

UNDERSTANDING PLANT DISEASES



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www.ct.gov/caes



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CAES Website
www.ct.gov/caes

PDIO Website
www.ct.gov/caes/pdio



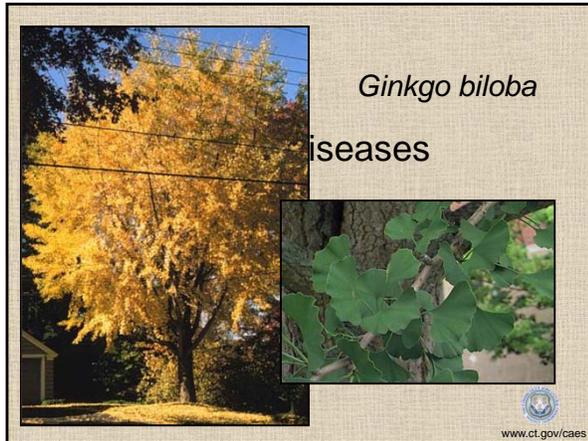
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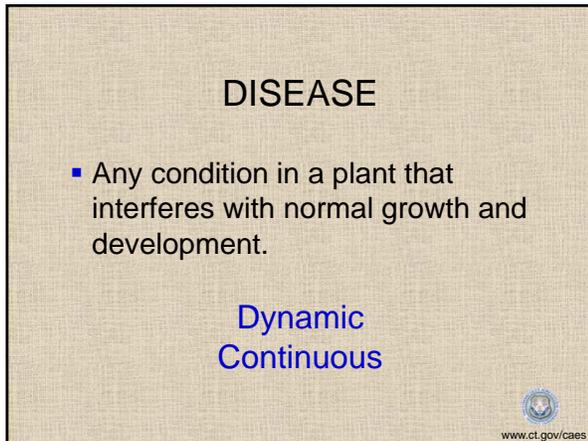
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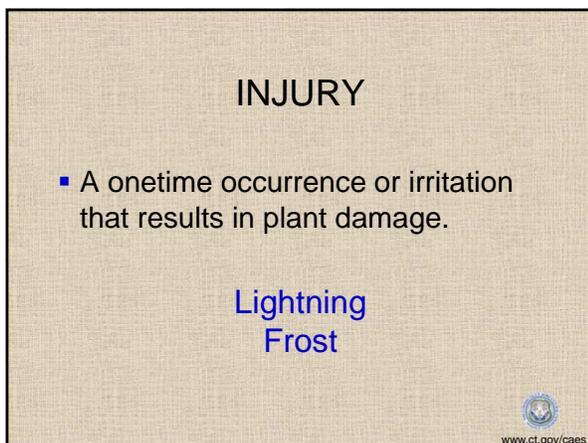
- Provide the tools that will allow you to recognize, understand, and responsibly manage key diseases of ornamentals in the landscape.

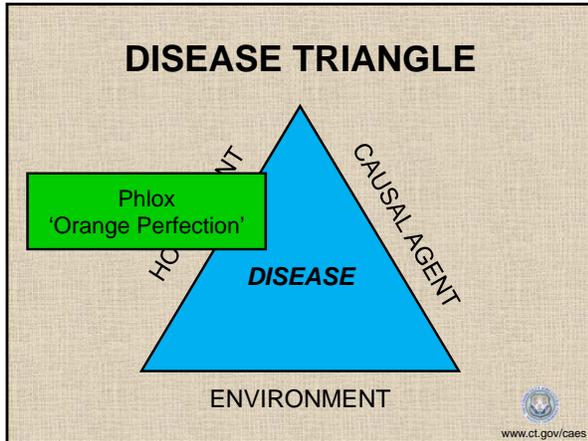


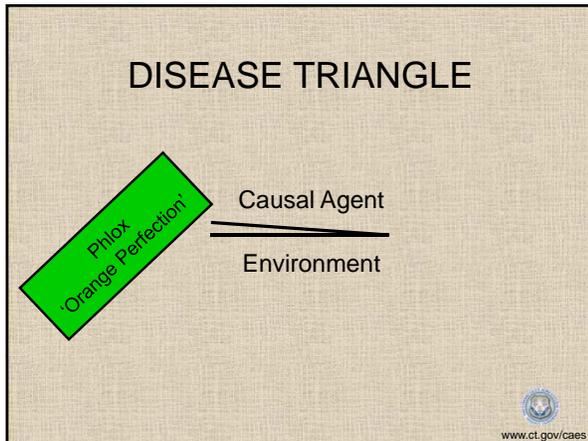
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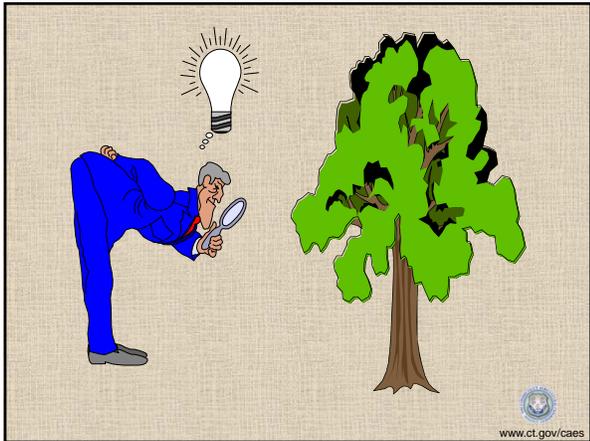


- PLANT HEALTH PROBLEMS**
- I. ABIOTIC (non-living agents)-**
1. Cultural
 2. Environmental
- II. BIOTIC (living agents)-**
1. Fungi and Fungus-like Organisms
 2. Bacteria
 3. Viruses and Viroids
 4. Phytoplasmas
 5. Nematodes
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SIGNS and SYMPTOMS

- Provide important clues about:
 - Type of disease
 - Causal agent
 - Ways the disease can spread



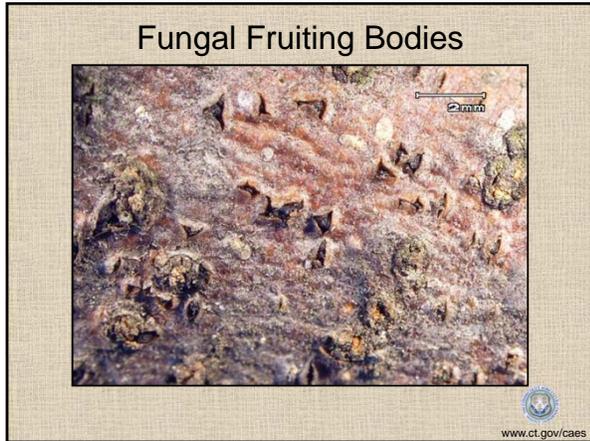


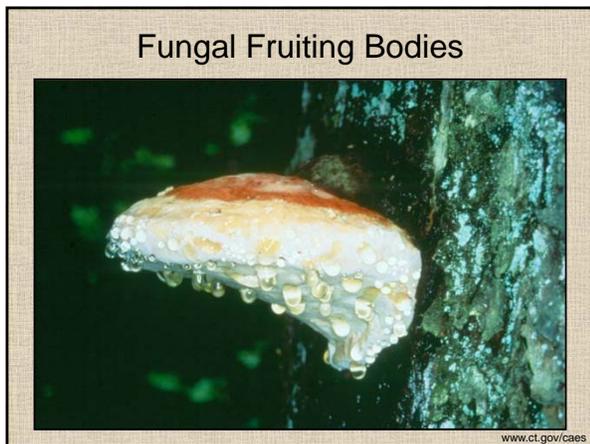
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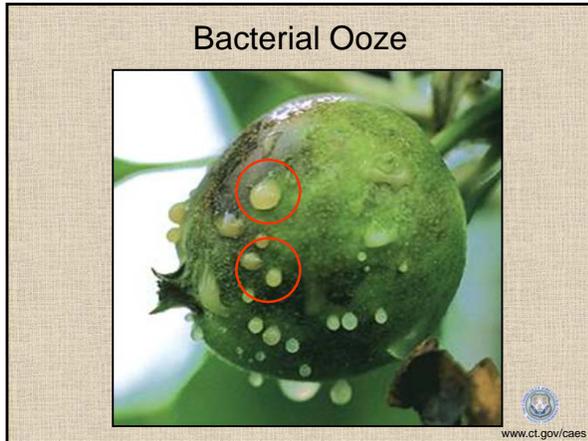
- The causal agent (pathogen or biotic agent) or its parts or products seen on a plant host.
- Examples: pycnidia, conidia, bacterial ooze

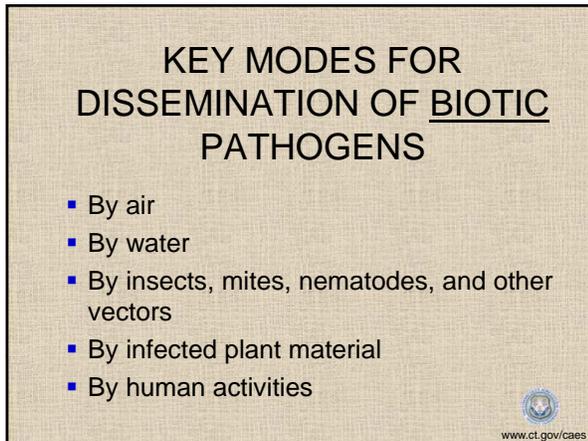


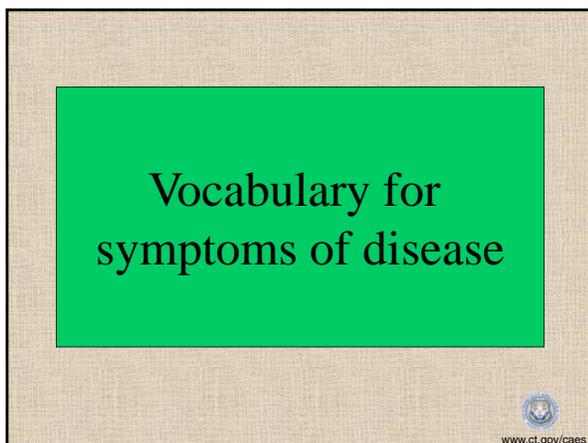












LEAF SPOT

- Spots of dead tissue on the foliage; the size, shape, and color may vary with the causal agent, but are usually limited to a small portion of the leaf.



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LEAF BLOTCH

- Dead areas of tissue on the foliage, irregular in shape and larger than leaf spots.



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BLIGHT

- **Rapid** yellowing, browning, collapse, and death of leaves, shoots, stems, flowers, or the entire plant; dieback of major portion of a plant, especially young, growing tissues.


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SCORCH

- Browning and death of indefinite areas along the leaf margins and between the veins of a leaf.



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UGA0014295



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WILT

- Drooping of leaves or shoots often due to lack of water in the plant.



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CANKER

- Dead area on a stem or branch; can be sunken, swollen, or discolored and are usually distinguished from adjacent healthy tissues by color.



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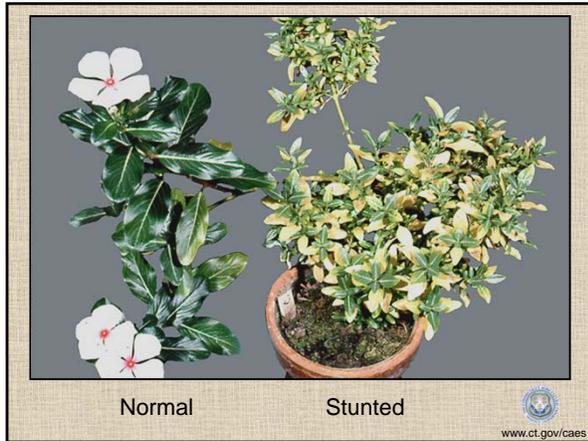


STUNTING

- Abnormally small sized plant parts due to the failure of those plant parts to grow to full size; can also be used to describe an entire plant.



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Normal

Stunted



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GALL

- Swelling or abnormal growth of plant tissues; can develop on leaves, stems, and roots; may be induced by insects, fungi, bacteria, or nematodes.



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CHLOROSIS

- Yellowing of normally green tissues due to lack of chlorophyll.



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NECROSIS

- Death of plant tissue.



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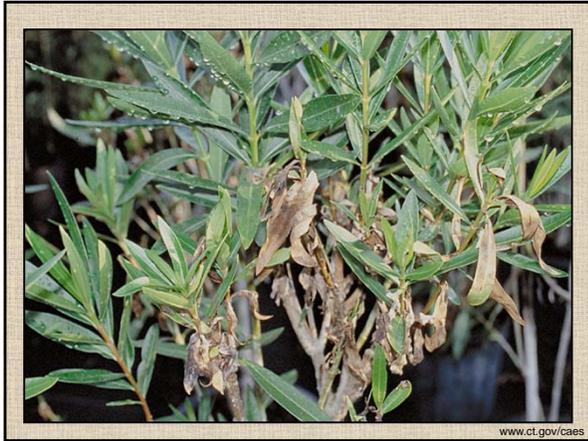


DIEBACK

- Death of the tips of leaves, shoots, and stems; failure of branches to develop, especially in the spring; large portion of dead in a woody plant.



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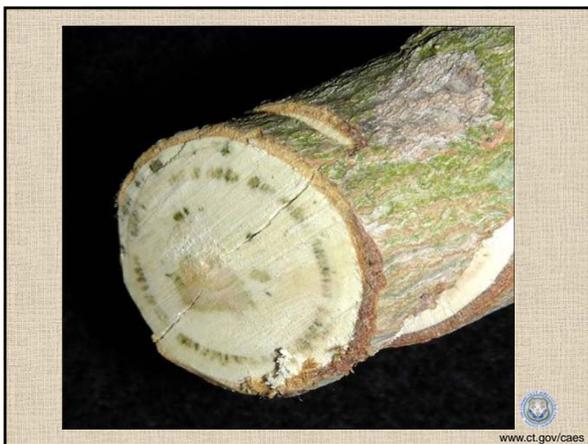


VASCULAR DISCOLORATION

- Streaking or darkening of vascular tissues.



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WITCHES' BROOM

- Abnormal proliferation of shoots from the same point on a plant resulting in a bushy, broom-like appearance.



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DISEASE PREVENTION AND MANAGEMENT

- Accurate Disease Diagnosis
- Management Program



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ACCURATE DIAGNOSIS:

- Need for Control
- Type of Control



Need help?

Contact your local diagnostic lab.



DIAGNOSTIC LABS

- National Plant Diagnostic Network (NPDN), established in 2002.
- <http://www.npdn.org/>
- Assist with accurate identification, especially of biotic agents.





NEPDN DIAGNOSTIC LABS

- **Connecticut- CT Agricultural Experiment Station and University of Connecticut**
- Maine-University of Maine
- Massachusetts- University of Massachusetts
- New Hampshire- University of New Hampshire
- New York- Cornell University
- Rhode Island- University of Rhode Island
- Vermont- University of Vermont



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PLANT DISEASE INFORMATION OFFICE

- How to contact us.
- How to collect, prepare, and submit a sample for diagnosis or identification.
- Sample submission form.

www.ct.gov/caes/pdio
203.974.8601
Toll-Free: 877.855.2237



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DISEASE MANAGEMENT =

*PROGRAM FOR MANAGING
PLANT HEALTH*

or

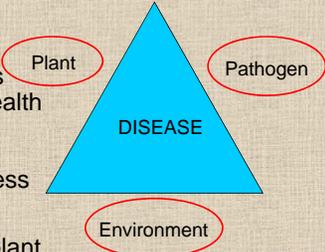
*INTEGRATED PLANT
HEALTH MANAGEMENT*



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Integrated Plant Health Management

- **Pathogen**
 - Sanitation
 - Fungicides
- **Plant**
 - Resistant species
 - Optimize plant health
- **Environment**
 - Space plants to reduce leaf wetness and RH
 - Establish hostile environment on plant surfaces (biopesticides)



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PLANT HEALTH MANAGEMENT PROGRAM :

1. Culture
2. Sanitation
3. Resistance
4. Biological
5. Chemical



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DISEASE MANAGEMENT

- The goal of disease management is not to completely eliminate diseases but **to manage them such that they remain at acceptable levels.**
- We don't have ZERO tolerance for disease in the landscape or home garden.



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Prevention!



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1. CULTURE

- A. Maintain Plant Vigor
- B. Rotate Plants
- C. Interplant (Companion planting)
- D. Mulch
- E. Control Weeds



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A. Maintain Plant Vigor

- i. Plant and Site Selection
- ii. Planting Practices
- iii. Plant Nutrition
- iv. Watering



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i. Plant and Site Selection

- Match plant to site, not site to plant



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The right plant for the right site!



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The wrong plant for the wrong site!



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ii. Planting Practices

- Correctly prepare the planting hole and rootball.



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Correctly Prepare the Rootball



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Correctly Prepare the Roots



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iii. Plant Nutrition

- Healthy soil is fundamental to healthy plants.
- Improve soil biodiversity.
- Soil test- provides a baseline for making decisions about nutrition.
- Make pH adjustments, if necessary.



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iv. Watering

- Maintain adequate moisture--avoid extremes: too much, too little.
- Usually ~ one inch per week.



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B. Rotate Plants

- Practice of not planting members of the same plant family in the same location or part of a garden.
- Rotations of 3-4 years are common (up to 10 years in some cases).
- Not feasible in many home landscapes.



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C. Interplant (Companion Planting)

- Method of planting based on how plants interact or affect one another.
- Still quite anecdotal.
- Need for "sound science."



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Marigolds for "Trapping" Root Knot Nematodes



French or French Dwarf Marigolds



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Root Knot Nematode Damage



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D. Mulch

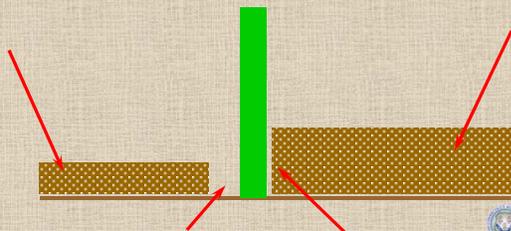
- Helps with:
 - Soil moisture retention
 - Soil temperature moderation
 - Weed control
 - DISEASE CONTROL



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MULCHING METHODS

YES	NO
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Proper Mulching



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E. Control Weeds

- Eliminates competition for available nutrients and water.
- Eliminates reservoir hosts of plant pathogens.

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INSV / TSWV (Tospo) Viruses



Have many weeds as reservoir hosts.

Transmitted by thrips.



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2. SANITATION

- A. Selecting and planting healthy plants.
- B. Removing or pruning infected plants or plant parts.
- C. Grooming plants.
- D. Using clean equipment.
- E. Scouting and keeping records.



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A. Selecting and Planting Healthy Plants

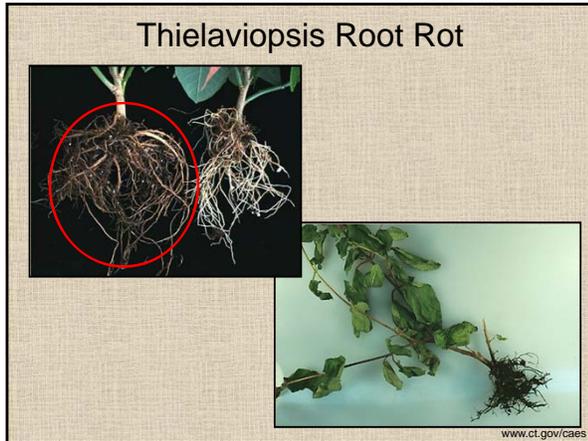


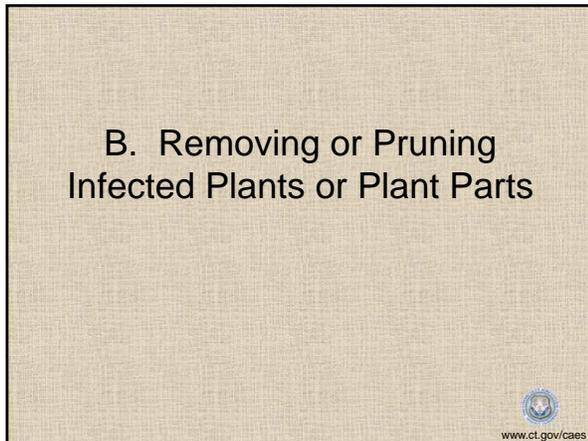
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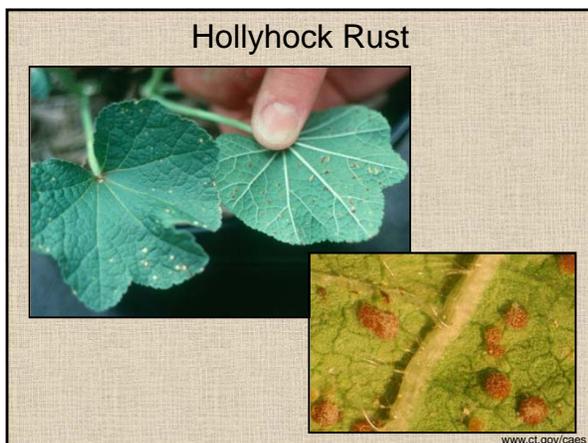
Pythium Root Rot

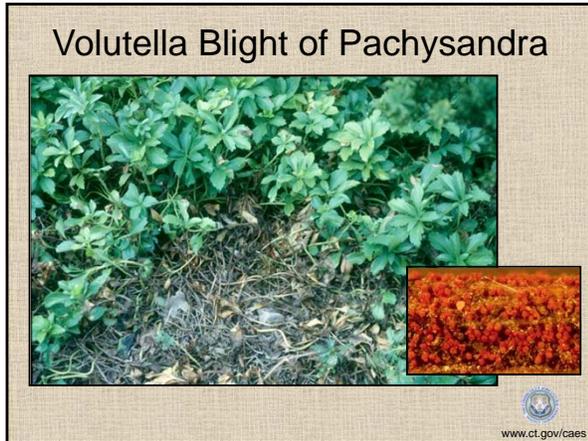


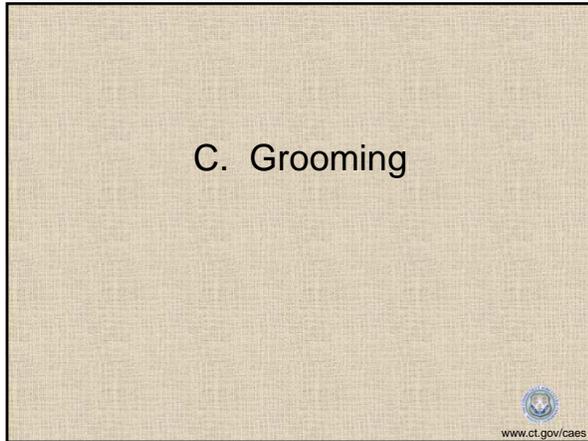
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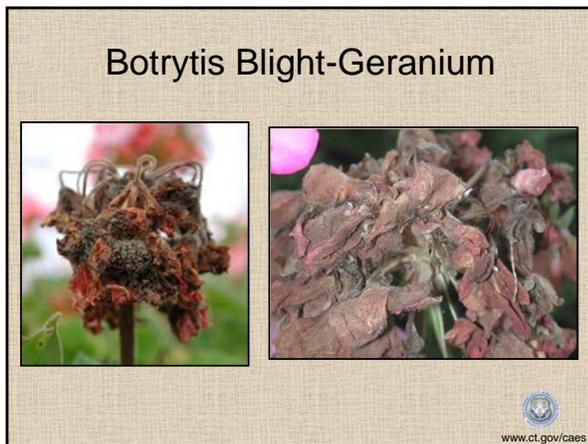












D. Using Clean Equipment

- Disinfecting with household bleach (1 part bleach: 9 parts water), hydrogen dioxide (Oxidate), or other approved products.



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Disinfect All Tools and Equipment



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E. Scouting and Keeping Records



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3. RESISTANCE

- Use of resistant or tolerant species or cultivars.
- Very effective but a genetic trait, can't be conferred to existing plants!
- Considerable interest and breeding activity.
- Examples: Resistant crabapples, phlox, monarda...



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Black Spot of Rose



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Powdery Mildew of Monarda



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4. BIOLOGICAL

- Use of living organisms to control other living organisms (good guys vs. bad guys).
- Modes of action:
 - **Competition**- The organism occupies all or most sites along the root or leaf and selectively excludes the pathogen from infecting.
 - **Parasitism**- The organism feeds on the pathogen.
 - **Antagonism (Antibiosis)**- The organism secretes toxins that inhibit the pathogen.



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4. BIOLOGICAL: (cont'd)

- Have EPA registration numbers.
- Examples:
 - *Trichoderma harzianum* Rifai strain
KRL-AG2 (Root Shield, Plant Shield)
 - *Bacillus subtilis* QST 713 strain
(Cease, Rhapsody, Serenade)



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5. CHEMICAL



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KEY FACTORS FOR USE:

- *When to Treat*
- *What to Use*



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WHAT IS A PESTICIDE?



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PESTICIDE

cide = to kill



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TYPES OF PESTICIDES

- Fungicide = kills fungi
- Bactericide = kills bacteria
- Nematicide = kills nematodes
- Insecticide = kills insects
- Herbicide= kills plants



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CATEGORIES OF PESTICIDES:

- Biological
- Biorational
- Traditional-Chemical



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BIOLOGICAL PESTICIDES

- Use of living organisms to control other living organisms (good guys vs bad guys)
- Main modes of action:
 - *Competition*
 - *Parasitism*
 - *Antagonism (Antibiosis)*



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BIORATIONAL PESTICIDES

- Considered to be environmentally-friendly.
- Usually more “user-friendly” than traditional pesticides.
- Some are acceptable for organic standards.
- Examples:
 - Potassium bicarbonates (Milstop, Kaligreen)
 - Oils: Horticultural & Neem (JMS Stylet Oil, PureSpray Green and Ultra-Fine Oil, Triact)
 - Soaps (Safer Insecticide Soap)



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TRADITIONAL (CHEMICAL) PESTICIDES

- Traditional compounds with traditional modes of action.
- Some are acceptable for organic standards*.
- Examples:
 - Chlorothalonil (Ortho Garden Disease Control)
 - *Copper (Champion, Concern Copper Soap Fungicide) (some restrictions for use)
 - *Sulfur (Safer Garden Fungicide II)



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SAFE PESTICIDE USE

- For the user
- For the consumer
- For the environment



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PESTICIDE SAFETY

- Toxicity categories and signal words.
- How to read the pesticide label.
- Proper use and handling of pesticides.



PESTICIDE TOXICITY

- All pesticides are classified on the basis of their toxicity.
- Toxicity is determined by certain hazard indicators to human or animal health.
- Much of this is based on the concept of "Lethal Dose."



LETHAL DOSE (LD₅₀)

- The dose required to kill half (50%) of a group of test animals.
- Dosage is expressed as a ratio: the amount of pesticide, in milligrams, per 1,000 grams of body weight of the test animal (usually rats).
- Example: LD₅₀ = 5 means a dosage of 5mg per 1,000g body weight.



LETHAL DOSE (LD₅₀)

- Used as the standard measure to determine relative toxicity.
- Allows one to make direct comparisons of toxicity levels of various pesticides.



LD₅₀ = 30 (more toxic)

LD₅₀ = 1,500 (less toxic)



SIGNAL WORDS

- Quick, visual indication of the level of toxicity of a pesticide.



PESTICIDE STORAGE

- Always store pesticides in original containers.
- Storage should be in a protected or locked area (limited access).
- Check label for storage requirements (example: some pesticides can't be frozen).
- Use the "triple rinse" method to prepare containers for disposal.



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NATIONAL PESTICIDE INFORMATION CENTER

- Phone: 1.800.858.7378
- Website: <http://npic.orst.edu/>
- Email Address: npic@ace.orst.edu



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CONNECTICUT POISON CONTROL



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BIOTIC PROBLEMS:

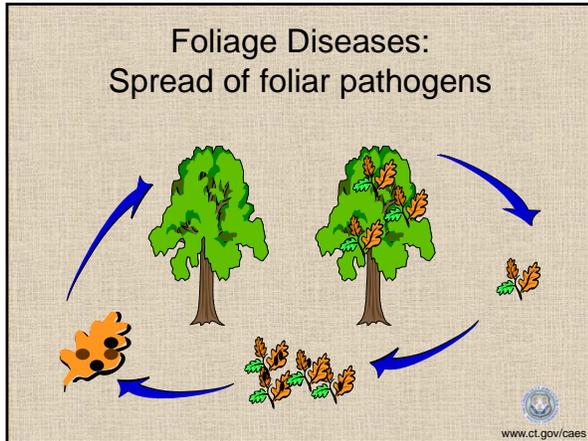
Goal:
Learn to recognize TYPES
of diseases, not the details
for all diseases.

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FOLIAGE DISEASES:

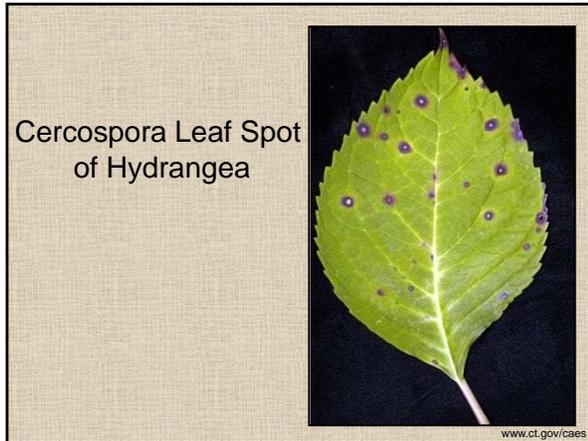
- Usually considered cosmetic or aesthetic rather than life-threatening.
- Infection is usually limited to the foliage.
- Premature leaf-drop or defoliation can occur.

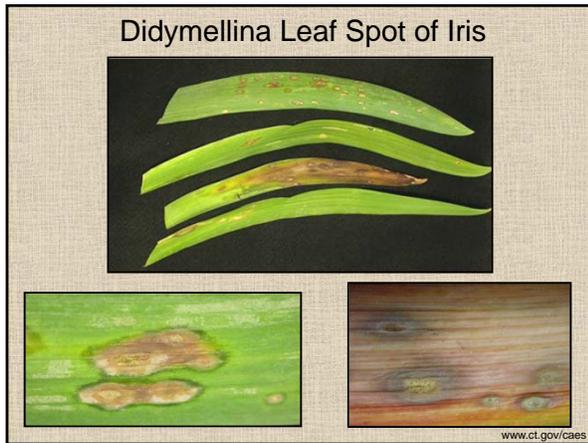
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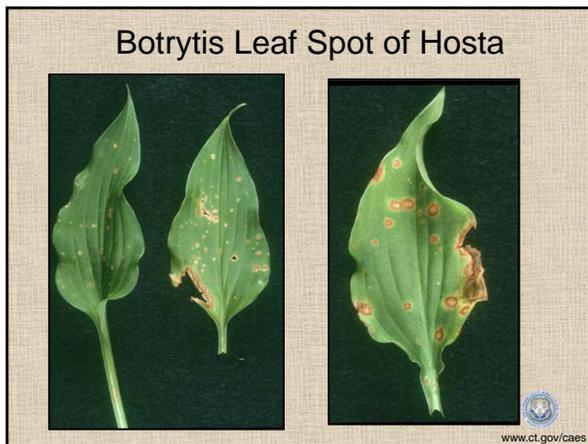


- FOLIAGE DISEASES:**
- Leaf Spots
 - Anthracnoses
 - Powdery Mildews
 - Downy Mildews
 - Rusts
- www.ct.gov/caes

- LEAF SPOTS**
- Characterized as dead areas scattered over the leaf surface; often have defined margins, but shape, size, and color of spot will vary with host-pathogen combination.
 - Causal agents are usually host-specific.
 - Most fungi require free water on the leaf surface in order to infect; most serious in wet weather or with overhead irrigation.
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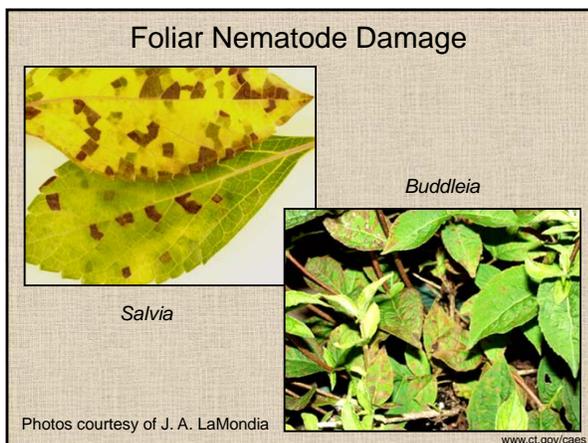




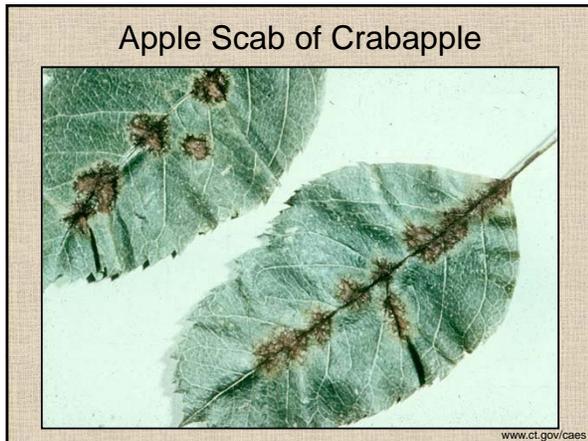


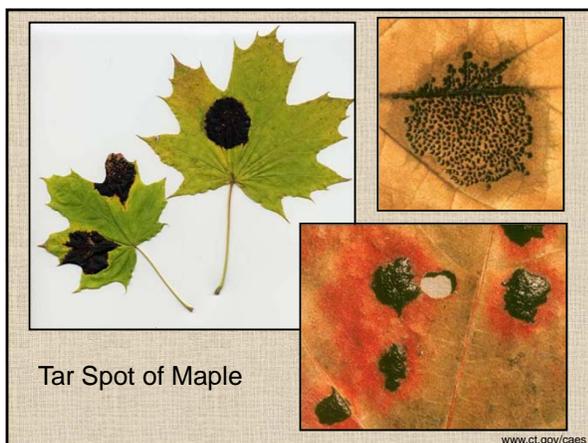




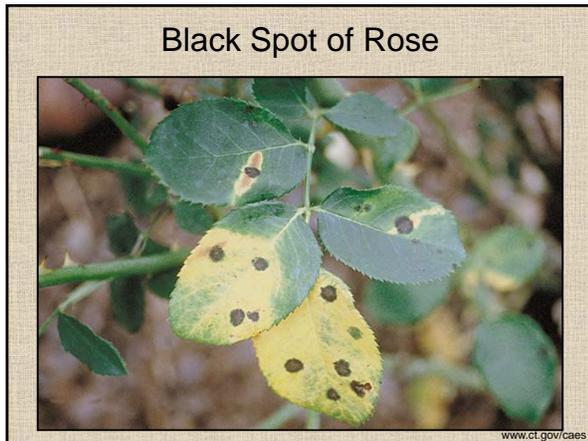








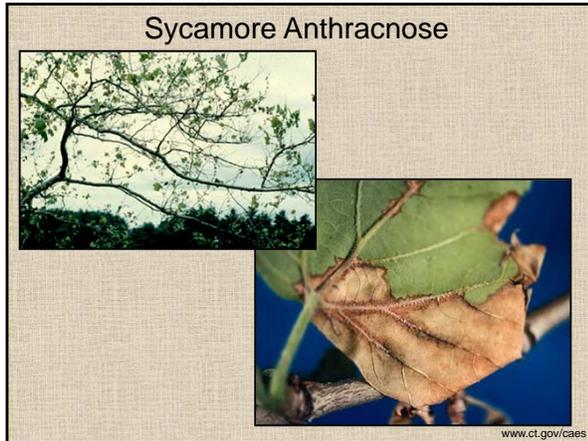


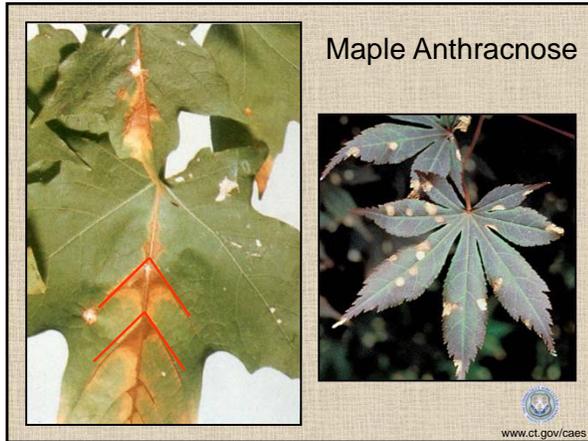


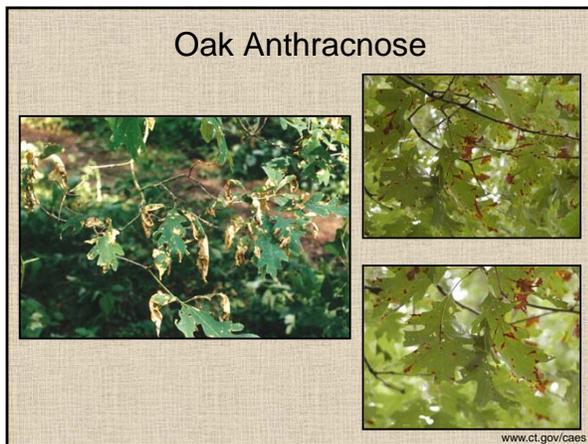
ANTHRACNOSES

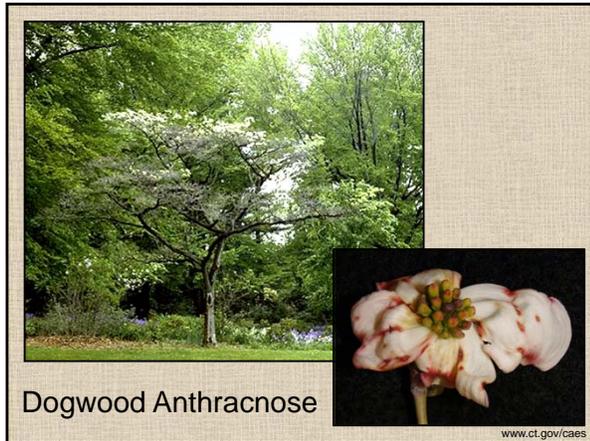
- Characterized as necrotic or dead areas on leaves.
- Often V-shaped or defined by the venation pattern of the leaf.
- Can also appear as blotchy dead areas or as discrete spots.
- Severe infections can result in twig and branch dieback.
- Usually more serious during cool, wet spring weather.

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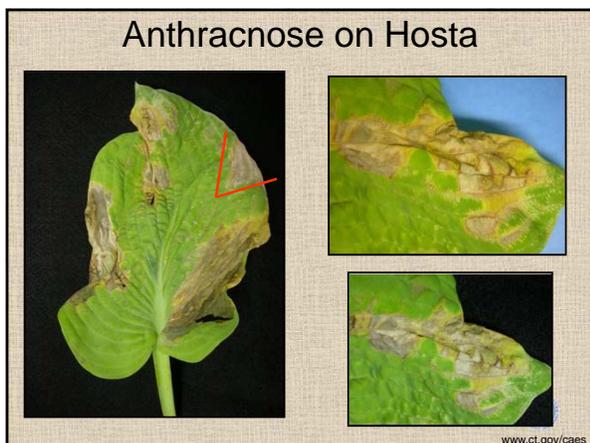












Anthracnose of Hollyhock




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POWDERY MILDEWS

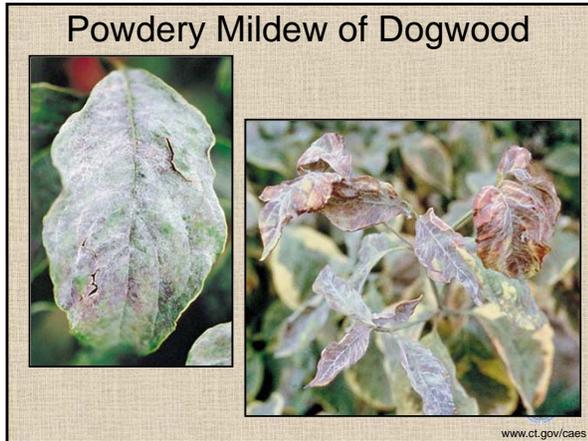
- Recognized by their distinctive diagnostic symptoms which are essentially the same on all hosts.
- First appear as chlorotic or pale-green, irregular patches on upper surface of the leaf; gradually develop into diagnostic grayish-white, powdery patches.
- Some are fluffy and white, others are grayish and sparse.
- *Don't* require free water on leaf surfaces in order to infect.

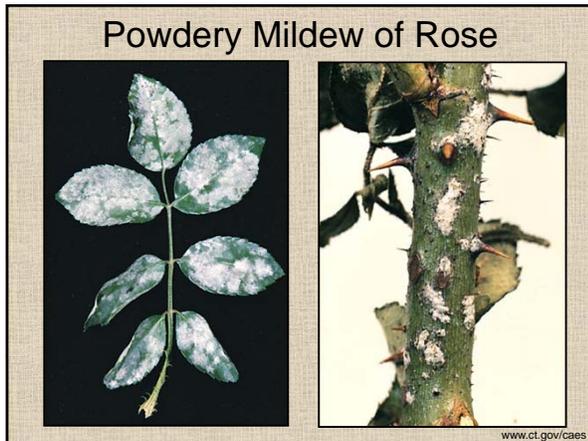

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Powdery Mildew of Oak

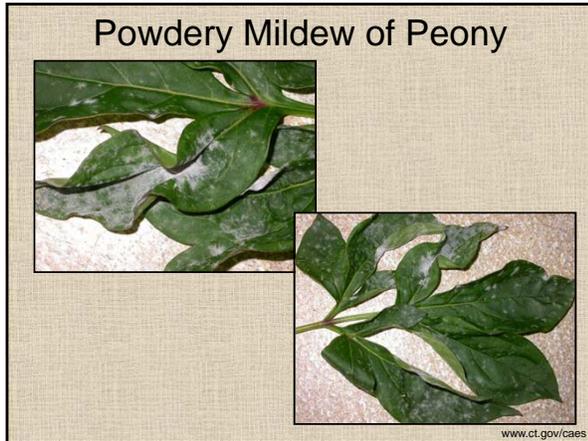


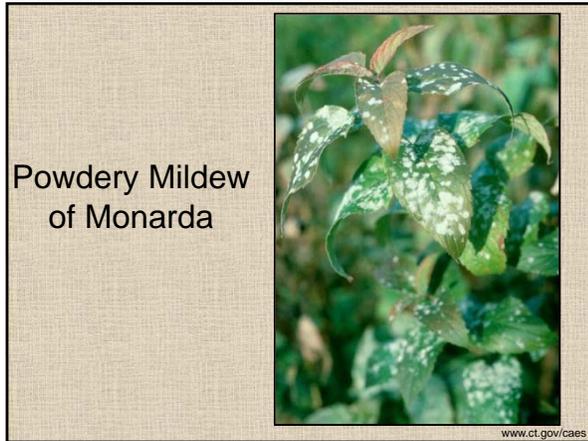
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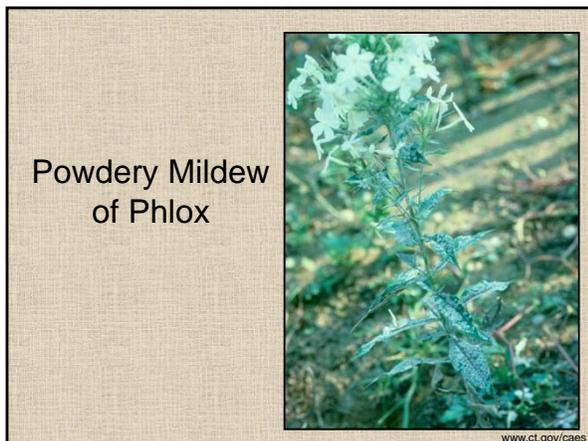












Downy Mildews

- Have become an increasing problem in the horticultural industry and are currently causing serious losses in many floricultural crops.
- The disease is often misidentified.
 - Downy mildew pathogens are very different from powdery mildews since they attack plant hosts under very different environmental conditions and are controlled by different classes of fungicides.



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DOWNY MILDEWS

- Symptoms first appear as pale-yellow or green areas on the upper leaf surface.
- Often misdiagnosed.
- Diagnostic symptoms gradually develop on the **undersurface of the leaf** as the pathogen grows out of the infected leaf.
 - Appears as a fuzzy, tan-gray-purple-brown mass.
- Symptoms often go unnoticed until leaves brown, shrivel, and drop.
- Highly specialized pathogens that are host specific.

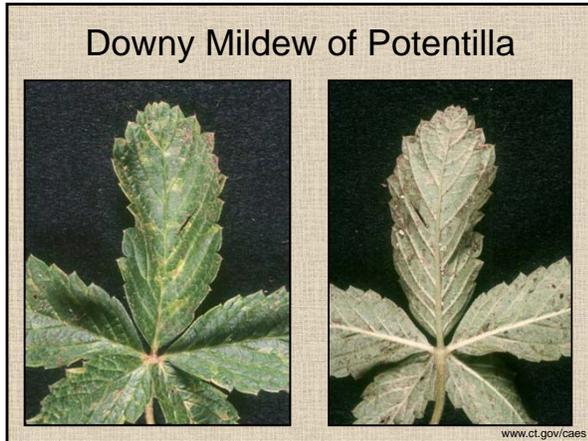


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Downy Mildew of Lamium



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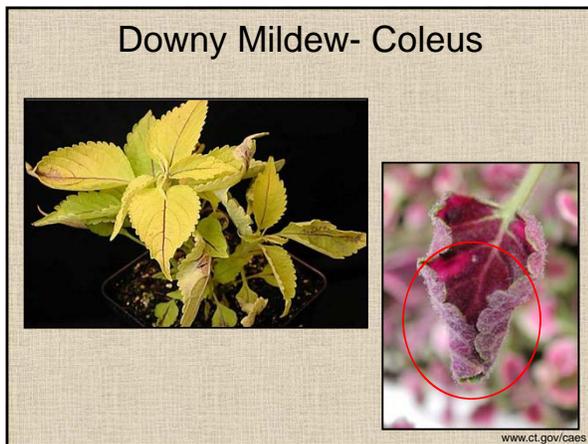












RUSTS

- Characterized as brightly colored, raised blisters or pustules that develop on leaves.
- More diagnostic symptoms usually develop as these structures break open to reveal the rusty, orange to brown spores that give these diseases their name.
- On evergreens and other hosts, galls or swellings can also develop on twigs.
- Highly specialized fungi that are host specific.



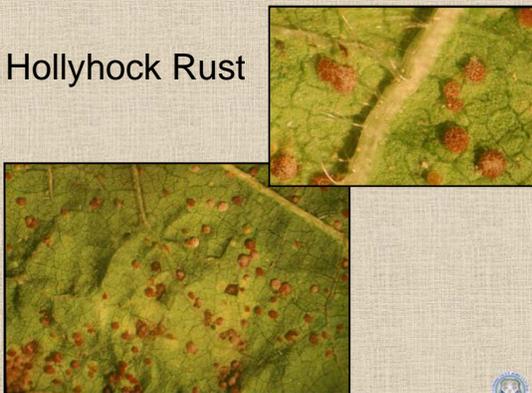
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Hollyhock Rust



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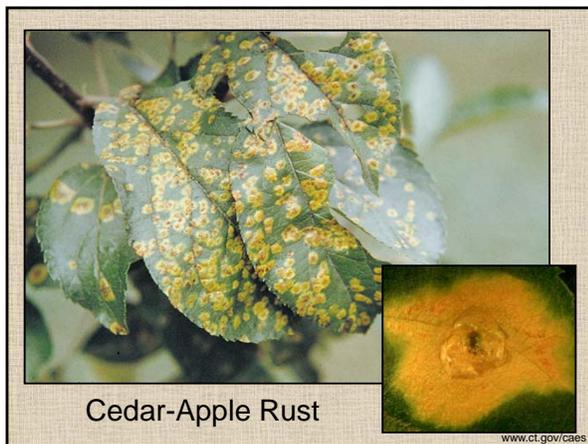
Hollyhock Rust

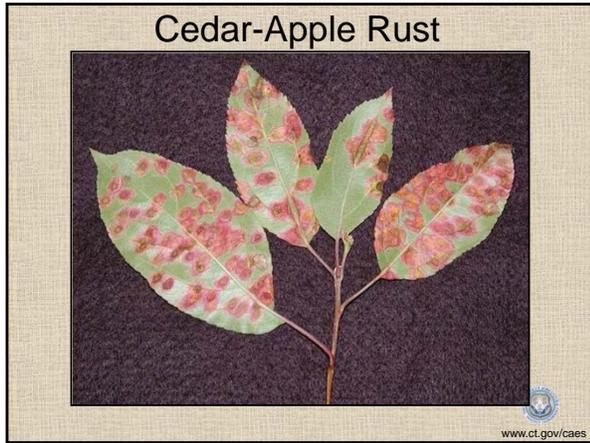


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MANAGEMENT OF FOLIAGE DISEASES:

- Maintain plant vigor by following sound cultural practices.
- Rake and remove symptomatic leaves and plant debris in autumn.
- Prune dead or dying branches or twigs in spring.
- Use resistant cultivars when available.
- Avoid overhead irrigation or water early in day.



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MANAGEMENT OF FOLIAGE DISEASES (cont'd):

- Use adequate spacing to promote good air circulation.
- Fungicides (based on disease diagnosis):
 - Biological (as protectants only):
 - *Trichoderma harzianum* Rifai strain KRL-AG2,
 - *Bacillus subtilis* QST 713 strain
 - Biorational:
 - Potassium bicarbonates, oils (Horticultural & Neem), soaps
 - Traditional:
 - Copper products, sulfur



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Examples

- Powdery Mildew of Zinnia:
 - Biological (as protectants only):
 - *Trichoderma harzianum* Rifai strain KRL-AG2,
 - *Bacillus subtilis* QST 713 strain
 - Biorational:
 - Potassium bicarbonates, oils (Horticultural & Neem), soaps
 - Traditional:
 - Sulfur
- Bacterial Spot of Zinnia:
 - Biological (as protectants only):
 - *Trichoderma harzianum* Rifai strain KRL-AG2,
 - *Bacillus subtilis* QST 713 strain
 - Traditional:
 - Copper products



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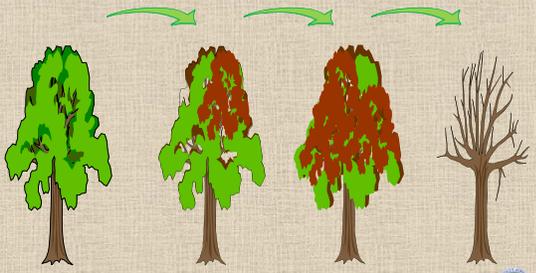
BLIGHT AND DIEBACK DISEASES:

- Characterized as sudden and conspicuous blackening or wilting of growing tips.
- Often more serious on plants that have been stressed.
- Can result in stem, branch, and plant death.



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BLIGHTS AND DIEBACKS

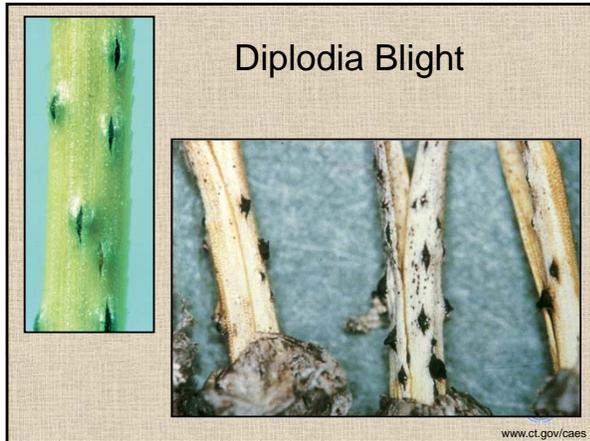


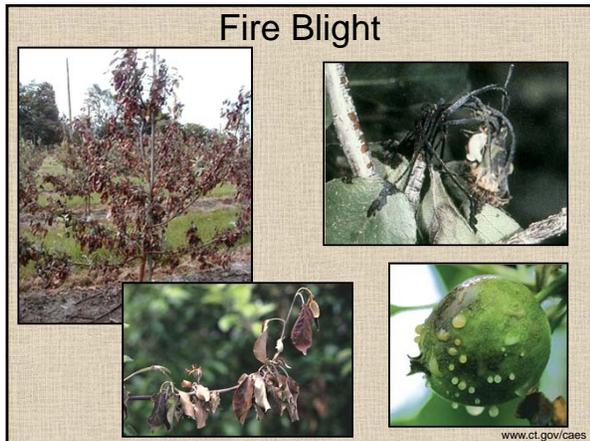
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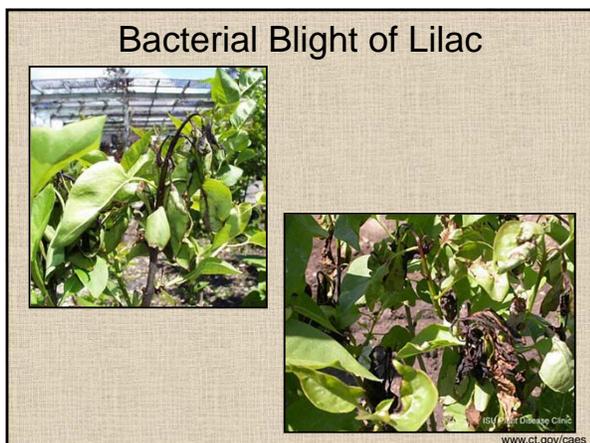
Diplodia Blight

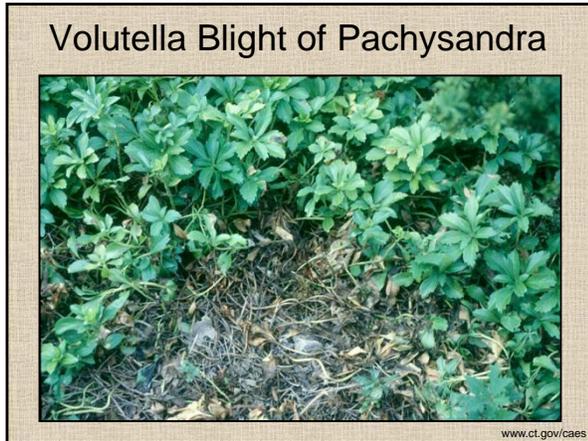


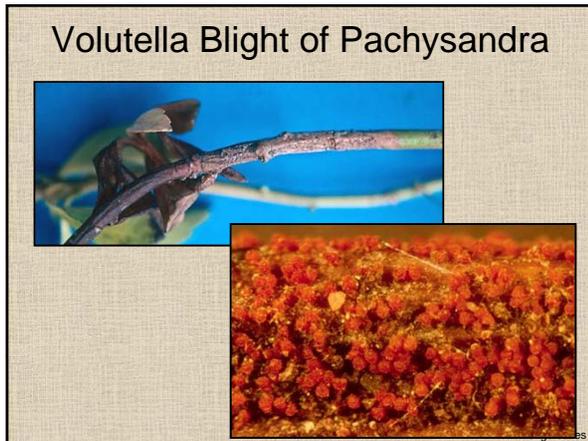
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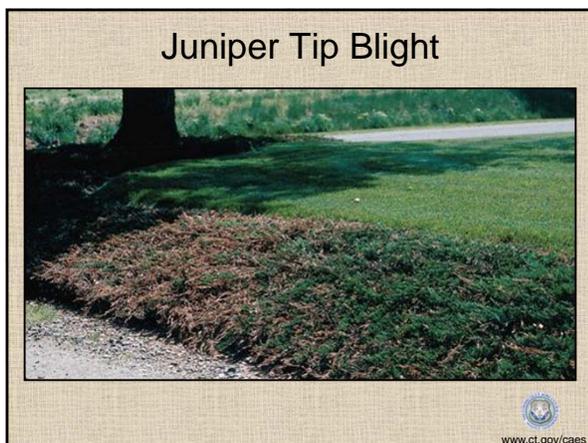


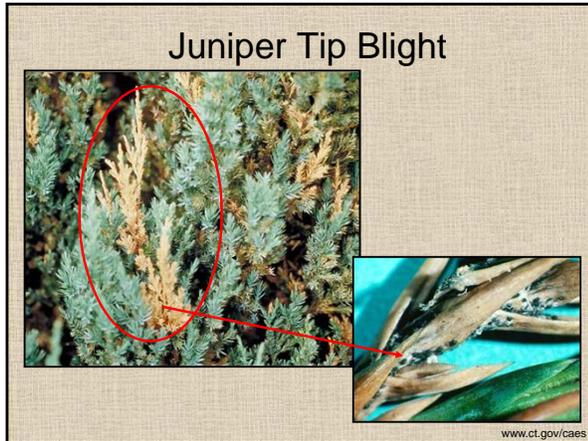


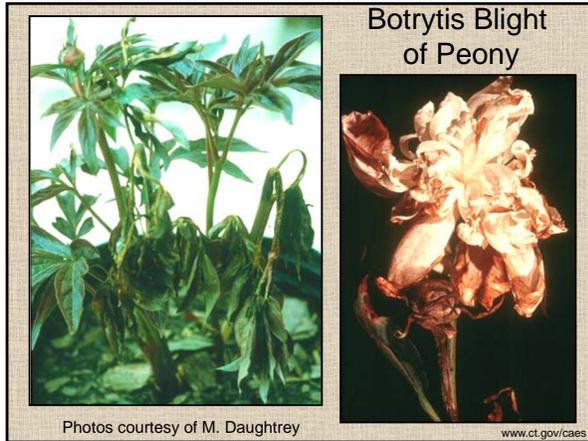




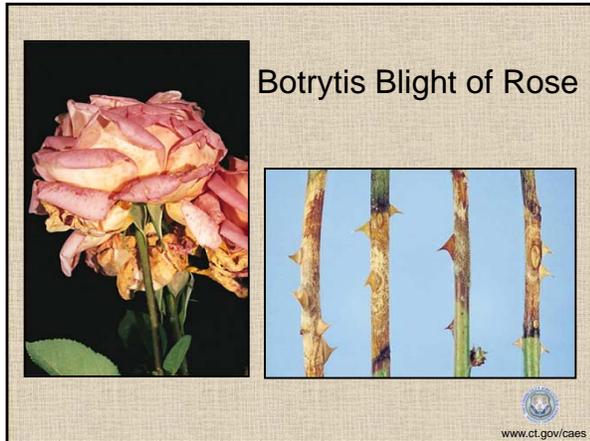


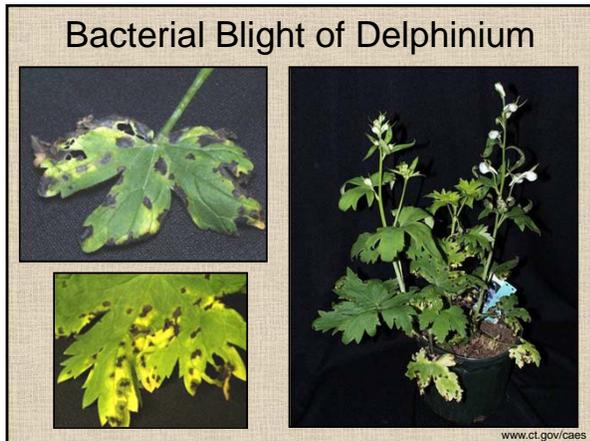


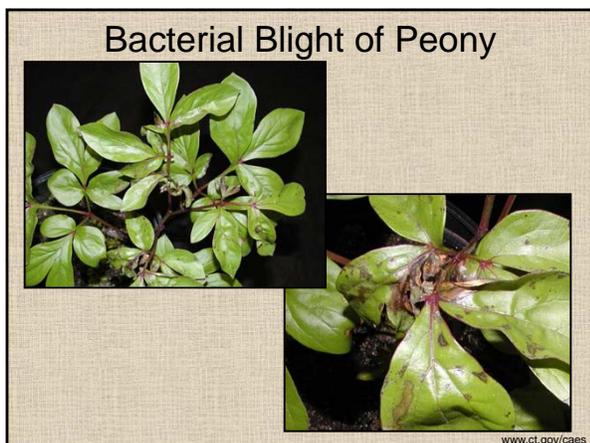












MANAGEMENT OF BLIGHT AND DIEBACK DISEASES:

- Avoid stress and maintain vigor by following sound cultural practices.
- Protect plants from winter injury and other stresses.
- Use resistant cultivars when available.
- Prune and remove diseased parts.



MANAGEMENT OF BLIGHT AND DIEBACK DISEASES (cont'd):

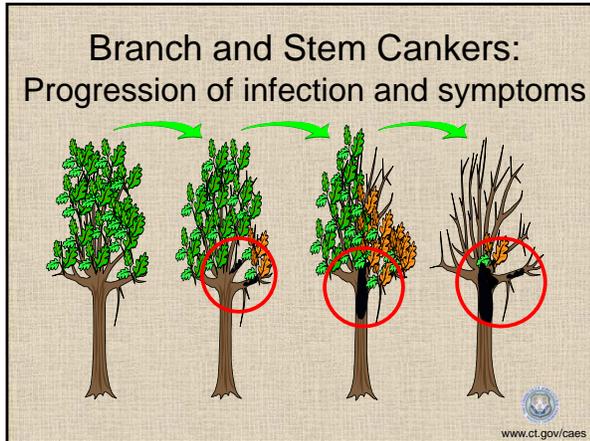
- Fungicides (based on disease diagnosis):
 - Biological (as protectants only):
 - *Trichoderma harzianum* Rifai strain KRL-AG2, *Bacillus subtilis* QST 713 strain
 - Traditional:
 - Copper products

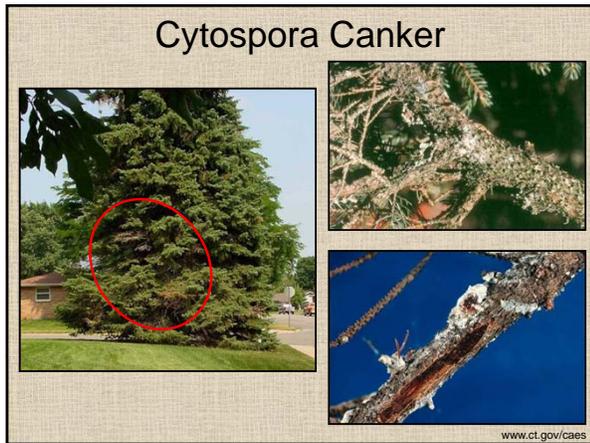


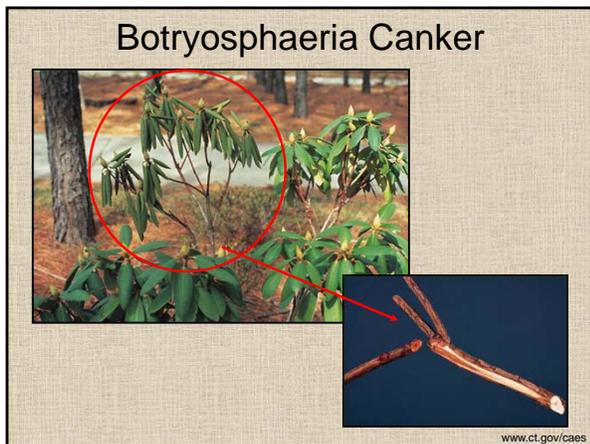
BRANCH AND STEM CANKER DISEASES:

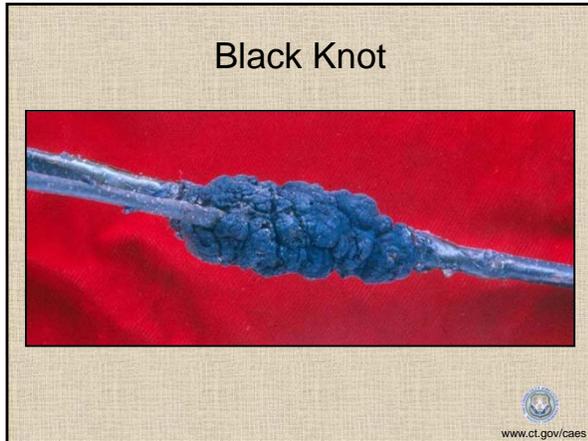
- Most pathogens do not actively invade host tissues but wait for an “opportunity” to invade through wounds or natural openings.
- Can result in stem, branch, and plant death.



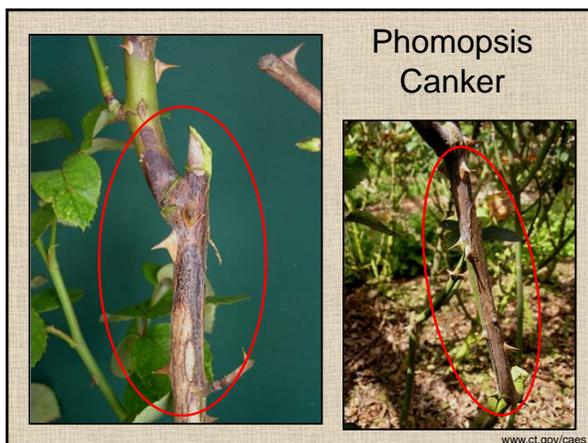


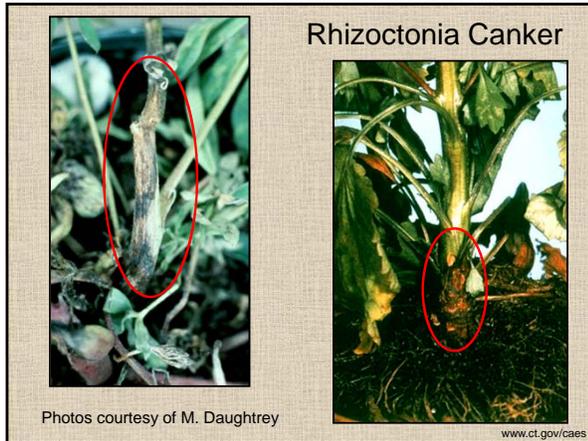












MANAGEMENT OF BRANCH AND STEM CANKER DISEASES:

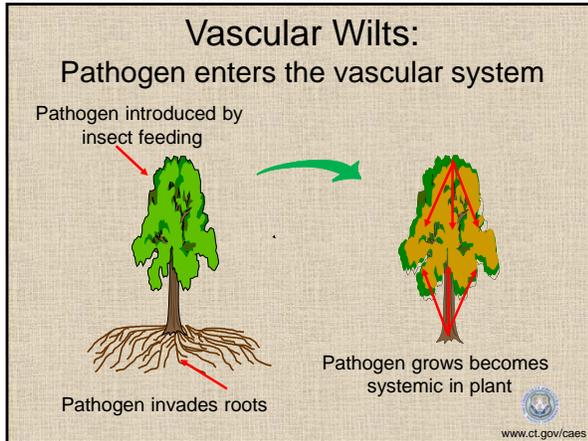
- Prune and remove affected parts or entire plants.
- Maintain vigor and reduce stress by following sound cultural practices.
- Fungicides (based on disease diagnosis):
 - Biological (as protectants only):
 - *Trichoderma harzianum* Rifai strain KRL-AG2,
 - *Bacillus subtilis* QST 713 strain
 - Traditional:
 - Copper products, sulfur

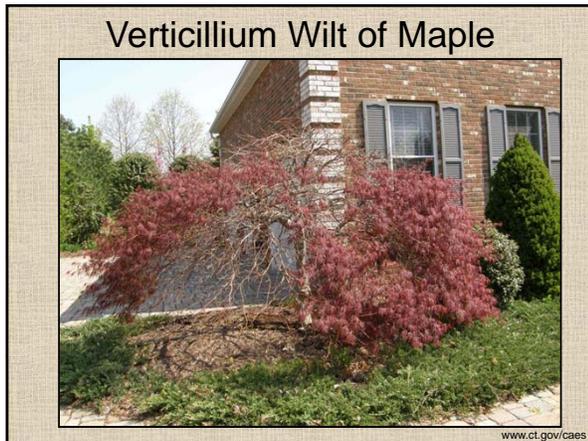

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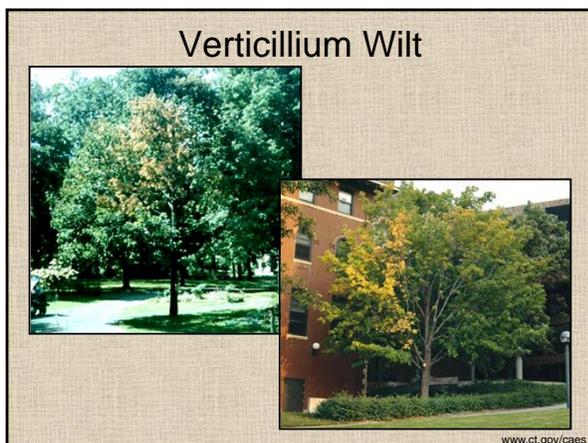
VASCULAR DISEASES:

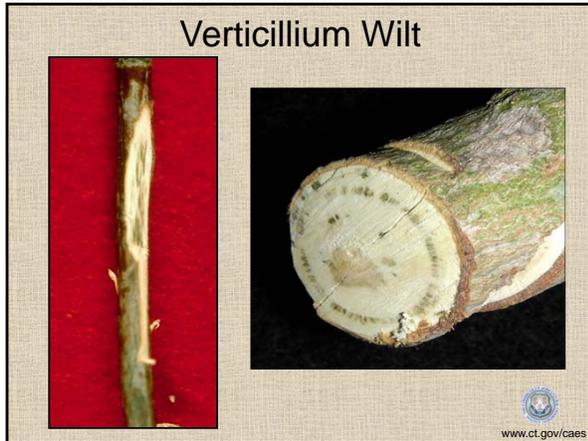
- The pathogen grows and multiplies in the vascular system (xylem or phloem) and becomes “systemic” in the plant.
- Once infected, plants cannot be cured.
- Can result in plant death.

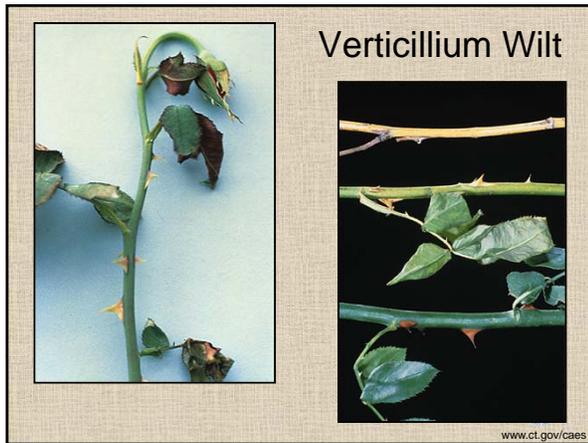

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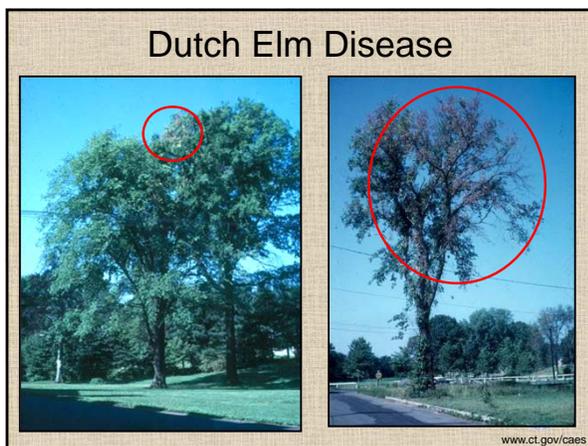


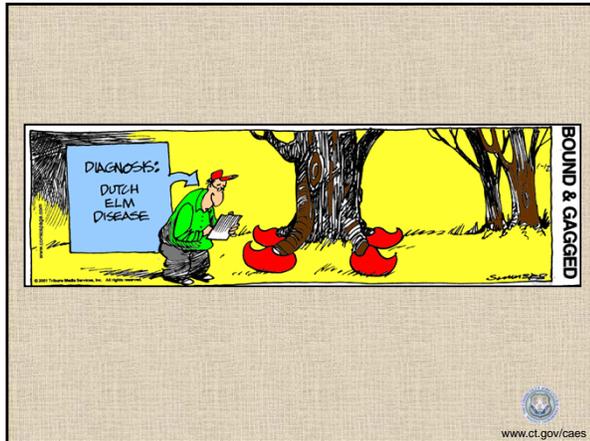


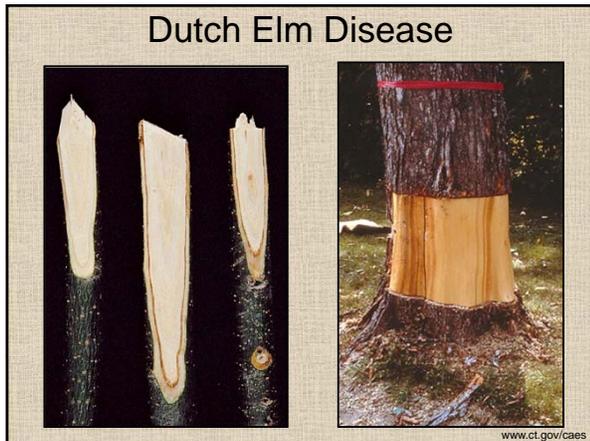


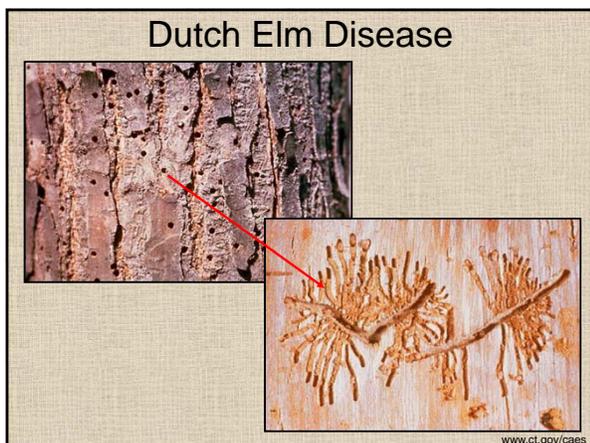












MANAGEMENT OF VASCULAR DISEASES:

- Prune and remove symptomatic branches, limbs, or stems as soon as possible.
- Use resistant species or cultivars when available.
- Maintain vigor following sound cultural practices.
- Avoid stress by appropriate site selection.
- Fungicides are not effective.
- Insect management can be helpful (based on diagnosis).



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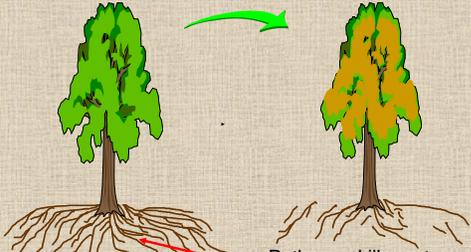
ROOT DISEASES:

- Pathogen invades the root system.
- Infection results in decay and death of roots and cankers and rot of the root/crown region.
- Nonspecific above-ground symptoms.
- Often results in plant death.



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Root Diseases: Pathogen enters root system

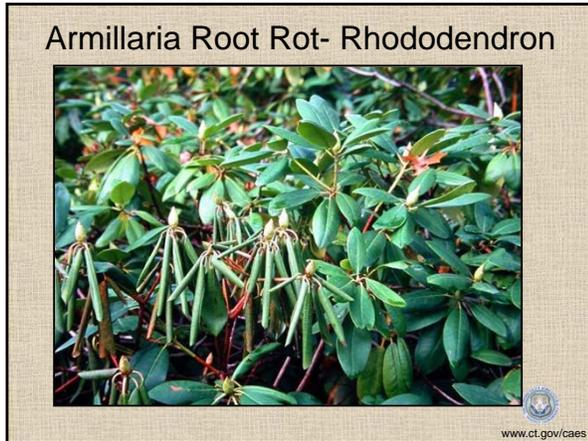


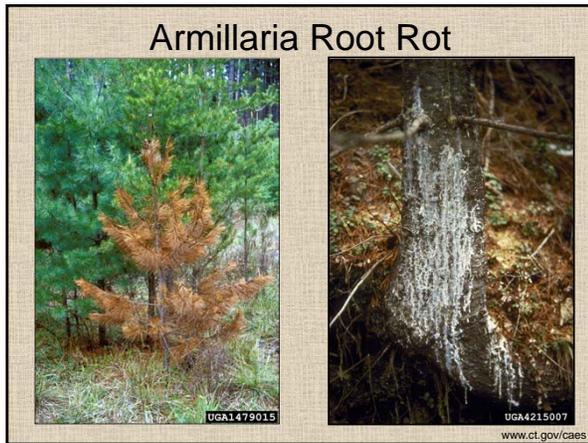
Pathogen invades roots and root collar

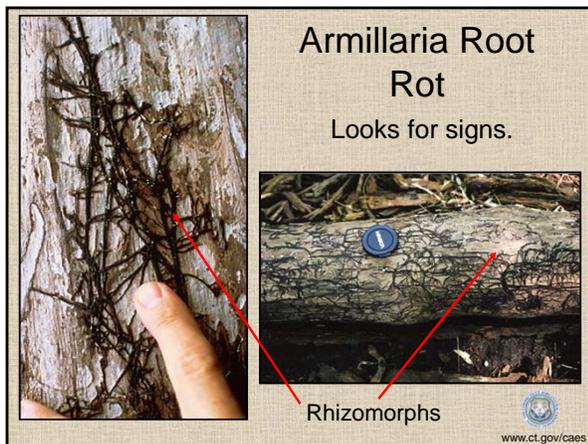
Pathogen kills roots and eventually kills plant

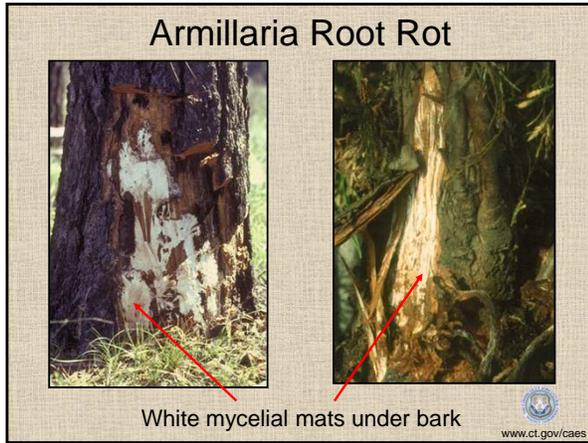


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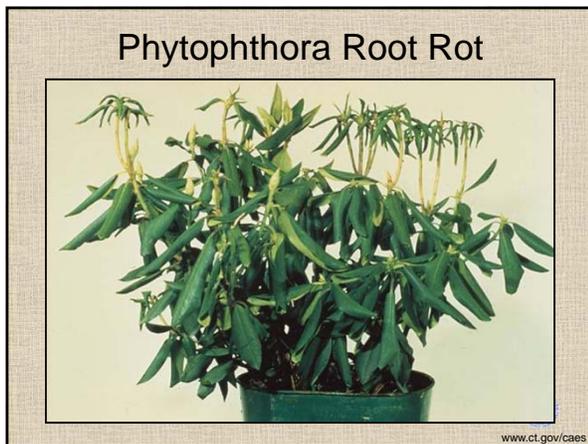












Phytophthora Root Rot



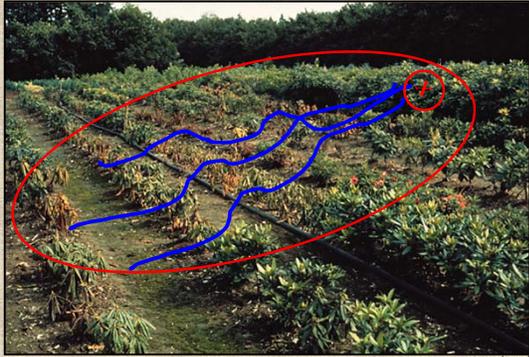
Water is a key factor for infection.

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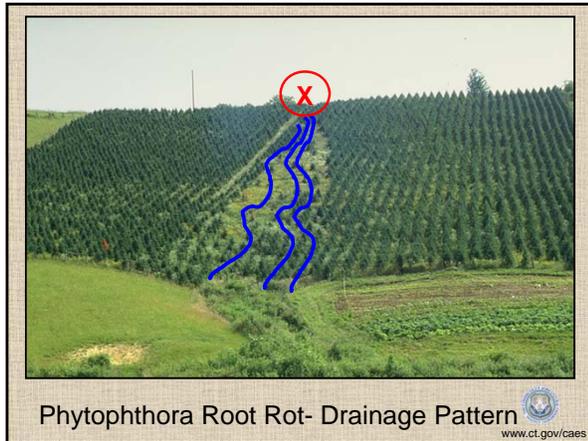


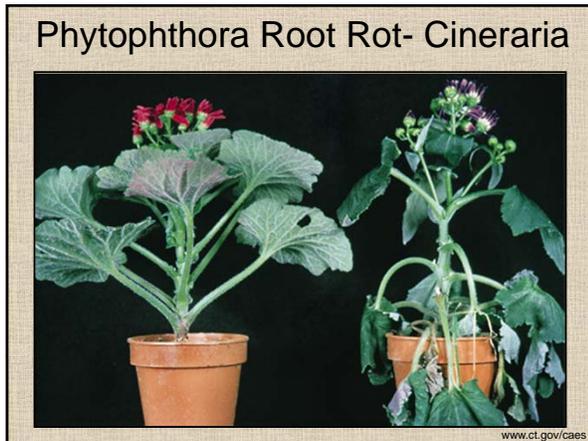
www.ct.gov/caes

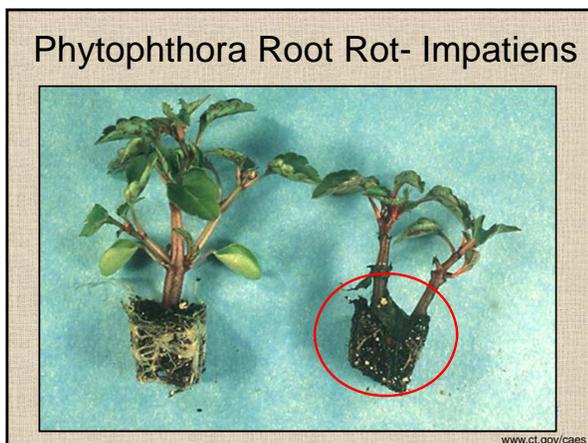
Phytophthora Root Rot-Drainage



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MANAGEMENT OF ROOT DISEASES:

- Protect plants from drought or flooding and avoid chronically wet areas.
- Use resistant species or cultivars when available.
- Maintain vigor following sound cultural practices.
- Remove and destroy infected plants; in some cases it is necessary to remove stumps and woody roots greater than ½ inch in diameter.



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MANAGEMENT OF ROOT DISEASES (cont'd):

- Fungicides are NOT curative but can be used in some cases to protect healthy plants in the vicinity of infected plants.
- Example: Phytophthora root rot
 - Biological (as protectants only):
 - *Trichoderma harzianum* Rifai strain KRL-AG2, *Bacillus subtilis* QST 713 strain
 - Traditional (as protectants only):
 - Fosetyl-AI, mefenoxam, and phosphorous acid or mono- and di-potassium salts of phosphorous acid



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ABIOTIC PROBLEMS:

- Cultural
- Environmental



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COMMON CULTURAL PROBLEMS

- Site Selection and Characteristics
- Planting Practices
- Nutrient Deficiencies and Toxicities
- Misapplied Pesticides



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COMMON ENVIRONMENTAL PROBLEMS

- Winter Injury
- Drought
- Excess Water
- Air Pollution



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DISEASES CAUSED BY ABIOTIC FACTORS



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ABIOTIC DISEASES

- Winter Injury
- Drought
- Excess Water
- Air Pollution
- Mineral Deficiencies and Toxicities



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WINTER INJURY



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SYMPTOMS:

- Dieback
- Foliar browning
- Sunscalding
- Bark cracking
- Failure to leaf-out in spring or development of abnormal foliage
- Sudden collapse
- Plant death



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CAUSAL FACTORS:

- Late spring frosts
- Cool summer followed by a warm fall and a sudden drop in temperature
- Excessive or late season nitrogen fertilization
- Excessive temperature fluctuations
- Dry soil
- Extremely low temperatures
- Lack of snow cover
- Reflected heat from snow cover
- Drying winds



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Winter Injury

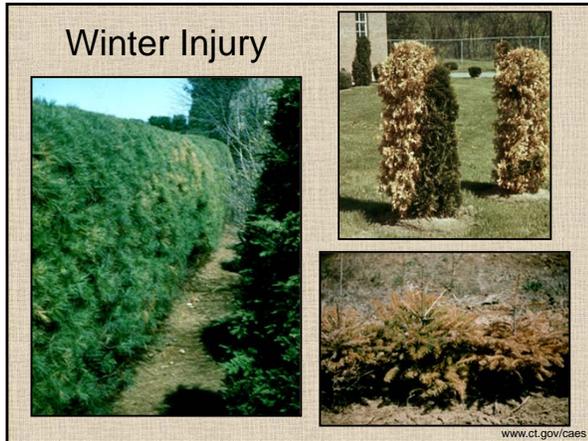


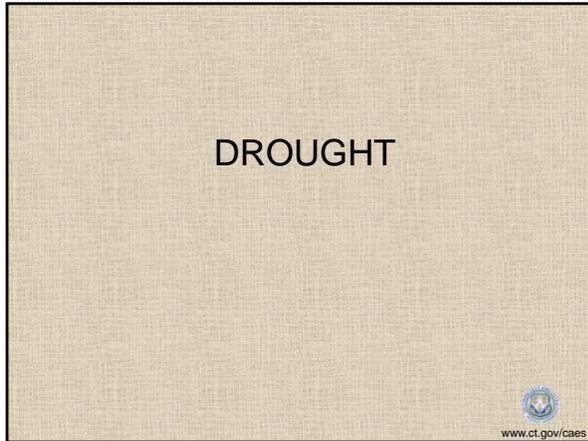
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Winter Injury



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CAUSAL FACTORS:

- Soil water becomes deficient and results in feeder root damage and death.
- Plants can't take up water since they have no functional roots.



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Drought



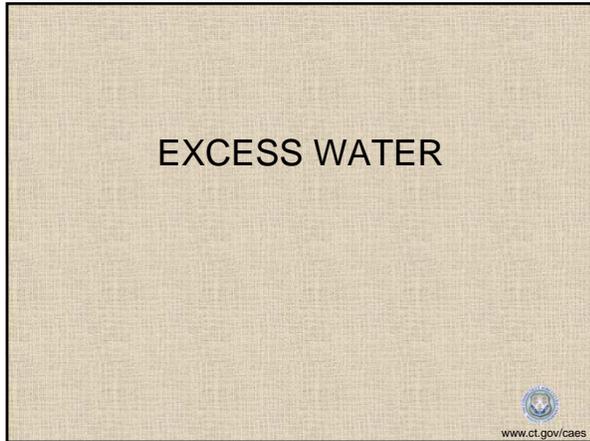
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Drought



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CAUSAL FACTORS:

- Roots in water-logged or flooded soils are asphyxiated from oxygen deprivation.
- Damaged roots die and decay.
- Plants can't take up water since they have no functional root system.



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Excess Water

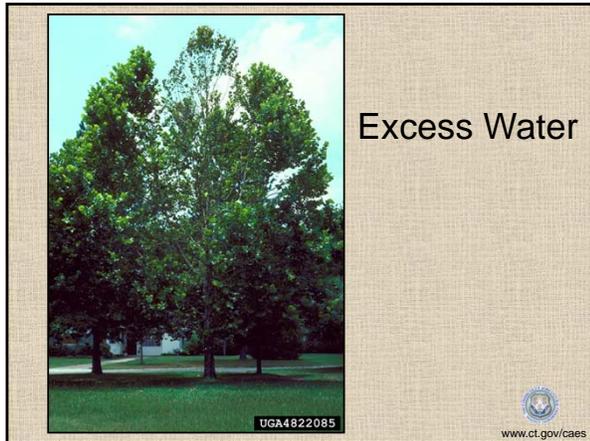


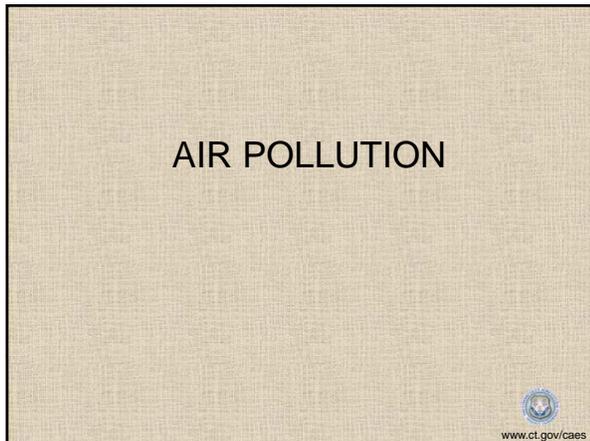
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Excess Water



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CAUSAL FACTORS:

- Oxidants (ozone, PAN)
- Sulfur dioxides
- Fluorides



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Sulfur dioxide injury



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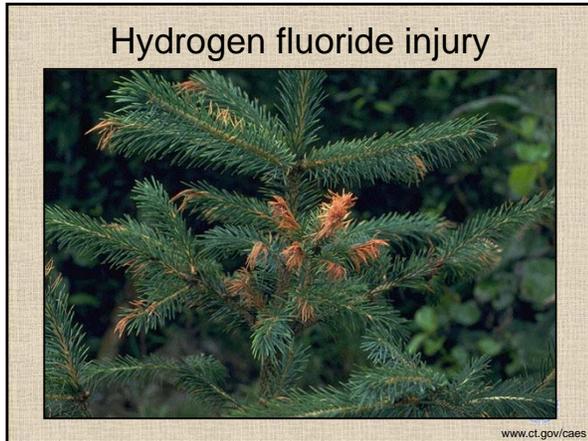
Ozone injury

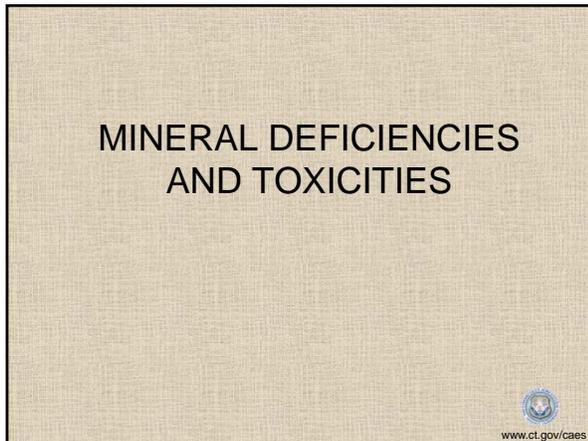


HGIC, U of MD



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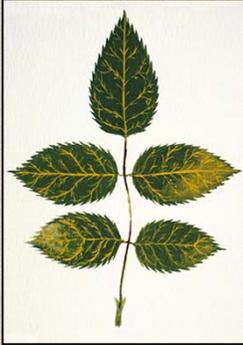
CAUSAL FACTORS:

- Primary- N, P, K
- Secondary- S, Ca, Mg
- Trace (micro)- Fe, Zn, Mn, Mo, Cu, Cl, B



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Nitrogen deficiency of rose



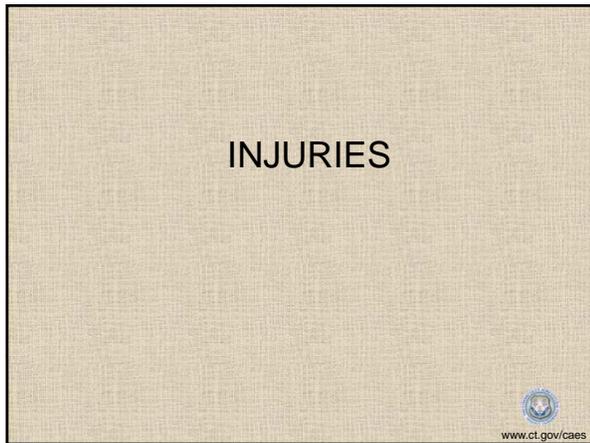
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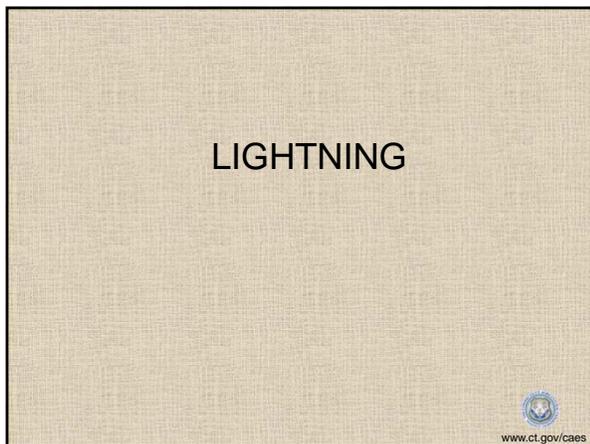
Iron deficiency of chrysanthemum

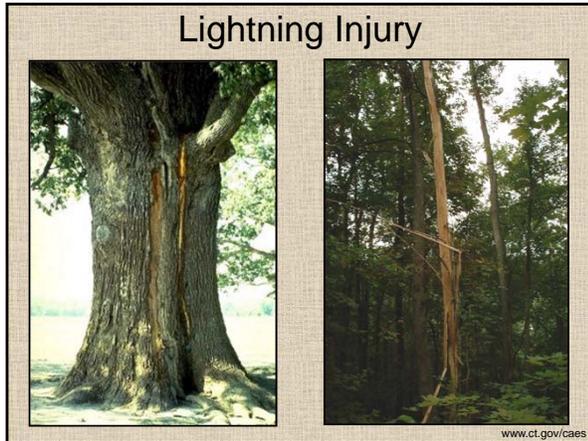


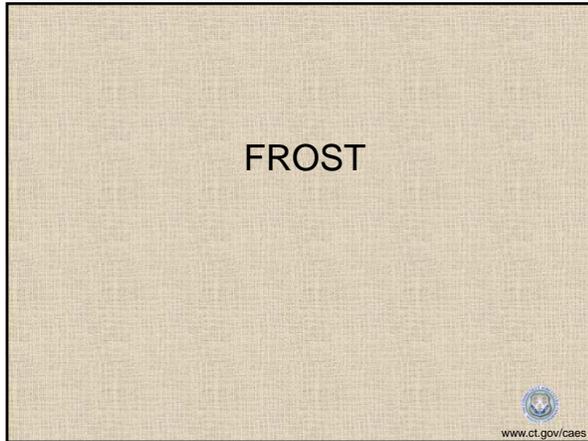
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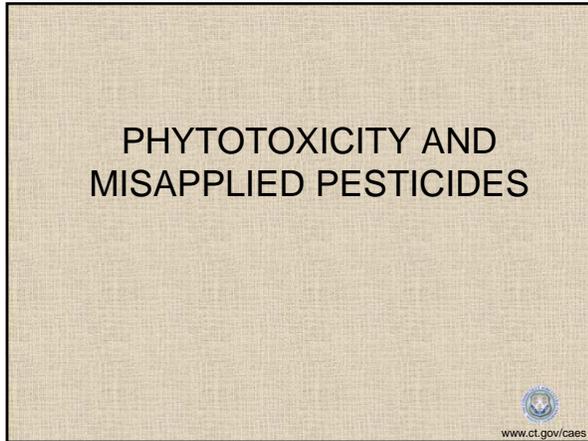


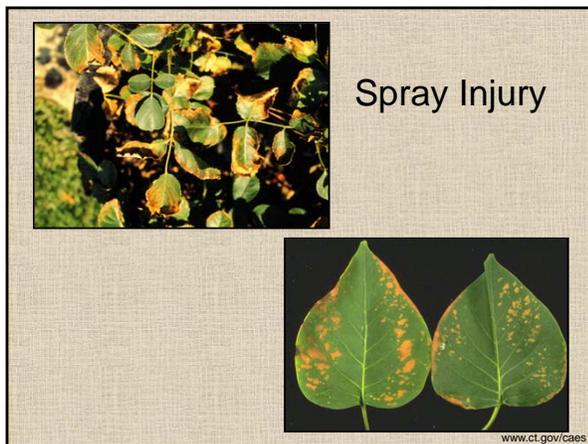


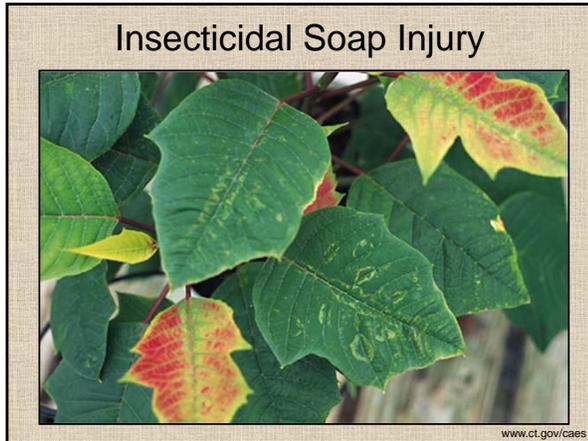


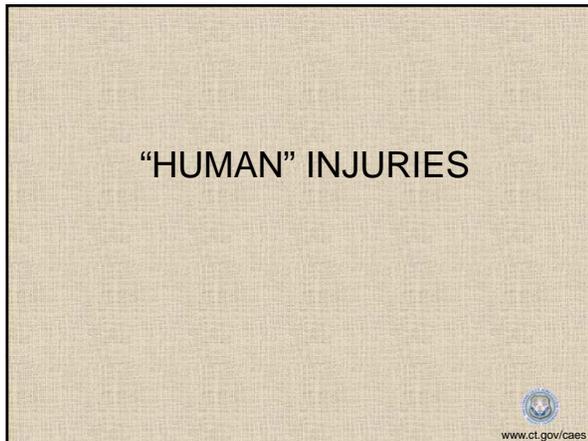




















STEPS IN DIAGNOSING PLANT
DISEASES
(Handout)



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