

# Diseases of Vegetables and Field Crops

Nicholas S. Dufault  
Extension Specialist  
Agronomic Crops & Vegetables  
Plant Pathology Department/IFAS  
University of Florida



# What is a plant disease?

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***Abnormal physiological function of an organism caused by a biotic or abiotic factor.***



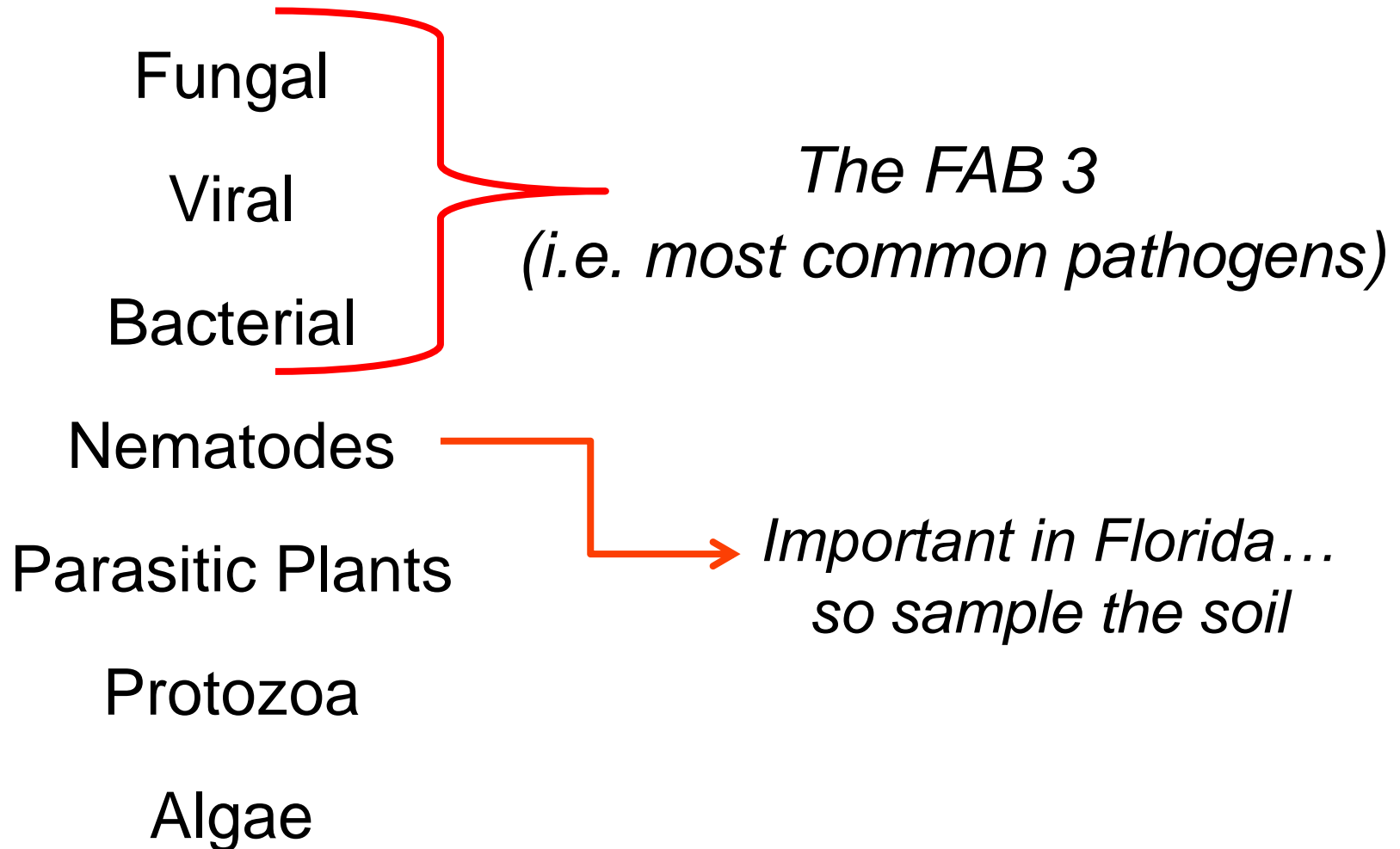
**Leaf spots**



**Iron Deficiency**

# Pathogens are disease causing agents.

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# Integrated Disease Management (IDM) is Critical

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- **Why?**
  - Cannot solely rely on one method of control to manage all the pathogens and pests!
  - TOO much of anything is a bad thing (e.g. methyl-bromide, DDT, etc.)

# What are some tools in our IDM kits?

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- Pathogen-free
  - Propagative material
  - Media/soil
- Preplant soil sterilization
  - Fumigants
  - Steam
  - Soil solarization
- Manipulation of soil PH

## Fumigants Alternatives

1. Chloropicrin
2. Methyl iodide
3. **Metam sodium**
4. **Telone II**
5. Telone C17
6. Telone C35
7. Pic-Clor 60
8. **Metam potassium**

Note: red text poor/erratic disease control

# More IDM Tools

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- Sanitation
  - Rogueing (remove plants)
  - Disinfestation of tools
  - Structures/Storage
- Other pest management
  - Insects
  - Weeds
  - Nematodes
- Biological controls



# 3 common IDM tools in plant pathology.

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- Rotation (non-host/cover cropping)
- Resistance (traditional, engineered)
- Chemical applications
  - Fungicides
  - Bactericides
  - Insecticides

# What do I have?

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First steps are to identify the host and pathogen.



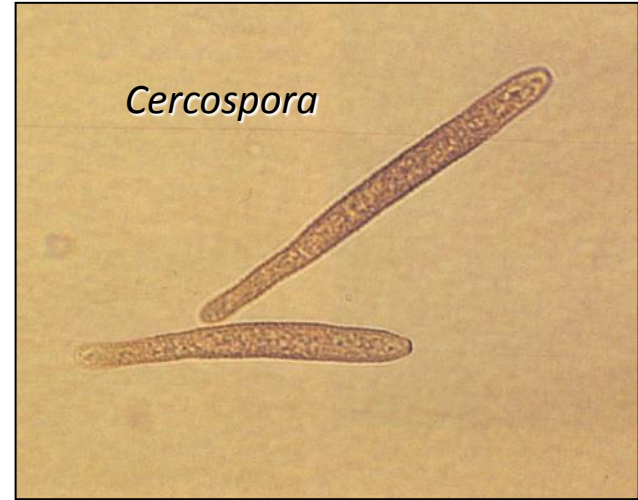
# What is the difference between a symptom and a sign?

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- Symptoms are:
  - disease responses expressed by the **host**
  - i.e. chlorosis, necrosis, stunting, wilt, canker
- Signs are:
  - physical structures of the **pathogen**
  - i.e. mycelium, perithecia, spores

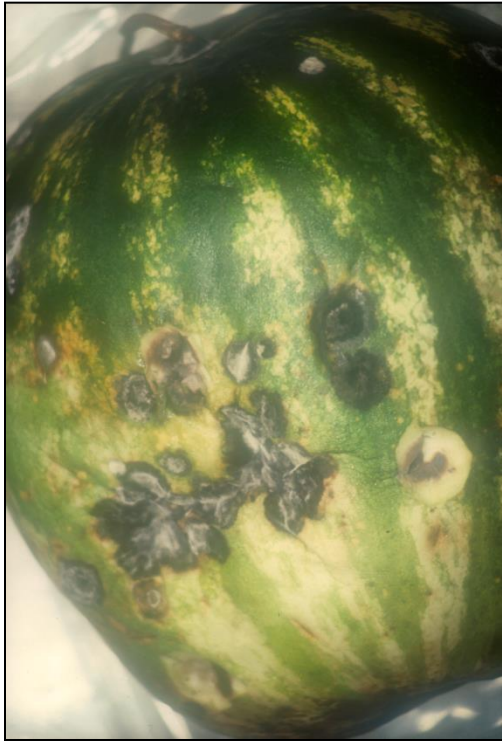
# Foliar & Fruit Fungal Diseases

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# Alternaria Fruit Rot

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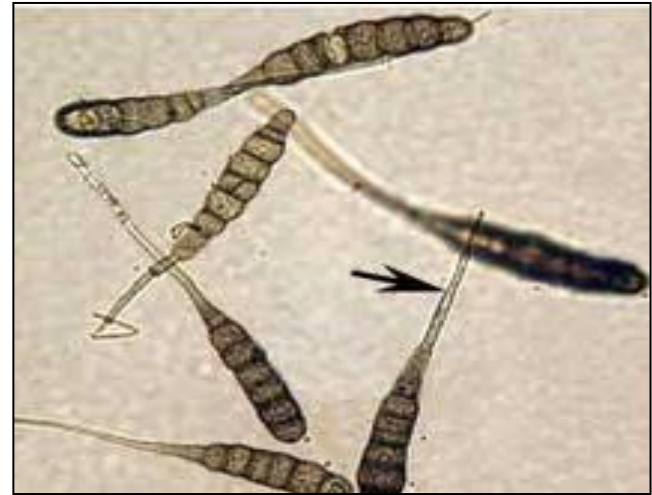


**Brown lesions that usually become black.**



# Alternaria Leaf Spots

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<http://www.avrdc.org/LC/cabbage/alter3.html>

# Potato Brown spot – (*Alternaria alternata*)

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Similar to early blight on potatoes, generally smaller. This pathogen also affects tomatoes and carrots.

**Azoxystrobin Resistance**

# *Botrytis* spp.

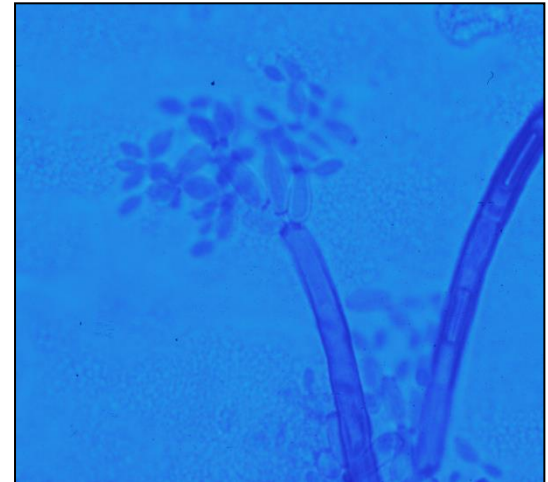
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## **A.K.A: Gray Mold**

The fungus appears as a gray, velvety covering of spores on dying flowers and on the fruit

- Stem cankers can develop
- Some water soaking can be apparent



# *Cercospora* spp.

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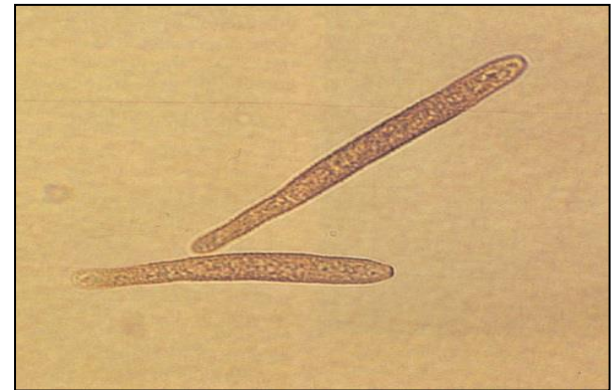


## **Typically a leaf spot**

Usually starts circular than expands to irregular (older foliage first)

Why is there a yellow halo?

Cercosporin

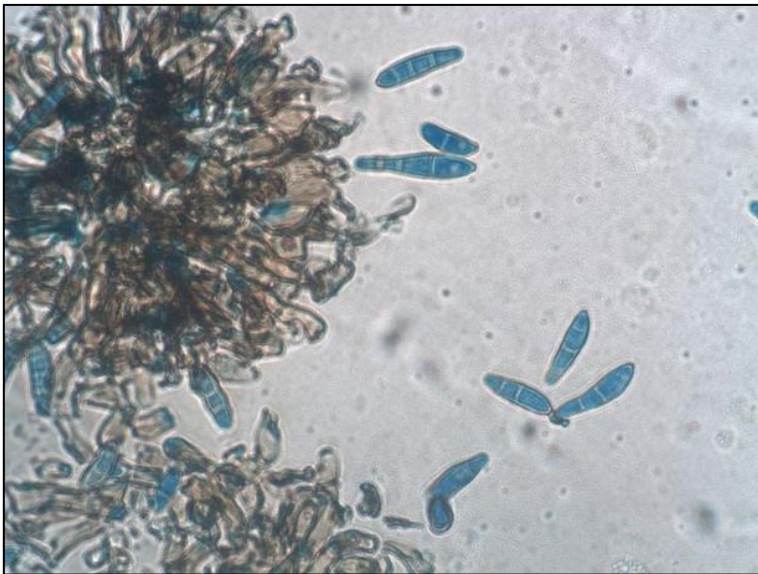


# Late Leaf Spot (LLS)

*Cercosporidium personatum*

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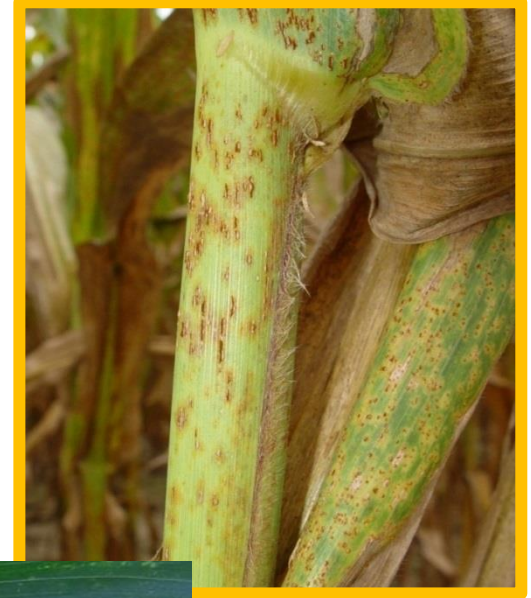
- Symptoms
  - Dark brown to black
  - Vary with leaf surface





# Rust Pathogens (Southern Rust)

Pustules on upper leaf surface



# *Colletotrichum* (Anthracnose)

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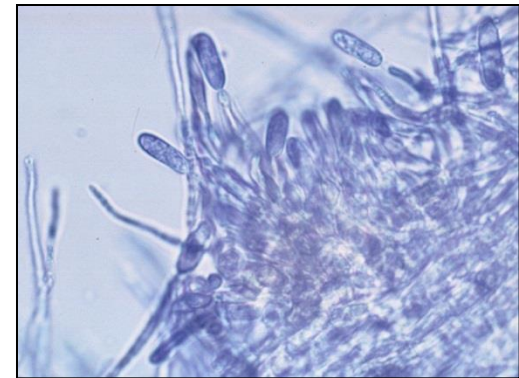


## **On Leaves:**

- light brown to reddish
- shot hole appearance

## **On Fruits:**

- circular, sunken
- water soaking
- darken with age



# *Collectotrichum* spp.

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*C. gloeosporioides*



*C. acutatum*

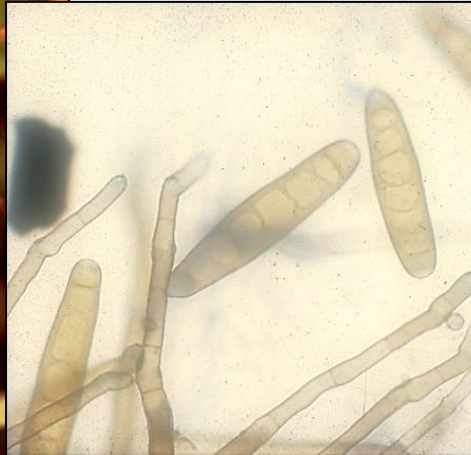
# *Corynespora* Blight

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## A.K.A: Target Spot

- Lesions are brown, circular and frequently ringed
- Yellow halo may be present



# *Didymella byroniae* (Phoma?)

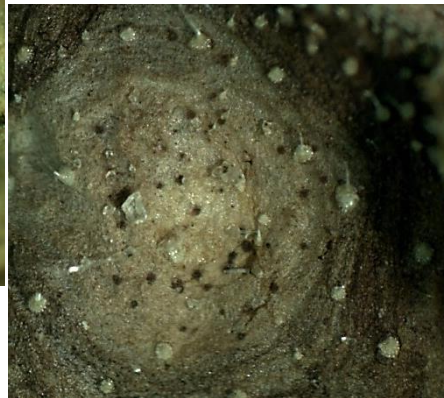
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## A.K.A: Gummy Stem Blight

- circular tan to dark brown lesions appear first at margins
- exudes gummy like material

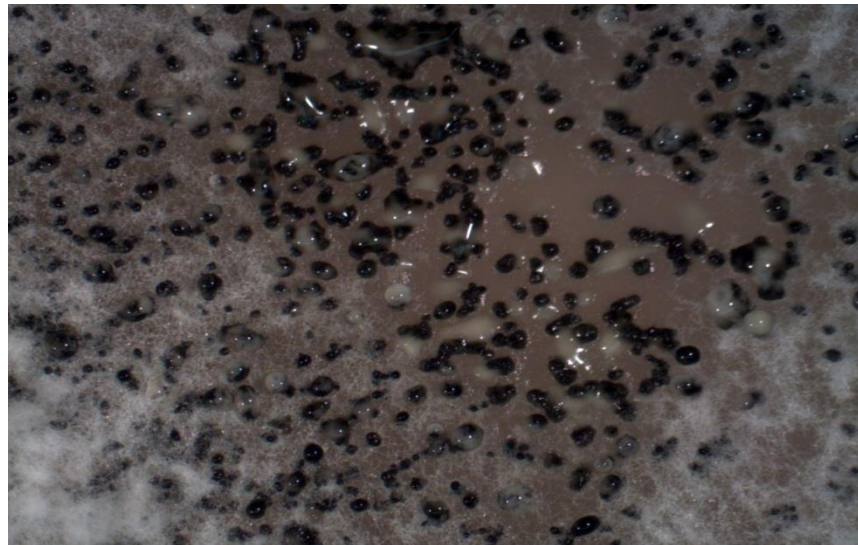
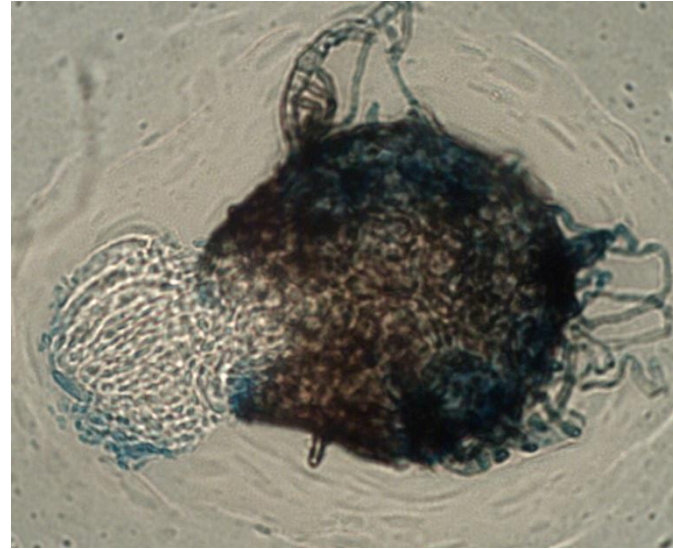
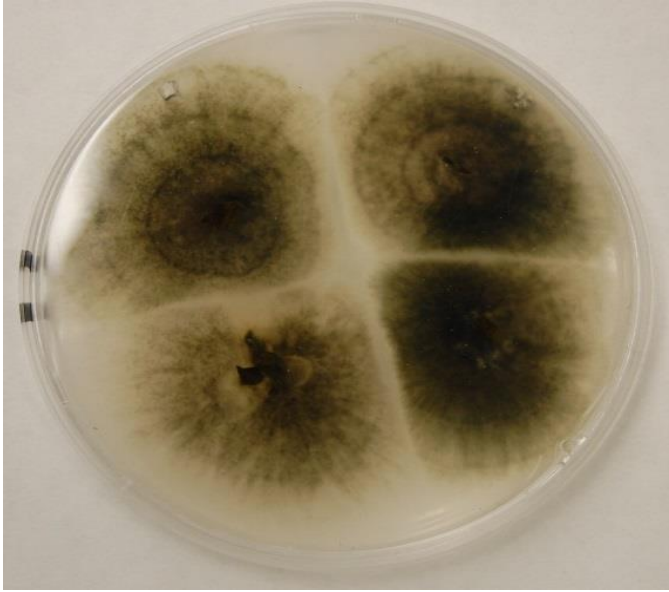


Pseudothecia



# *D. Bryoniae* Culture

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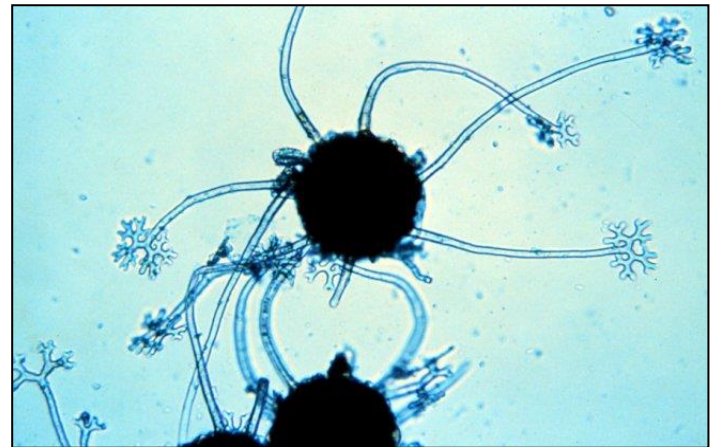
# Powdery Mildew

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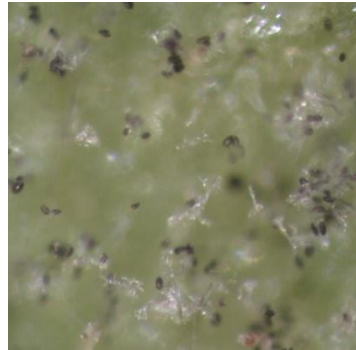
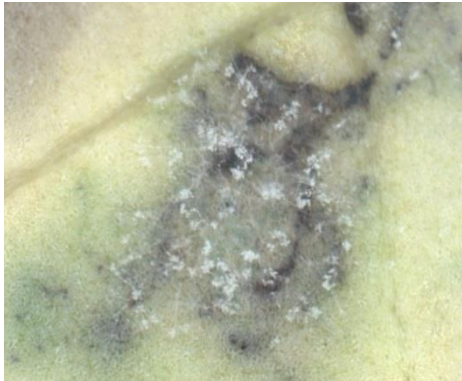
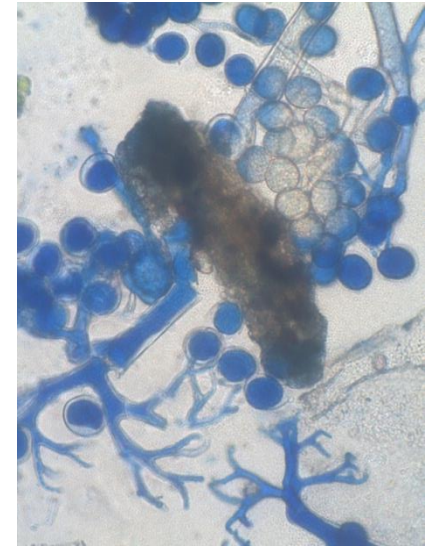
Photo - R. McGovern

- Upper leaf surface
- Found in shaded areas (older leaves)
- Associated with dry weather (Spread)



**Cleistothecia (branched & ornament)**

# Downy Mildew (oomycete)



- Angular lesions; signs leaf bottom side
- High moisture (Rain or > 90% RH)

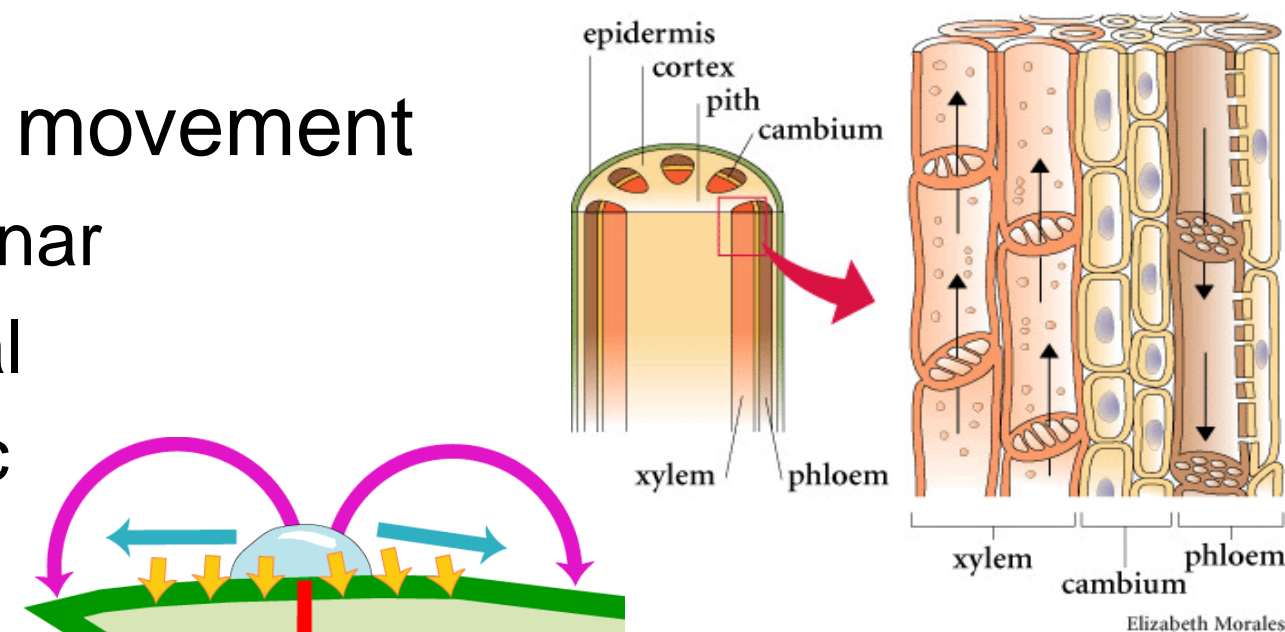


# Fungicides are an important component of disease management.

- Contact vs Penetrant
  - Contact must be applied before infection
  - Penetrant usually provides “curative” effects

- Penetrant movement

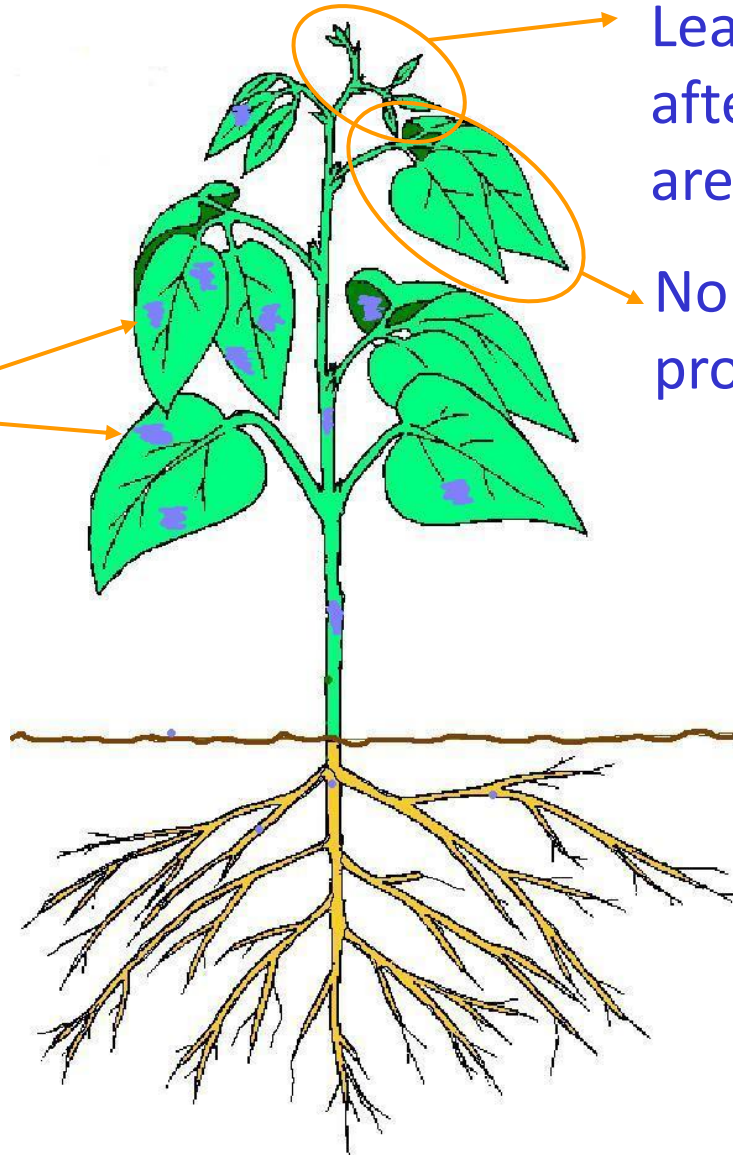
- Tranlaminar
- Acropetal
- Systemic



# Mobility within the plant

## Contact

Droplets spread out and remain on the surface where applied; do not move inside



Leaves produced after the application are not protected

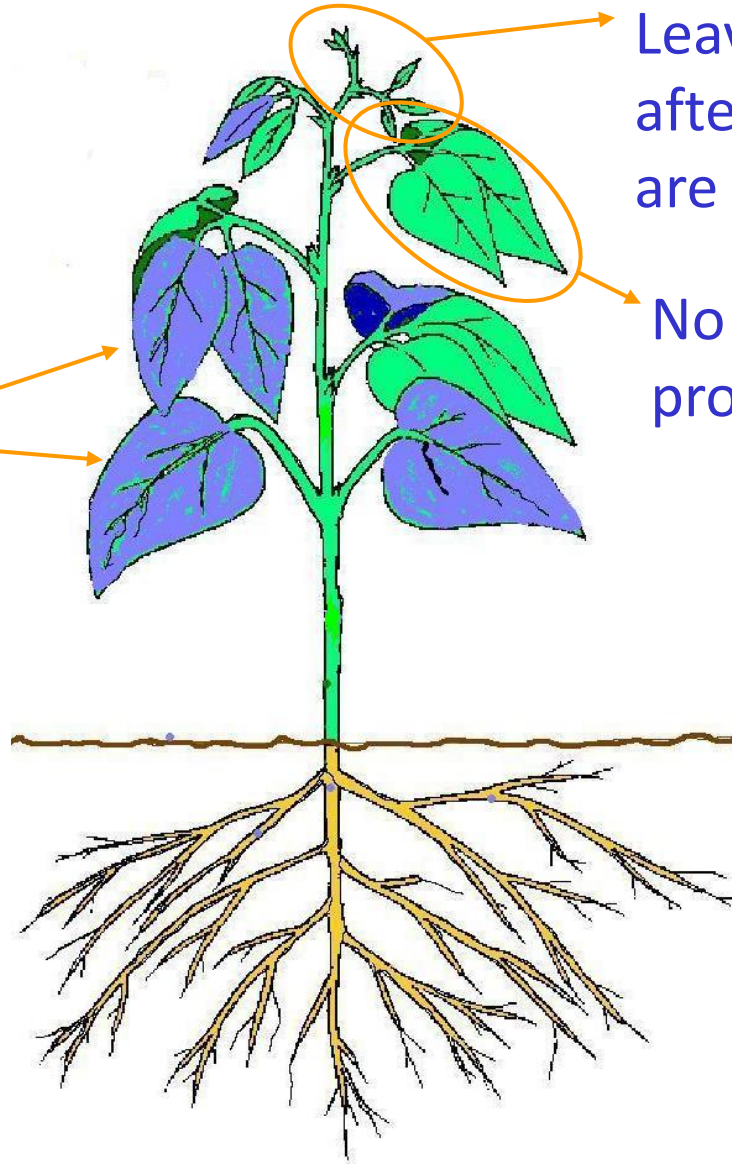
No chemical = no protection

# Mobility within the plant

## Systemic:

### (i) Locally / translaminar

Droplets spread out  
and are absorbed by  
plant tissue



Leaves produced  
after the application  
are not protected

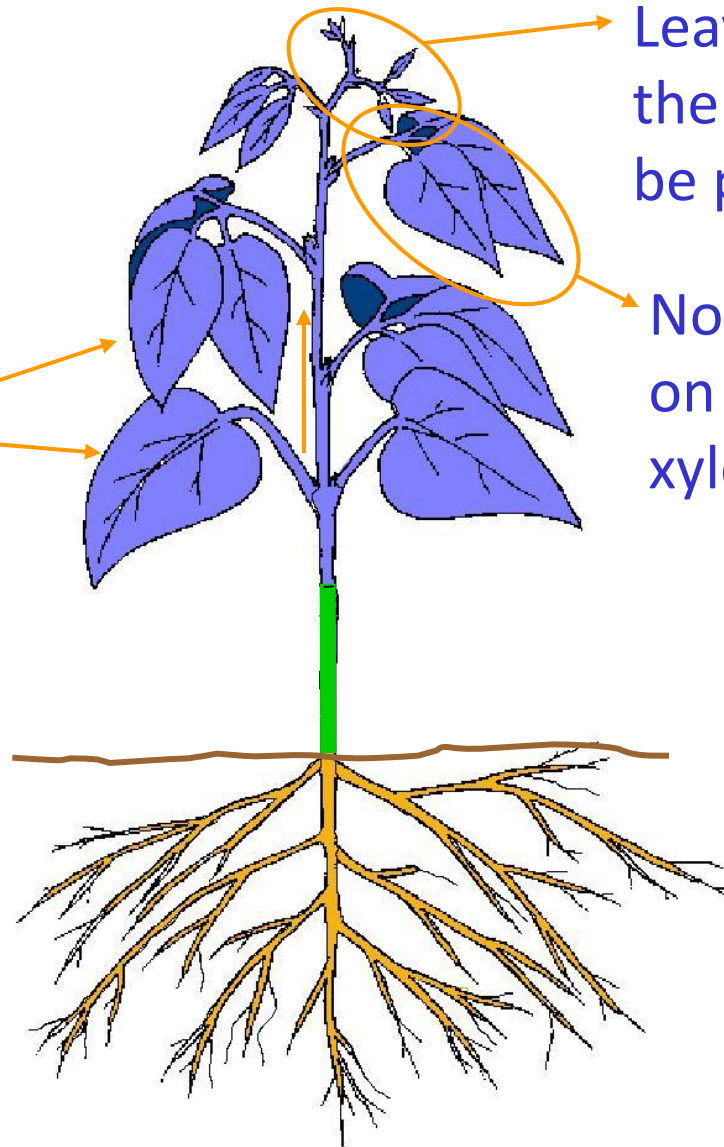
No chemical = no  
protection

# Mobility within the plant

**Systemic:**

**(ii) acropetal**

Droplets spread out and are absorbed by leaf tissue. Fungicide moves upwards in the xylem to edge of leaves and new growth



Leaves produced after the application MAY be protected

No chemical = rely on fungicide via xylem

**Table 1.3.** Phytomobility of active ingredients in turf fungicides

Fungicide	Phytomobility classification	Movement throughout the plant	Movement among cells
chlorothalonil	Contact	...	...
mancozeb	Contact	...	...
thiram	Contact	...	...
PCNB	Contact	...	...
chloroneb	Contact	...	...
etridiazole	Contact	...	...
iprodione	Local penetrant	Translaminar	Uncertain
vinclozolin	Local penetrant	Translaminar	Uncertain
trifloxystrobin	Local penetrant	Translaminar	Apoplastic
pyraclostrobin	Local penetrant	Translaminar	Apoplastic
cyazofamid	Local penetrant	Translaminar	Apoplastic
fludioxonil	Local penetrant	Translaminar	Apoplastic
polyoxin D	Local penetrant	Translaminar	Apoplastic
azoxystrobin	Acropetal penetrant	Xylem mobile	Apoplastic
fluoxastrobin	Acropetal penetrant	Xylem mobile	Apoplastic
fenarimol	Acropetal penetrant	Xylem mobile	Apoplastic
metconazole	Acropetal penetrant	Xylem mobile	Apoplastic
myclobutanil	Acropetal penetrant	Xylem mobile	Apoplastic
propiconazole	Acropetal penetrant	Xylem mobile	Apoplastic
tebuconazole	Acropetal penetrant	Xylem mobile	Apoplastic
triadimefon	Acropetal penetrant	Xylem mobile	Apoplastic
triticonazole	Acropetal penetrant	Xylem mobile	Apoplastic
flutolanil	Acropetal penetrant	Xylem mobile	Apoplastic
boscalid	Acropetal penetrant	Xylem mobile	Apoplastic
mefenoxam	Acropetal penetrant	Xylem mobile	Apoplastic
thiophanate-methyl	Acropetal penetrant	Xylem mobile	Apoplastic
propamocarb	Acropetal penetrant	Xylem mobile	Apoplastic
fluopicolide	Acropetal penetrant	Xylem mobile	Apoplastic
fosetyl aluminum	Systemic penetrant	Ambimobile	Symplastic
phosphonic acids	Systemic penetrant	Ambimobile	Symplastic

Only a few are truly systemic!

# For contact fungicides, protection only as good as coverage!

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**100% is not possible**, but increased volume and spreading agents can help.

# Biological Fungicides

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- SARs: acibenzolar-S-methyl, phosphonates

Activates the plant's own defense system (produces proteins), beneficial because defense active before infection.

- Oils: clove + rosemary + thyme oil, neem oil, parafinic oil
- Biocontrols: *Bacillus subtilis* and others

# Root, Crown, Stem Rots and Blight Fungal Diseases

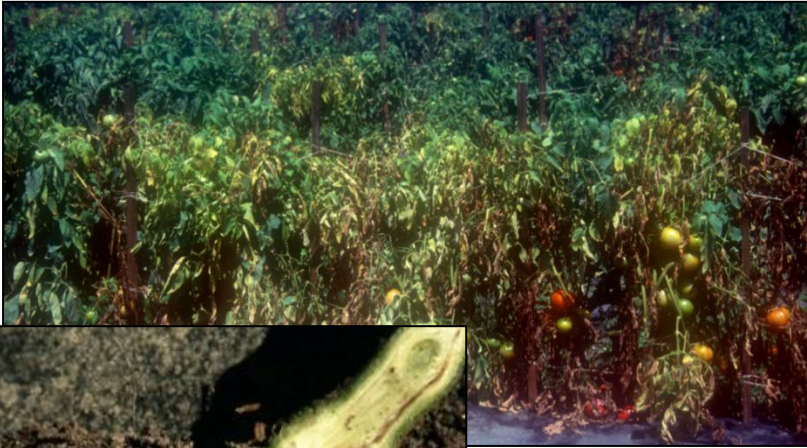
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# Fusarium Wilts

- Severe in light, sandy soil
- Complex with nematodes
- Problem in warm tropical climates (Florida?)
- Lab diagnostics required



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**Generally, one side of the plant wilts first.**

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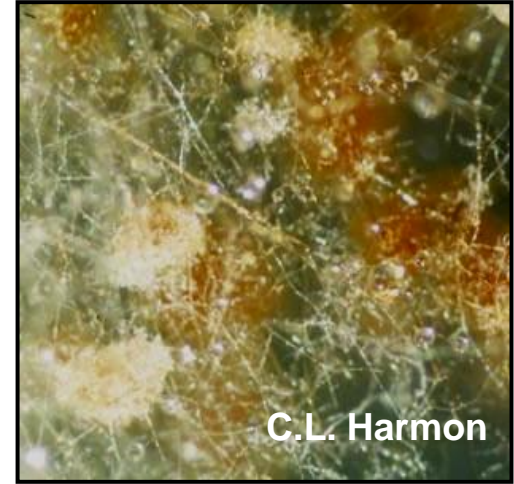


# Fusarium wilt of cotton, first symptoms usually go unnoticed until 3<sup>rd</sup> or 4<sup>th</sup> crop.

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# Rhizoctonia



Most common: *R. solani*

- 90 degree branching mycelium
- Damping off and root rots
- Occasional foliar blights (Moisture!)

# *Sclerotium (rolfsii)*



- Mycelium growth creates a white mat
- Sclerotia form on tissue (often tan)
- Survives in soil for a long time

# Sclerotinia Diseases



## A.K.A: White Mold

General wilting symptoms develop, but fungal growth best indicator of disease.

- Heat treatment limited effect
- Sclerotia are “tough buggers”



# Phytophthora (oomycete)



- Often wide host range
- Rapid wilting from root and crown rots
- Circular water soaked lesions on the leaves
- Water molds

# *Phytophthora* of tobacco

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- Blank Shank
- Discing apparent in pith
- Still a problem today





# *Phytophthora* Fruit Rot

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Water soaked or  
depressed spots

'Yeast' like growth not  
thick (sproangia)

Usually on underside of  
fruit that was in contact  
with ground



# Pythium

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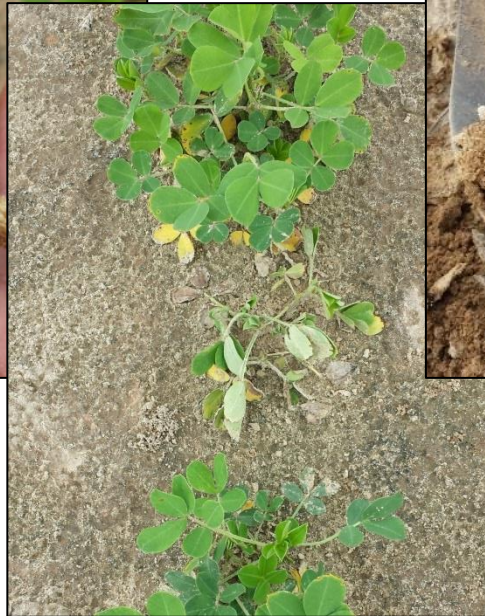
- In field, white cottony mycelial growth (wet)
- Stunting, but nothing else
- Root & stems are usually dark brown, soft and rotted

# *Aspergillus niger*, Crown Rot

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- Generally a dry season disease
- Black spores at crown
- Shredded crown tissue



# What is this doing to my peanuts?

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Bird nest fungi (*Cyathus spp*) - Eggs called peridioles.

# Laboratory methods for further identification of fungi

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- Moist chambers
- Culture media, selective
- Baiting
- Staining
- Spore identification
- Storage of reference cultures and samples
- Keys and resources
- Molecular and immunological techniques



# How do you manage soil borne diseases?

## Agricultural Management Options for Climate Variability and Change: Sod-Based Rotation<sup>1</sup>

David Wright, Jim Marois, Clyde Fraise, and Daniel Dourte<sup>2</sup>

This series of EDIS publications provides information about different agricultural management options available to improve resource-use efficiency and adapt to climate variability and change. To see the complete series of publications, visit [http://edis.ifas.ufl.edu/topic\\_series\\_agricultural\\_management\\_options](http://edis.ifas.ufl.edu/topic_series_agricultural_management_options).

change as well as improve their resource-use efficiency. This series of EDIS publications gives information on these existing technologies, and this publication focuses on the use of a sod-based rotation in crop production systems.

### What is sod-based rotation?

However, some pathogens can survive for many years (10+)

# Chemicals can be used to manage but:

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- Where must we apply the product?

It is best when it reaches the stem, crown and roots. Most application techniques for foliar so....

Seed Treatment, Drenches, In-furrow,  
Fumigants

# Or through the drip!

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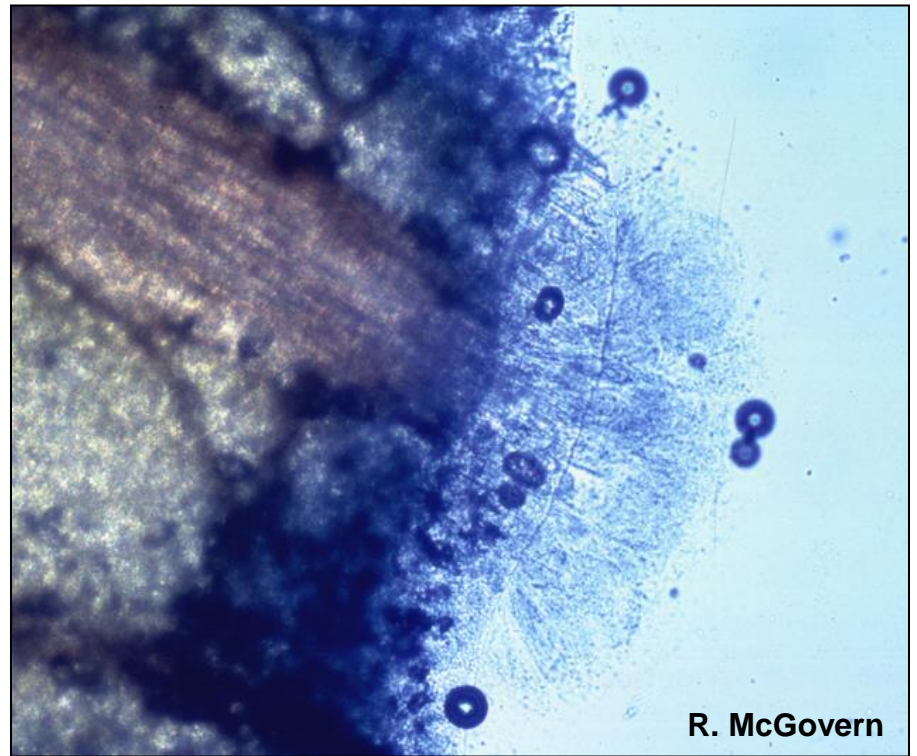
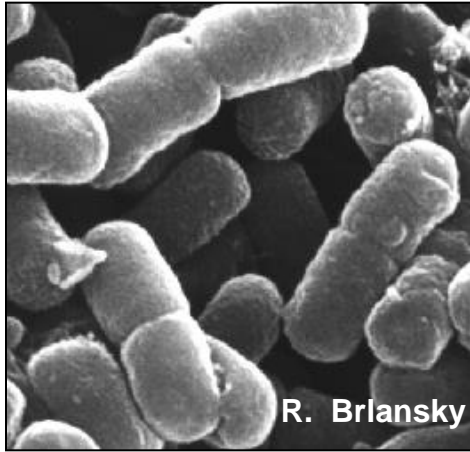
# Chemical Management (Root, Crown & Stem)

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- Fumigants: 1,3-dichloropropene + chloropicrin, chloropicrin, methyl isothiocyanate (metam sodium, basamid), methyl bromide + chloropicrin, methyl iodide + chloropicrin
- Fungicides: fludioxonil – *Fusarium*, *Rhizoctonia*; PCNB – *Rhizoctonia*, *Sclerotium*; propamocarb - *Pythium*, *Phytophthora*; mefenoxam + chlorothalonil or copper or mancozeb
- Biocontrols: *Bacillus subtilis*, *Gliocladium virens*, *Streptomyces lydicus*, *Trichoderma harzianum*, etc.

# Bacteria

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# Bacterial Fruit Blotch (Acidovorax)

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Seed transmitted pathogen

Dark olive green stain or blotch on upper part of the fruit



# Erwinia

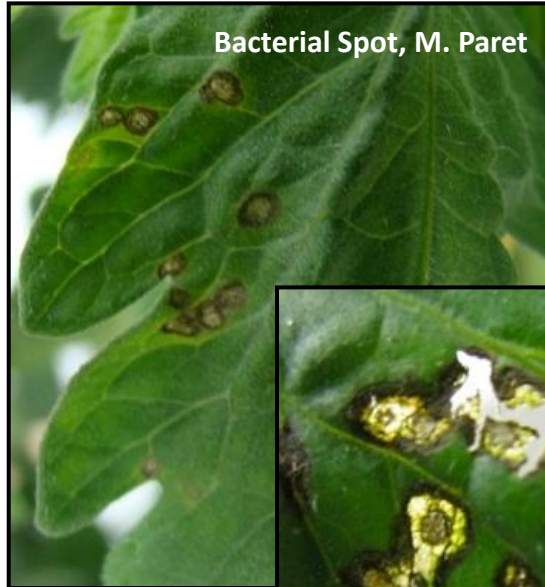
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## **A.K.A: Soft Rot**

- Also a wilt pathogen, found in crown and runners
- Natural or mechanical openings (mishandling)

# *Xanthomonas* spp.



- Often will start at margins
- Yellow halos are present
- Also produces a leaf spot with small water soaked lesions
- Colonies tend to be yellow

# *Xanthomonas* on the Fruit

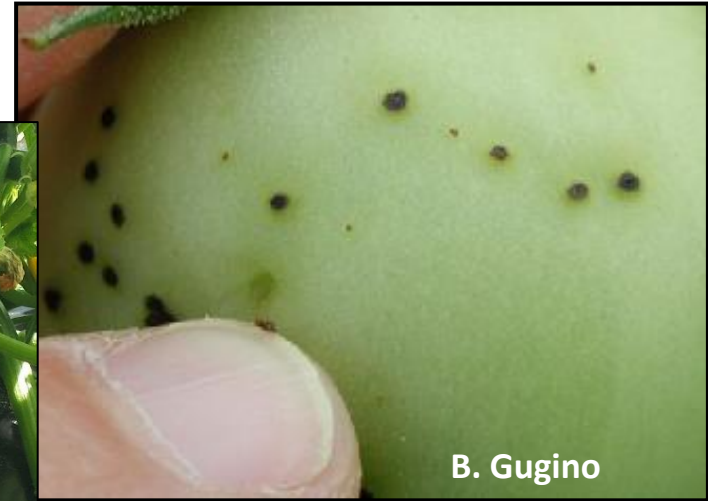
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- Generally spots are < 3 mm
- Spots are water soaked when wet
- Organism survives on plant debris

# *Pseudomonas* spp.

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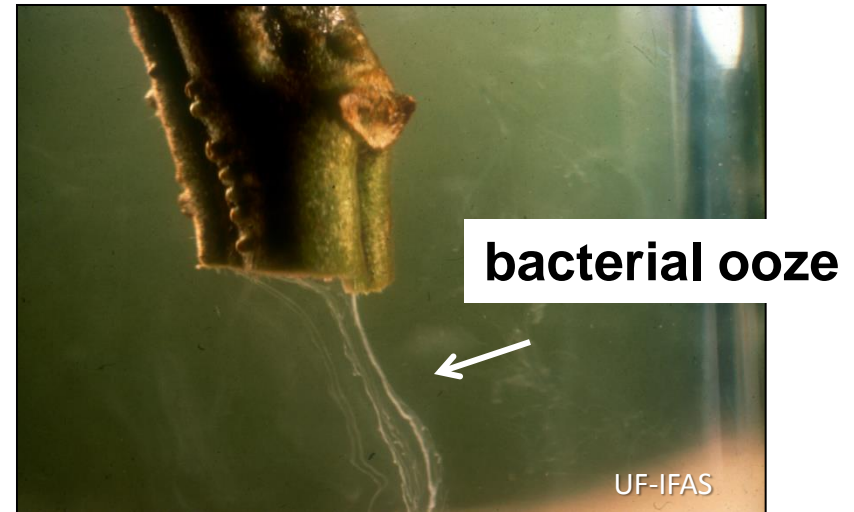
- Often termed “angular leaf spot”
- Small water soaked leaf lesions that expand until limited by veins
- On fruit, lesions often have a white, crusty exudate
- White colony growth on media

# *Ralstonia* spp.



## A.K.A: Bacterial Wilt

- disease occurs in foci associated with water accumulation
- stem discoloration and ooze from lower stem in water important indications





# ***Ralstonia* is an important pathogen**

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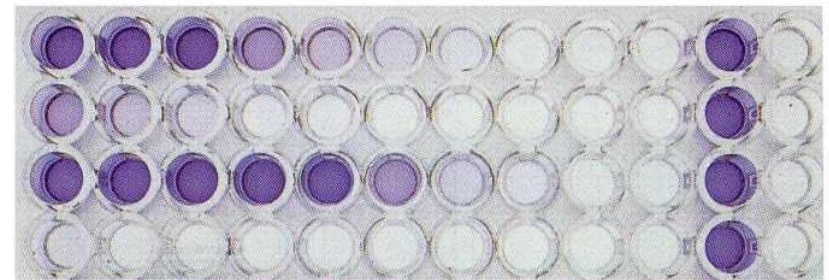
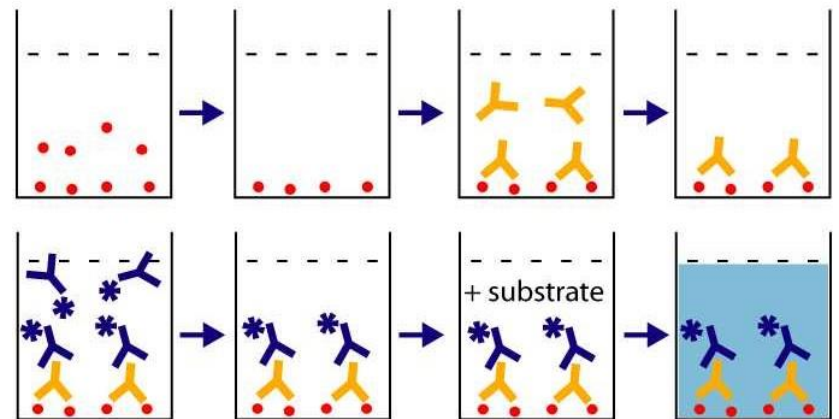
***Ralstonia solanacearum* Race 3 Biovar 2  
(formerly *Pseudomonas solanacearum*)**



***Ralstonia solanacearum* Race 3 Biovar 2 is on the USDA-APHIS *Significant Agents List* because of the threat that it poses to US potato production. Its occurrence requires immediate notification of appropriate state/federal regulatory personnel. *Rs ImmunoStrip* test available from AgDia.**

# How can we detect bacterial infections?

- Bacterial streaming
- Microscopy (light, electron, stains)
- Selective media
- Bioassays
- ELISA
- Fatty acid analysis
- Biolog (Redox)
- PCR



<http://www.biolog.com/>

<http://cybercarnet.net/public/img/>

# Managing Bacterial Infections

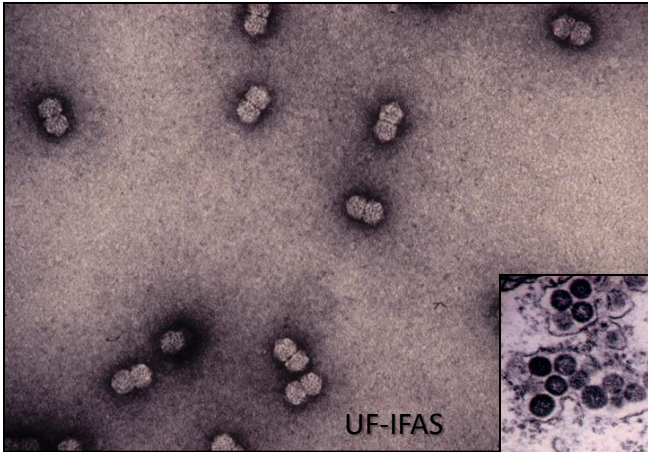
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- Multisite MOA: coppers (Kocide 3000, COC WP, etc.); mancozeb (Manzate, Dithane-DF Rainshield, etc.; **must be combined with a copper fungicide**); hydrogen dioxide (Oxidate)
- Combinations: manzate + copper (Mankocide); mancozeb + zoxamide (Gavel 75 DF); famoxidone + cymoxanil (Tanos)
- Antibiotics: streptomycin (Agri-mycin-17, Bac-Master)
- Biocontrols: *Pseudomonas subtilis* (Rhapsody, Serenade Max, Sonata)
- SARs: acibenzolar-s-methyl (Actigard 50 WG); bacteriophages

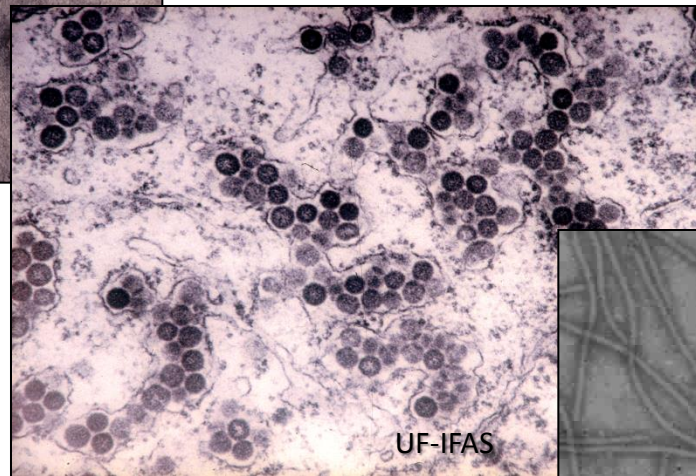
# Vegetable Viruses

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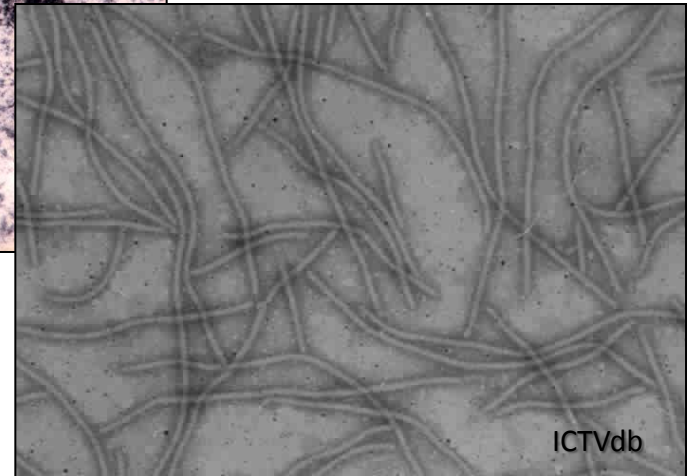
Geminivirus



Tospovirus



Potyvirus



# Geminiviridae

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## Tomato yellow leaf curl virus

- Upward leaf curling
- Mottling
- Chlorotic leaf margins

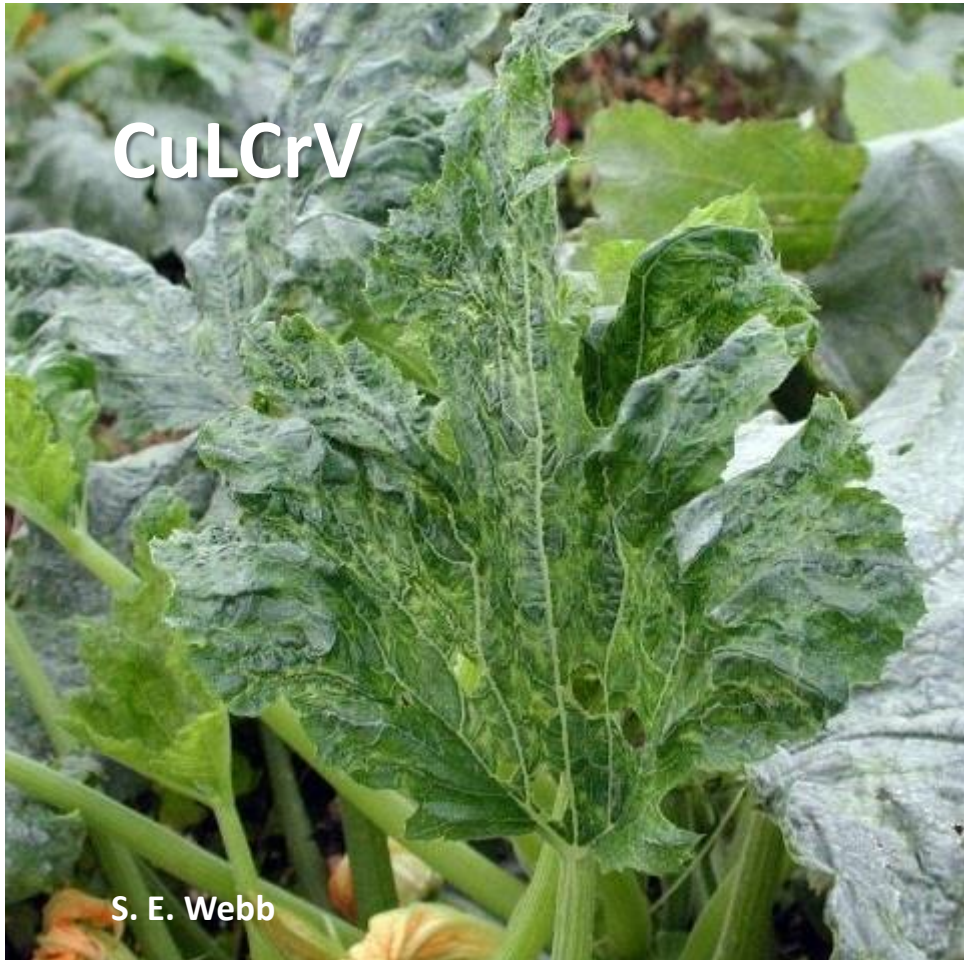


***Bemisia tabaci***

Transmitted by adult white flies.

# Geminiviridae

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## **Cucurbit Leaf Crumple Virus**

- 2007 found on common bean
- White fly transmitted
- Shows up pretty much every year now.

# Tospoviridae



## Tomato Spotted Wilt Virus

- Small, brown flecks on leaves
- Plants stunted & droopy



*Thrips tabaci*  
*T. setosus*  
*T. palmi*  
*Frankliniella schultzei*  
*F. occidentalis*  
*F. fusca*  
*Scirtothrips dorsalis*

# Potyviridae



## Watermelon Mosaic Virus

- 20 species of aphids (non-persistent manner)
- Symptoms vary
  - Green mosaic
  - Chlorotic rings
  - malformation



*Myzus persicae*  
*Acyrtosiphon solani*  
*Aphis craccivora*  
*Macrosiphum euphorbiae*



# Potyviridae

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## Potato Virus Y

- Aphid spread, non-persistent
- Tuber born virus
- Mosaic, necrosis with leave collapse
- Oil spray interfere with aphids

**JMS Stylet-Oil**

# Squash Vein Yellowing Virus

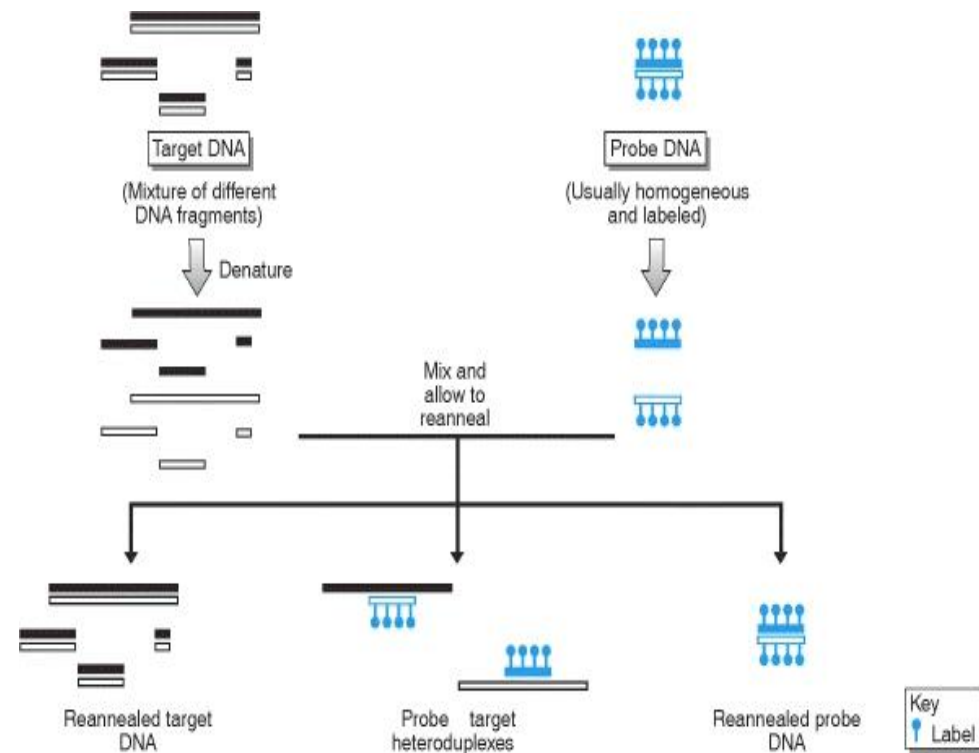
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- Detected in 2003
- Whitefly-transmitted virus
- Slight yellowing of foliage
- Collapse of entire vine
- Discoloration in the rind

# What would be the best methods for detecting a Virus?

- Electron Microscopy
- Bioassays
- Immunology (ELISA)
- PCR
- Hybridization assays
  - Dot Blot
  - Southern Blot
  - Spot Blot



# How do we manage virus diseases?

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- Control the vector (sprays, mulches)
- Cultural practice/certified seed
- Oils: JMS Stylet Oil
- SARs: acibenzolar-s-methyl

**Join the RESISTENCE!**

# Not Everything is a Disease

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**But plant pathologist 'wish' they were, however there are many physiological problems out there as well.**

# Edema: abnormal accumulation of water

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# Enlarge Lenticels (excess moisture)



# Spray Damage

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Watch for Copper!





# What is deer blight?

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# Where is the plot?

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# Look for prints!

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# What's on this plate?

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