UNDERSTANDING PLANT DISEASES

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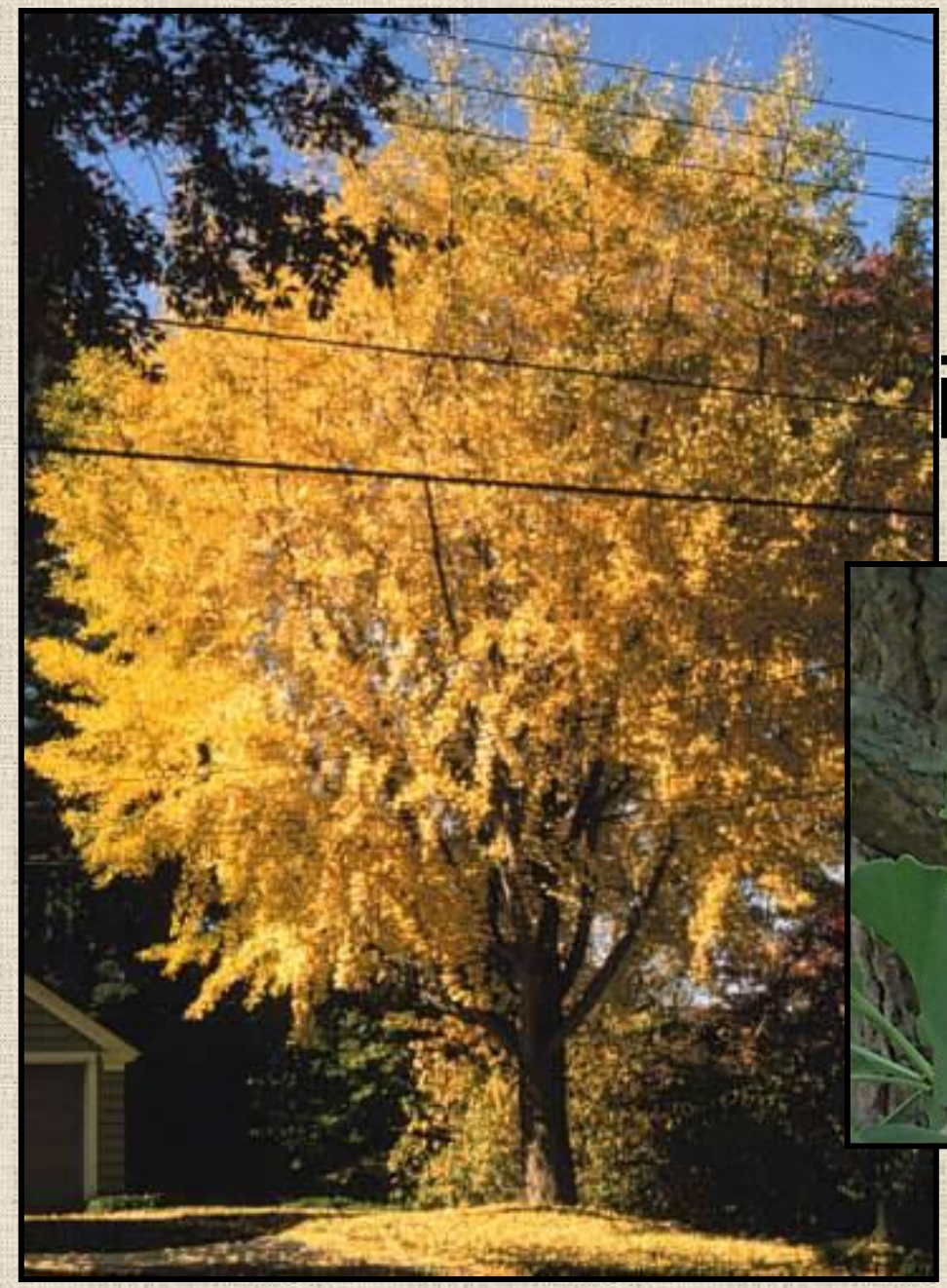
CAES Website
www.ct.gov/caes

PDIO Website
www.ct.gov/caes/pdio

OBJECTIVES:

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



Ginkgo biloba

iseases

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DISEASE

- Any condition in a plant that interferes with normal growth and development.

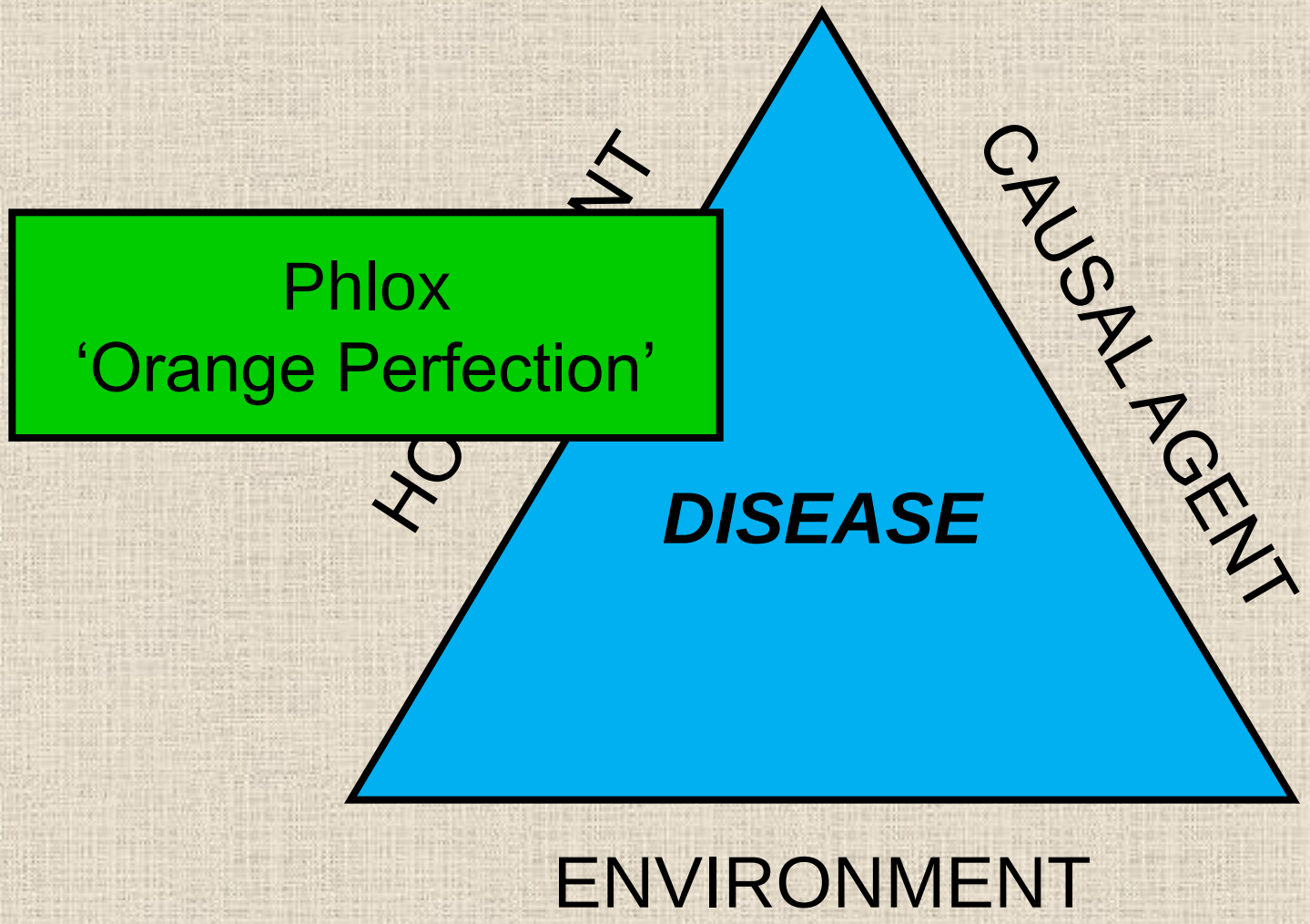
Dynamic
Continuous

INJURY

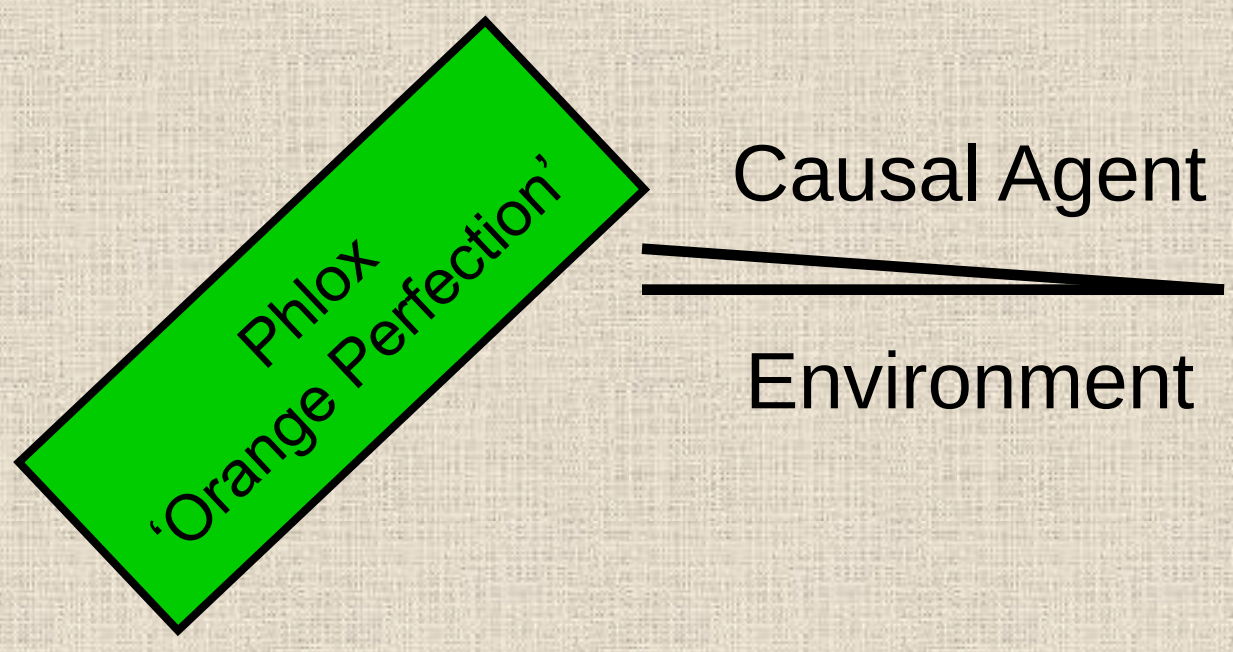
- A onetime occurrence or irritation that results in plant damage.

Lightning
Frost

DISEASE TRIANGLE



DISEASE TRIANGLE



PLANT HEALTH PROBLEMS

I. ABIOTIC (non-living agents)-

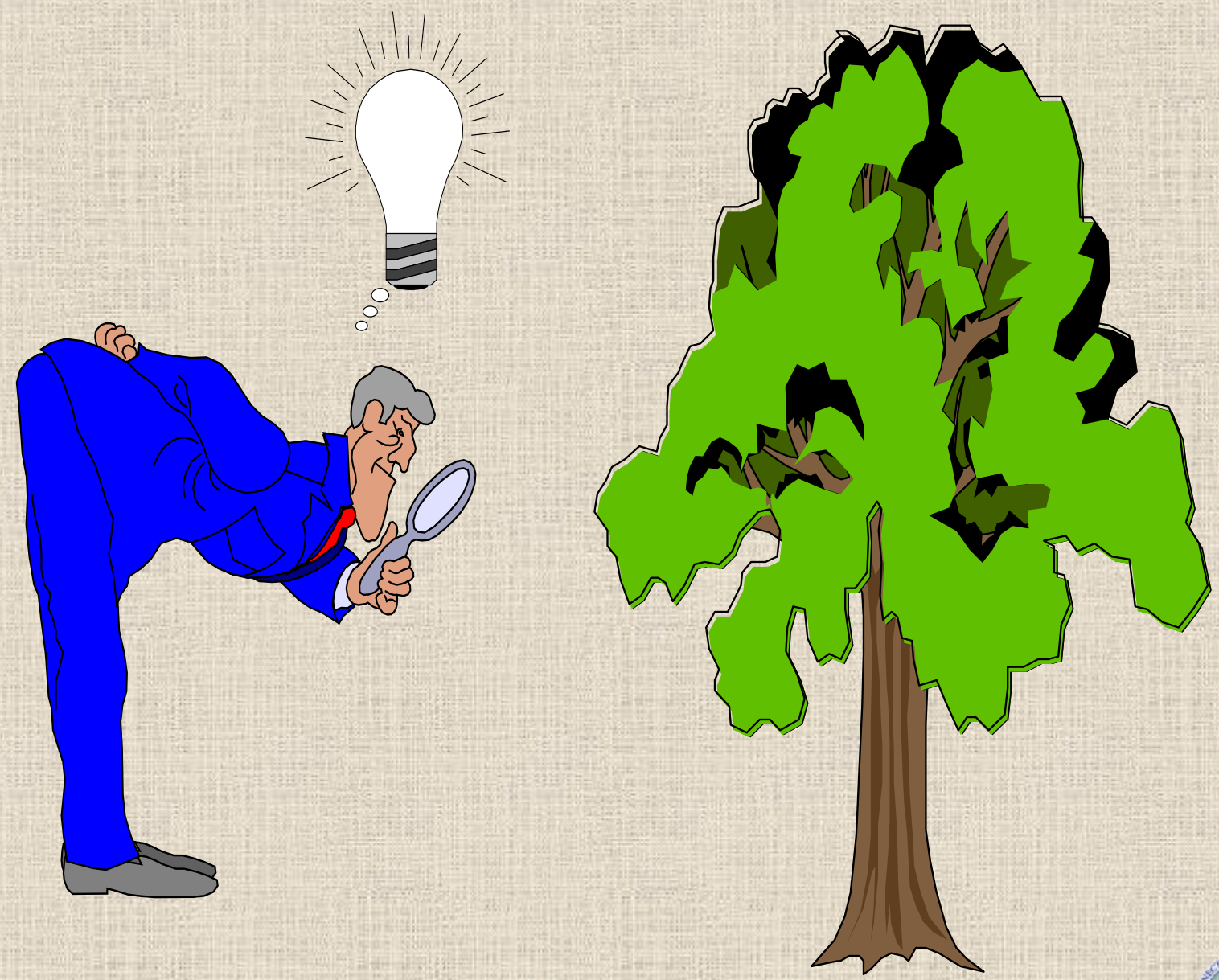
1. Cultural
2. Environmental

II. BIOTIC (living agents)-

1. Fungi and Fungus-like Organisms
2. Bacteria
3. Viruses and Viroids
4. Phytoplasmas
5. Nematodes

SIGNS and SYMPTOMS

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



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SIGN

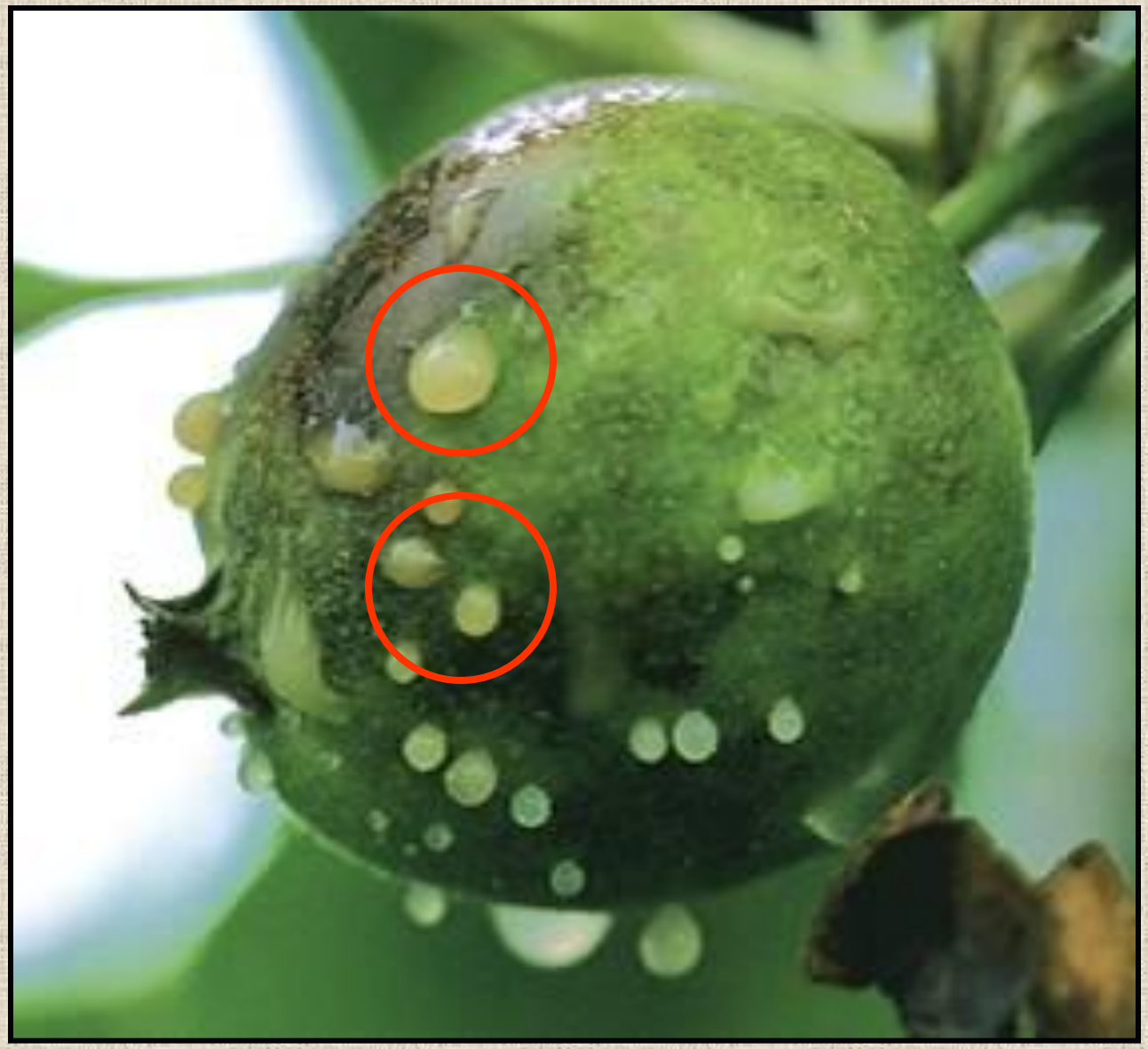
- The causal agent (pathogen or biotic agent) or its parts or products seen on a plant host.
- Examples: pycnidia, conidia, bacterial ooze

Fungal Fruiting Bodies

Fungal Fruiting Bodies

Fungal Fruiting Bodies

Bacterial Ooze



KEY MODES FOR DISSEMINATION OF BIOTIC PATHOGENS

- By air
- By water
- By insects, mites, nematodes, and other vectors
- By infected plant material
- By human activities

Vocabulary for symptoms of disease

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.

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.

SCORCH

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


UGA0014295

WILT

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


UGA9000029

CANKER

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

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.

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.


R. Mulrooney,
U of DE

CHLOROSIS

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

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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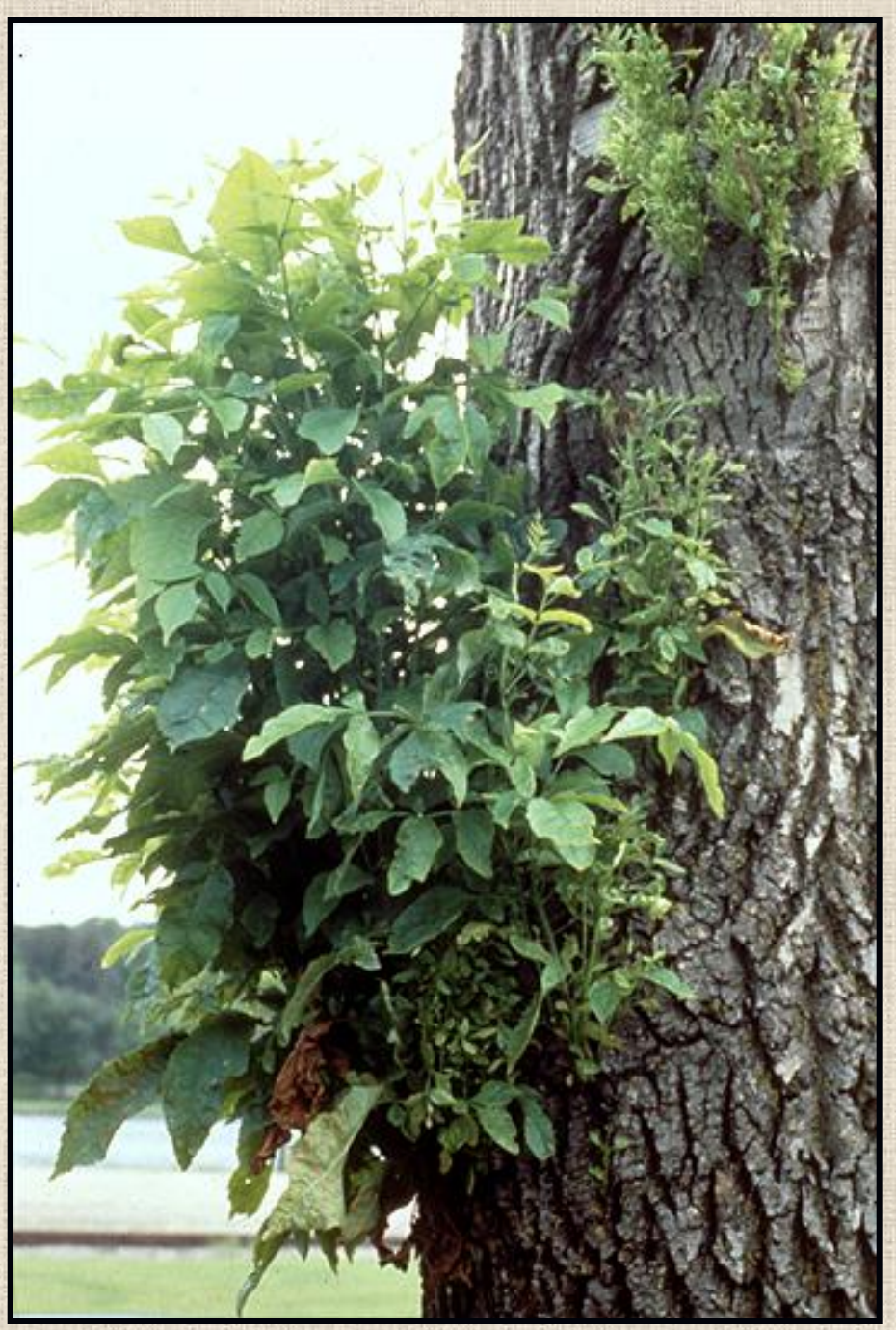
VASCULAR DISCOLORATION

- Streaking or darkening of vascular tissues.

WITCHES' BROOM

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



DISEASE PREVENTION AND MANAGEMENT

- Accurate Disease Diagnosis
- Management Program

ACCURATE DIAGNOSIS:

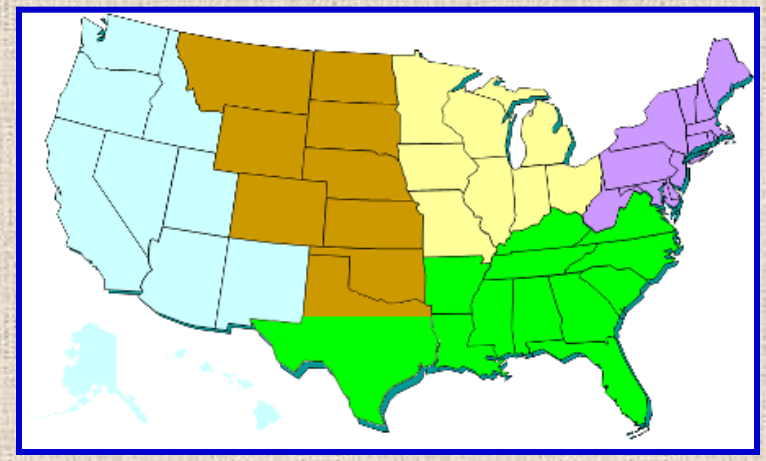
- Need for Control
- Type of Control

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.



NPDN
National Plant Diagnostic Network

USDA | NIFA

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

PLANT DISEASE INFORMATION OFFICE

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

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203.974.8601
Toll-Free: 877.855.2237

DISEASE MANAGEMENT =

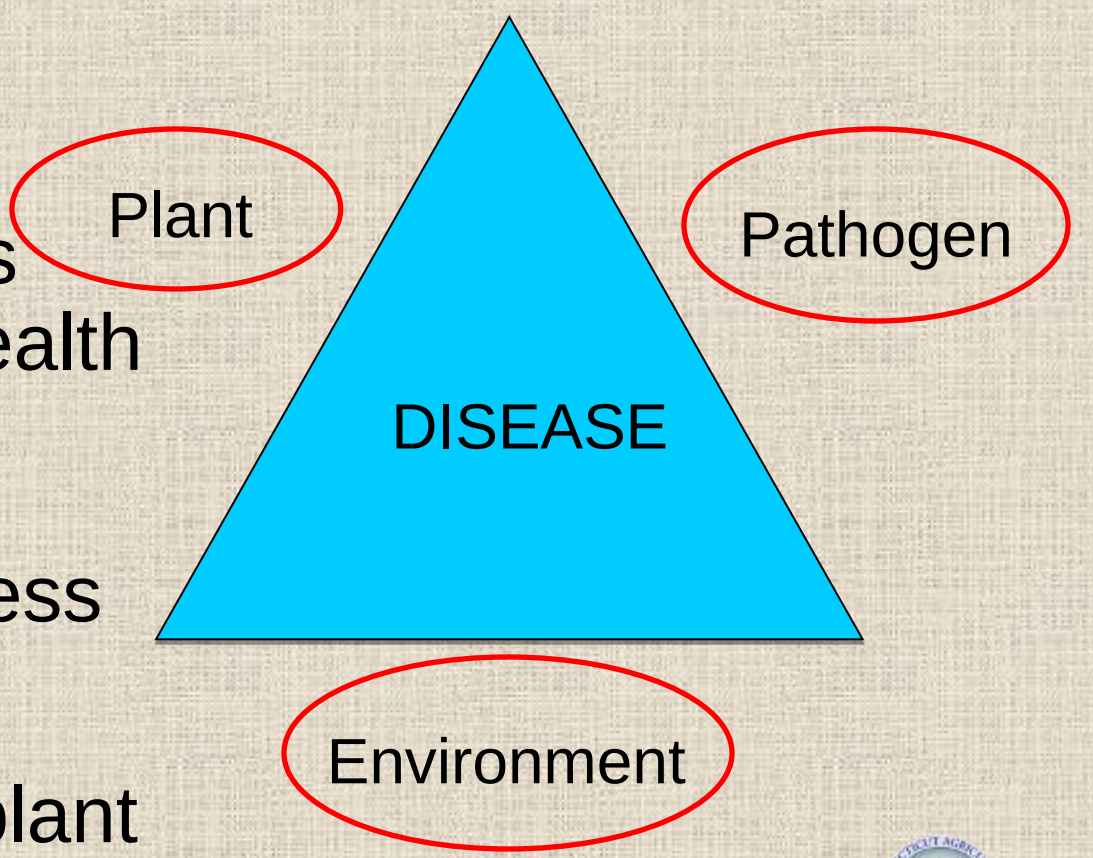
PROGRAM FOR MANAGING PLANT HEALTH

or

INTEGRATED PLANT HEALTH MANAGEMENT

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)



PLANT HEALTH MANAGEMENT PROGRAM :

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

DISEASE MANAGEMENT

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

Prevention!

1. CULTURE

A. Maintain Plant Vigor

B. Rotate Plants

C. Interplant (Companion planting)

D. Mulch

E. Control Weeds

A. Maintain Plant Vigor

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

i. Plant and Site Selection

- Match plant to site, not site to plant

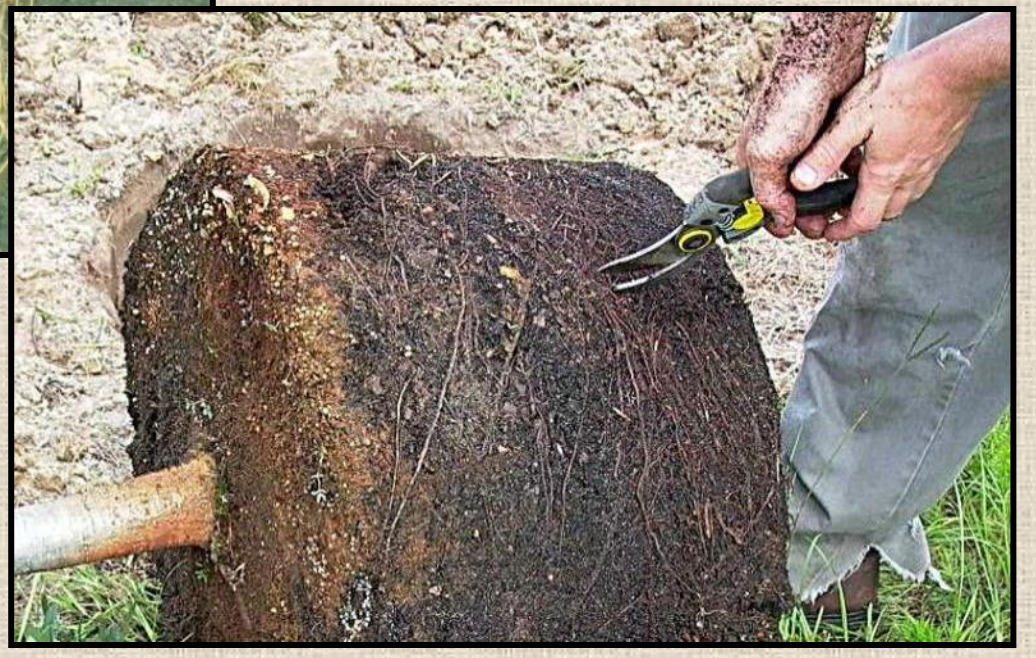
The right plant for the right site!

The wrong plant for the wrong site!

ii. Planting Practices

- Correctly prepare the planting hole and rootball.

Correctly Prepare the Rootball



Correctly Prepare the Roots

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.

iv. Watering

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

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.

C. Interplant (Companion Planting)

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

Marigolds for “Trapping” Root Knot Nematodes

French or French Dwarf Marigolds

Root Knot Nematode Damage

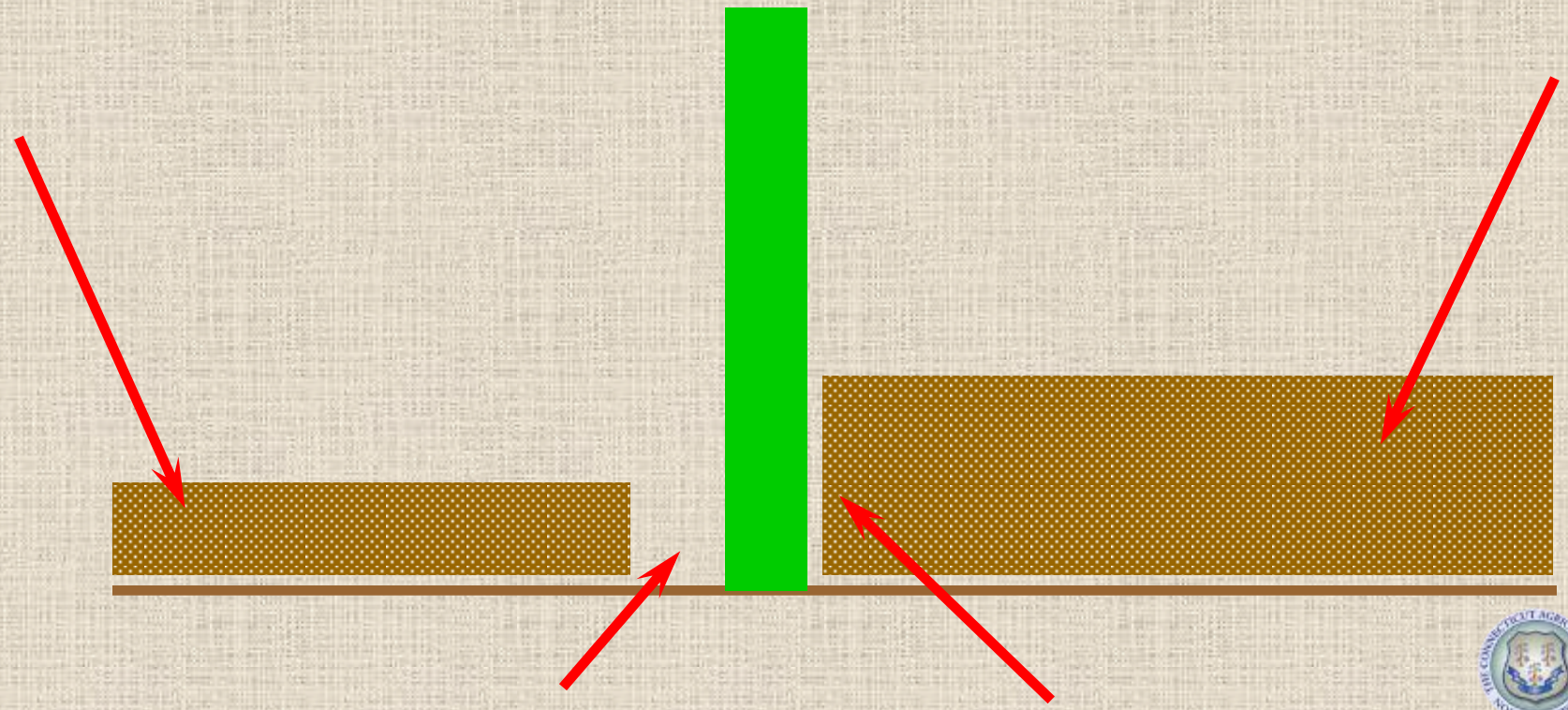
D. Mulch

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

MULCHING METHODS

YES

NO



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NO

Proper Mulching

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E. Control Weeds

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

INSV / TSWV (Tospo) Viruses

Have many weeds as reservoir hosts.

Transmitted by thrips.

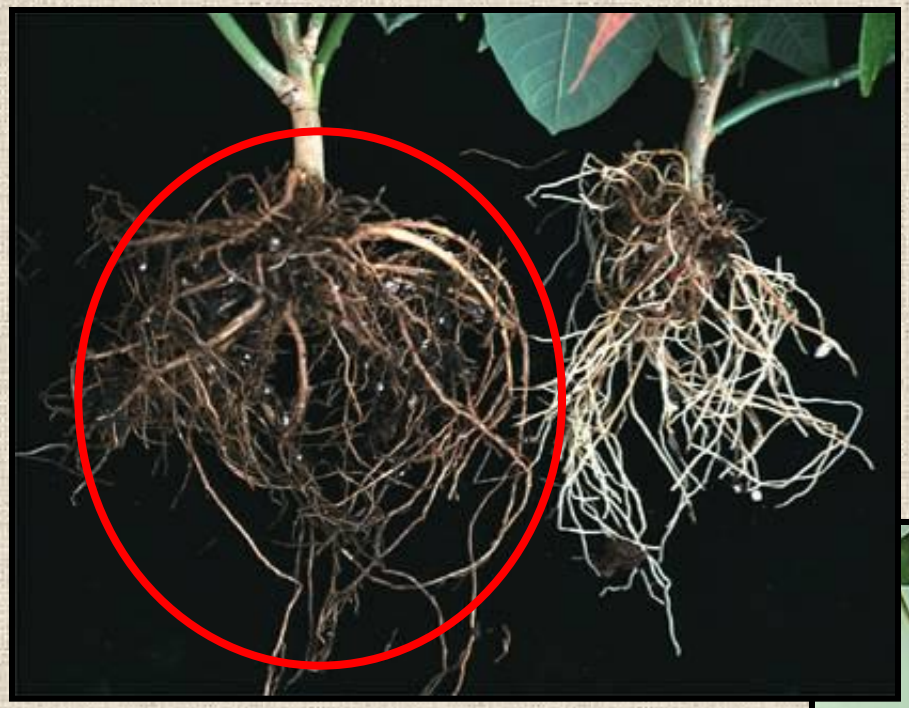
2. SANITATION

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.

A. Selecting and Planting Healthy Plants

Pythium Root Rot

Thielaviopsis Root Rot



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B. Removing or Pruning Infected Plants or Plant Parts

Hollyhock Rust

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Volutella Blight of Pachysandra

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C. Grooming

Botrytis Blight-Geranium

D. Using Clean Equipment

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

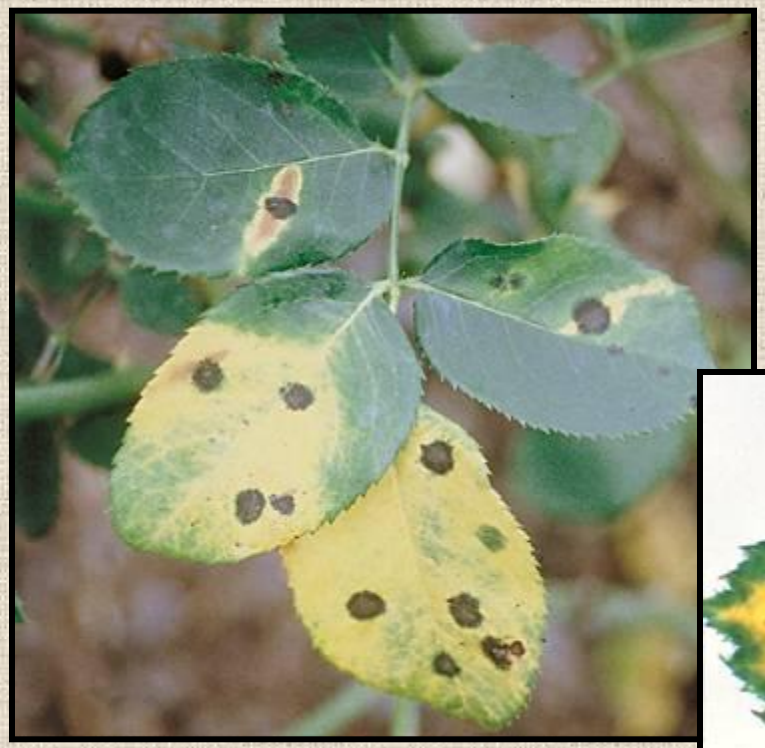
Disinfest All Tools and Equipment

E. Scouting and Keeping Records

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…

Black Spot of Rose



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Powdery Mildew of Monarda

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 secrets toxins that inhibit the pathogen.

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)

5. CHEMICAL

KEY FACTORS FOR USE:

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

WHAT IS A PESTICIDE?

PESTICIDE

cide = to kill

TYPES OF PESTICIDES

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

CATEGORIES OF PESTICIDES:

- Biological
- Biorational
- Traditional-Chemical

BIOLOGICAL PESTICIDES

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

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)

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)

SAFE PESTICIDE USE

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

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 (LD_{50})

- 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: LD_{50}= 5 means a dosage of 5mg per 1,000g body weight.

LETHAL DOSE (LD_{50})

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

LD_{50} = 30 (more toxic)

LD_{50} = 1,500 (less toxic)

SIGNAL WORDS

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

SIGNAL WORDS

- **DANGER**- (often accompanied by “Poison” and a skull and crossbones), toxicity category I *(highly toxic)*
- **WARNING**- toxicity category II *(moderately toxic)*
- **CAUTION**- toxicity category III *(slightly toxic)*
- **CAUTION**- toxicity category IV *(relatively non-toxic)*

PESTICIDE USE

1. How to read the pesticide label.
2. Proper use and handling of pesticides.

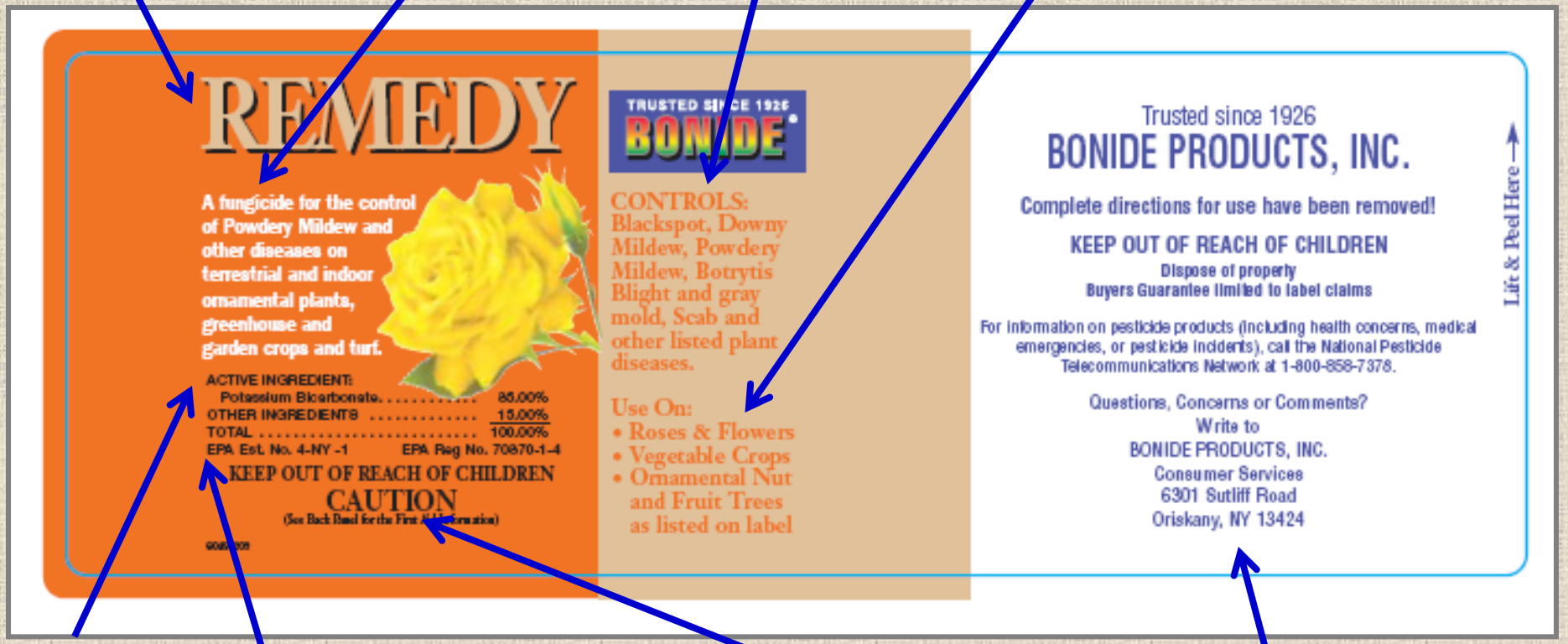
THE PESTICIDE LABEL

Trade name

Type of product

Pests controlled

Plant use



Active ingredient

EPA registration number

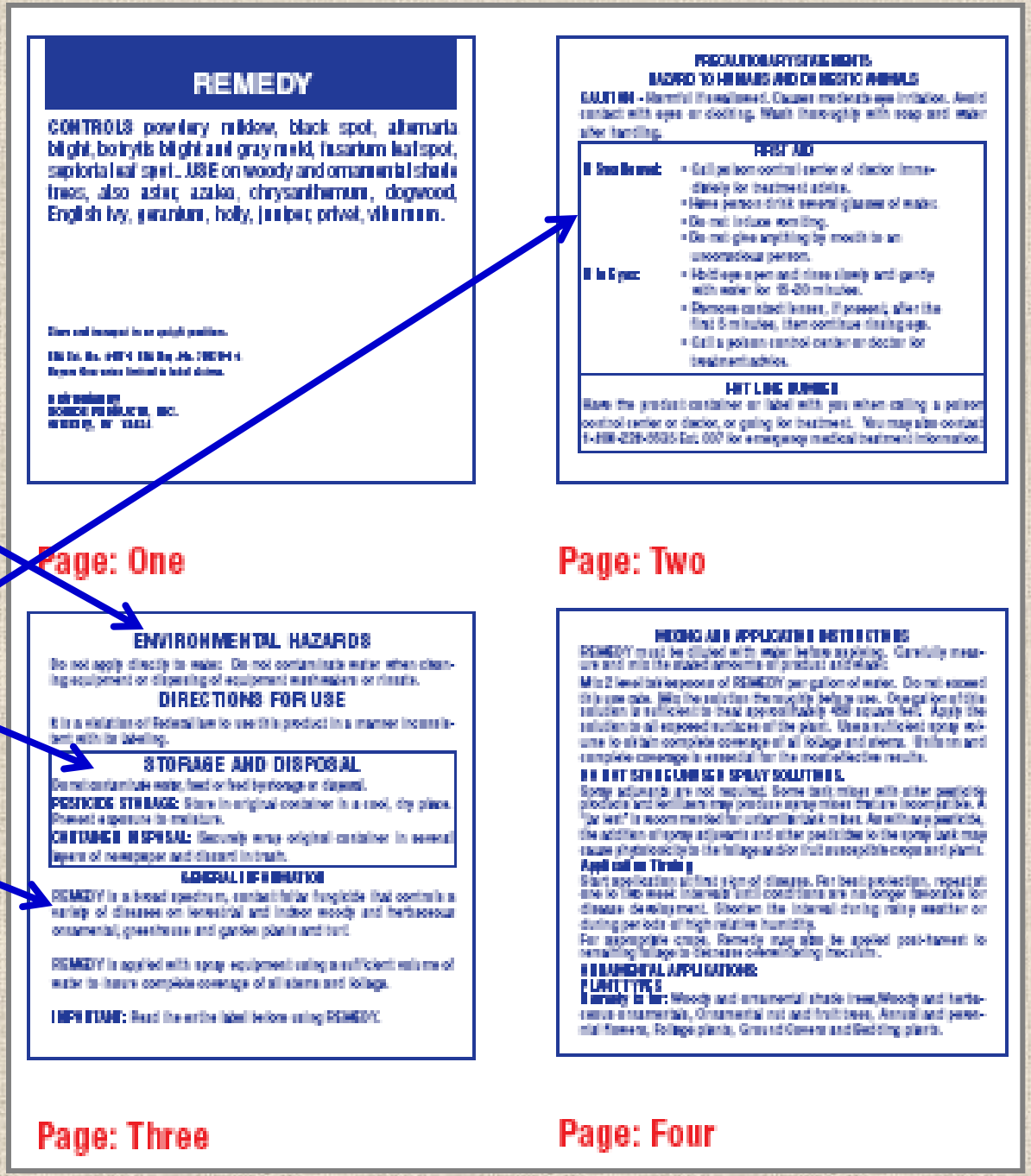
Signal word

Manufacturer info

Environmental hazards

Storage and disposal

First aid



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The label is the law!

Detailed information on how to use the product.

FOR USE ON:

*Ageratum
*Ajuga
*Almond-Ornamental
*Alyssum
*Andromeda
*Aphelandra
Apple-Ornamental
*Apricot-Ornamental
*Artemisia
*Aster
*Azalea
*Boxwood
*Calendula
*Carnation
*Centaurea montana
*Cherry-Ornamental
*Chrysanthemum
*Cineraria
*Citrus
*Coleus
*Columbine
*Coral Bells (Heuchera)
*Crape Myrtle
*Crassula
*Croton
*Delphinium
*Dianthus
*Dizygotheca
*Dogwood
*English Ivy
*Episcia
*Euonymus
*Fern
*Forsythia
*Gazania
*Geranium
*Gladiolus
*Gloxinia
*Gypsophila
*Hawthorn
*Heliopsis scabra
*Hibiscus
*Holly
*Hoya
*Hydrangea
*Impatiens
*Iris
*Juniper
*Kalanchoe
*Lavender
*Lemon balm
*Lipstick balm
*Lipstick Vine (Aeschynanthus)
*Marigold
*Monarda (Bee Balm)
*Nectarine-Ornamental
*Pachysandra
*Palm
*Pansy
*Peach-Ornamental
*Peperomia
*Periwinkle
*Philodendron
*Phlox
*Pilea
*Pine
*Pittosporum
*Plum-Ornamental
*Poinsettia
*Poppy
*Pothos
*Primrose
*Privet
*Protea
*Prune-Ornamental
*Pulmonaria

*NOT FOR THIS USE IN CALIFORNIA

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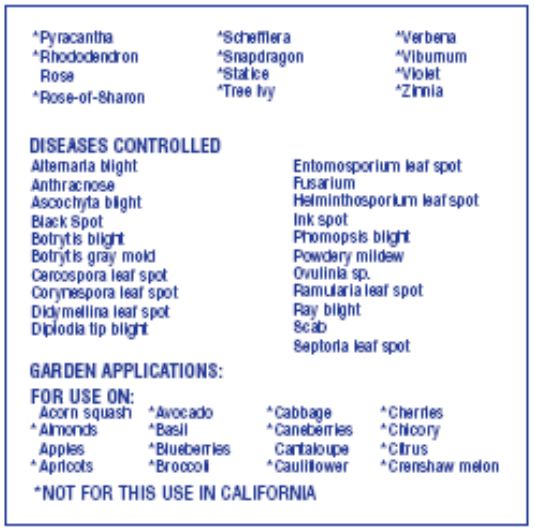

*Pyracantha
*Rhododendron
Rose
*Rose-of-Sharon
*Schefflera
*Snapdragon
*Statice
*Tree Ivy
*Verbena
*Viburnum
*Violet
*Zinnia

DISEASES CONTROLLED

Alternaria blight
Anthracnose
Ascochyta blight
Black Spot
Botrytis blight
Botrytis gray mold
Cercospora leaf spot
Corynespora leaf spot
Didymellina leaf spot
Diplodia tip blight
Entomosporium leaf spot
Fusarium
Helminthosporium leaf spot
Ink spot
Phomopsis blight
Powdery mildew
Ovulinia sp.
Ramularia leaf spot
Ray blight
Scab
Septoria leaf spot

GARDEN APPLICATIONS:

FOR USE ON:

Acorn squash
*Almonds
Apples
*Apricots
*Avocado
*Basil
*Blueberries
*Broccoli
*Cabbage
*Caneberries
Cantaloupe
*Cauliflower
*Cherries
*Chicory
*Citrus
*Crenshaw melon

*NOT FOR THIS USE IN CALIFORNIA

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Garden Applications continued

Cucumber
*Dry Beans
*Eggplant
*Endive
*Escarole
Grapes
Honeydew
*Kale
*Lettuce
*Lima Bean
*Mango
Muskmelon
*Mustard greens
*Okra
*Oregano
*Peaches
*Pears
*Peas
*Pecans
*Peppers
*Pistachio
*Plums
*Potatoes
*Prunes
Pumpkin
*Radicchio
*Rosemary
*Sage
*Snap beans
*Snow peas
*Spinach
Strawberries
Summer squash
*Sweet Potatoes
*Thyme
*Tomatoes
*Turnip
*Walnut
Watermelon
*Winter squash
Zucchini

*NOT FOR THIS USE IN CALIFORNIA

DISEASES CONTROLLED

Alternaria leaf spot
Anthracnose
Botrytis
Downy Mildew
Fusarium
Phoma
Phytophthora
Powdery mildew

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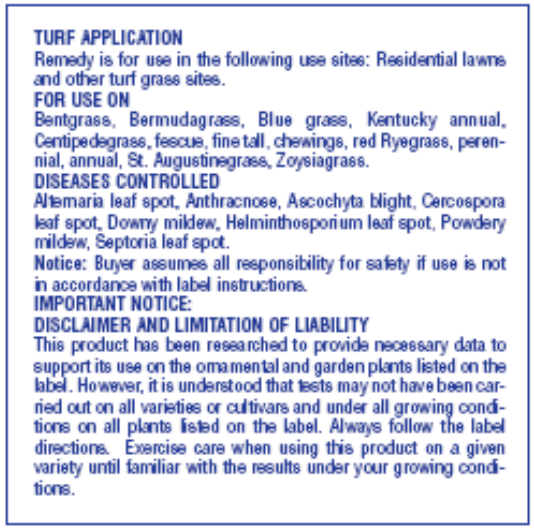

TURF APPLICATION

Remedy is for use in the following use sites: Residential lawns and other turf grass sites.

FOR USE ON

Bentgrass, Bermudagrass, Blue grass, Kentucky annual, Centipedegrass, fescue, fine tall, chewings, red Ryegrass, perennial, annual, St. Augustinegrass, Zoysiagrass.

DISEASES CONTROLLED

Alternaria leaf spot, Anthracnose, Ascochyta blight, Cercospora leaf spot, Downy mildew, Helminthosporium leaf spot, Powdery mildew, Septoria leaf spot.

Notice: Buyer assumes all responsibility for safety if use is not in accordance with label instructions.

IMPORTANT NOTICE:

DISCLAIMER AND LIMITATION OF LIABILITY

This product has been researched to provide necessary data to support its use on the ornamental and garden plants listed on the label. However, it is understood that tests may not have been carried out on all varieties or cultivars and under all growing conditions on all plants listed on the label. Always follow the label directions. Exercise care when using this product on a given variety until familiar with the results under your growing conditions.

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PESTICIDE USE

- Always read the label before each and every use.
- Wear protective clothing and eyewear.
- Change clothing and wash hands after any pesticide application.
- If pesticide is spilled on clothing or skin, remove contaminated clothing immediately and wash skin thoroughly.
- Keep children and pets away from all mixing and spraying activities.
- Keep children and pets off the area sprayed until the spray is dry.
- Mix only the amount to be used.

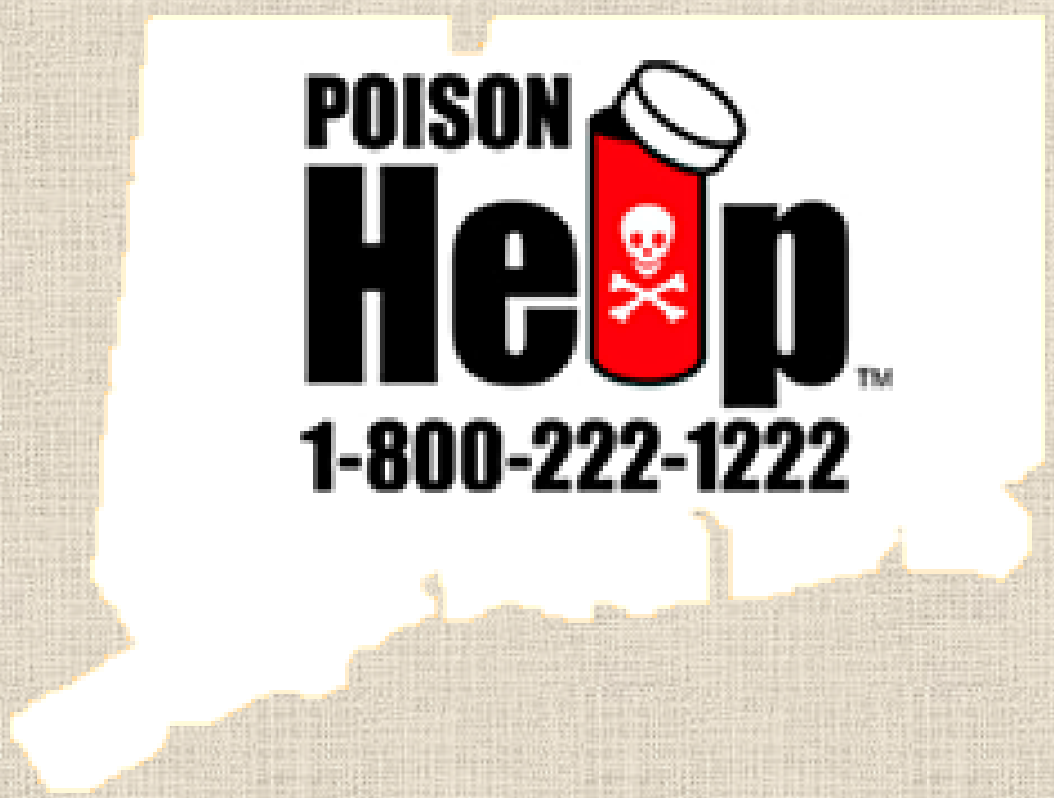
PESTICIDE STORAGE

- 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.

NATIONAL PESTICIDE INFORMATION CENTER

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

CONNECTICUT POISON CONTROL



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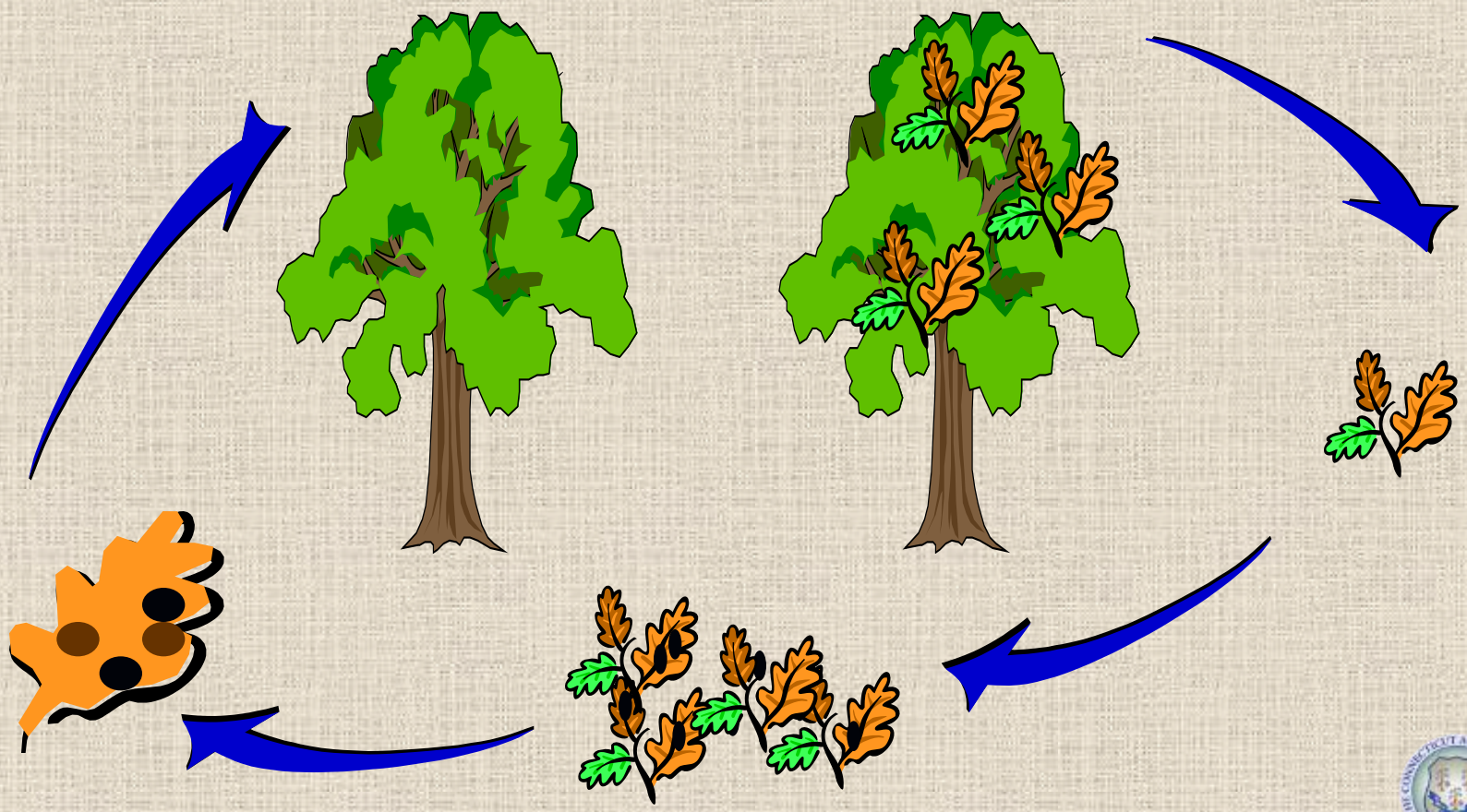
BIOTIC PROBLEMS:

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

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.

Foliage Diseases: Spread of foliar pathogens



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FOLIAGE DISEASES:

- Leaf Spots
- Anthracnoses
- Powdery Mildews
- Downy Mildews
- Rusts

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.

Cercospora Leaf Spot of Hydrangea

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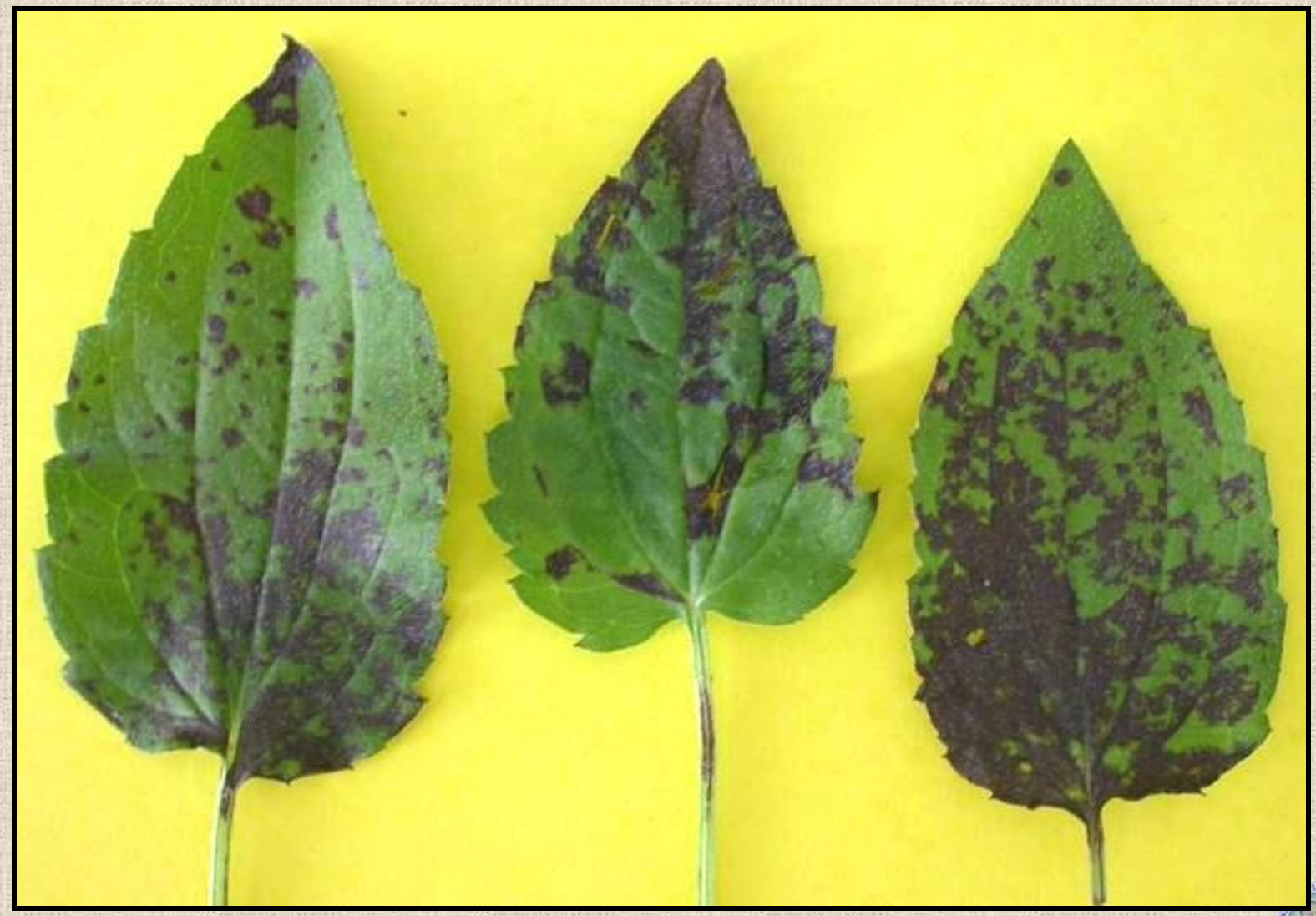
Didymellina Leaf Spot of Iris

Botrytis Leaf Spot of Hosta

Septoria Leaf Spot on Phlox

Septoria Leaf Spot on Rudbeckia



Foliar Nematode Damage

Salvia

Buddleia

Photos courtesy of J. A. LaMondia

Bacterial Spot of Zinnia

Apple Scab of Crabapple

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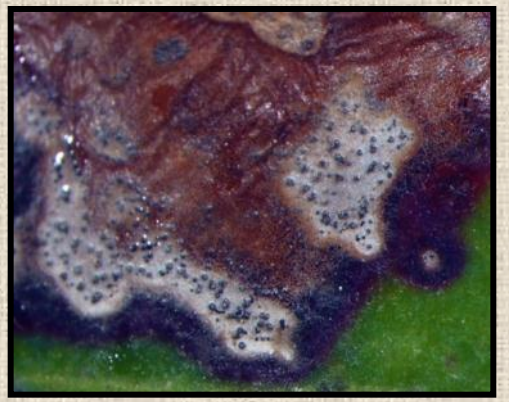
Tar Spot of Maple

Leaf Spot of Mountain Laurel



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Black Spot of Rose

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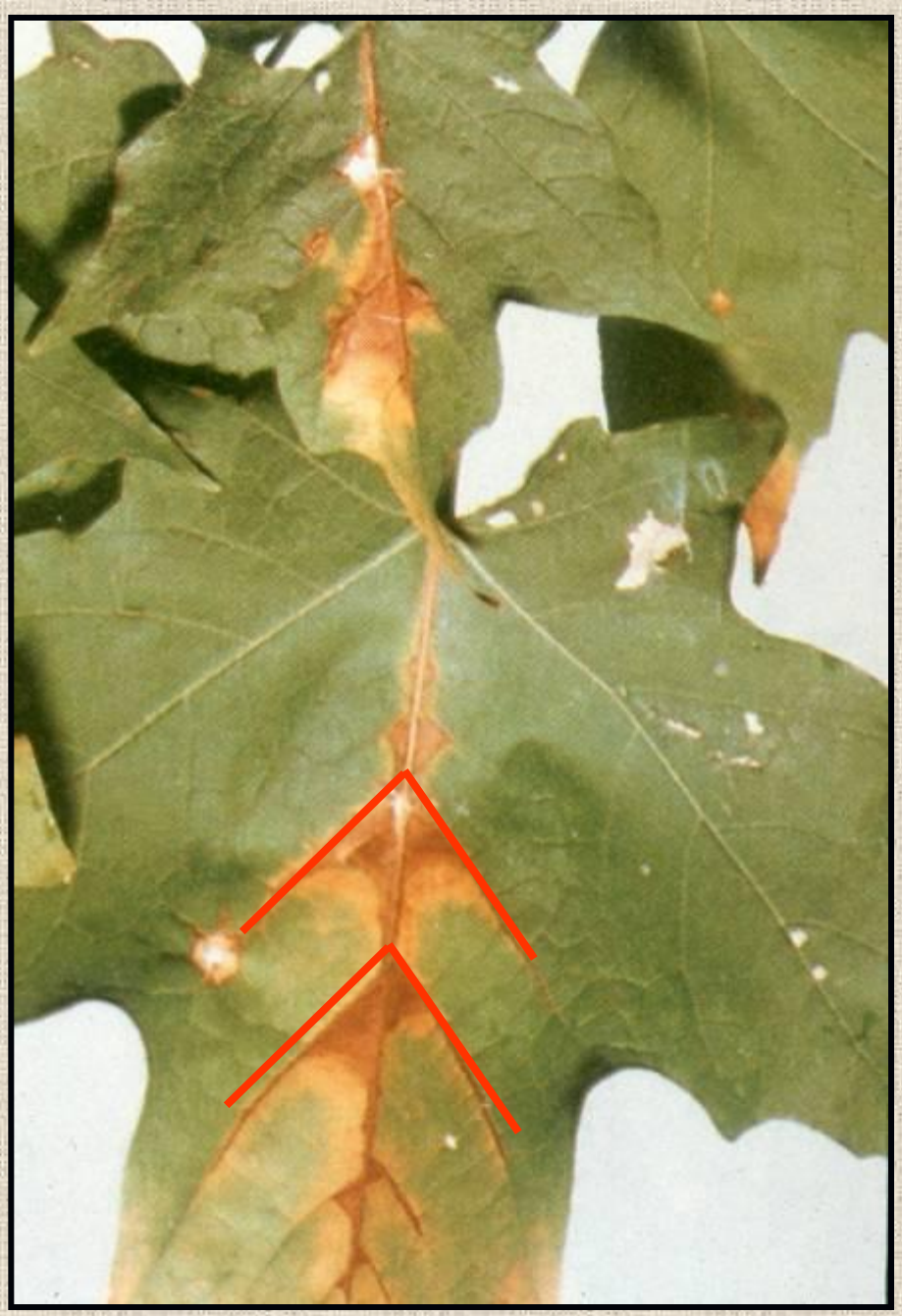
ANTHRACNOSES

- 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.

Sycamore Anthracnose

Maple Anthracnose



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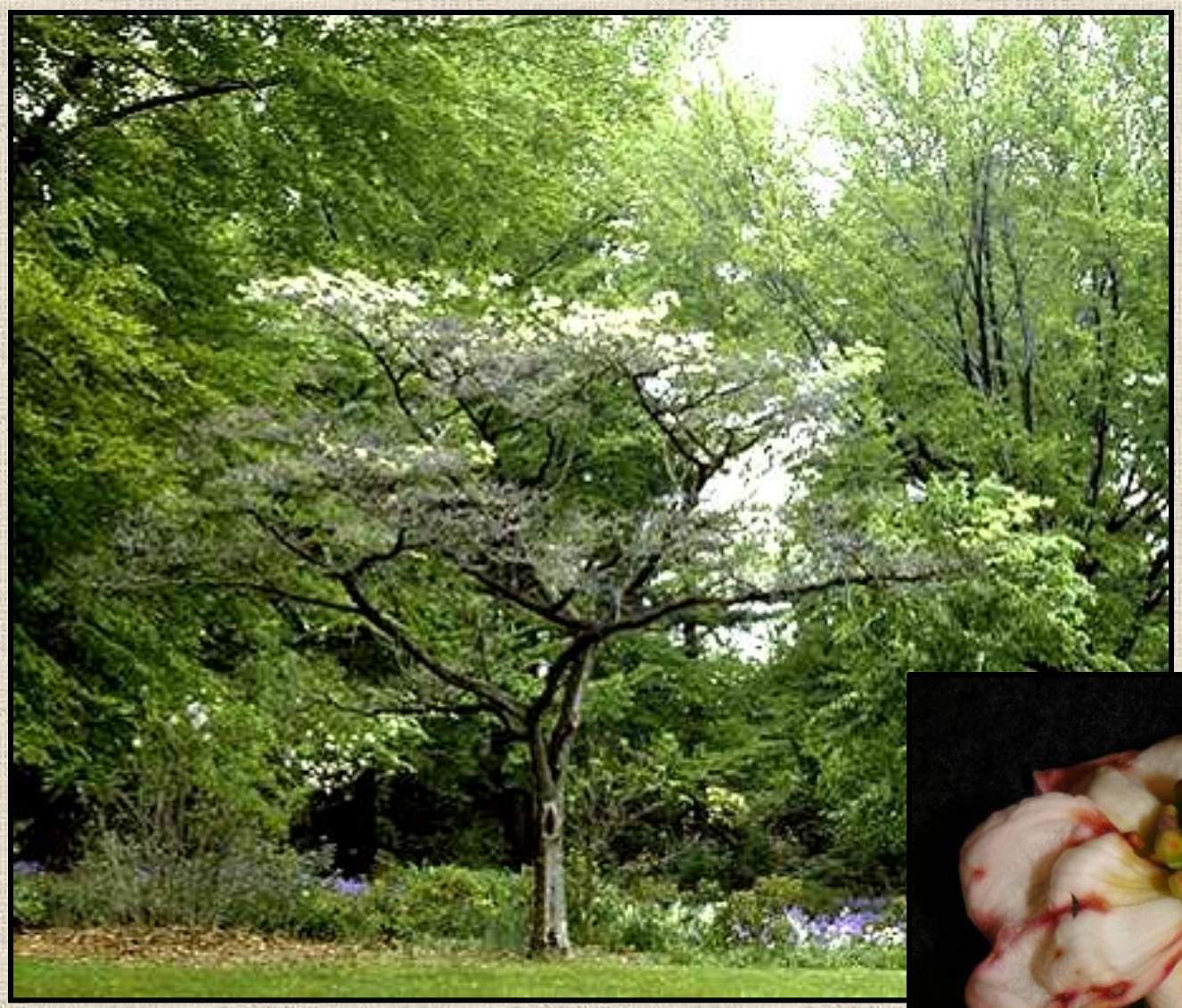
Oak Anthracnose



Dogwood Anthracnose

Dogwood Anthracnose

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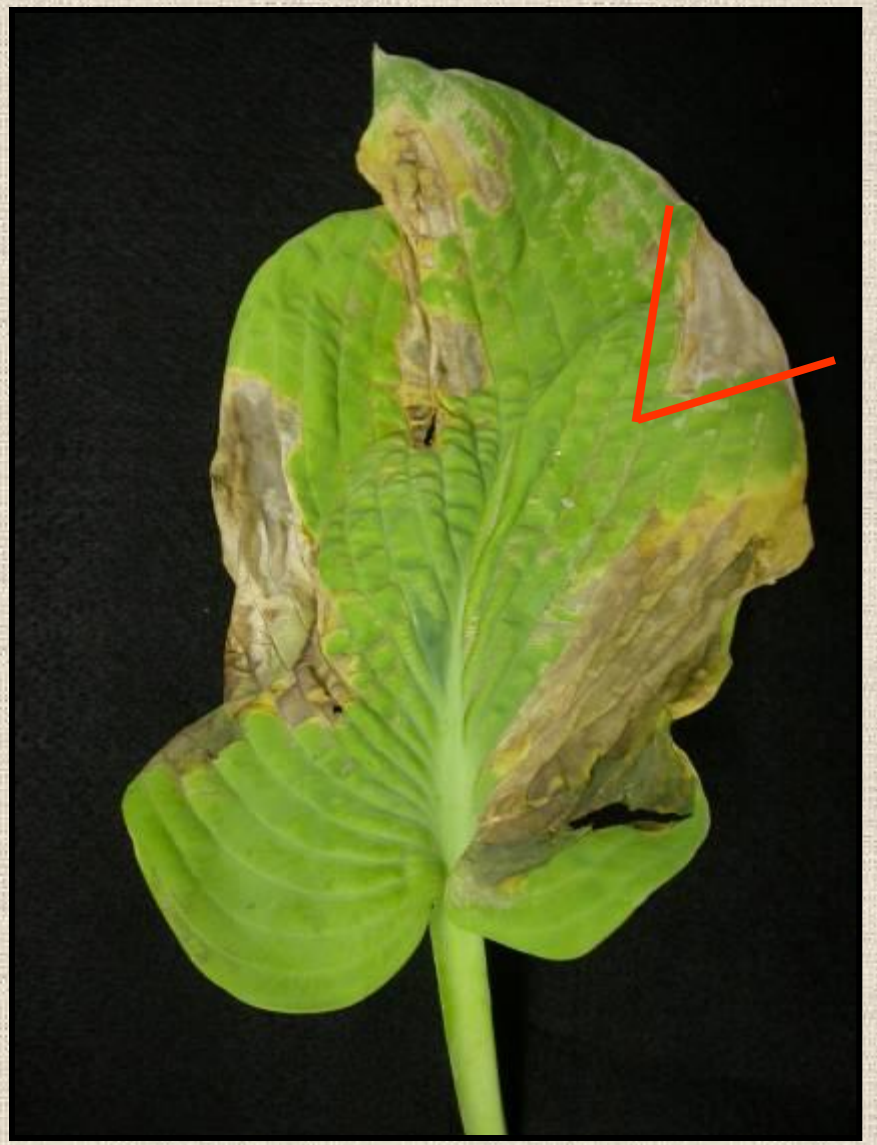
Anthracnose on Hosta



Anthracnose of Hollyhock

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 sparce.
- *Don't* require free water on leaf surfaces in order to infect.

Powdery Mildew of Oak

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Powdery Mildew of Dogwood

Powdery Mildew of Rose

Powdery Mildew of Sedum

Photos courtesy of Leanne Pundt

Powdery Mildew of Peony

Powdery Mildew of Monarda

Powdery Mildew of Phlox

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Downy Mildews

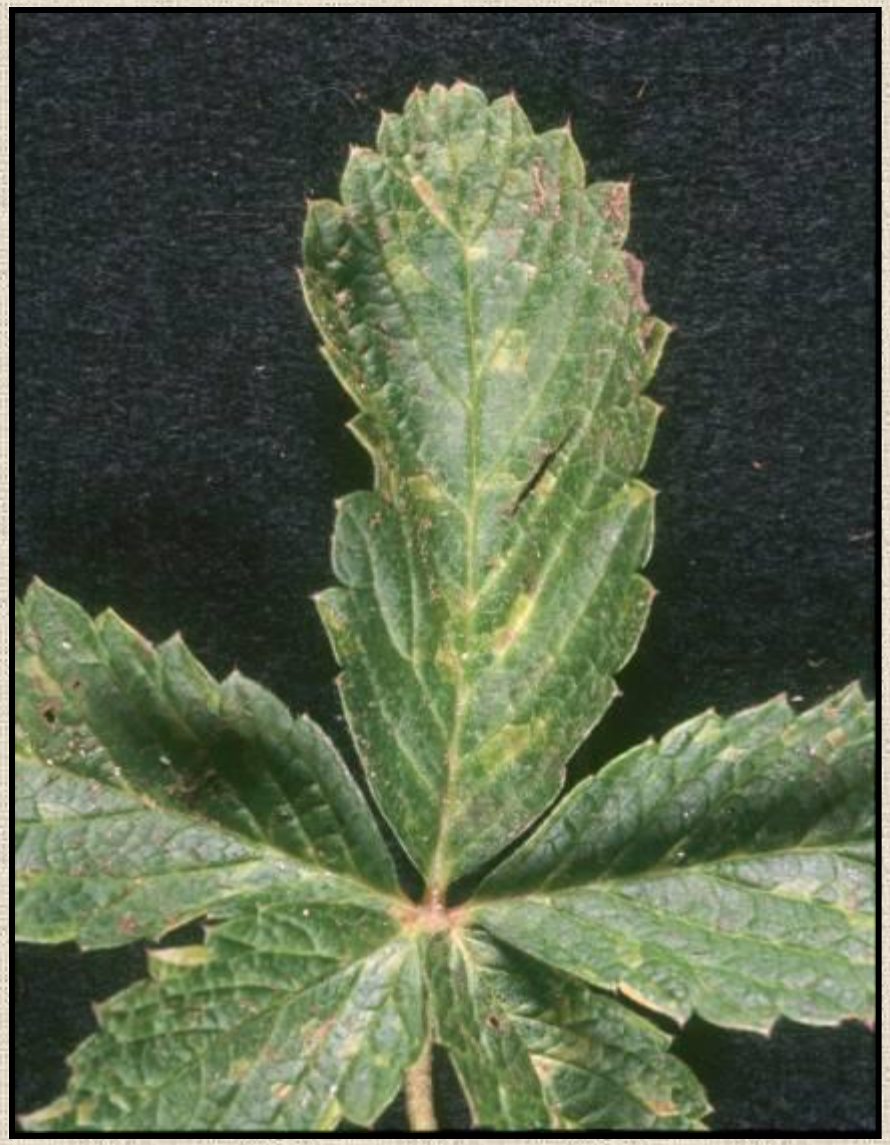
- Have become an increasing problem in the horticultural industry and are currently causing serious losses in many floricultural crops.
- The disease is often misidentified.
  - Downy mildew pathogens are very different from powdery mildews since they attack plant hosts under very different environmental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

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.

Downy Mildew of Lamium

Downy Mildew of Potentilla



Downy Mildew of Rudbeckia

Downy Mildew of Salvia

Downy Mildew of Coreopsis

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Downy Mildew- Impatiens

Downy Mildew- Coleus

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.

Hollyhock Rust

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Hollyhock Rust

Rust of Yarrow

Rust- New England Aster

Cedar-Apple Rust

Cedar-Apple Rust

Cedar-Apple Rust- Juniper

Cedar-Apple Rust Juniper

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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.

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

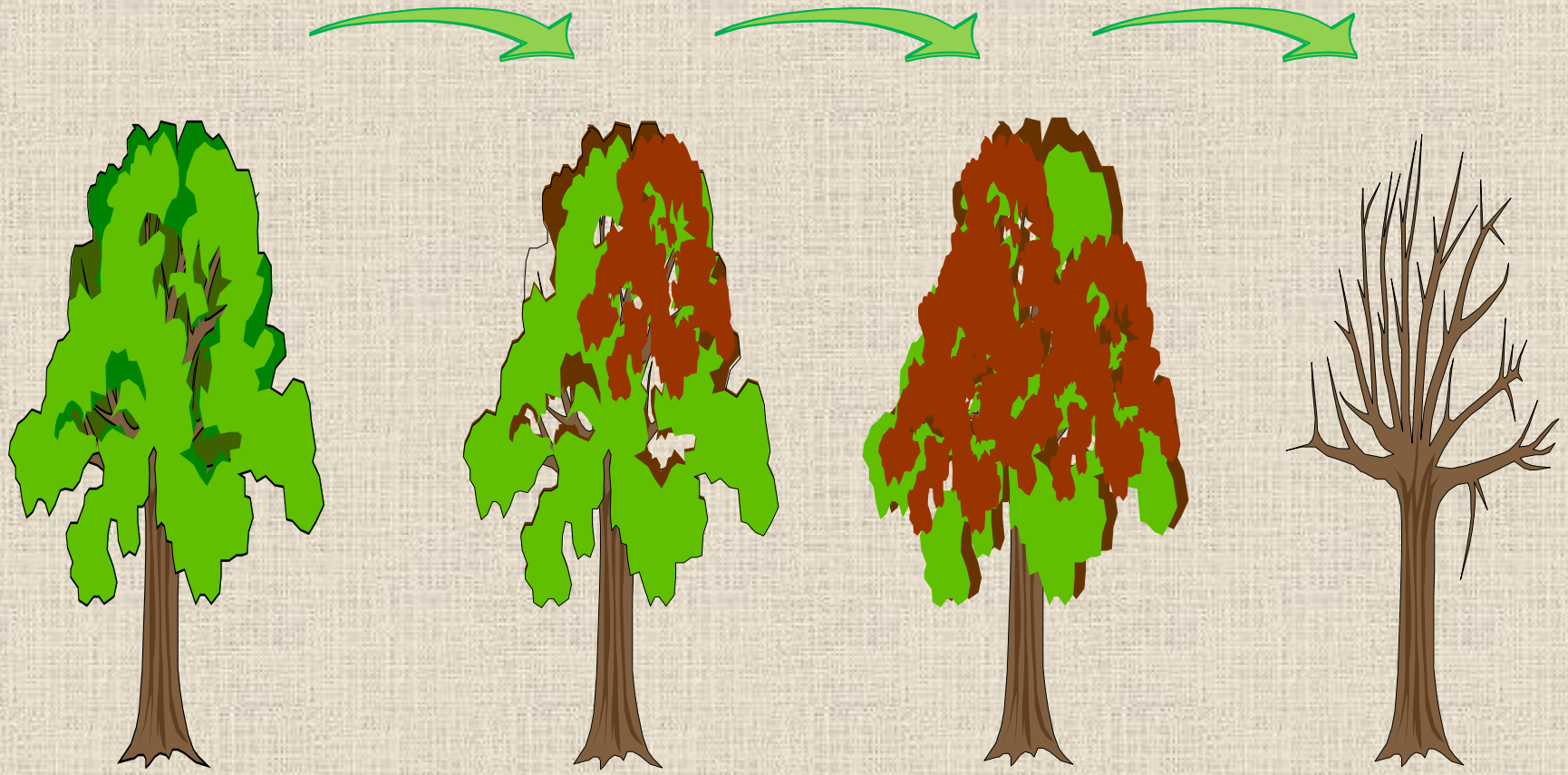
Examples

- 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

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.

BLIGHTS AND DIEBACKS



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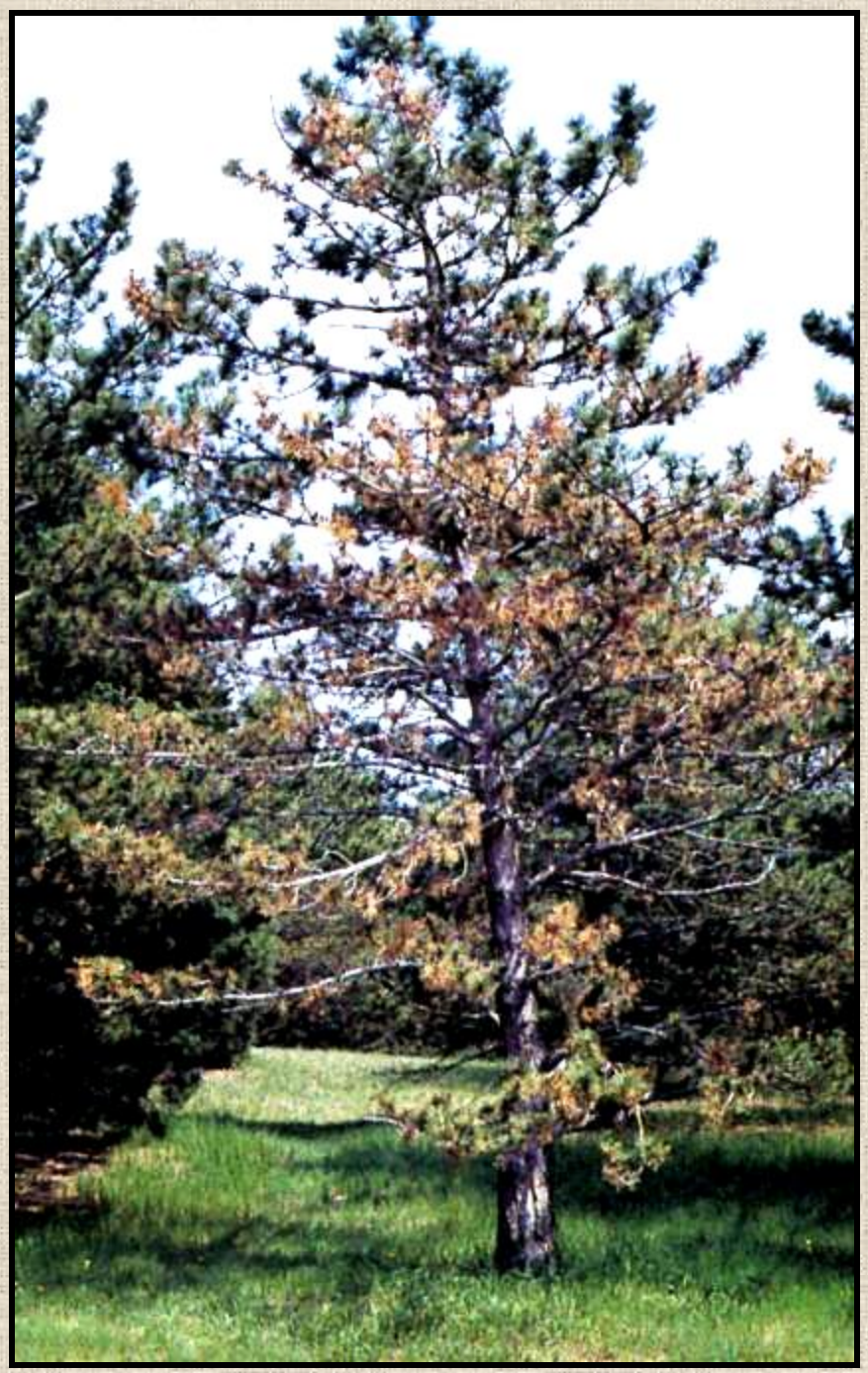
Diplodia Blight



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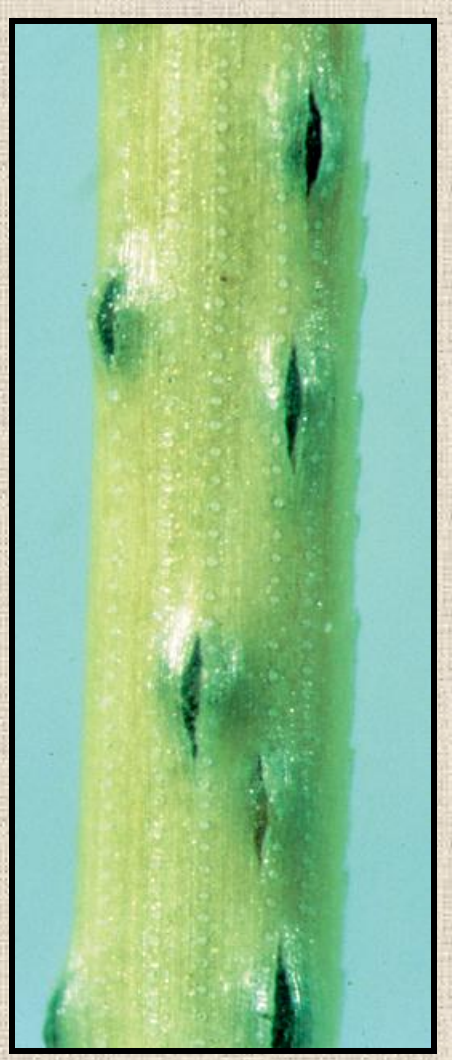

Diplodia Blight

Fire Blight

Bacterial Blight of Lilac

Volutella Blight of Pachysandra

Volutella Blight of Pachysandra

Juniper Tip Blight

Juniper Tip Blight

Botrytis Blight of Peony

Photos courtesy of M. Daughtrey

Botrytis Blight of Geranium

Botrytis Blight of Rose

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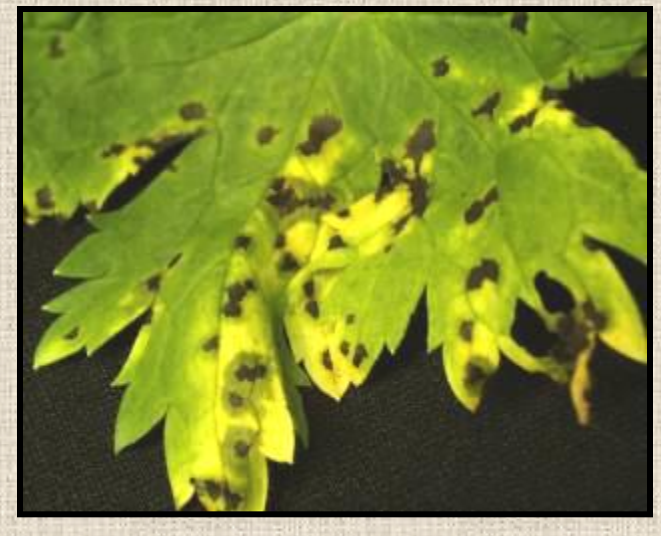
Bacterial Blight of Delphinium



Bacterial Blight of Peony

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.

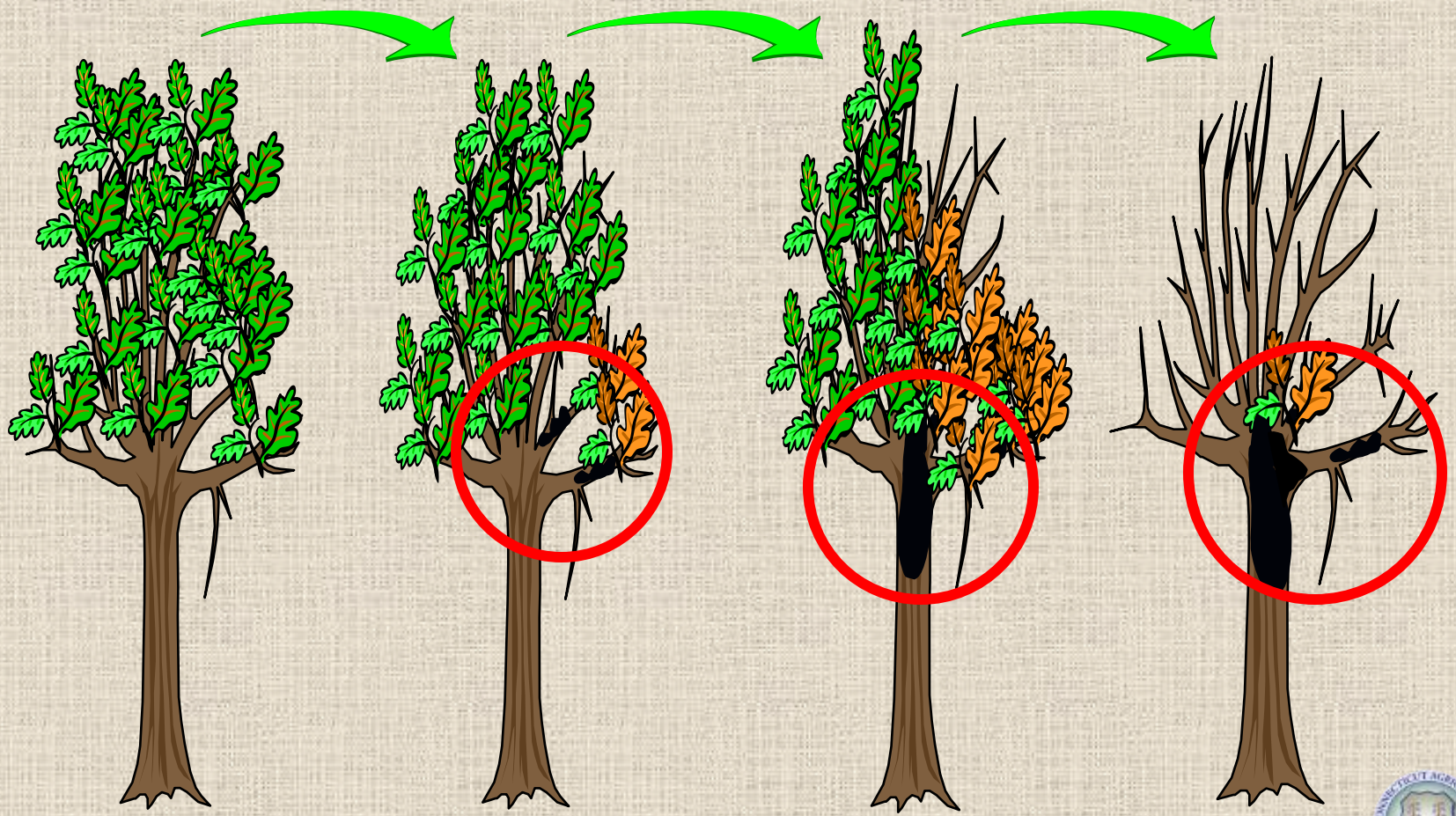
MANAGEMENT OF BLIGHT AND DIEBACK DISEASES (cont'd):

- 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.

Branch and Stem Cankers: Progression of infection and symptoms



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Cytospora Canker

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Botryosphaeria Canker

Black Knot

Black Knot

www.ct.gov/caes

Phomopsis Canker

Rhizoctonia Canker

Photos courtesy of M. Daughtrey

MANAGEMENT OF BRANCH AND STEM CANKER DISEASES:

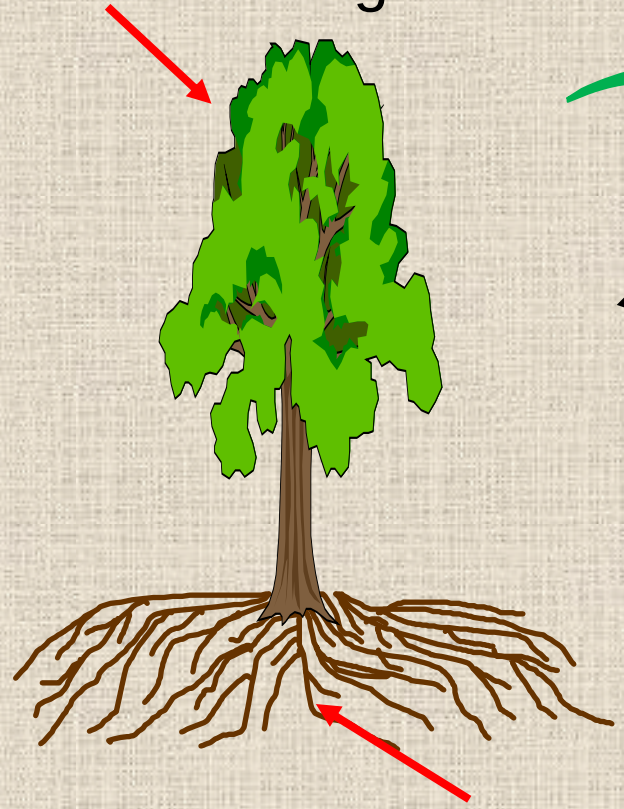
- Prune and remove affected parts or entire plants.
- Maintain vigor and reduce stress by following sound cultural practices.
- Fungicides (based on disease diagnosis):
  - Biological (as protectants only):
    - *Trichoderma harzianum* Rifai strain KRL-AG2, *Bacillus subtilis* QST 713 strain
  - Traditional: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

VASCULAR DISEASES:

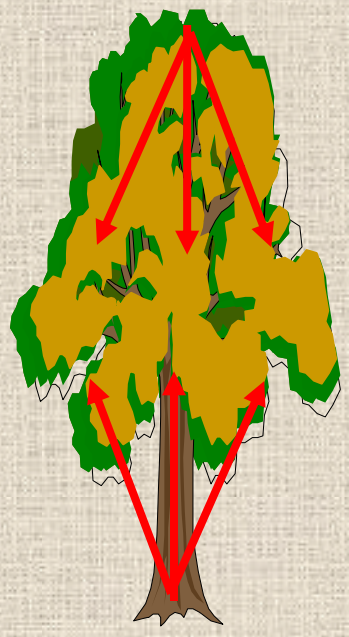
- The pathogen grows and multiplies in the vascular system (xylem or phloem) and becomes “systemic” in the plant.
- Once infected, plants cannot be cured.
- Can result in plant death.

Vascular Wilts:
Pathogen enters the vascular system

Pathogen introduced by insect feeding



Pathogen invades roots



Pathogen grows becomes systemic in plant

Verticillium Wilt of Maple

Verticillium Wilt

Verticillium Wilt

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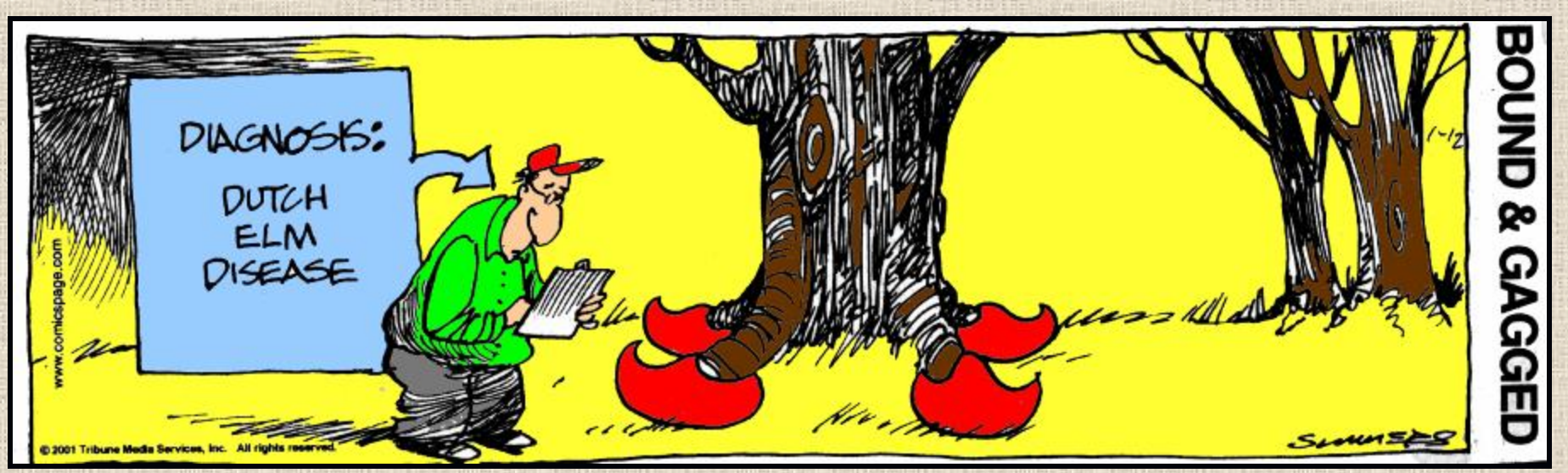
Verticillium Wilt

Dutch Elm Disease


DIAGNOSIS:
DUTCH
ELM
DISEASE
BOUND & GAGGED
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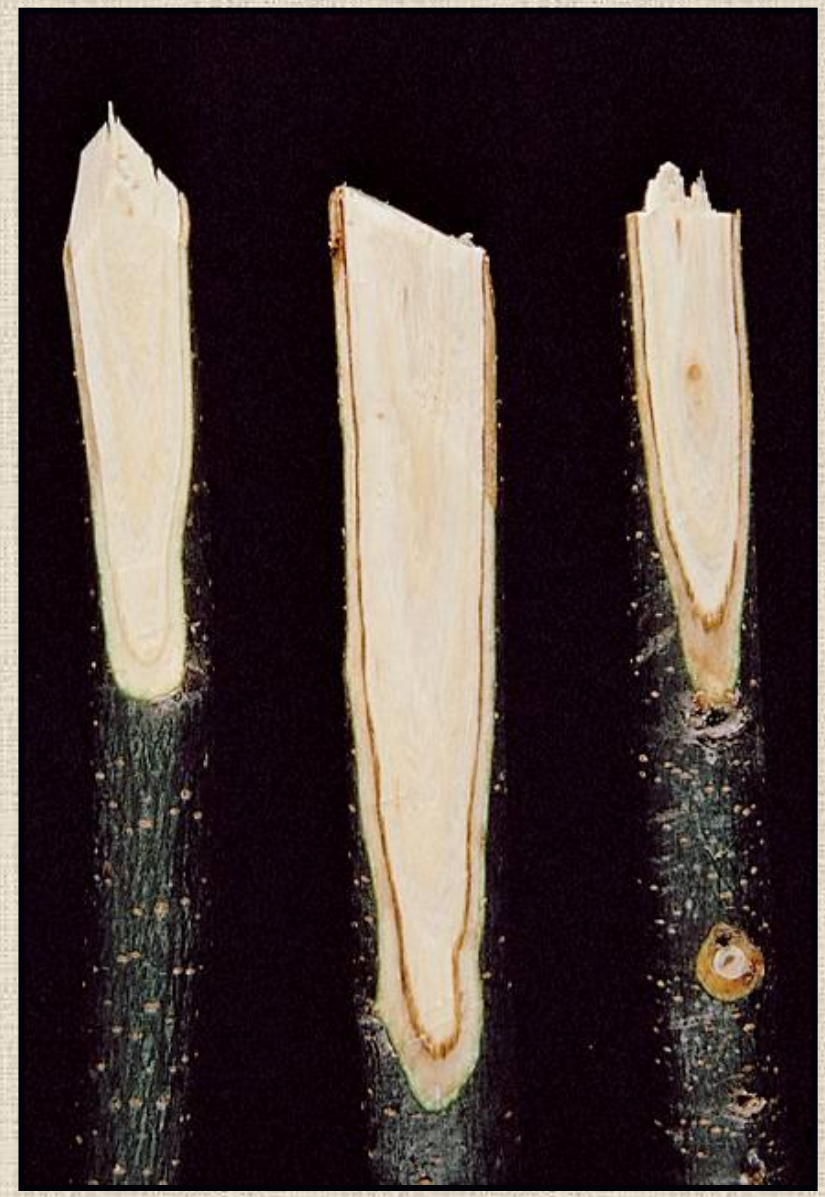
Dutch Elm Disease



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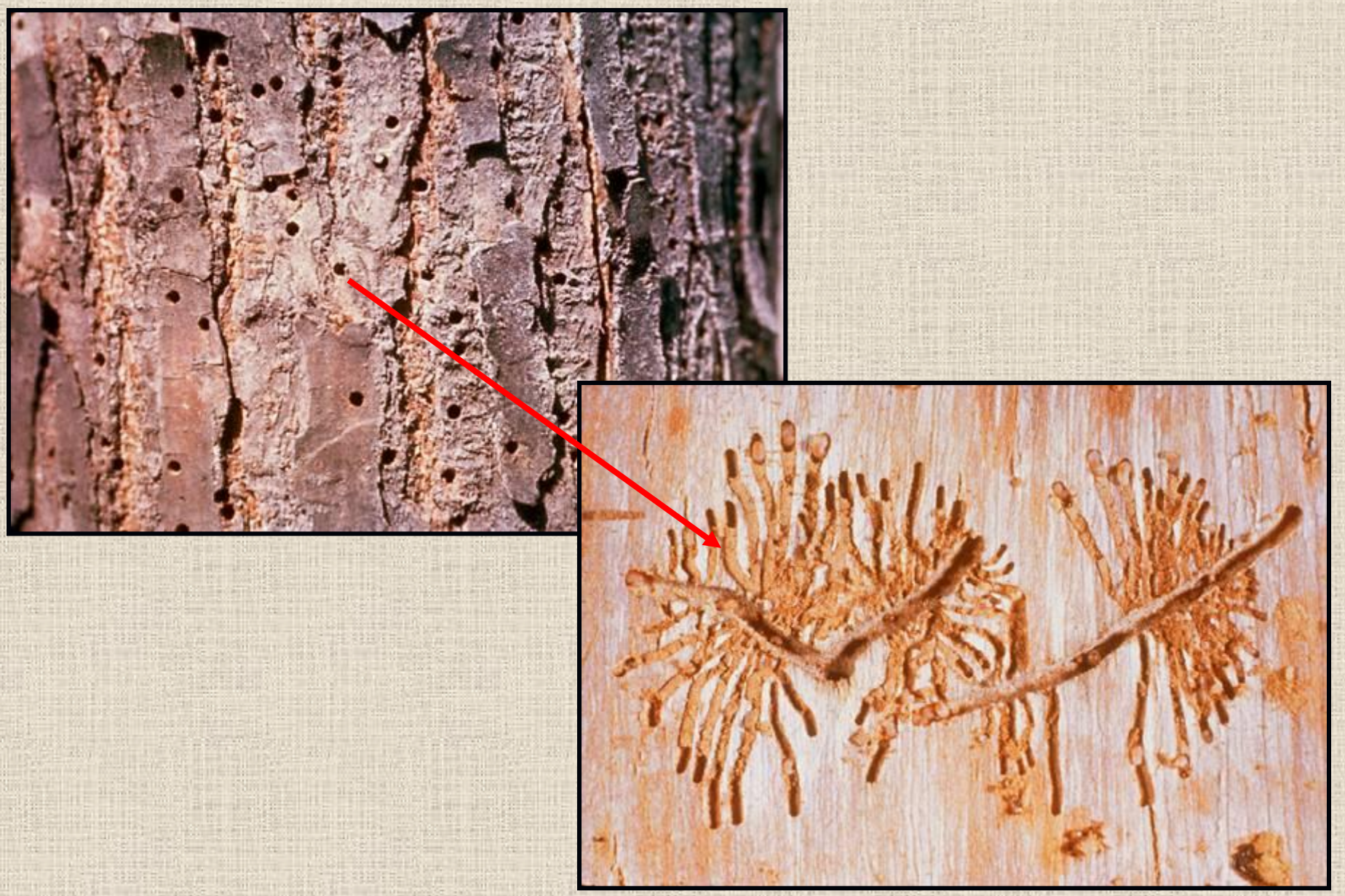
Dutch Elm Disease



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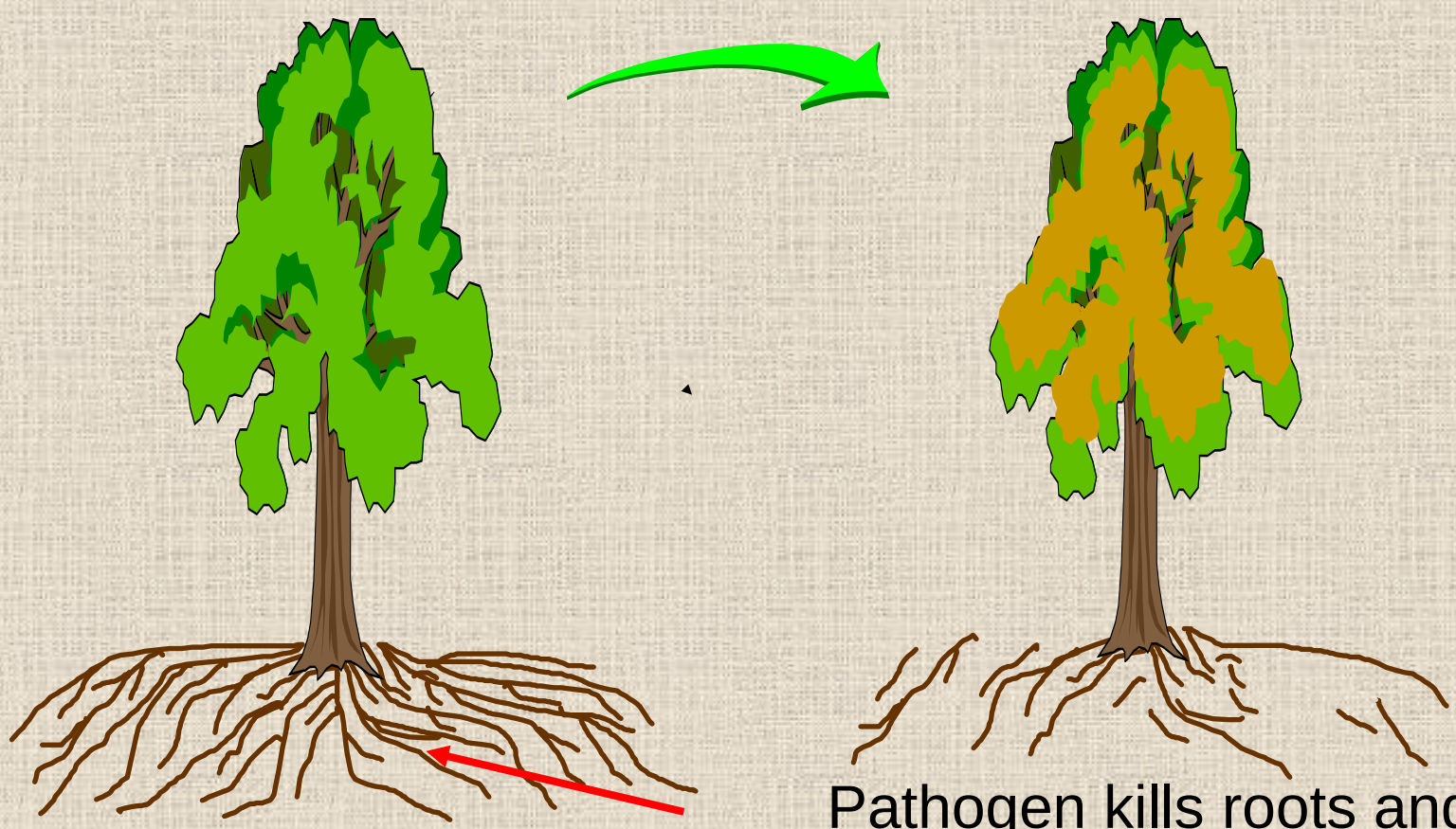
MANAGEMENT OF VASCULAR DISEASES:

- 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).

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.

Root Diseases:
Pathogen enters root system

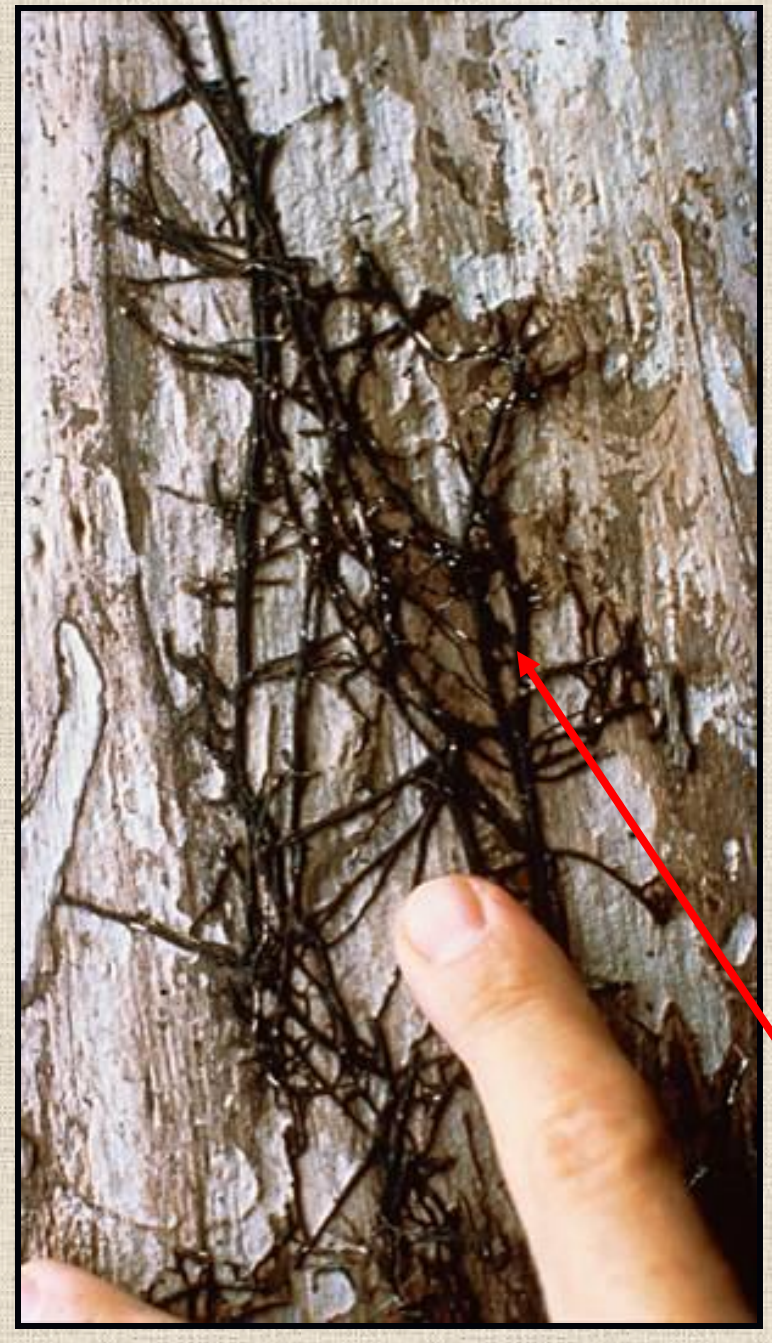


Pathogen invades roots and root collar

Pathogen kills roots and eventually kills plant

Armillaria Root Rot- Rhododendron

Armillaria Root Rot



Armillaria Root Rot

Looks for signs.

Rhizomorphs

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Armillaria Root Rot

White mycelial mats under bark

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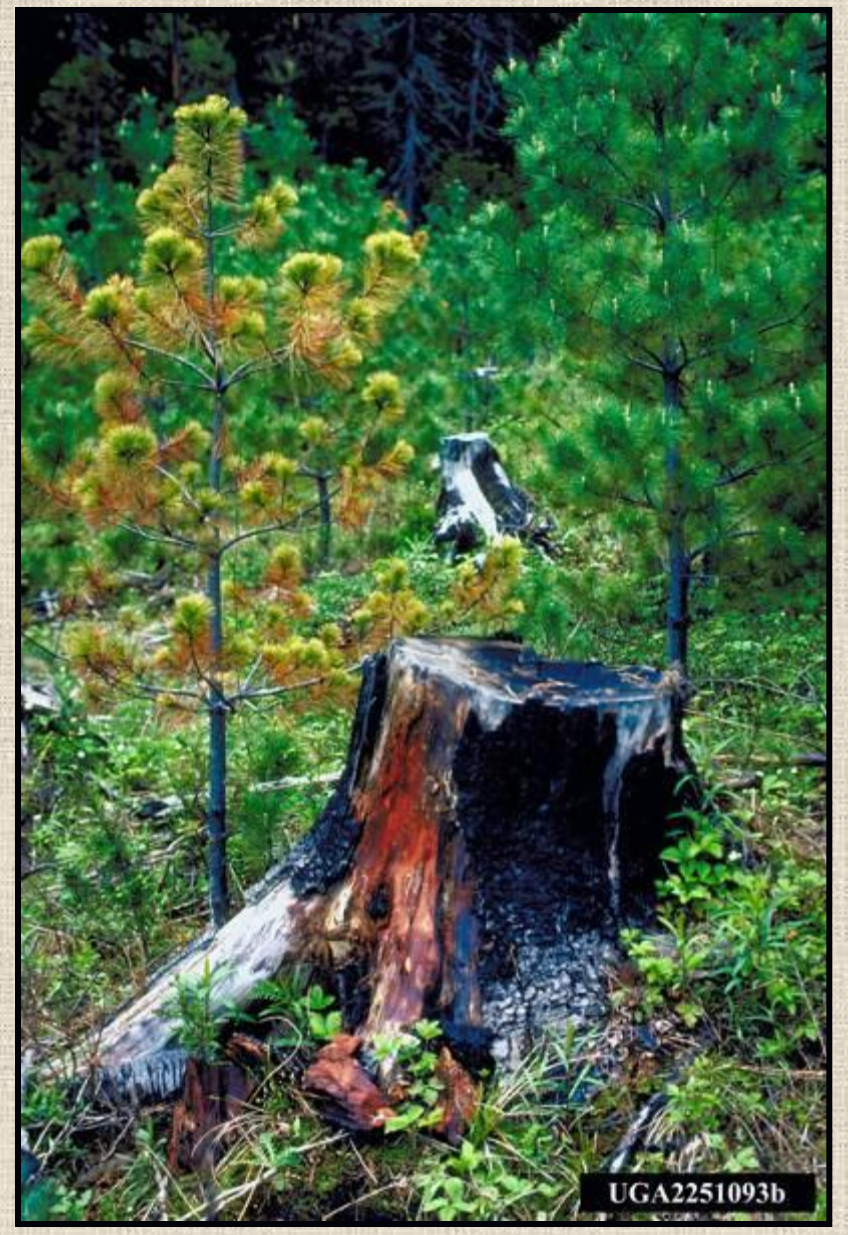


Armillaria Root Rot

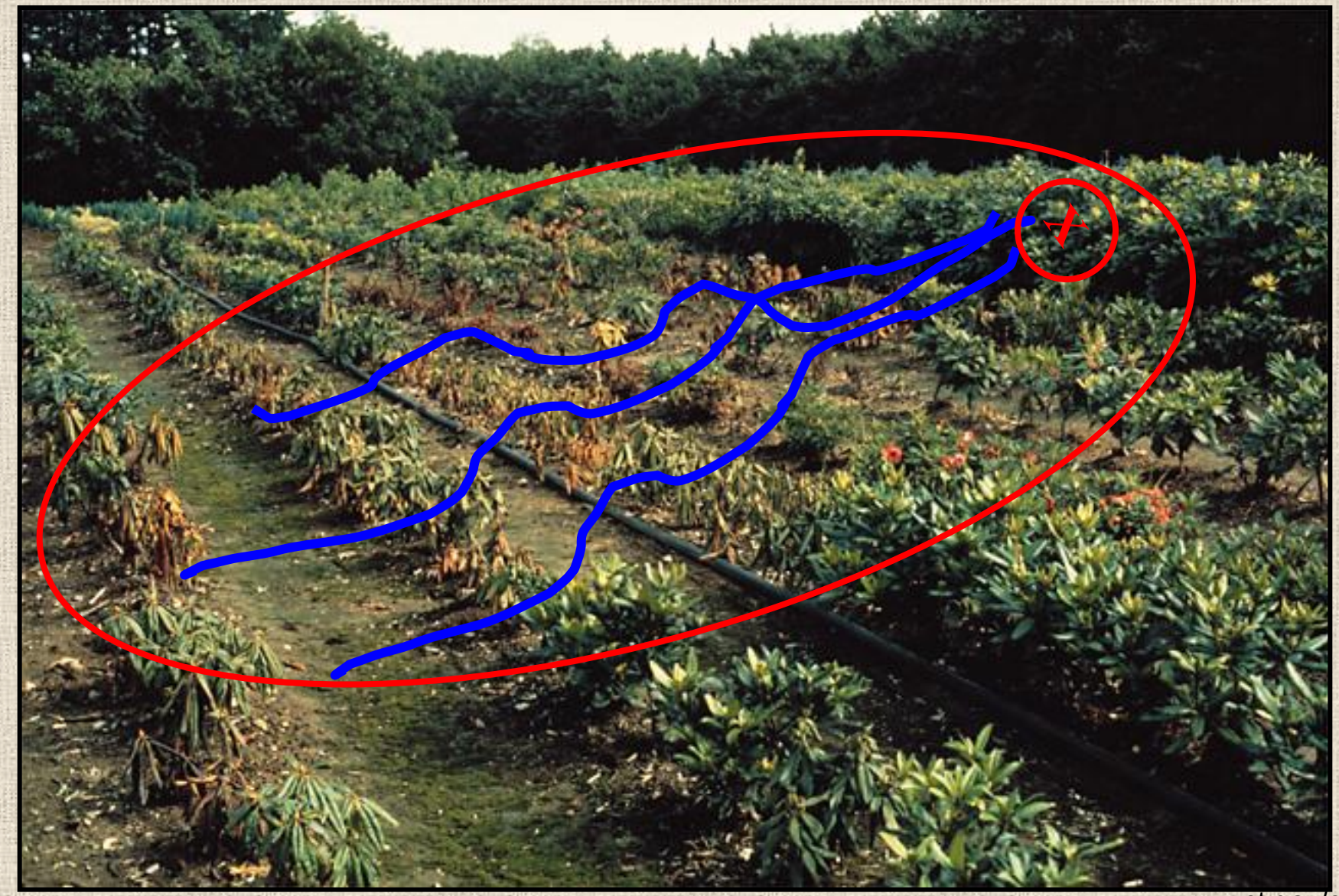
Fruiting bodies (“mushrooms”)

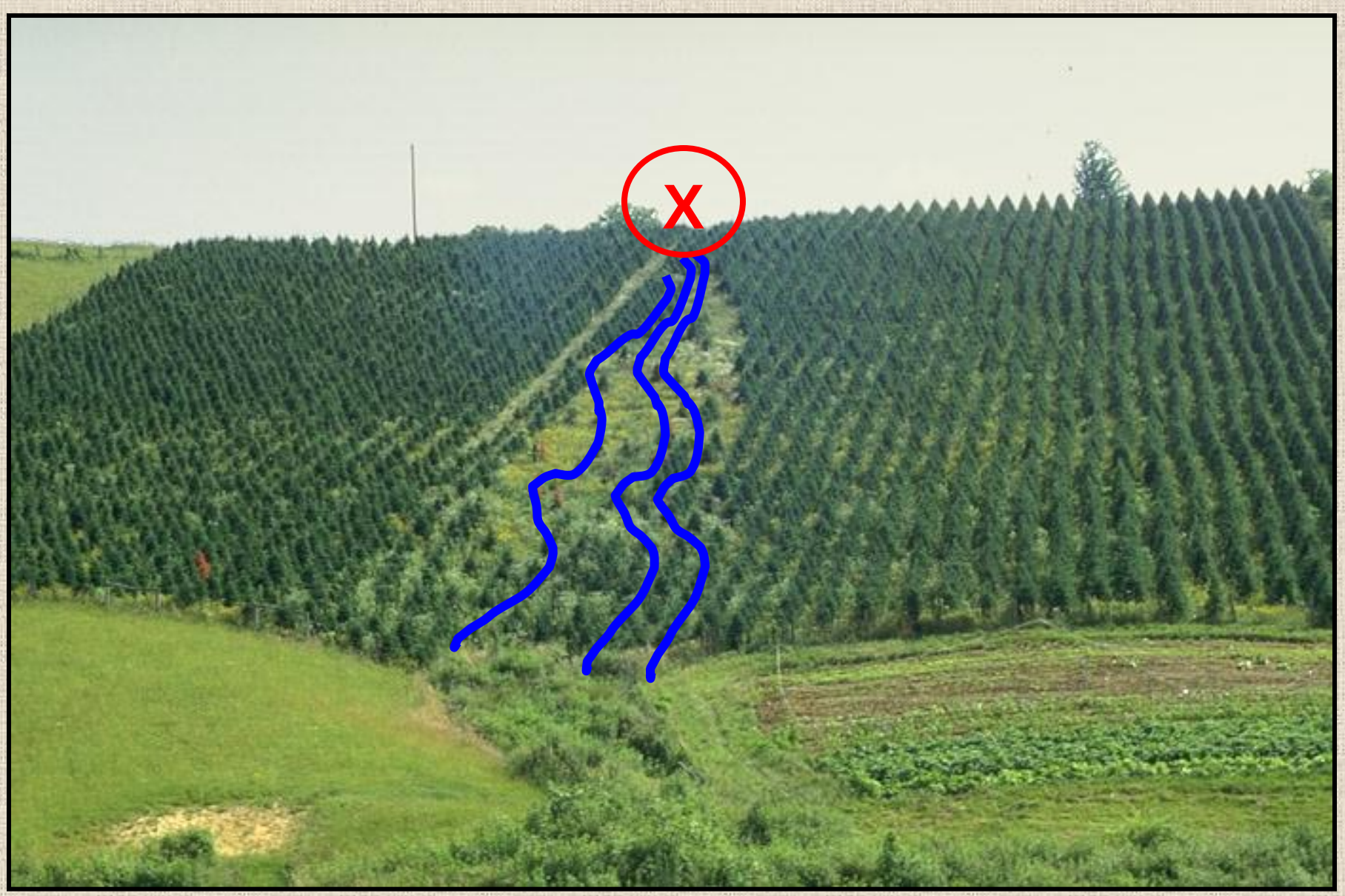
Phytophthora Root Rot

Phytophthora Root Rot

Water is a key factor for infection.

Phytophthora Root Rot-Drainage





Phytophthora Root Rot- Drainage Pattern

Phytophthora Root Rot- Cineraria

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Phytophthora Root Rot- Impatiens

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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.

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-Al, mefenoxam, and phosphorous acid or mono- and di-potassium salts of phosphorous acid

ABIOTIC PROBLEMS:

- Cultural
- Environmental

COMMON CULTURAL PROBLEMS

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

COMMON ENVIRONMENTAL PROBLEMS

- Winter Injury
- Drought
- Excess Water
- Air Pollution

DISEASES CAUSED BY ABIOTIC FACTORS

ABIOTIC DISEASES

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

WINTER INJURY

SYMPTOMS:

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

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

Winter Injury

Winter Injury

Winter Injury

DROUGHT

SYMPTOMS:

- Loss of turgor in needles or leaves
- Dieback, stunting, drooping
- Foliar browning or chlorosis
- Stem cracking, wilting
- General thinning and poor growth
- Sudden collapse
- Plant death

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.

Drought

Drought

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Drought

EXCESS WATER

SYMPTOMS:

- Epinasty
- Stem swelling
- Chlorosis
- Stunted growth
- Twig dieback
- Sudden collapse
- Plant death

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.

Excess Water

Excess Water

Excess Water

AIR POLLUTION

SYMPTOMS:

- Stippling of leaves or needles
- Foliar browning
- Altered leaf or needle color
- Slowed growth
- Lack of vigor
- Dieback
- Plant death

CAUSAL FACTORS:

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

Sulfur dioxide injury

Ozone injury

Hydrogen fluoride injury

MINERAL DEFICIENCIES AND TOXICITIES

SYMPTOMS:

- Altered leaf or needle color
- Chlorosis
- Flecking, necrosis
- Slowed growth
- Distortion of leaves or growing tips
- Loss of vigor
- Plant death

CAUSAL FACTORS:

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

Nitrogen deficiency of rose

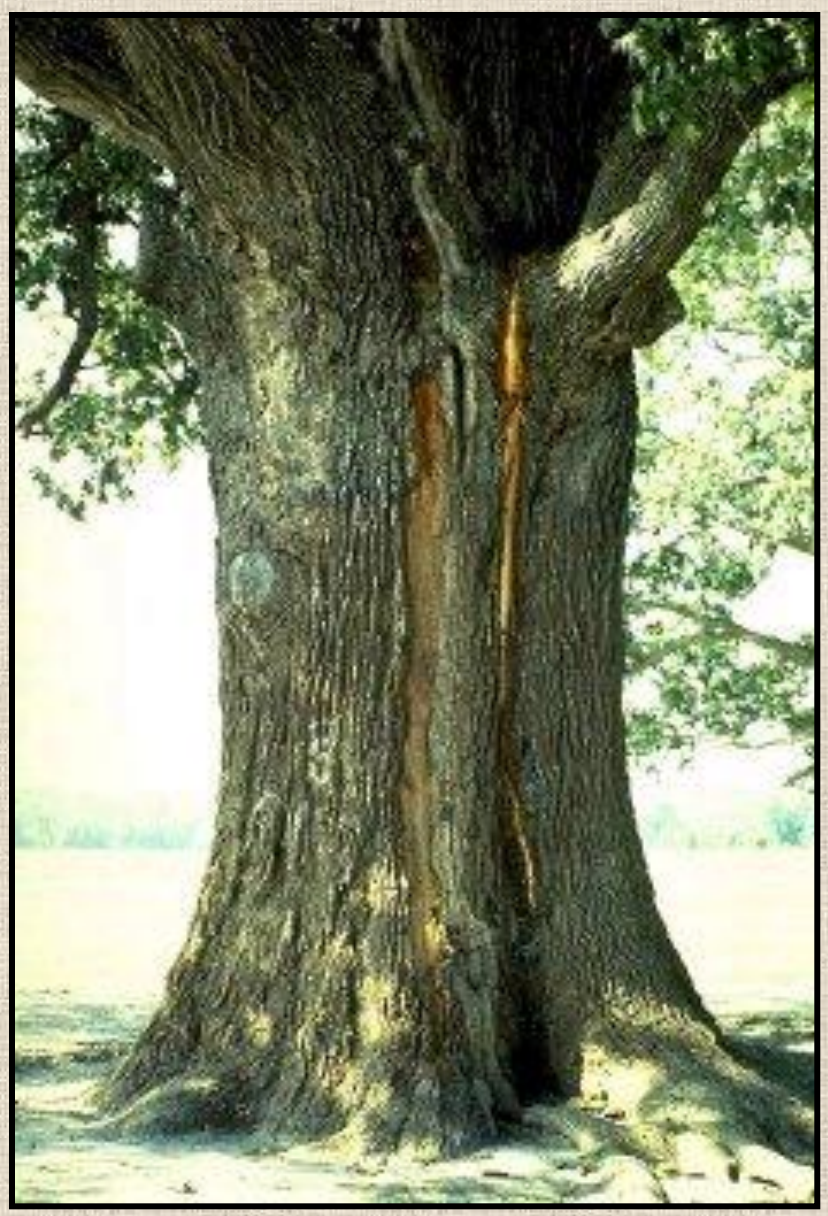
Iron deficiency of chrysanthemum

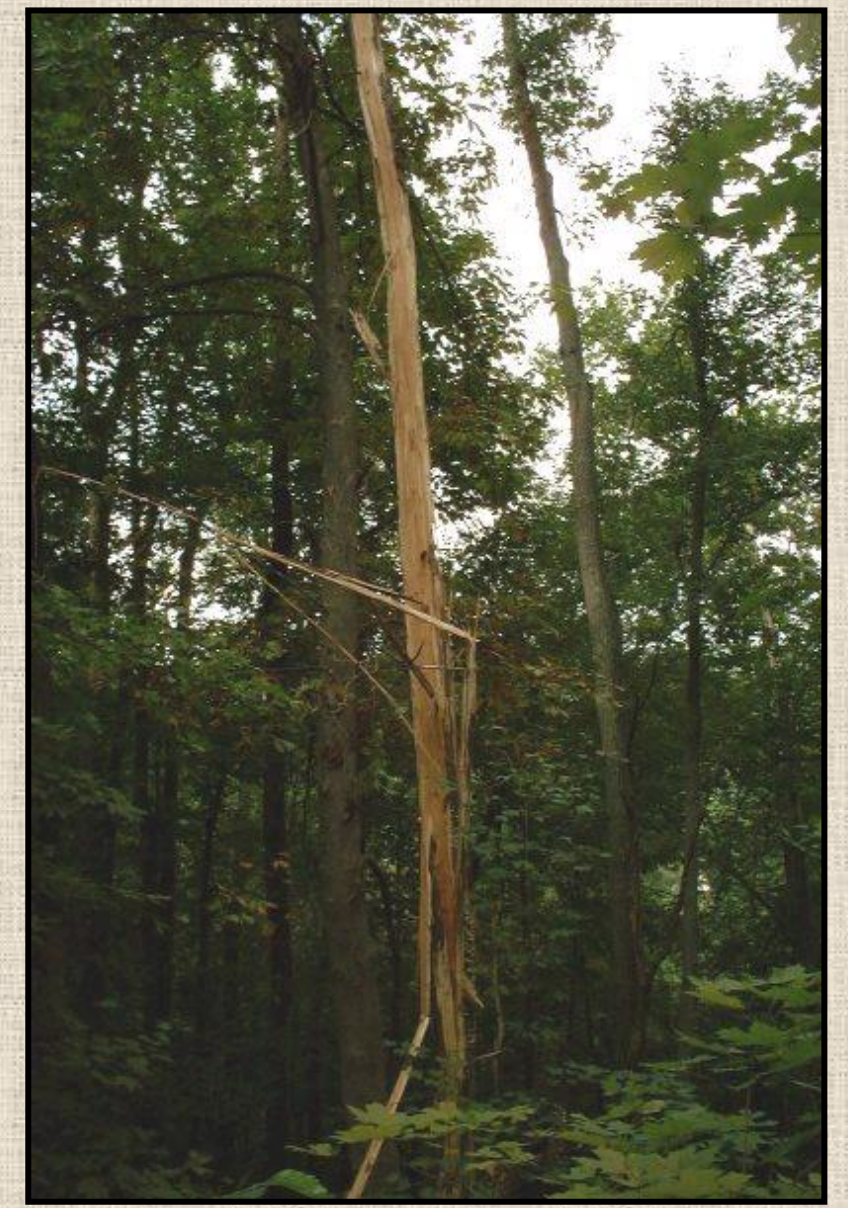
Iron and manganese toxicities of geranium

INJURIES

LIGHTNING

Lightning Injury





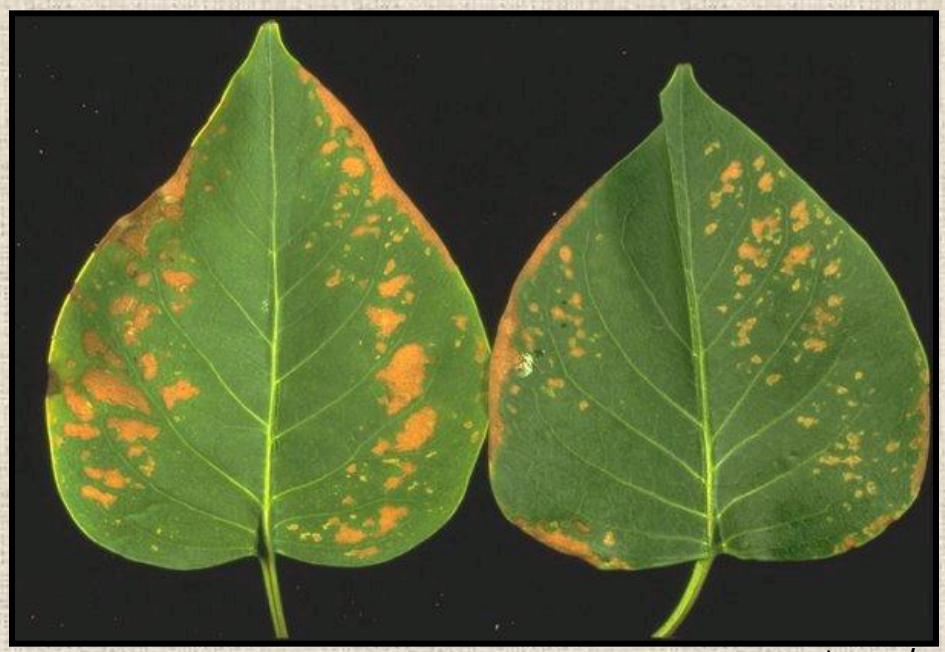
FROST

Frost Injury

Frost Injury

PHYTOTOXICITY AND MISAPPLIED PESTICIDES

Spray Injury



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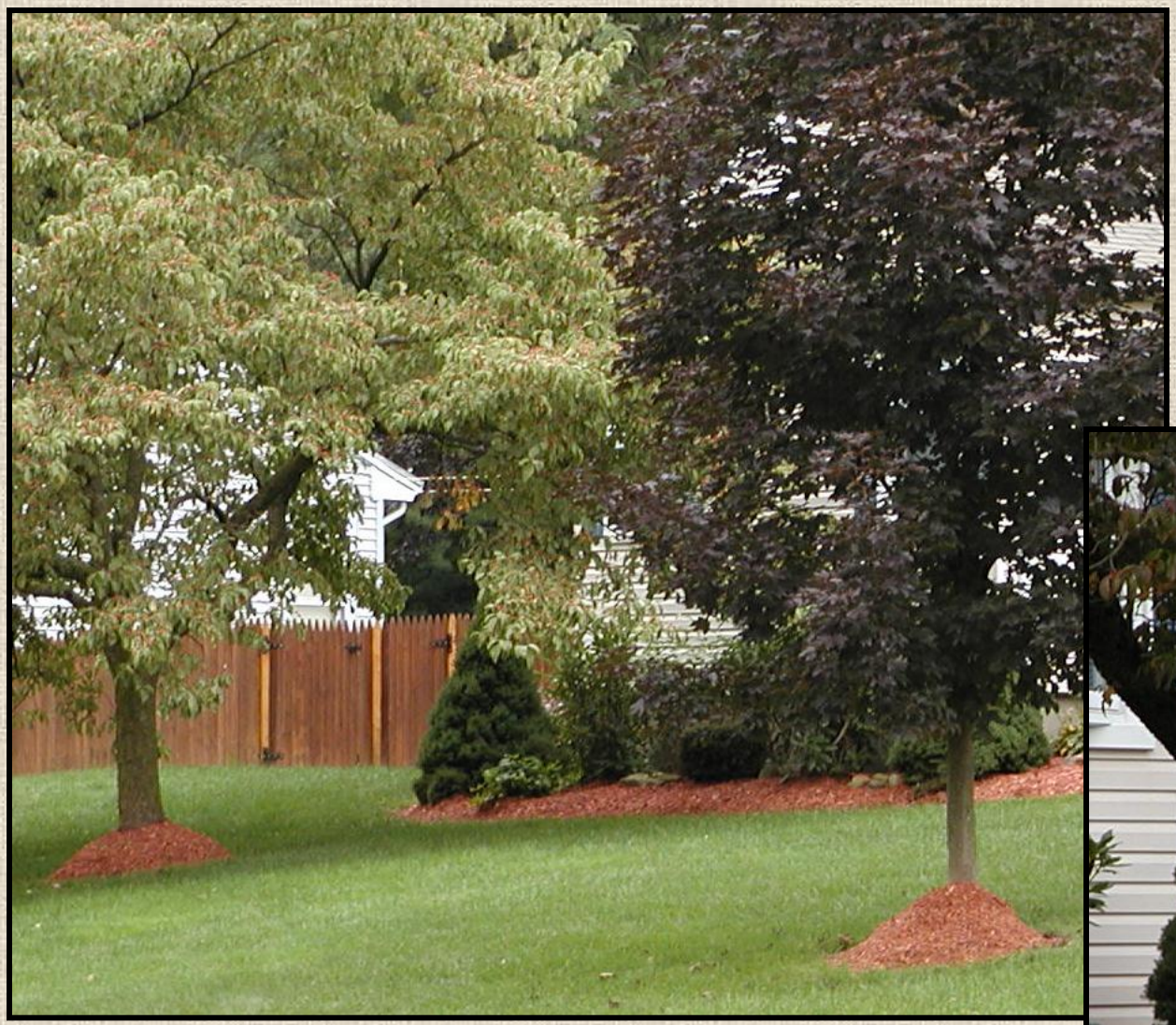
Insecticidal Soap Injury

“HUMAN” INJURIES



Incorrect Mulching

“Dog Chain Injury”

String Trimmer Injury

Duct Tape Injury

STEPS IN DIAGNOSING PLANT DISEASES (Handout)

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