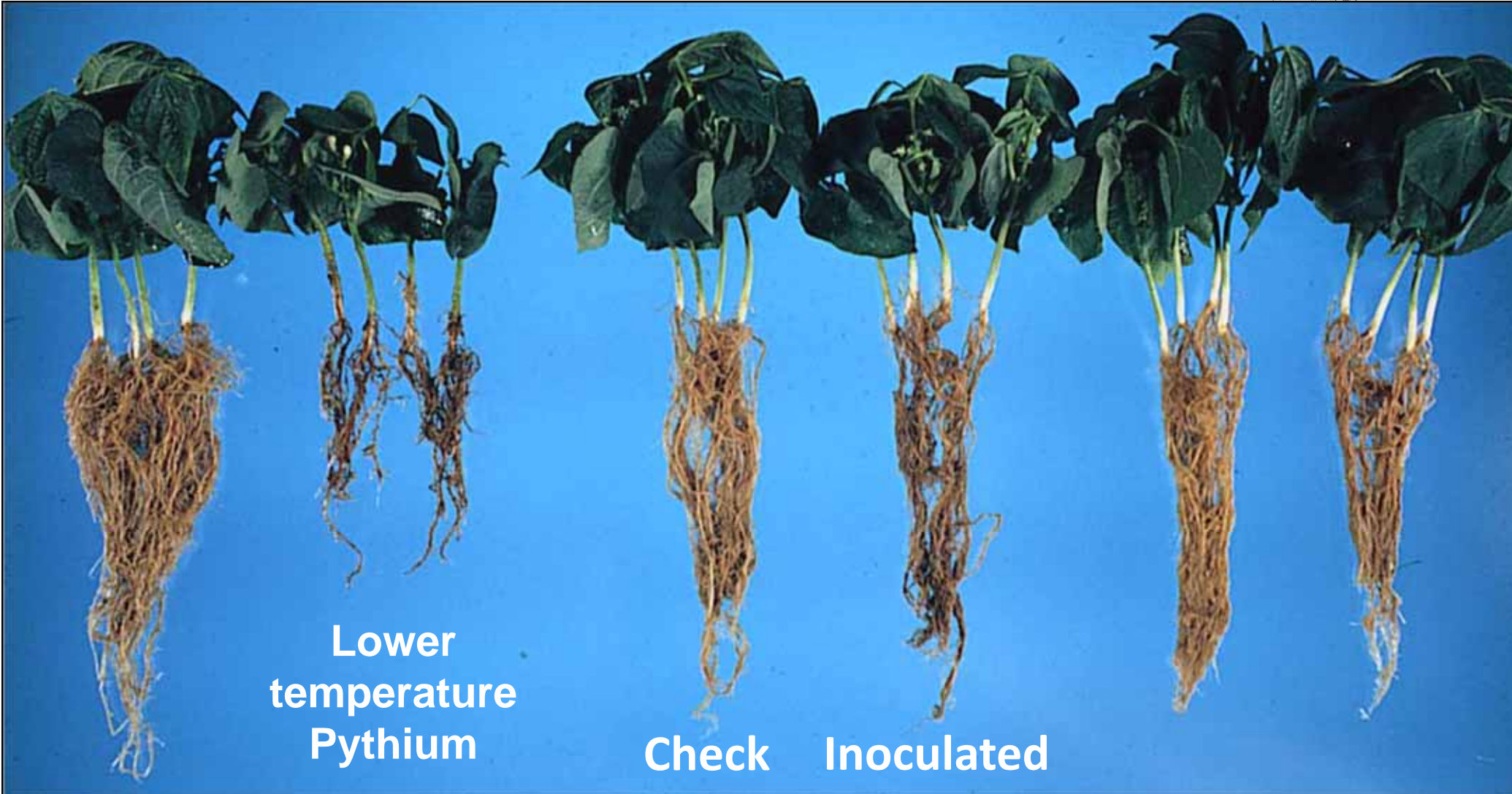
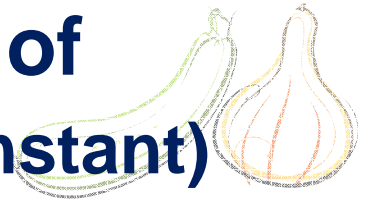
- ➔ Oomycete water-mold pathogen.
- ➔ Hosts include most vegetable crops
- ➔ **Symptoms include:** damping-off, seedling root rots especially before emergence
- ➔ Causes feeder root pruning on older plants
- ➔ Favorable environmental conditions: **cool and wet**



Pythium root rot on bean



Effect of temperature on the development of *Pythium ultimum* type root rot (moisture constant)



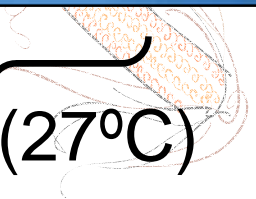
Lower
temperature
Pythium

Check Inoculated

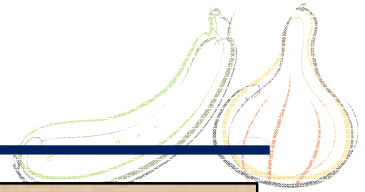
59°F (15°C)

70°F (21°C)

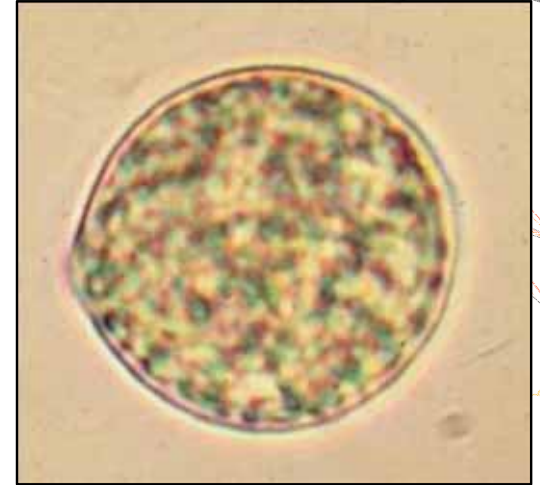
81°F (27°C)



Pythium root rot (*Pythium* spp.)



Agar plate with Pythium

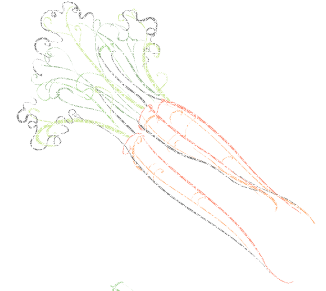
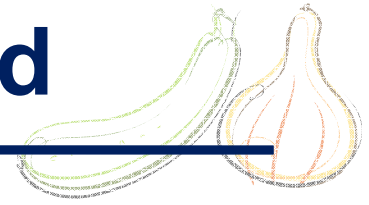


Zoospore



Oospores

Pythium root rot on ornamental gourd



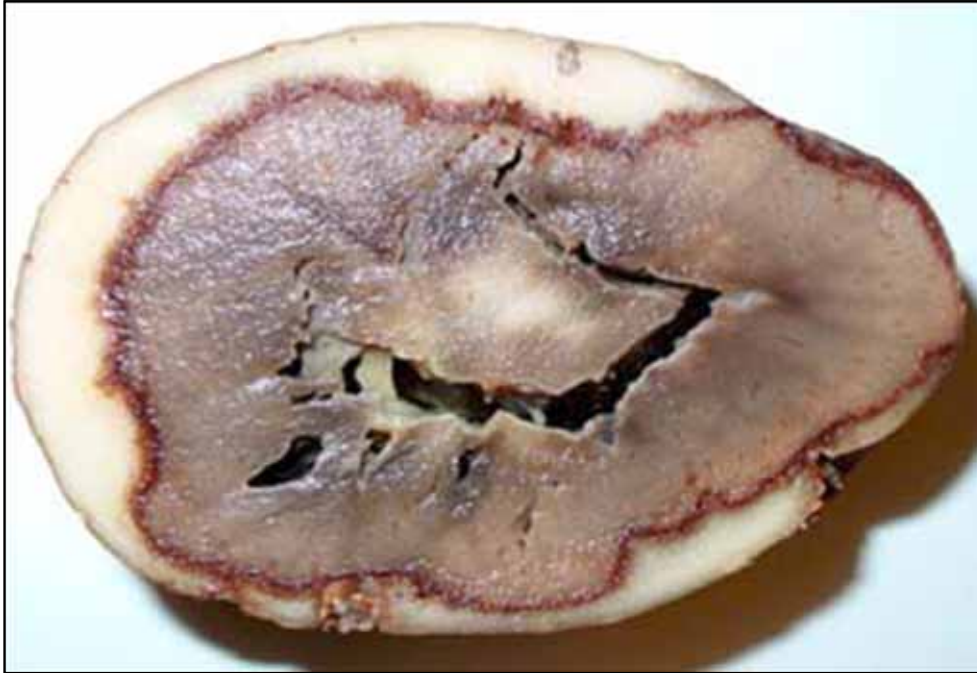
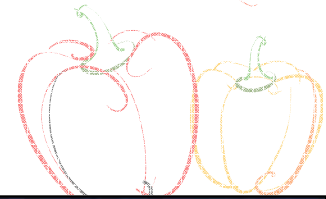
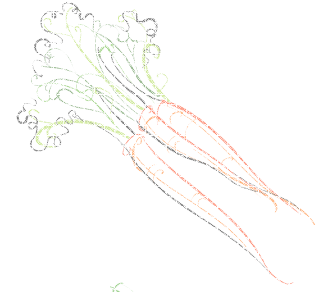
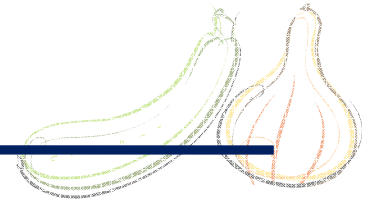
Tom Butzler

Cavity spot on carrot

(*Pythium* spp.)



Pythium leak of potato (*Pythium* spp.)



©T.A. Zitter

Rhizoctonia on carrot

(*Rhizoctonia solani*)



Rhizoctonia root rot (*Rhizoctonia* spp.)



- ➔ Hosts include most vegetables and many weeds
- ➔ **Symptoms include:** primarily root rots and damping-off
- ➔ Soil inhabitant producing sclerotia
- ➔ Favored by a wide range of environmental conditions: **warm soil and excess nitrogen as well as wounding**



Rhizoctonia stem canker and black scurf (*Rhizoctonia solani*)



➔ Common soilborne pathogen on vegetables

➔ Subgroups or anastomosis groups

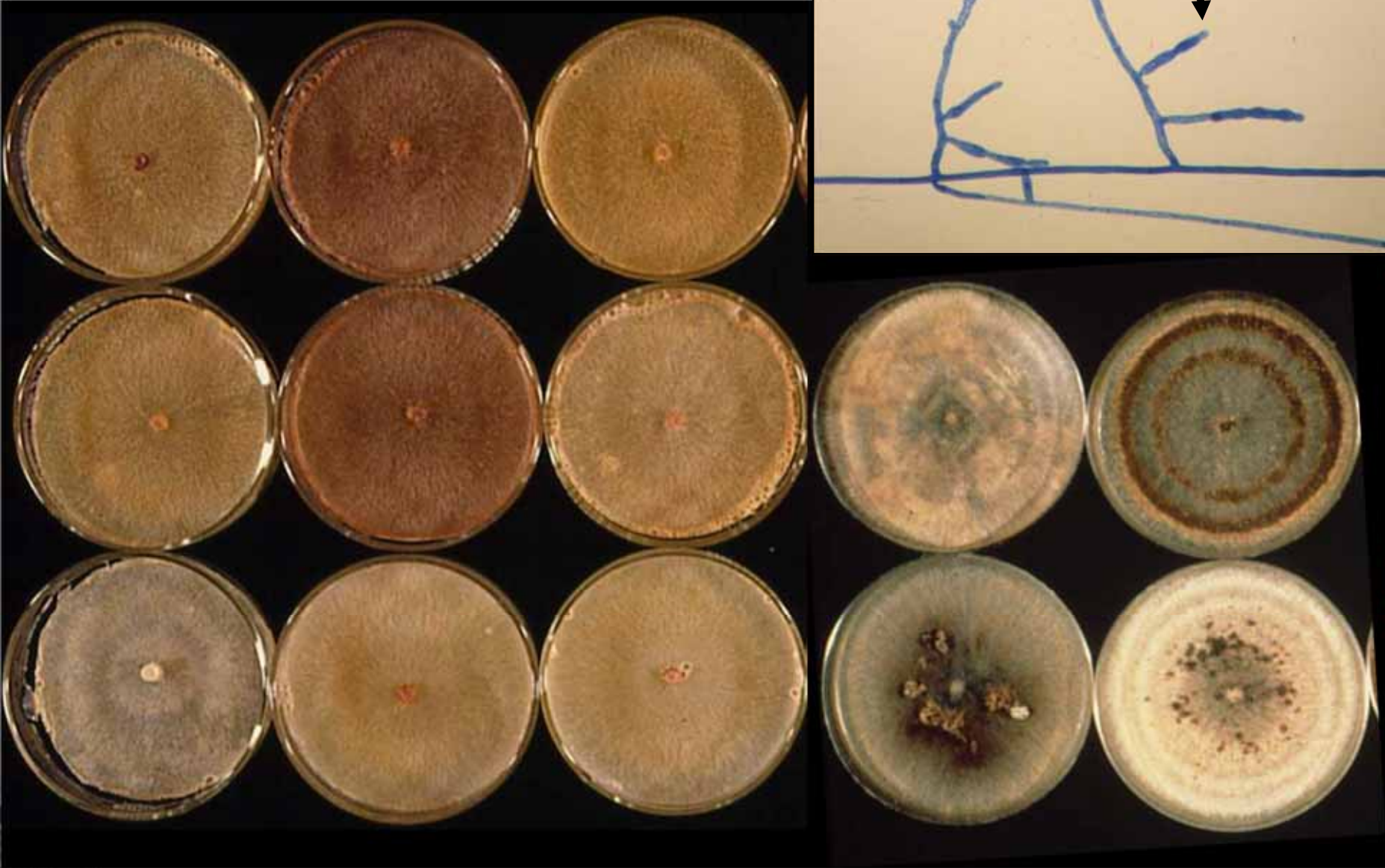
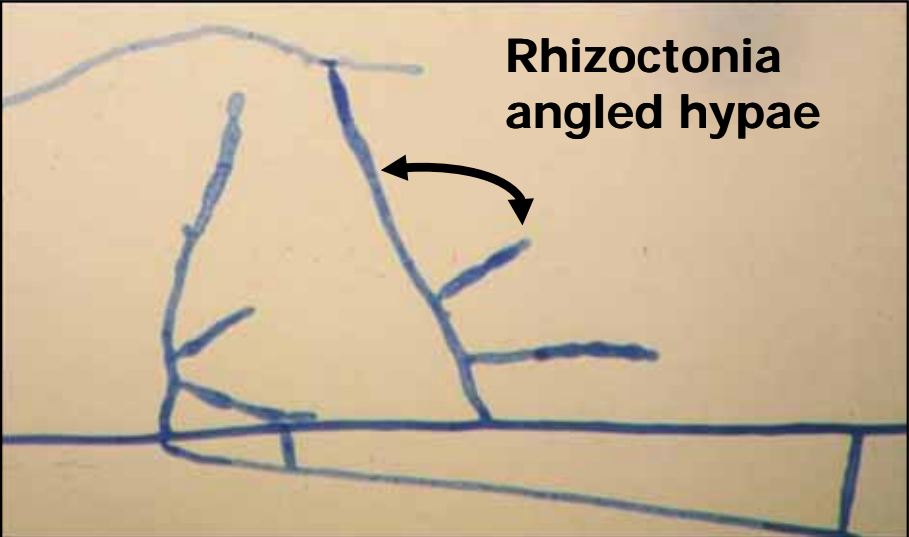
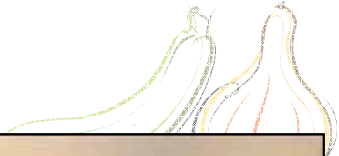
AG-1

AG-2

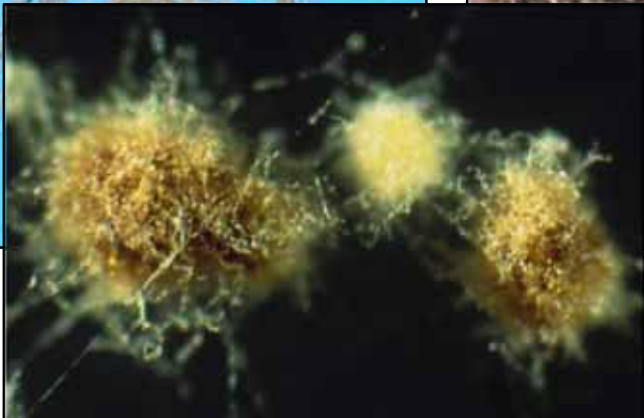
AG-3 (potato)



Diversity of *Rhizoctonia solani* isolates in culture



Rhizoctonia on snap bean



Web blight

(*Thanatephorus cucumeris*)



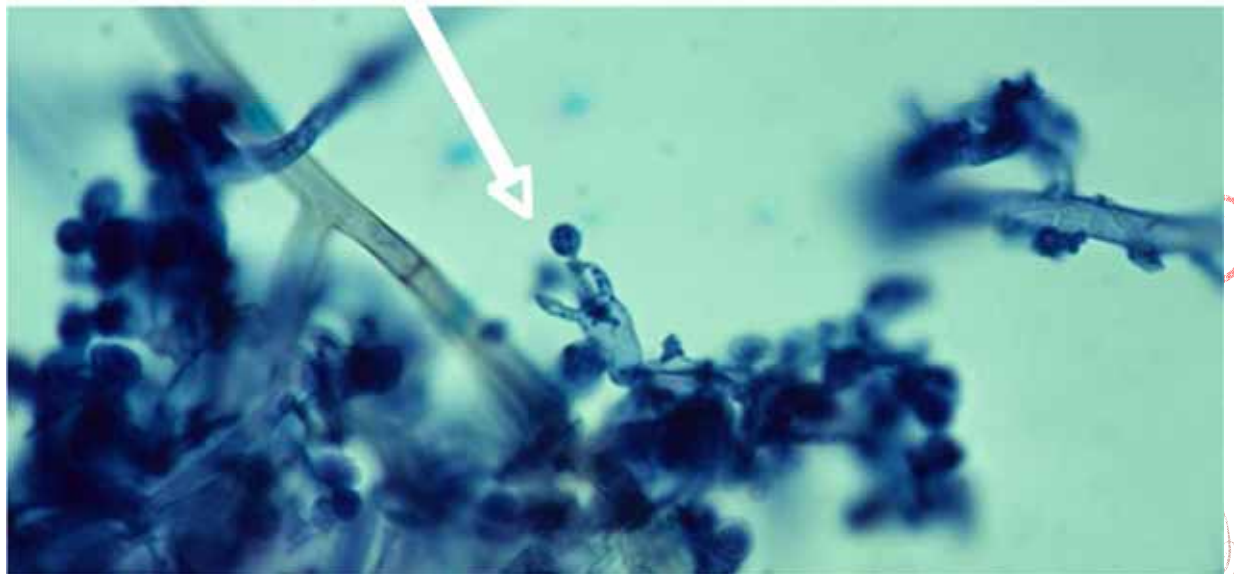
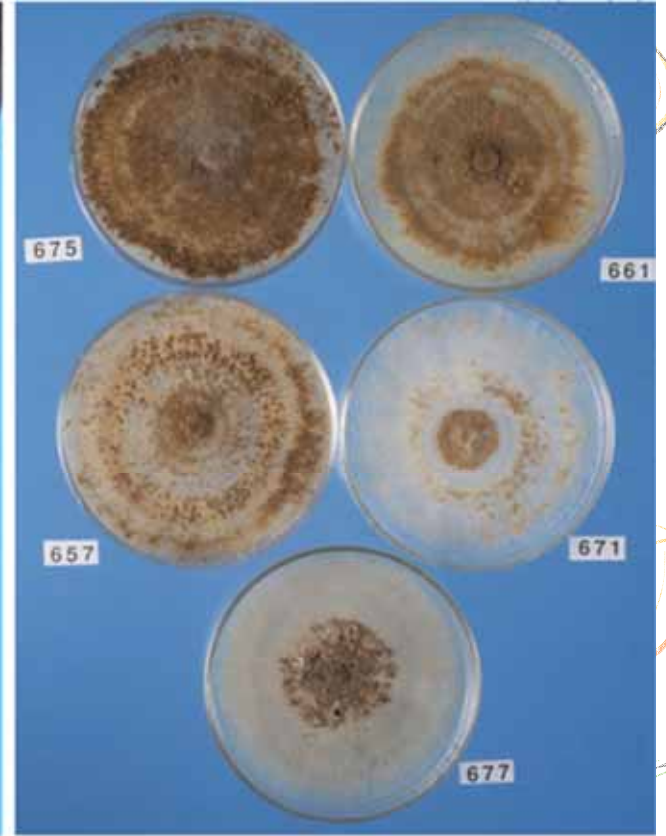
Rhizoctonia on beets

(*Rhizoctonia solani*)



Rhizoctonia on beets

(*Thanatephorus cucumeris*)



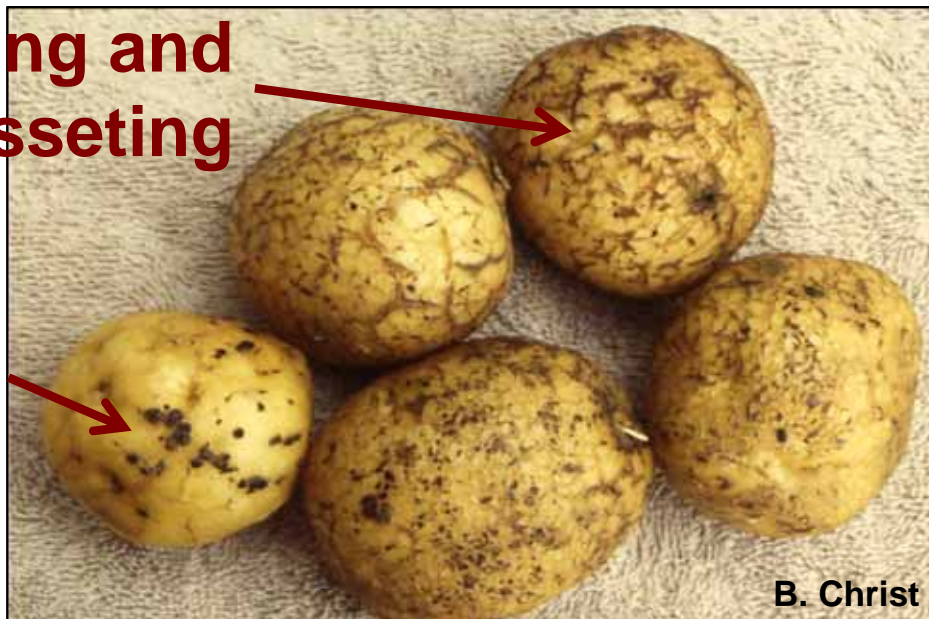
Black scurf (*Rhizoctonia solani*)



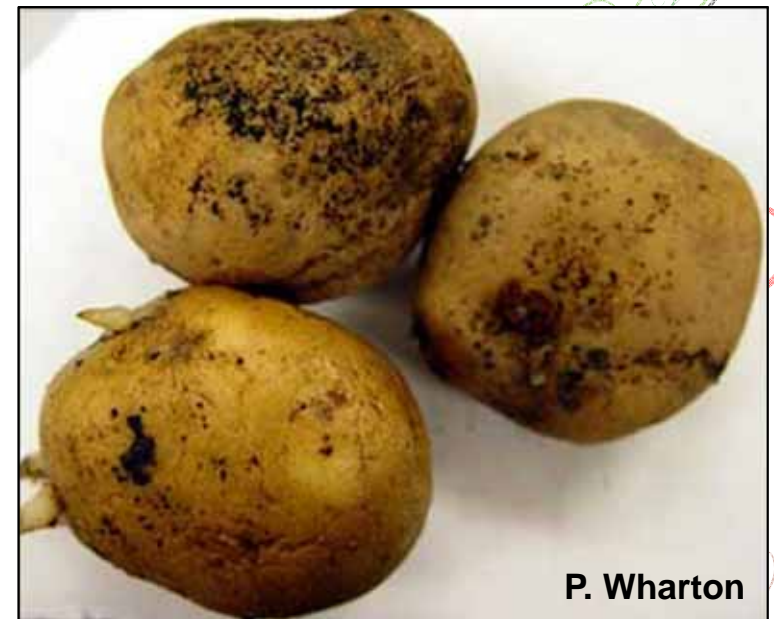
- ➔ Dark brown to black **sclerotia** that are irregularly shaped
- ➔ Resembles soil that does not wash off



Cracking and russeting



Sclerotia



Stem canker on potato (*Rhizoctonia solani*)



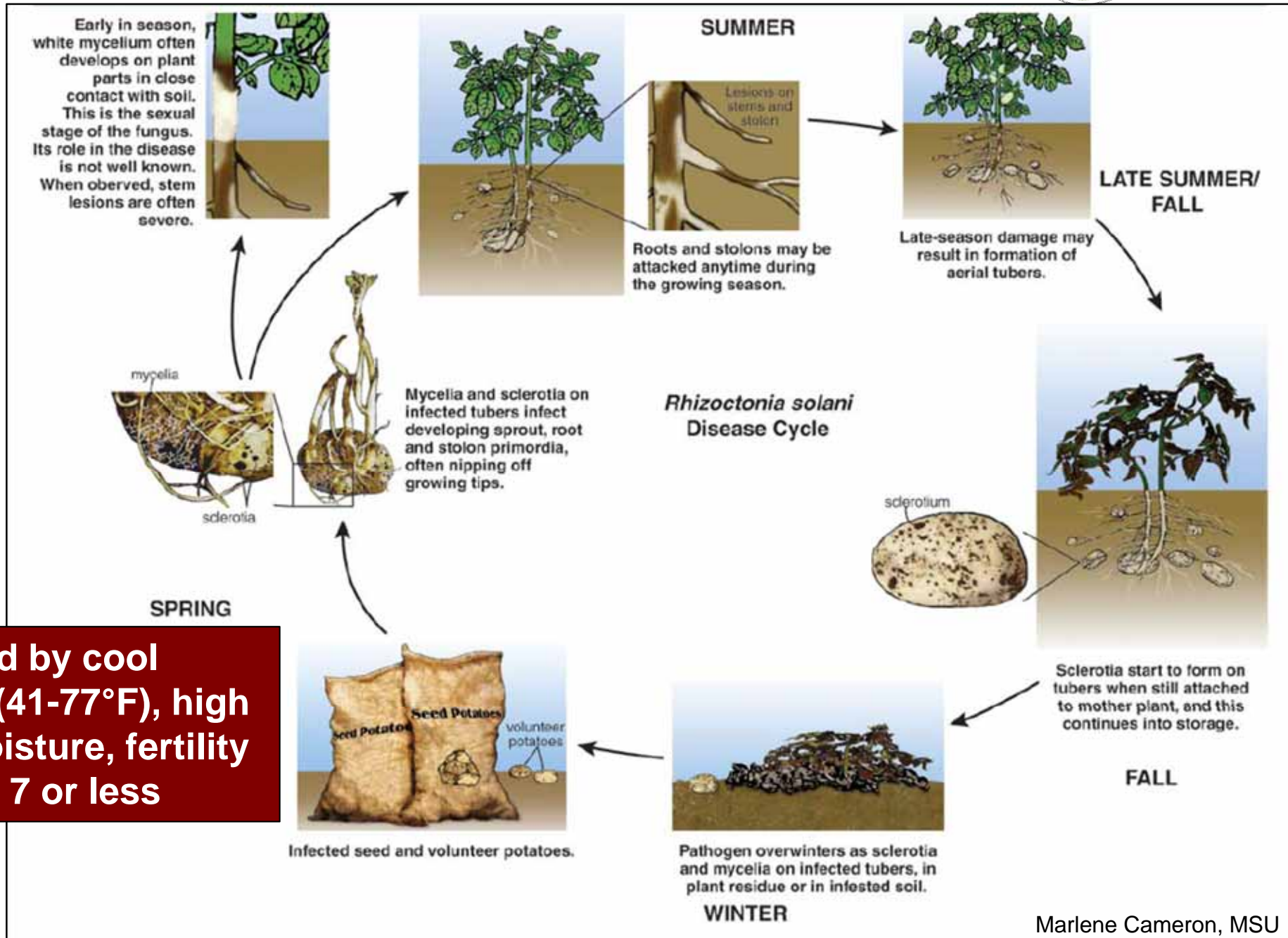
Reddish-brown to black lesions on sprouts, stolons and roots



Can girdle affected area



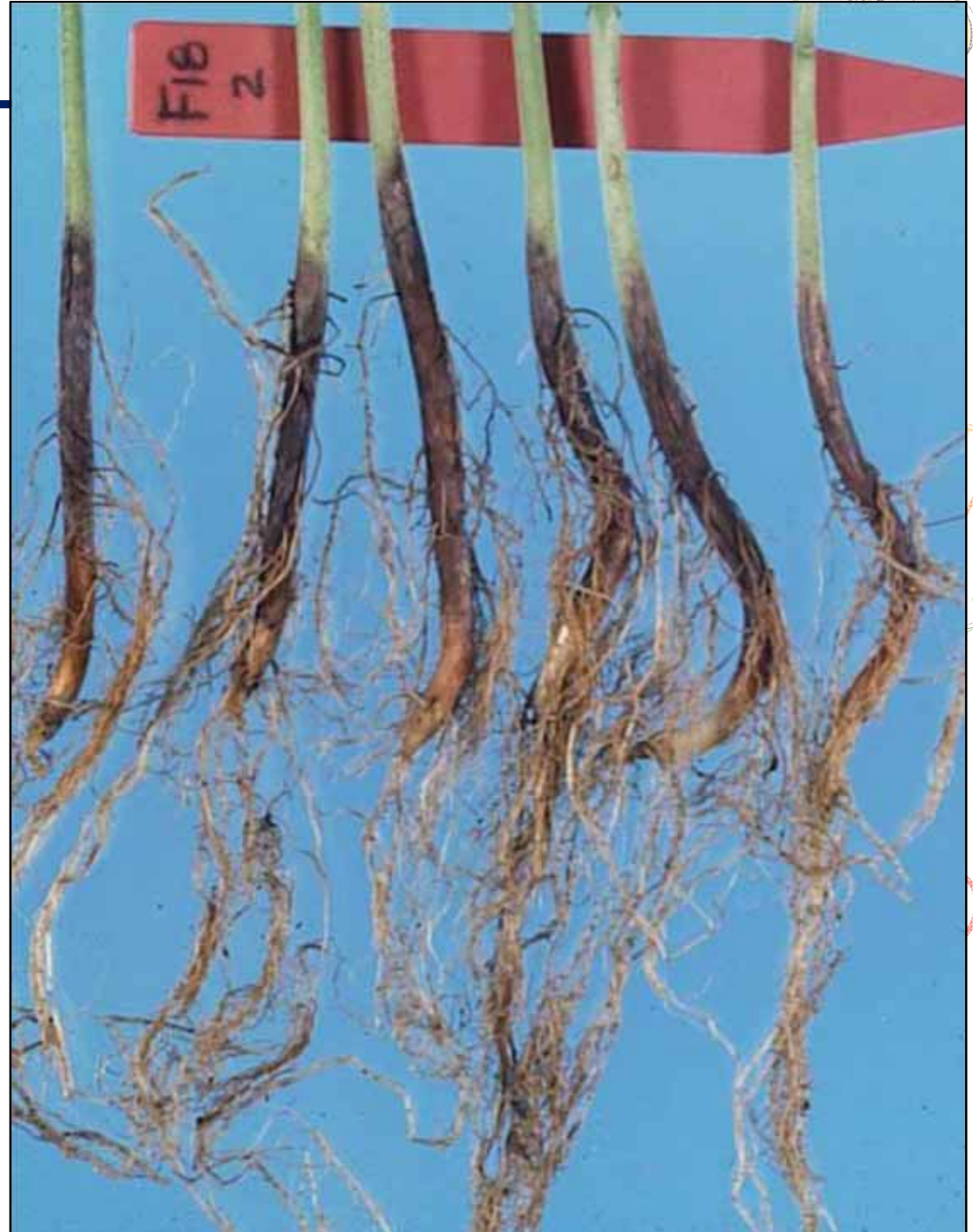
Rhizoctonia stem canker and black scurf



Fusarium root rot (*F. solani* f. sp. *phaesoli*)



Fusarium root rot (*F. solani* f. sp. *phaesoli*)



Fusarium root rots (*Fusarium solani* f.sp. *pisi*)



- ➔ Different species or strains infect many vegetables (f. sp.)
- ➔ **Symptoms include:** damping-off, root, stem, and fruit rots
- ➔ Can survive in crop debris and overwinter as chlamydospores
- ➔ Favorable environmental conditions: **warmer soil temperatures than *Pythium* spp.**



Peas

Diversity of Fusarium isolates in culture



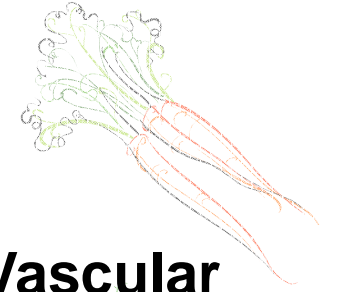
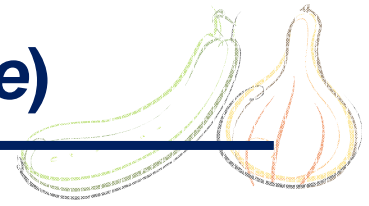
Fusarium crown rots on celery



Fusarium crown and fruit rots



Fusarium wilt (*F. oxysporum* f. sp. *nicotianae*)



**Vascular
discoloration**



Fusarium wilts (*Fusarium oxysporum* f. sp. various)



- ➔ Different strains are host specific and infect crops like tomato, cucurbits, and spinach
- ➔ **Symptoms include:** wilting and vascular discoloration
- ➔ Can survive in crop debris and overwinter as chlamydospores
- ➔ Favorable environmental conditions: **warmer weather (82-86°F) and acid, sandy soils**

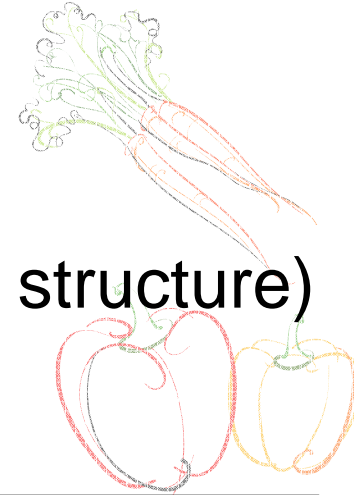


Clemson University - USDA Cooperative Extension
Slide Series, Bugwood.org

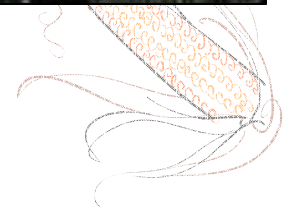
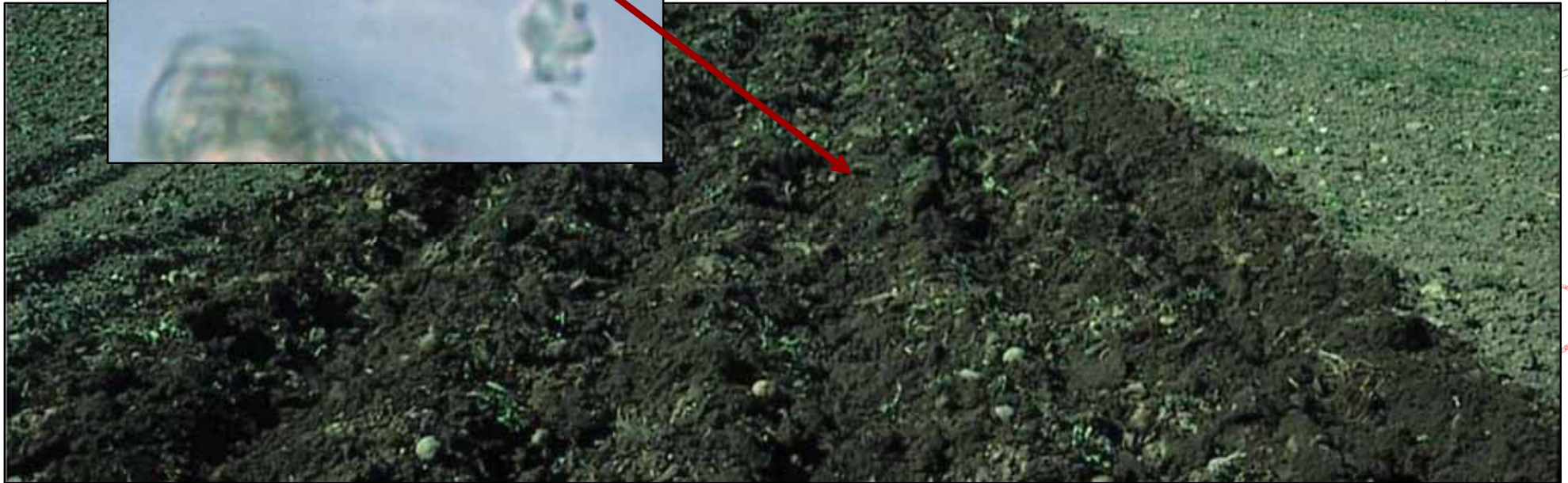
UGA1234206

Fusarium wilt

(*F. oxysporum* f. sp. *phaesoli*)



Chlamydospore
(overwintering survival structure)



Thielaviopsis root rot (*Thielaviopsis basicola*)



**Characteristic
black roots**

Thielaviopsis root rot (*Thielaviopsis basicola*)



➔ Hosts include many vegetables

➔ **Symptoms include:**
damping-off and black
root rot

➔ Can survive in crop
debris and overwinter
as chlamydo spores

➔ Favorable environmental
conditions: **cool and wet
spring followed by high
summer temperatures**



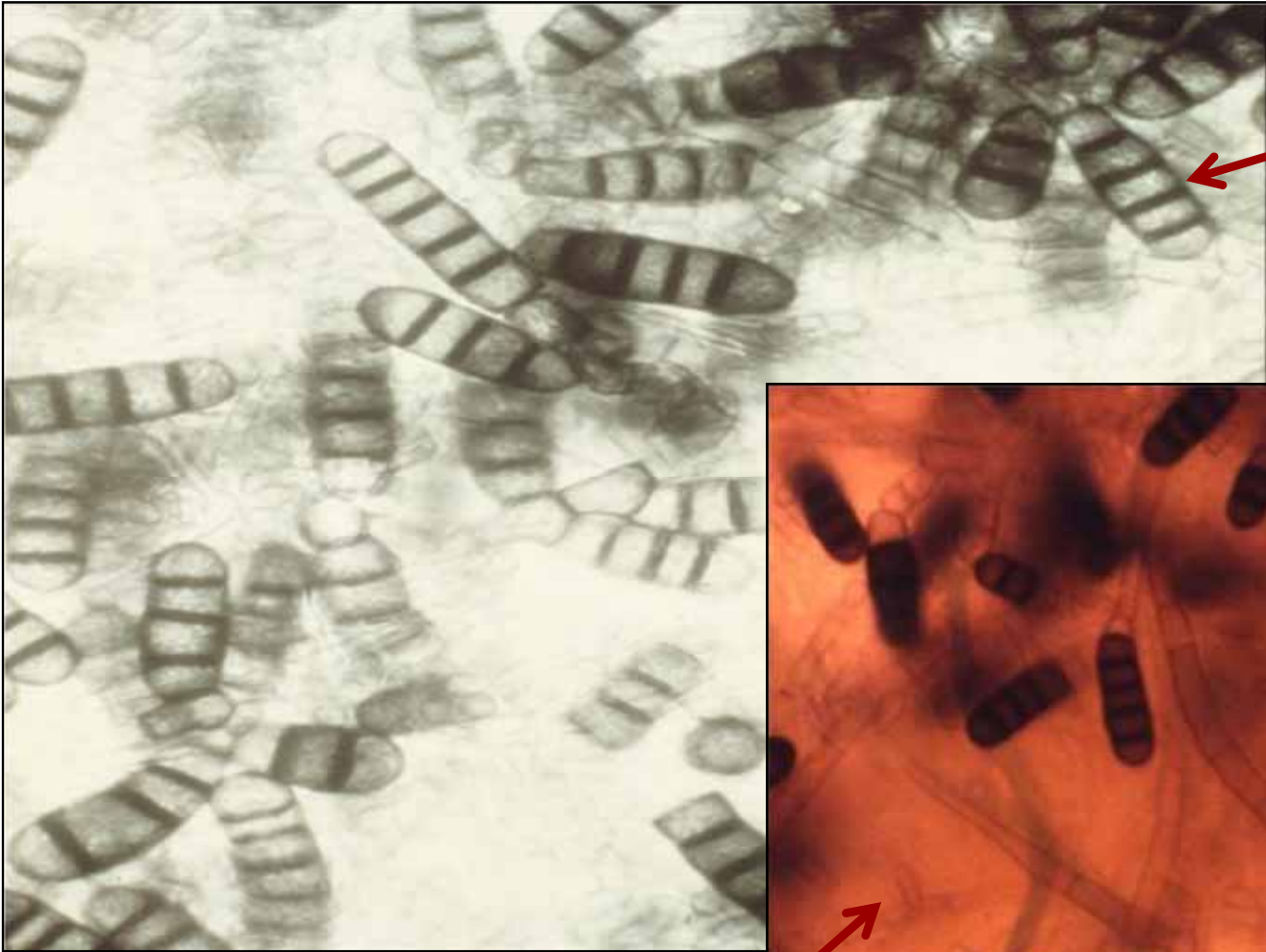
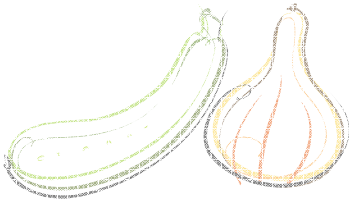
Thielavopsis on carrot

(*Thielaviopsis basicola*)



Thielaviopsis root rot

(*Thielaviopsis basicola*)



Chlamydospores



Phialospores



Pythium



Rhizoctonia



Root rot complex

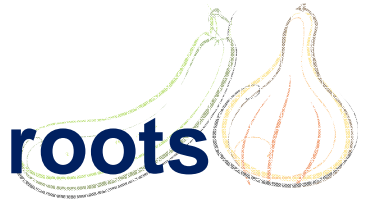
Thielaviopsis



Fusarium



Effect of individual fungal pathogens or combinations of pathogens on snap bean roots



Check

Pythium

Fusarium

Rhizoctonia

P & F

P & R

R & F

P, R & F

Sclerotinia on carrot

(*Sclerotinia sclerotiorum*)



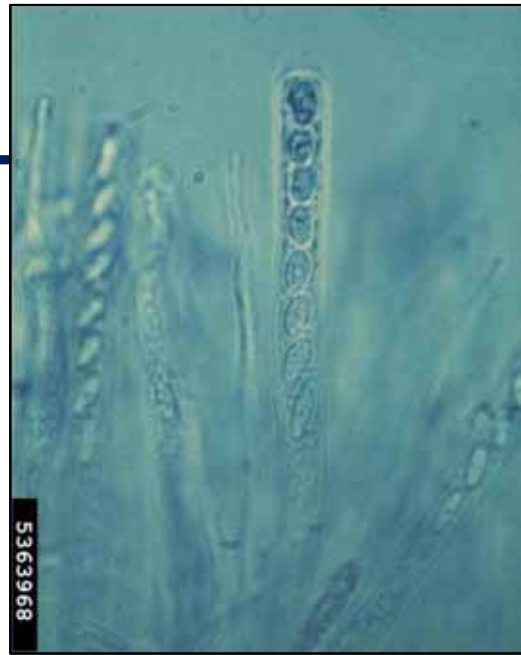
Lifecycle



Sclerotia germinating and produce apothecia



Overwinter as sclerotia *



Spore release coincides with flowering *



Primary infections



Production of sclerotia



Secondary infections**

White mold (*Sclerotinia sclerotiorum*)

- ➔ Soilborne pathogen with a wide host range (400+)
- ➔ Severity is highly dependent on favorable weather conditions for the pathogen...wet and 68-77°F

Snap bean,
tomato, cabbage,
carrot, cucurbits,
soybean,
sunflower,
alliums...most
vegetables



White mold on bean (*Sclerotinia sclerotiorum*)



Sclerotinia head rot (*Sclerotinia sclerotiorum*)



Timber rot on tomato (*Sclerotinia sclerotiorum*)



Lettuce drop (*Sclerotinia minor*)



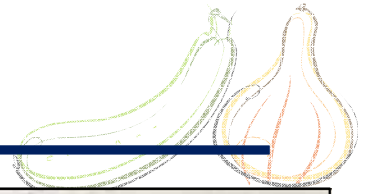
In the NE, primarily
a problem on
muck/high organic
matter soils.

Clubroot

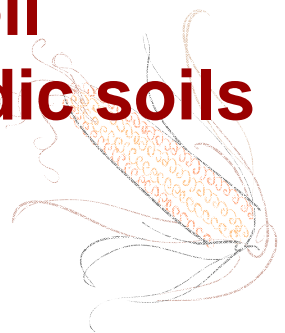
(*Plasmodiophora brassicae*)



Club root (*Plasmodiophora brassicae*)



- ➔ Hosts include cabbage, cauliflower, broccoli, brussels sprouts, radish, mustard and other brassicas
- ➔ **Symptoms include:** galling on hypocotyl and roots, wilting and stunting
- ➔ Obligate pathogen that survives as resting spores
- ➔ Favorable environmental conditions: **increasing soil moisture as temps increase above 68°F and acidic soils**



Common scab of potato (*Streptomyces* spp.)

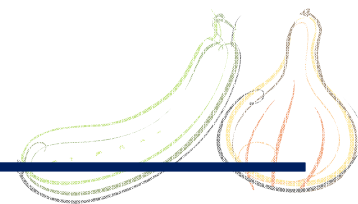


- ➔ **Symptoms include:** infects lenticels or wounds in tubers and causes plant suberization
- ➔ Survives in soil or crop debris or seed tubers
- ➔ Favorable environmental conditions: **dry soils with pH above 5.2**



B. Christ

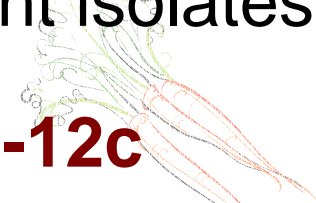
Common scab (*Streptomyces* spp.)



➔ Response of **Katahdin** (very susceptible) to 2 different isolates

Isolate ME 01-12h

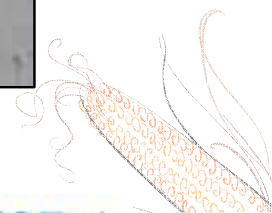
Isolate ID 01-12c



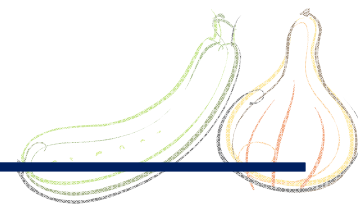
10^8



10^{10}



Common scab (*Streptomyces* spp.)



➔ **Inoculum density** is a critical factor in disease severity



uninoculated



9.2×10^6



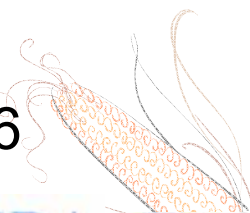
9.2×10^7



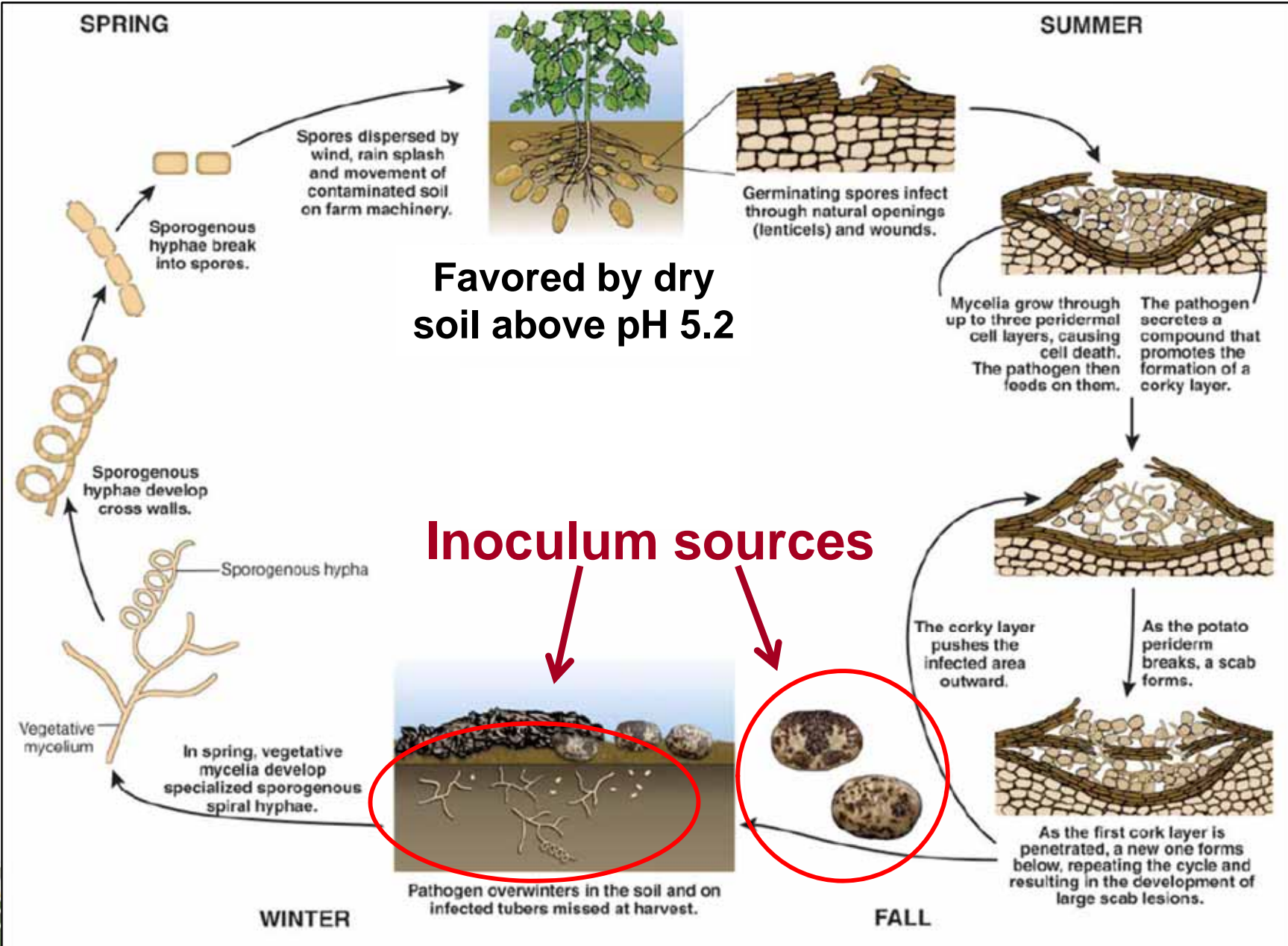
9.2×10^8



Superior (upper row, more resistant) and Green Mt (lower, more susceptible) inoculated with ID01-16



Common scab (*Streptomyces* spp.)

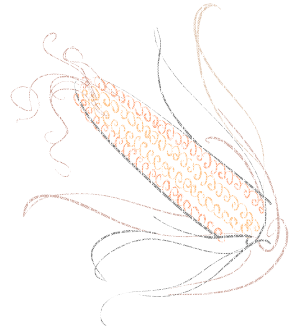
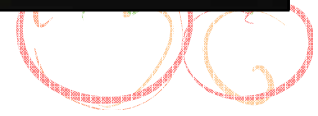
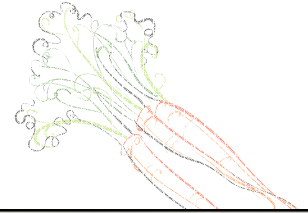


Verticillium wilt (*Verticillium albo-atrum* and *V. dahliae*)



Verticillium wilt (*Verticillium albo-atrum* and *V. dahliae*)

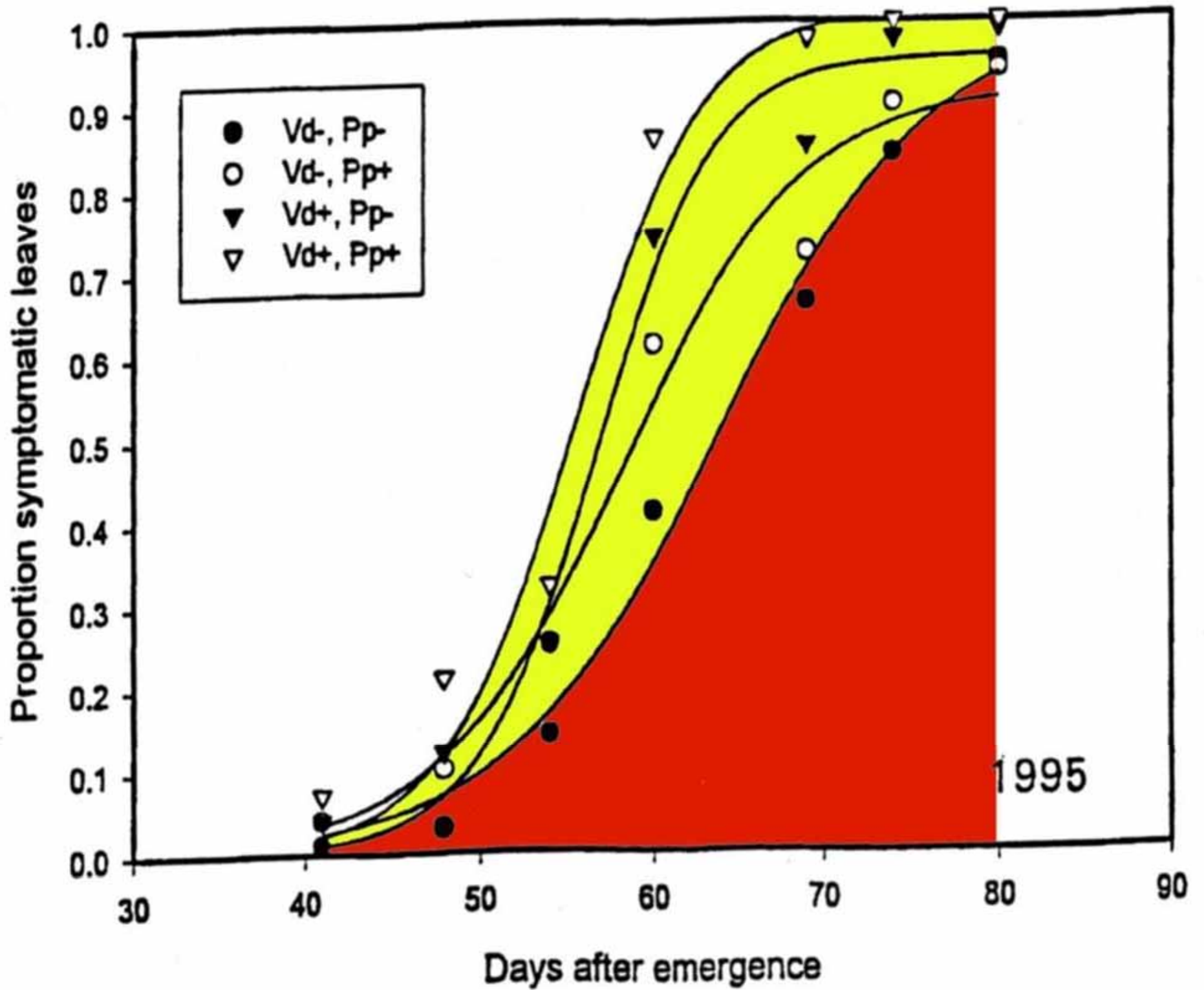
- ➔ Hosts include many vegetables especially tomato, eggplant, pepper and melons
- ➔ **Symptoms include:** wilt and vascular discoloration however, they are slower to develop
- ➔ Can survive as mycelium or microsclerotia
- ➔ Favorable environmental conditions: **cooler weather and neutral to alkaline soils**



Potato early dying disease (PED)

(*Pratylenchus penetrans* + *Verticillium dahliae*)

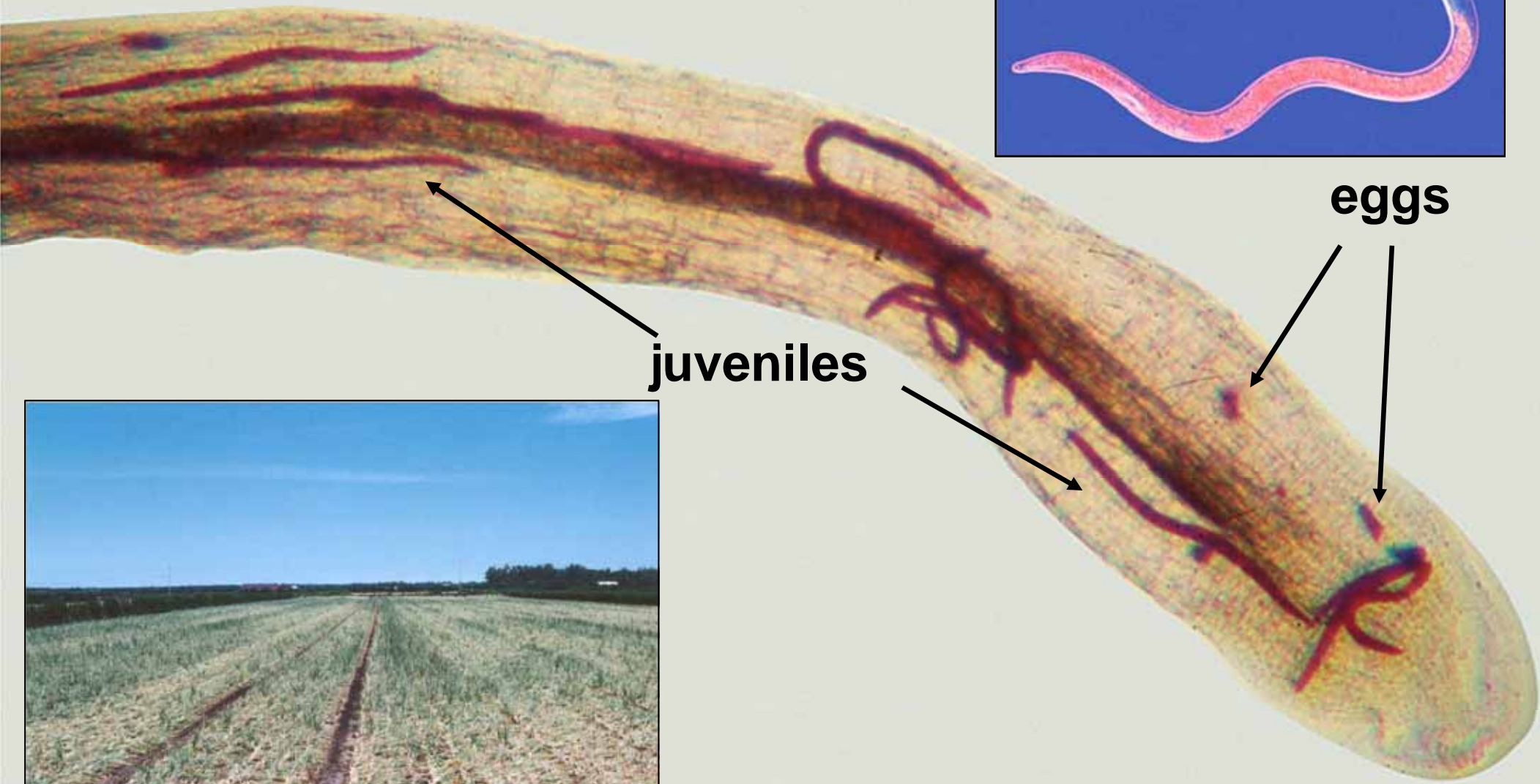




Lesion nematode (*Pratylenchus penetrans*)

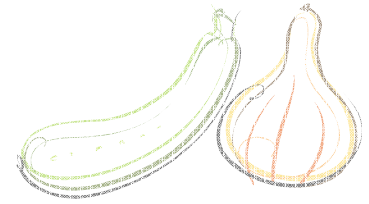


Root-lesion nematode (*Pratylenchus penetrans*) in an onion root



Lesion nematode

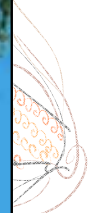
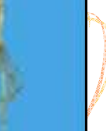
(*Pratylenchus penetrans*)



- ➔ >400+ hosts including fruit trees, grain crops, vegetables and many common weeds
- ➔ **Symptoms include:** poor plant vigor, stunting, wilting, root pruning and discoloration
- ➔ Survive as migratory ectoparasites both in the plant root and in the soil
- ➔ Favorable environmental conditions: **more damage caused in sandy soils** where water and nutrients are limited

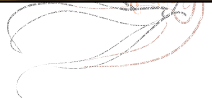


Northern root-knot nematode (*Meloidogyne hapla*)



Northern root-knot nematode

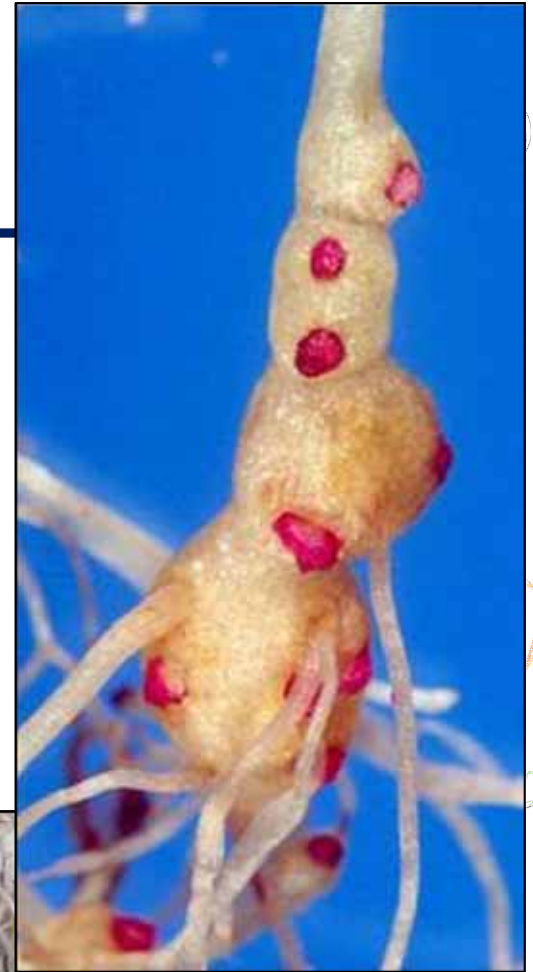
(*Meloidogyne hapla*)



Northern root-knot nematode

(Meloidogyne hapla)

- ➔ Hosts include most agronomic crops including vegetables and many common weeds
- ➔ **Symptoms include:** stunting, galling, forking, delayed maturity
- ➔ Survive mostly in plant roots; short part of lifecycle in soil
- ➔ Favorable environmental conditions: **more damage caused in sandy soils**



Bloat nematode on garlic

(*Ditylenchus dipsaci*)



Bloat nematode on garlic

(Ditylenchus dipsaci)

- ➔ Wide host range but especially destructive on garlic, onion and leek
- ➔ **Symptoms include:** bulbs are discolored, shrunken, soft, light in weight, eventually decay
- ➔ Survive in a desiccated state in soil for several years





Questions on symptoms and signs of soilborne pathogens of vegetables?

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