

Diseases of Trees

- Arboriculture 101

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DR. YONGHAO LI
PLANT DISEASE INFORMATION OFFICE
THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION
123 HUNTINGTON ST.
NEW HAVEN, CT 06511

PHONE: 203-974-8601
EMAIL: YONGHAO.LI@CT.GOV

Outline

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- Plant disease
 - Definition
 - Causal agent
 - Symptom and sign
 - Disease diagnosis
- Disease development
 - Disease triangle
 - Host range
 - Infection
 - Dispersal
 - Overwinter
- Disease management
 - Host resistance
 - Exclusion
 - Eradication
 - Sanitation
 - Prevention
 - ✦ Cultural practices
 - ✦ Fungicide application
- Common tree diseases

What is a Plant Disease

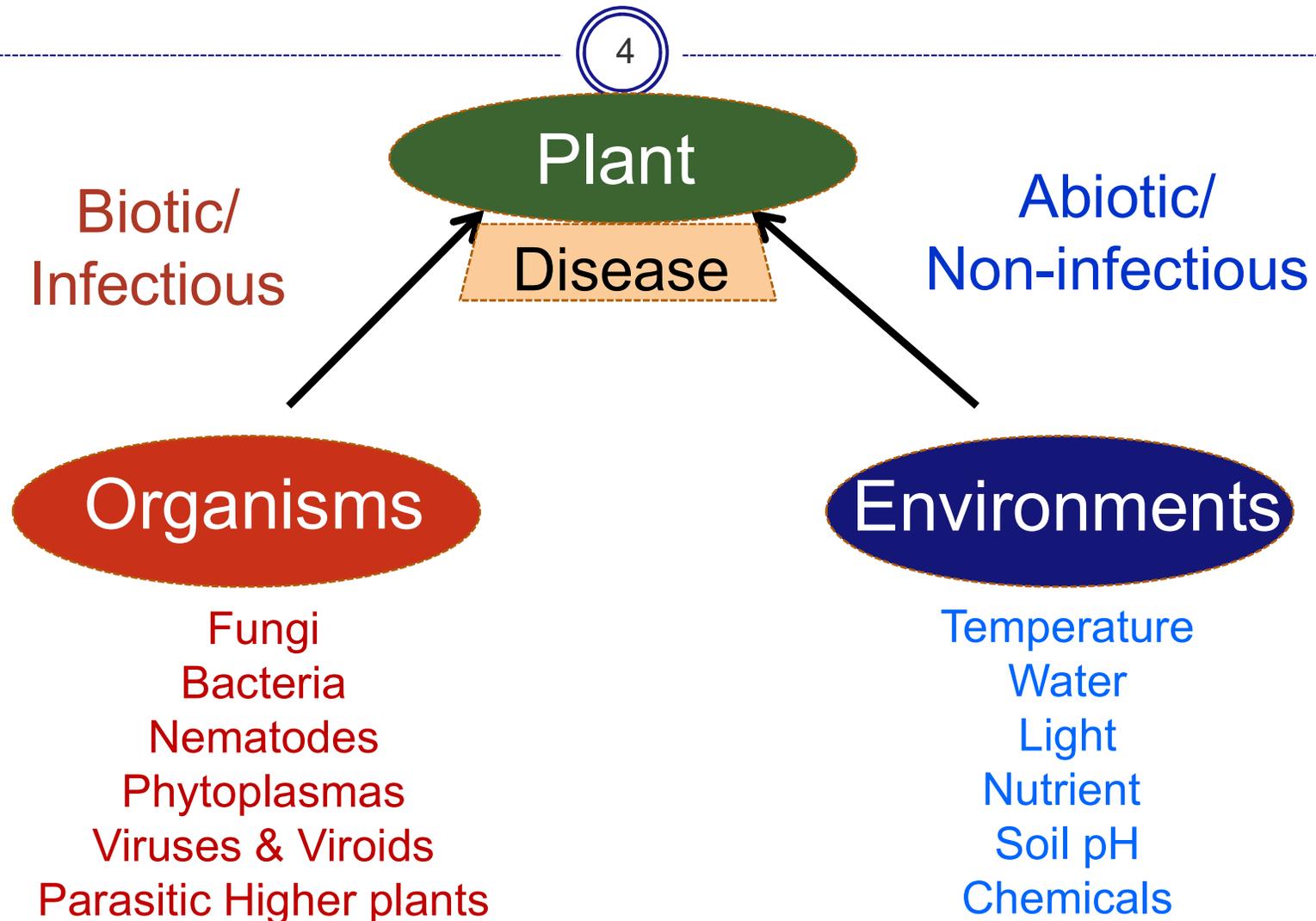
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- an abnormal condition that interferes normal growth and development of a plant and reduces its yield and/or quality

physiological process
and appearance



What are Causal Agents



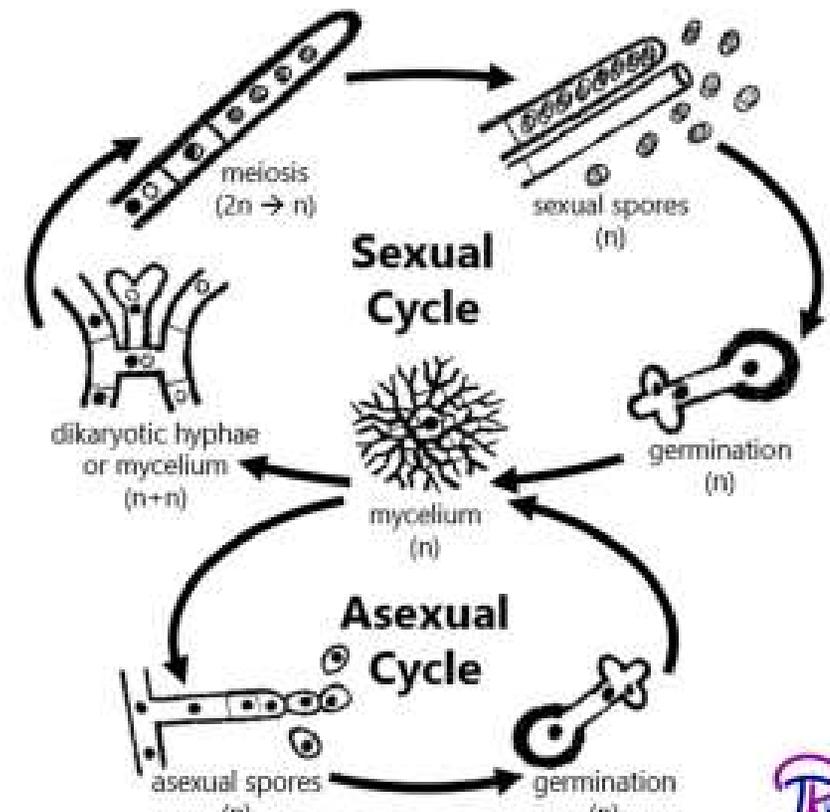
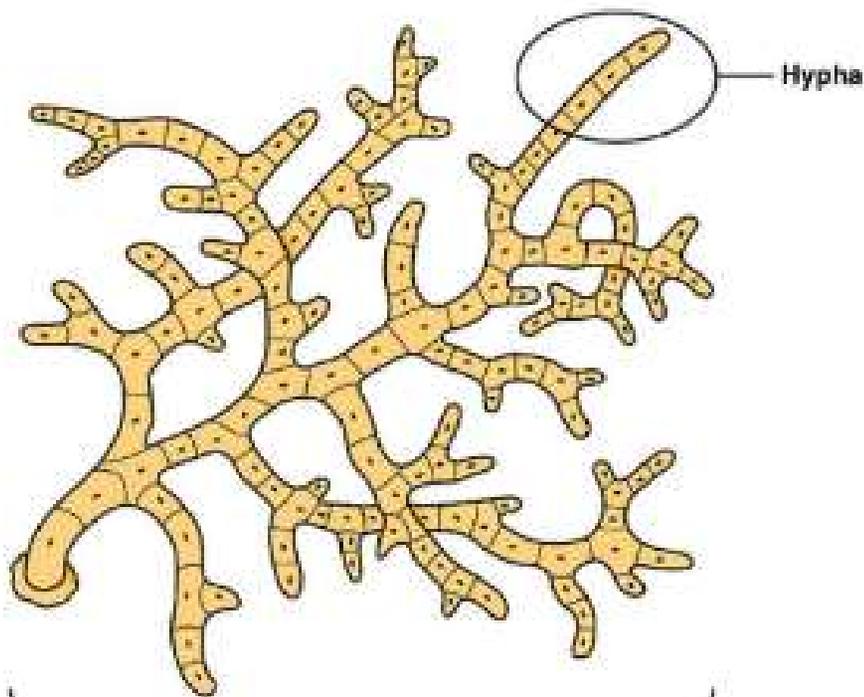
- Pathogen: a **disease-producing organism** or biotic agent

Fungi

5

- Growth: extension of thread-like structures – hyphae

- Reproduction: fragmentation, budding, or production spores



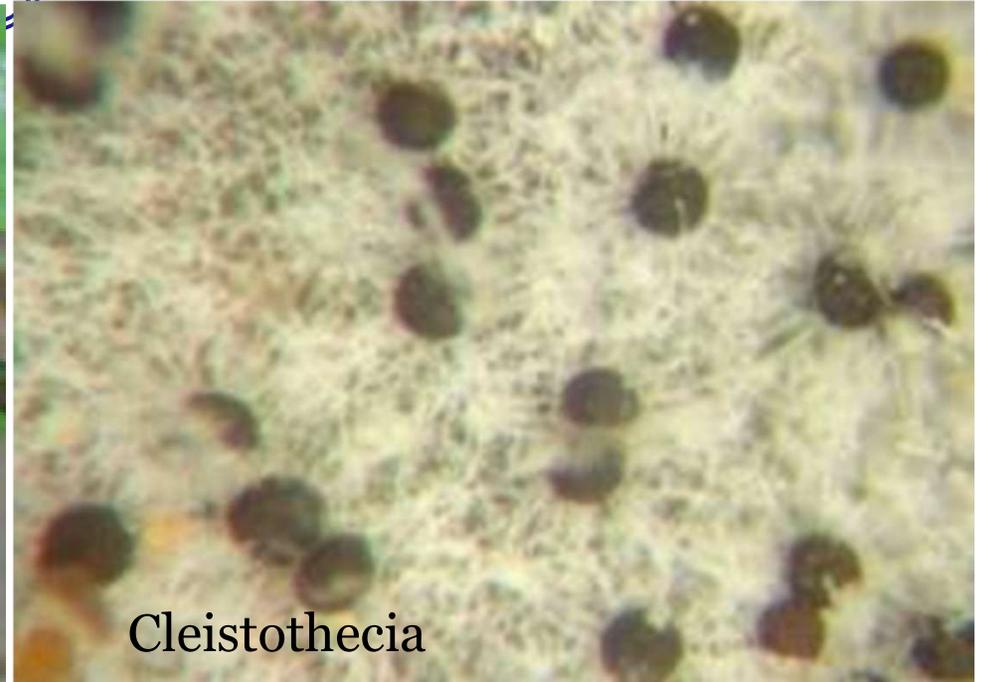
Fungi - Living

6

- Heterotroph - obtains energy from **other** organisms
 - Saprophytic – Most fungi obtain nutrients from **dead** or decaying organic matter, do not hurt living organisms
 - Parasitic – obtain nutrients from **living** cells, may cause diseases, but not all parasites
 - ★ Obligate: **Only** grow as a parasite on or in a **living** host
 - ★ Facultative: absorb nutrients from both **dead and living** hosts
 - Symbiotic - A **mutually beneficial** relationship with other organisms (plants, animals, or algae), to not hurt living organisms

Fungi - Reproduction

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Cleistothecia

Conidia



Powdery mildew



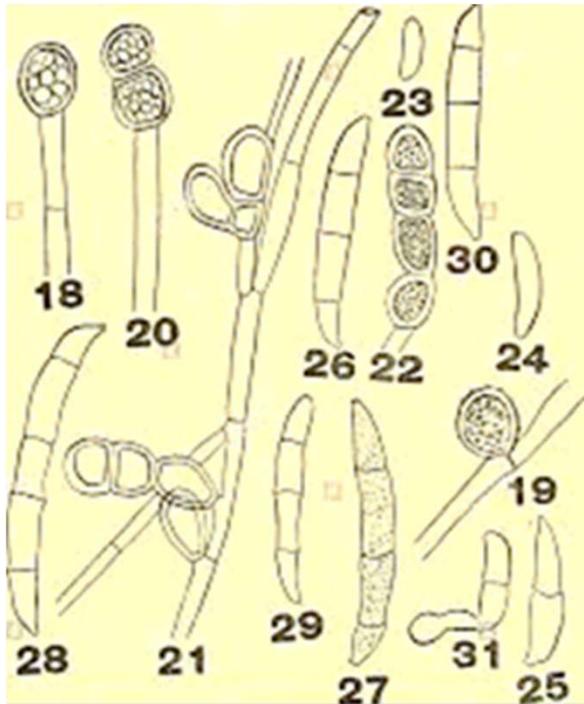
Ascospores

Fungi - Resting Structures

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- Chlamydospore

- a **thick-walled** asexual resting **spore** formed from hyphal cells or conidial cells



- Sclerotium

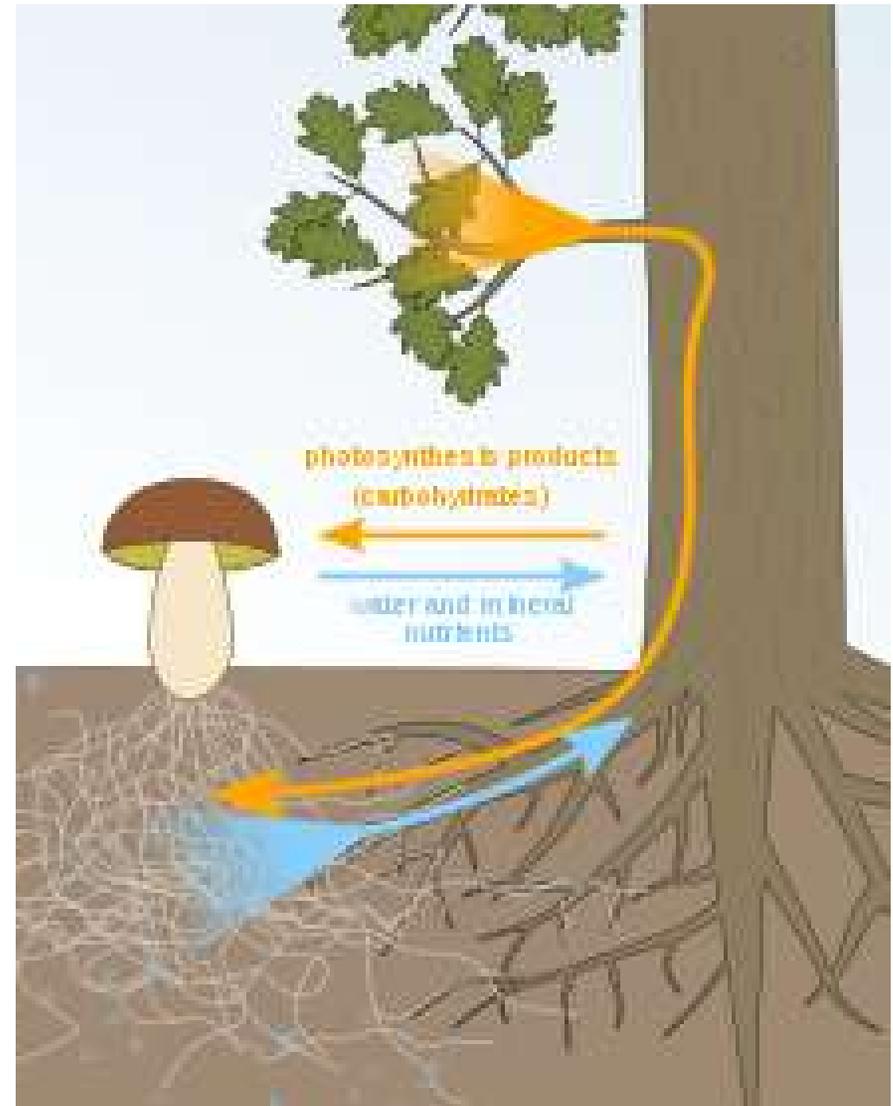
- a vegetative resting body, composed of a **compact mass of hyphae**



Fungi - Mycorrhizae

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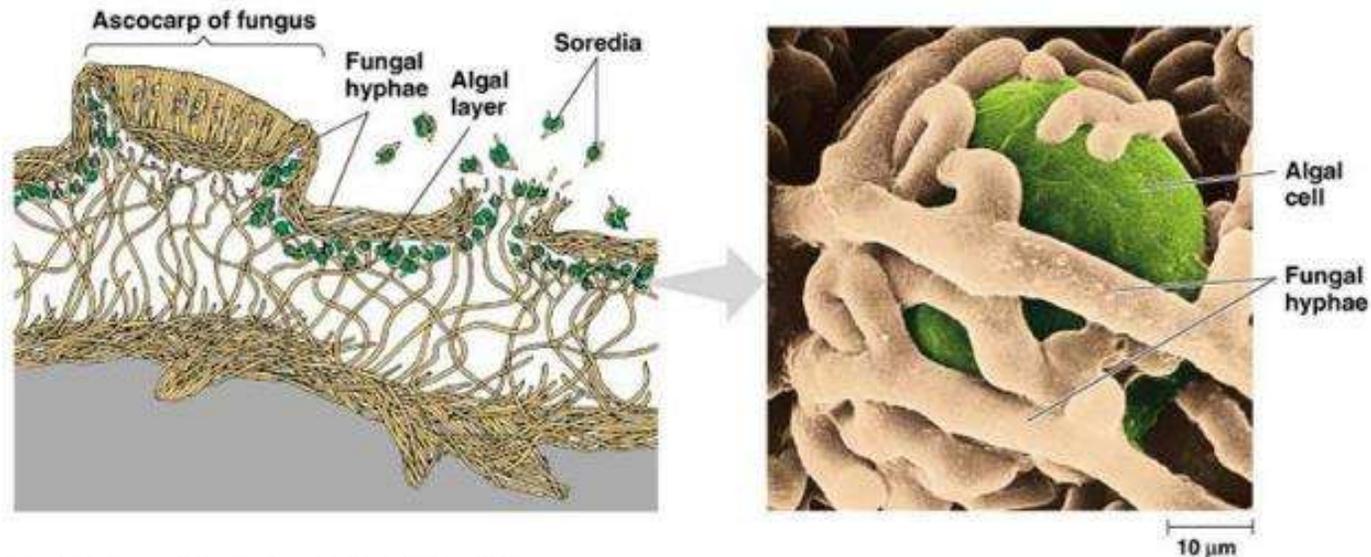
- A mutual **symbiotic** association between a **fungus** and a **plant**
- **Plants** provide fungi with **food**
- The **fungi** help the plants suck up **water** and provide **nutrients**
- Around **90% of plants** are in mutually-beneficial relationships with fungi.



Fungi - Lichen

10

- A **symbiotic** partnership of **fungi** and **algae**
 - The **algae** photosynthesize and provide **food** for the fungus;
 - The **fungus** provides a **place** for the algae

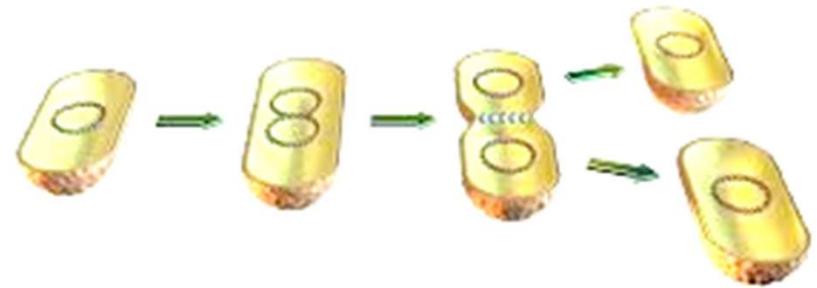


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Bacteria

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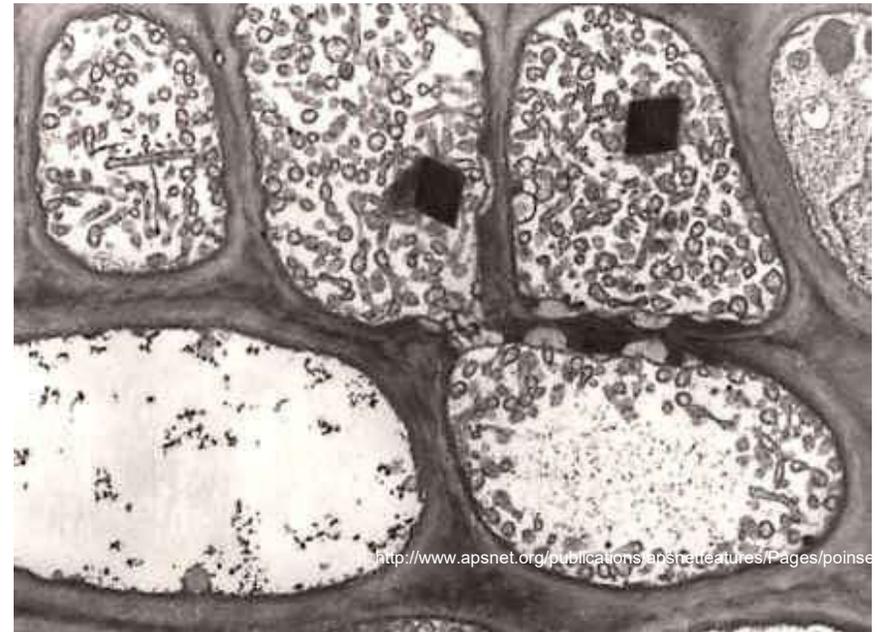
- A **single-celled** organism with a cell wall
- Reproduces by **division**
- One division/20 min
- From one cell to a million cells in 10 hours
- Diseases:
 - Bacterial leaf scorch
 - Fire blight



Phytoplasma

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- A **phloem**-limited and **single-celled**
- **Lacking** the cell wall
- Transmitted through **leafhoppers**, plant propagation materials and seeds
- An **obligate parasite**
- Diseases
 - Ash yellows
 - Elm yellows



Electron microscopy of cross-section of gladiolus phloem tissue infected with phytoplasma. x6000.

Virus

13

- **Nucleoprotein** (nucleic acid and protein)
- **No cell** structure
- **Obligate parasite**
- Survive **in living** host cells
- Transmitted by **insects, nematodes, and grafts**
- Diseases:
 - Rhododendron ring spot virus



Nematode

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- Simple **animal**
- Microscopic worm
- Transmitted through **soil**, running **water**, rain-splash, **insects**
- Root or foliar diseases
 - Beech leaf disease
 - Pine wilt



Symptom

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- Symptom: an indication of disease by **reaction of the host**



Symptom

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- Chlorosis: the failure of **chlorophyll** development



5559089

Symptom

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- Necrosis: the **death** of cells or tissue



Symptom

18

- Spot: a symptom of disease characterized by a **limited necrotic area**, as on leaves, flowers, and stems



Symptom

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- Blotch: a **necrotic** area of tissue **irregular** in form



Symptom

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- Scorch: any symptom that resembles the result of **flame or fire** on the affected part, often seen at the **margin** of leaves



Leaf Scorch of Maple

Symptom

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- Blight: a **sudden** and **extensive** spotting, discoloration, or destruction of leaves, flowers, stems, or entire plants



Symptom

22

- Canker: a plant disease characterized (in woody plants) by the **death of cambium** tissue



Symptom

23

- Dieback: the **progressive death** of shoots, beginning at the **tips**



Symptom

24

- Gall: an **abnormal swelling** or localized outgrowth produced **by a plant**



Symptom

25

- Rot: the **softening**, discoloration, and often **decay** of plant tissue



Symptom

26

- Wilt: drooping of leaves from lack of water



Symptom

27

- Vascular discoloration: **streaking** or darkening of **vascular** tissues



Sign

28

- Sign: an indication of a disease from **direct observation** of a **pathogen** or its parts



Sign

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Nectria canker

Plant Disease Diagnosis

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- **Correct plant identification**
 - family and genus
 - Recognize healthy plant appearance (species and varieties)
 - A list of plant diseases associated with the plant



Plant Disease Diagnosis

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- Check for symptoms and signs
 - Symptoms
 - ✦ Progression of disease symptoms
 - ✦ Variations in symptoms – more than one causal agents
 - Signs
 - ✦ Only associated with certain diseases
 - ✦ Secondary organisms on diseased parts

Plant Disease Diagnosis

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- Ask questions
 - Watering
 - Weather conditions (temperature, hail)
 - Use of pesticides and chemicals





Plant Disease Diagnosis

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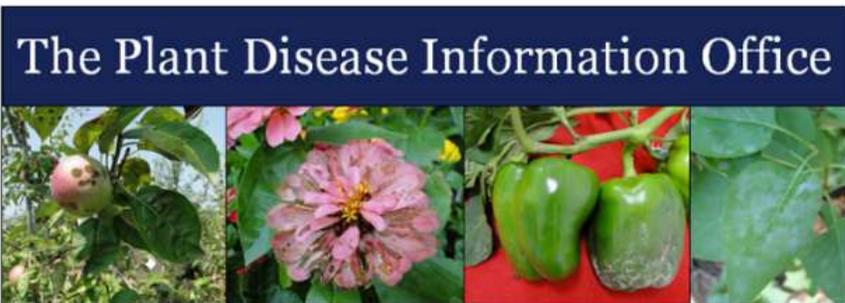
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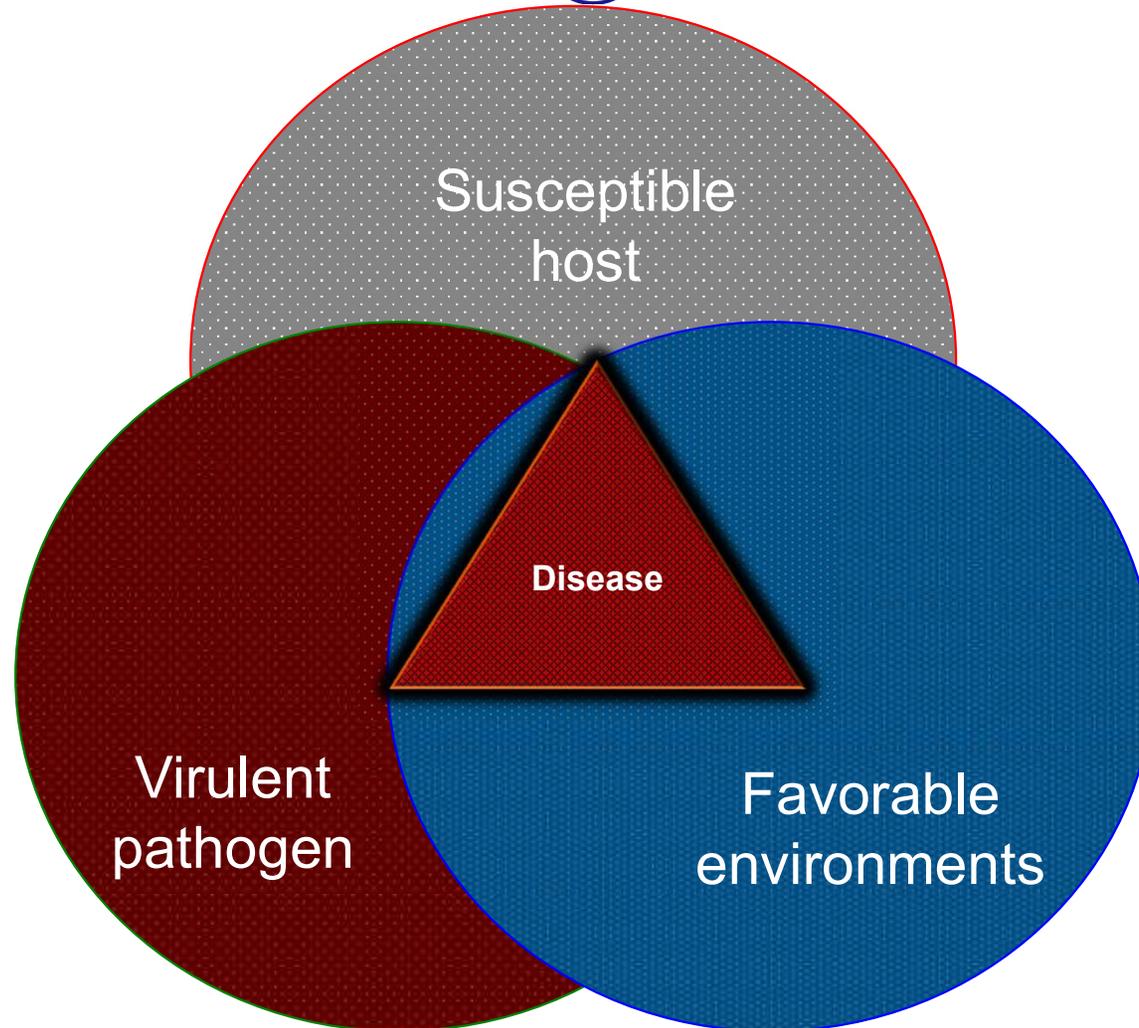
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The Plant Disease Information Office (PDIO) is part of the [Department of Plant Pathology and Ecology](#) at [The Connecticut Agricultural Experiment Station](#) (CAES). The PDIO is a full-service plant disease diagnostic laboratory that assists all Connecticut stakeholders, including homeowners and professionals. Plant samples are diagnosed utilizing molecular, serological, biochemical, and traditional diagnostic methods. The PDIO also assists with inquiries about plants, plant identification, and plant health. Inquiries and samples can be submitted via phone, email, mail, and in person. More information can be found in the [Sample Submission](#) and [PDIO Brochure](#) sections.

Disease Development

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Disease triangle

Disease Development

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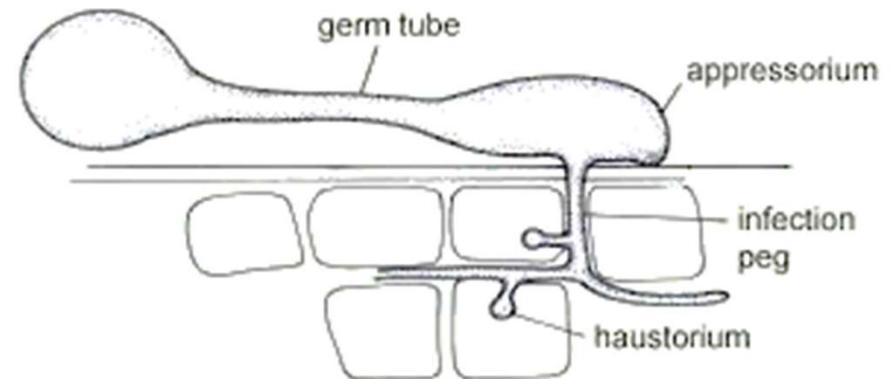
- Host range: the range of **plants** on which a **pathogen** infects
 - *Ophiostoma ulmi*: the causal agent of Dutch elm disease
 - ★ Host range: only elm trees (*Ulmus* spp.)
 - *Verticillium dahlia*: the casual agent of Verticillium wilt
 - ★ Host range: over 300 woody and herbaceous including tomato, strawberry, rose, maple, and elm

Disease Development

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○ Penetration: the **initial invasion** of a host by a pathogen

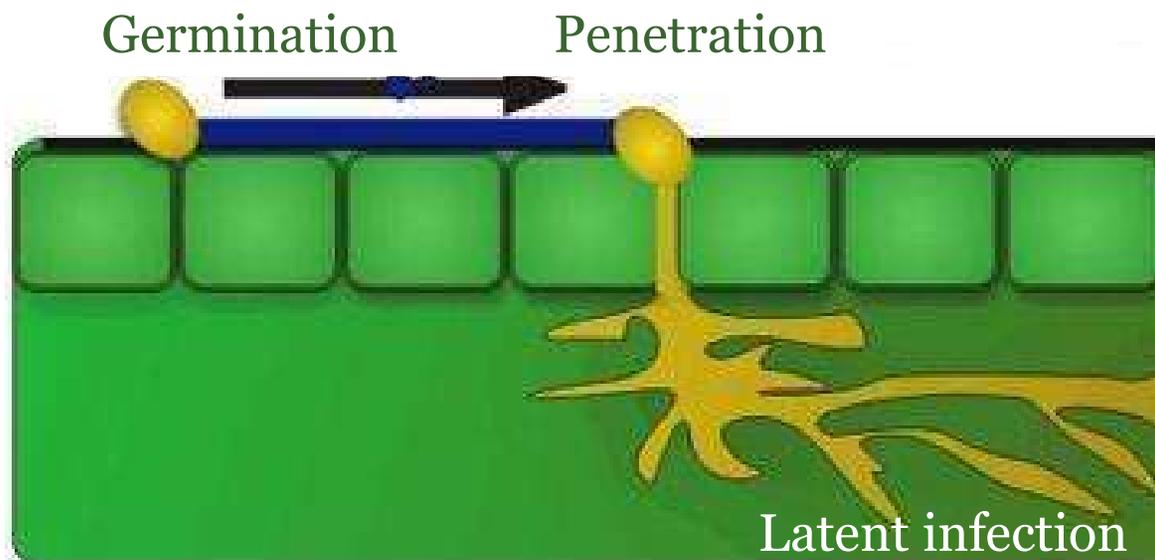
- Directly through cell wall
 - ★ Leaf, stem, and root
- Natural opening
 - ★ stomata, lenticels
- Wound
 - ★ Mechanical, pruning, insect, physical injury



Disease Development

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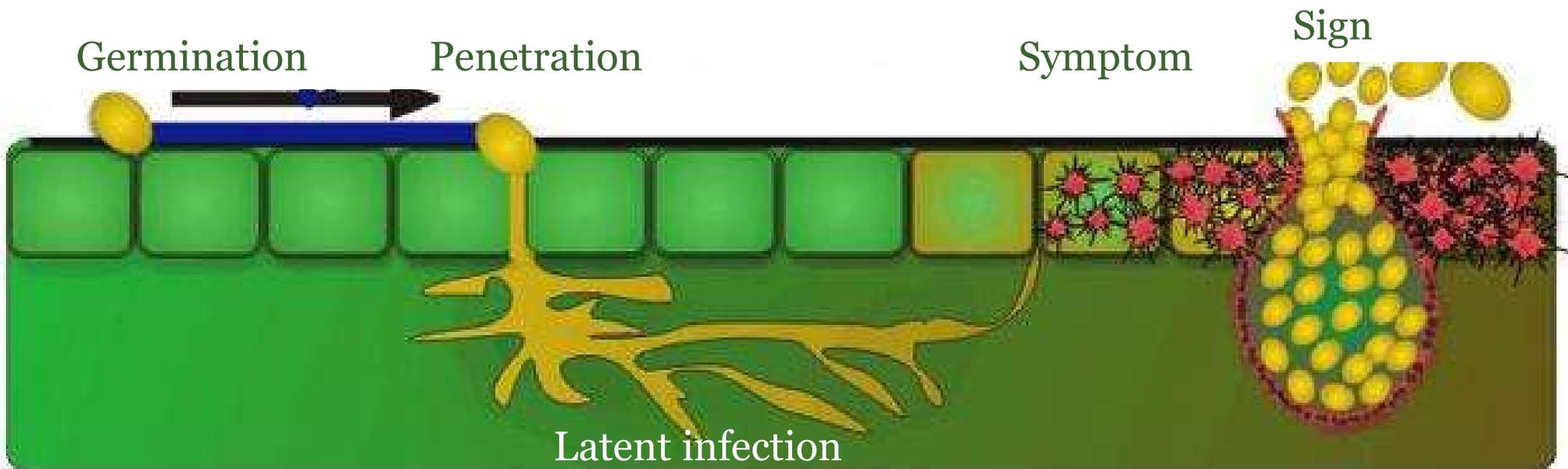
- Infection: **penetrating** and establishing a **parasitic relationship** with a host plant
- Latent infection: an infection **unaccompanied by visible symptoms**



Disease Development

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- Latent period: the **time** between **infection** and the production of **new inoculum** and/or **symptoms**.
 - Host resistance
 - Environments
 - Types of fungal pathogens



Disease Development

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- Dispersal: the **spread of a pathogen (inoculum)** from diseased to healthy plants or tissues
 - Rain- or water-splash (short)
 - ★ Fungal spores, bacterial cells, foliar nematode
 - Running water
 - ★ Fungi, bacteria, and nematodes
 - Wind or air movement (long)
 - ★ Fungal spores
 - Insects (depends on insect species and their mobility)
 - ★ Fungal spores, bacteria, nematodes, virus, phytoplasma
 - Human and animal activity (short and long)
 - ★ All plant pathogens through plant materials, tools, equipment

Disease Development

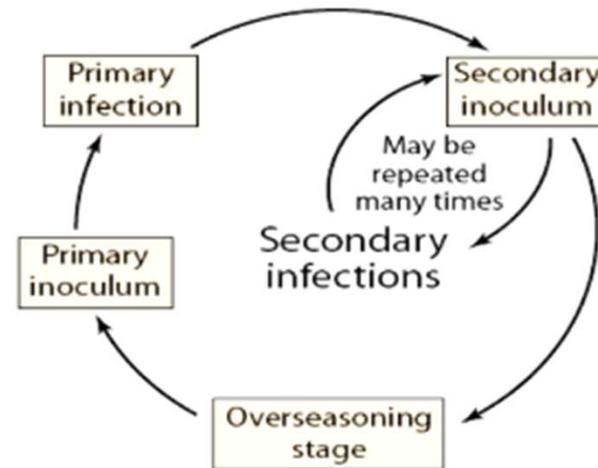
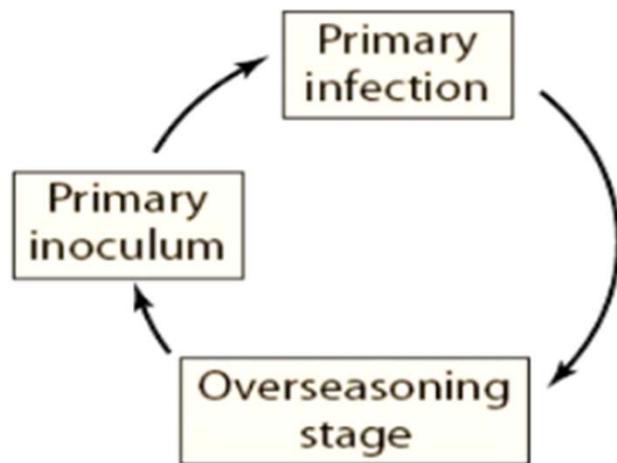
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- Overwinter: to **survive or persist** through the winter
 - Soil: Resting structures (more than 5 years)
 - ✦ Fungi
 - Plant debris: Saprophytic (1-2 years)
 - ✦ Fungi, bacteria, nematode
 - In/on living plants
 - ✦ All pathogens
 - Annual plants in protected structures
 - Perennial roots, bulbs, or tubers
 - Woody plants – roots, stems, buds, or leaves (evergreen)

Disease Development

41

- Disease cycle: a series of sequential **events** from **initial infection** to over-seasoning, until **another infection** occurs



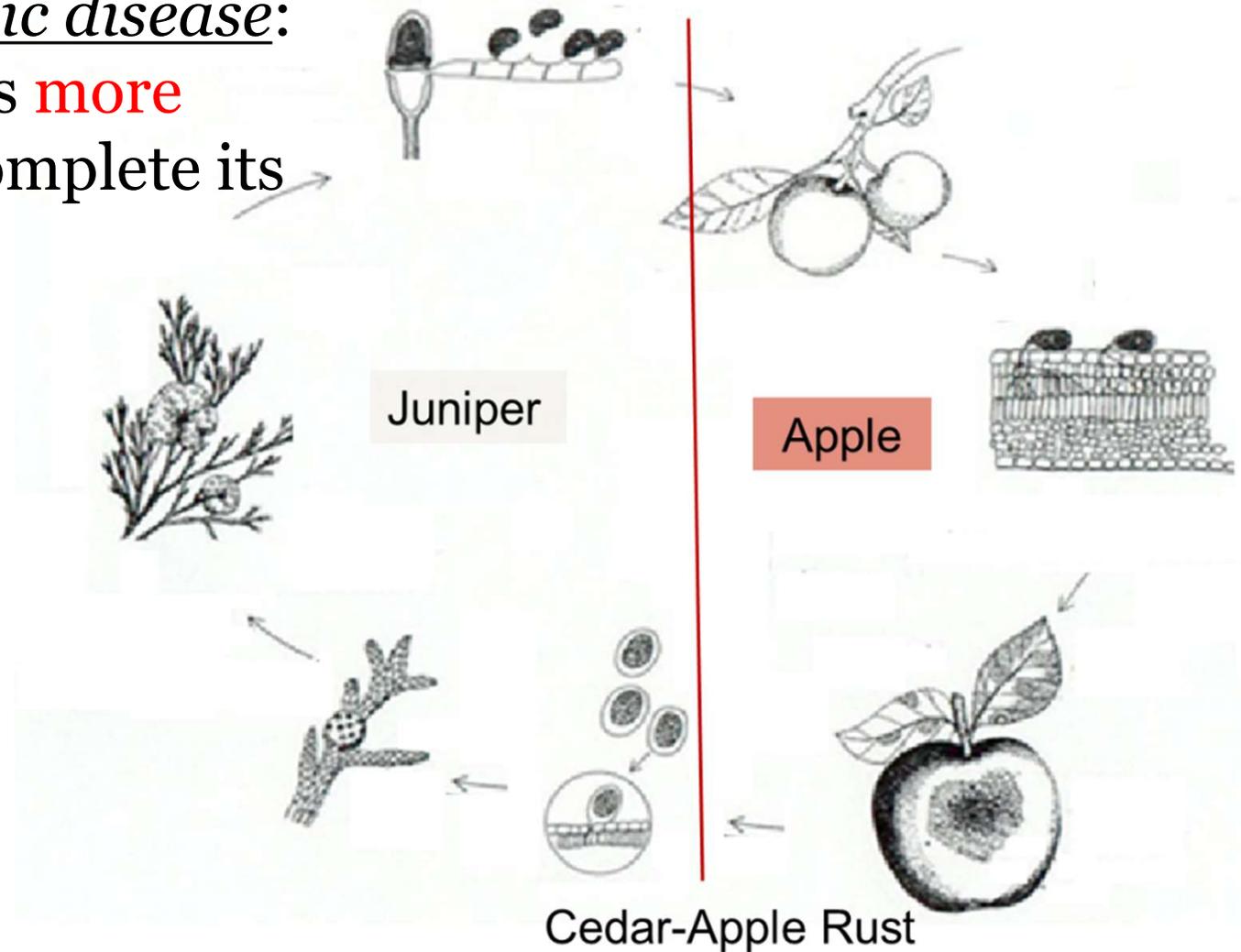
- Monocyclic: only **one cycle** per season

- Polycyclic: **more than one** infection cycle per season

Disease Development

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Multi-host life cyclic disease:
the pathogen needs **more than one host** to complete its life cycle

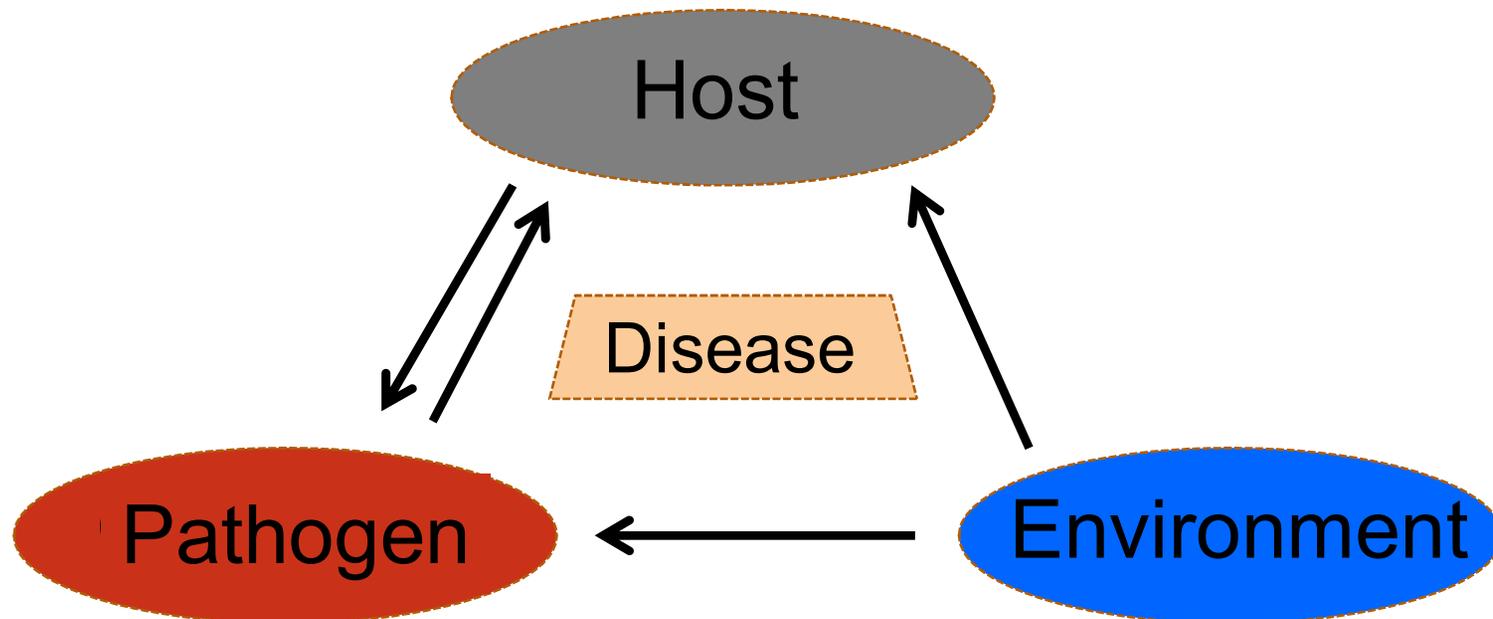


Disease Management

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Management Triangle

- Host resistance
- Reduced inoculum
- Favorable to host/ unfavorable to pathogen



Disease Management - Host

44

- Right tree in the right place
 - USDA Zones
 - Avoid winter injury
 - ★ Vulnerable to other diseases
 - Mature size
 - ★ Maintain adequate space between trees when they are mature



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Disease Management - Host

45

- **Resistant tree species/varieties**
 - Dutch elm disease – Chinese elm and its hybrids
 - Chestnut blight – Chinese or Japanese chestnut and their hybrids
 - Verticillium wilt – ginkgo, beech, pines, spruce

Disease Management - Pathogen

46

- *Sanitation:*
 - Destroy fallen leaves, fruits, and other plant materials
 - Prune diseased/dead branches
 - Sanitize tools with 10% household bleach or 70% alcohol

Disease Management - Pathogen

47

- Fungicide: used to inhibit or kill the fungus causing the disease, preventative treatments.
- Mode of Action (MOA):
 - Fungicide Resistance Action Committee (FRAC)
 - *FRAC MOA code*: numbers and letters used to distinguish the fungicide groups according to their cross-resistance behavior.

Read and follow the pesticide label

Disease Management - Pathogen

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Trade name

Formulation

Daconil® 720 Flowable Fungicide

GROUP M5 FUNGICIDE

FRAC MOA group

For control of turf and ornamental diseases

For control of diseases of apricot, cherry (sweet and tart), nectarine, peach, plum and prune trees

Common name

Active Ingredient:

Chlorothalonil (tetrachloroisophthalonitrile) 54.0%

Other Ingredients: 46.0%

Total: 100.0%

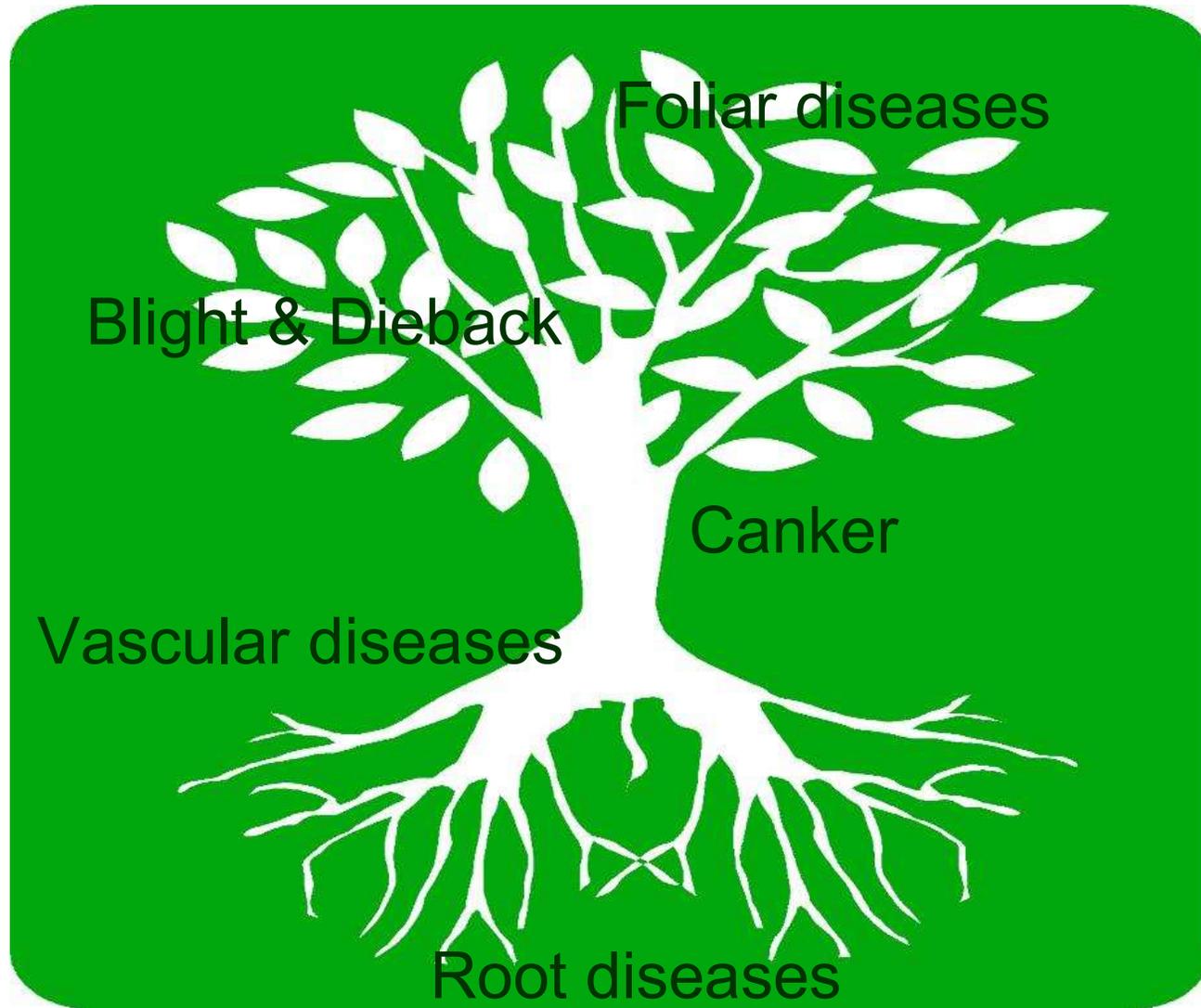
Daconil 720 Flowable Fungicide is formulated as a suspension concentrate (SC) and contains 6.0 pounds chlorothalonil per gallon.

Disease Management - Environment

49

- Maintaining tree vigor & conditions unfavorable to pathogens
 - *Plant requirements* : pH, drainage, light
 - *Mulching*: weed control, soil moist
 - *Fertilizing*: time, soil test, balanced nutrients
 - *Watering*: one inch water/week, deep soaking
 - *Avoid sprinkler/overhead irrigation*
 - *Avoid excessive water*: newly installed trees
 - *Air circulation*: lower humidity

Common Diseases



Foliar Diseases

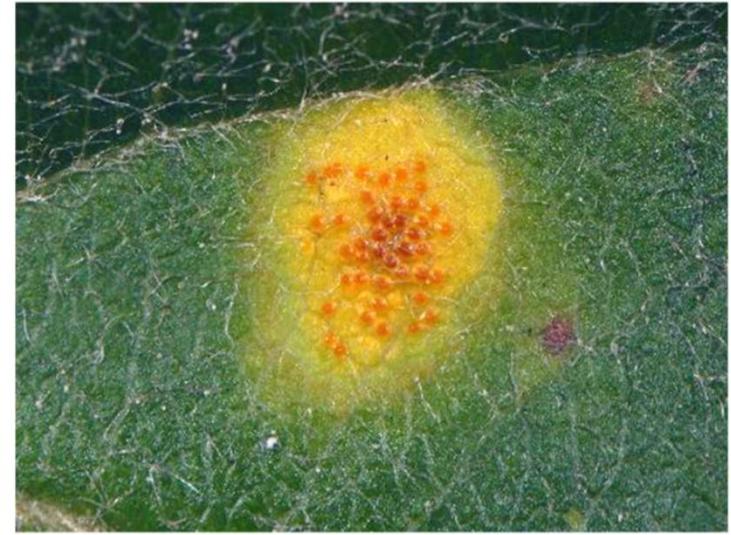
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Apple scab

Foliar Diseases

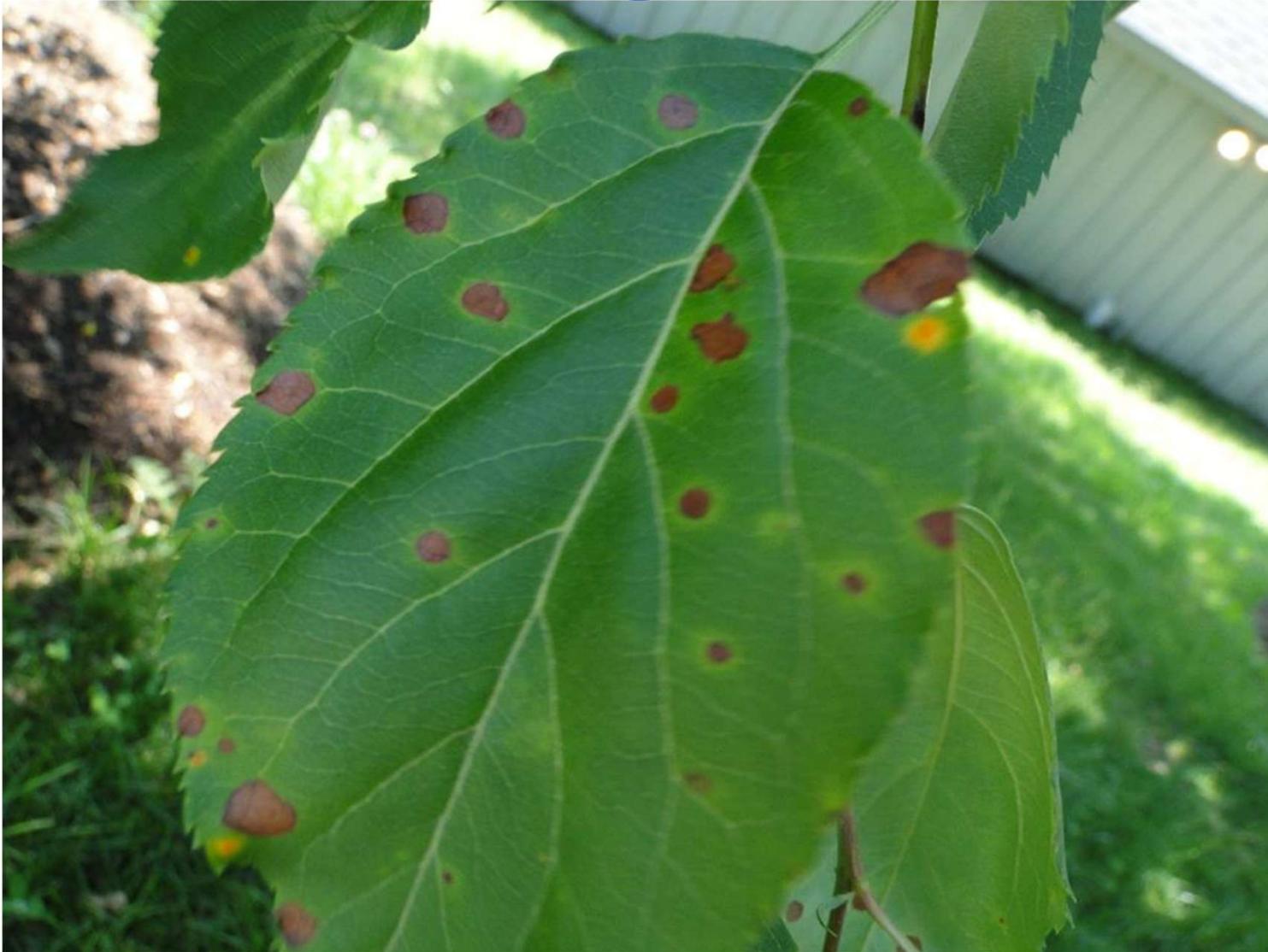
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Cedar-apple rust

Foliar Diseases

53



Frogeye leaf spot of apple

Foliar Diseases

54



Anthrachnose of Beech

Anthrachnose

Foliar Diseases

55



Beech leaf disease

Foliar Diseases

56



Blumeriella leaf spot of cheery

Foliar Diseases

57



Powdery Mildew of Dogwood

Powdery mildew of dogwood

Foliar Diseases

58



Anthracnose of Dogwood

Foliar Diseases

59



Elm black spot

Foliar Diseases

60



Anthracnose of hornbeam

Foliar Diseases

61



Powdery mildew of horse chestnut

Foliar Diseases

62



Leaf blotch of horse chestnut

Foliar Diseases

62



Anthracnose of maple

Foliar Diseases

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Phyllosticta leaf spot

Foliar Diseases

65



Tar Spot of Maple

Tar spot of Norway maple

Foliar Diseases

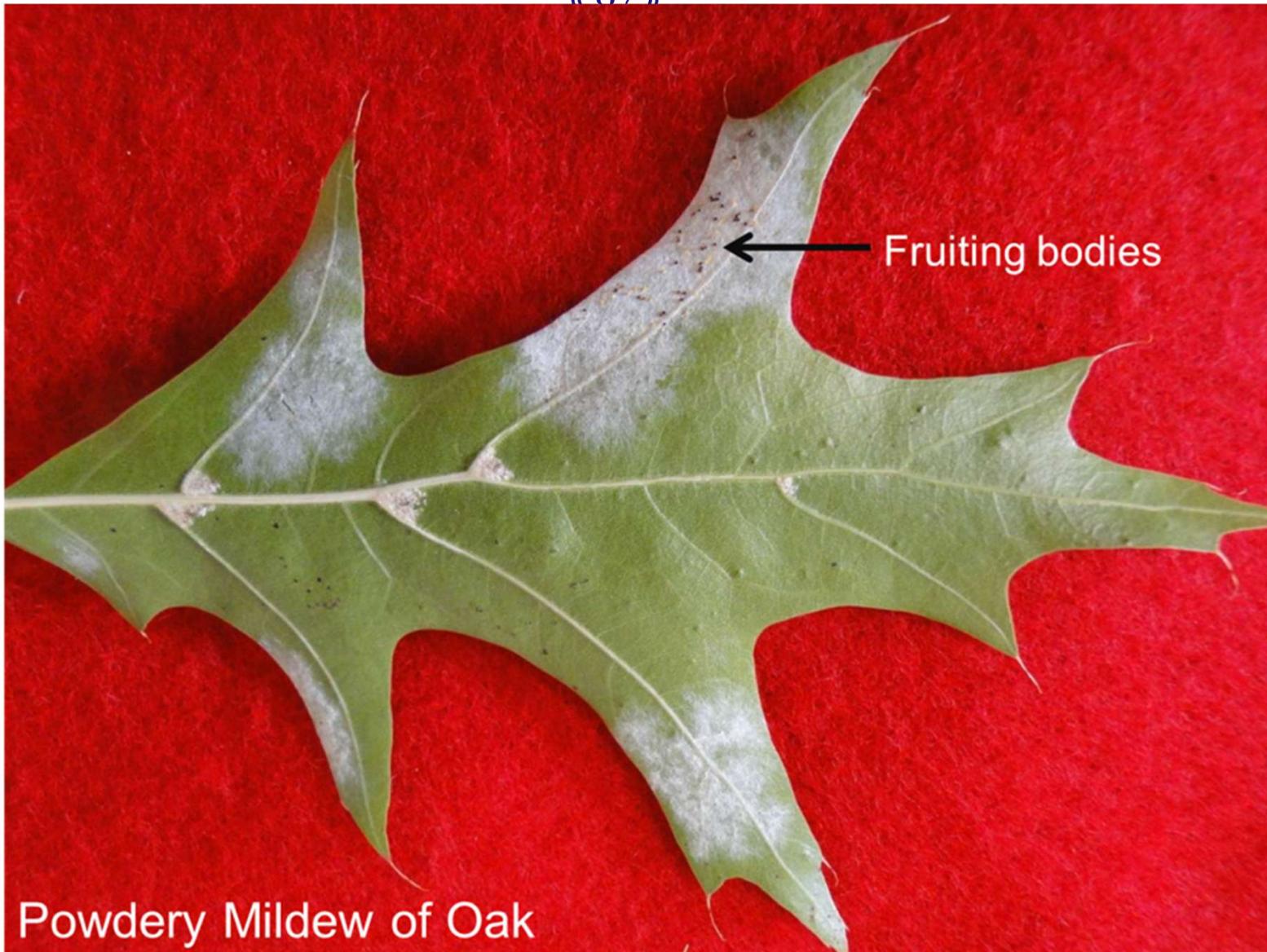
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Powdery mildew of maple

Foliar Diseases

67



Powdery Mildew of Oak

Powdery mildew

Foliar Diseases

68



Anthracnose of oak

Foliar Diseases

69



Tubakia leaf spot of oak

Foliar Diseases

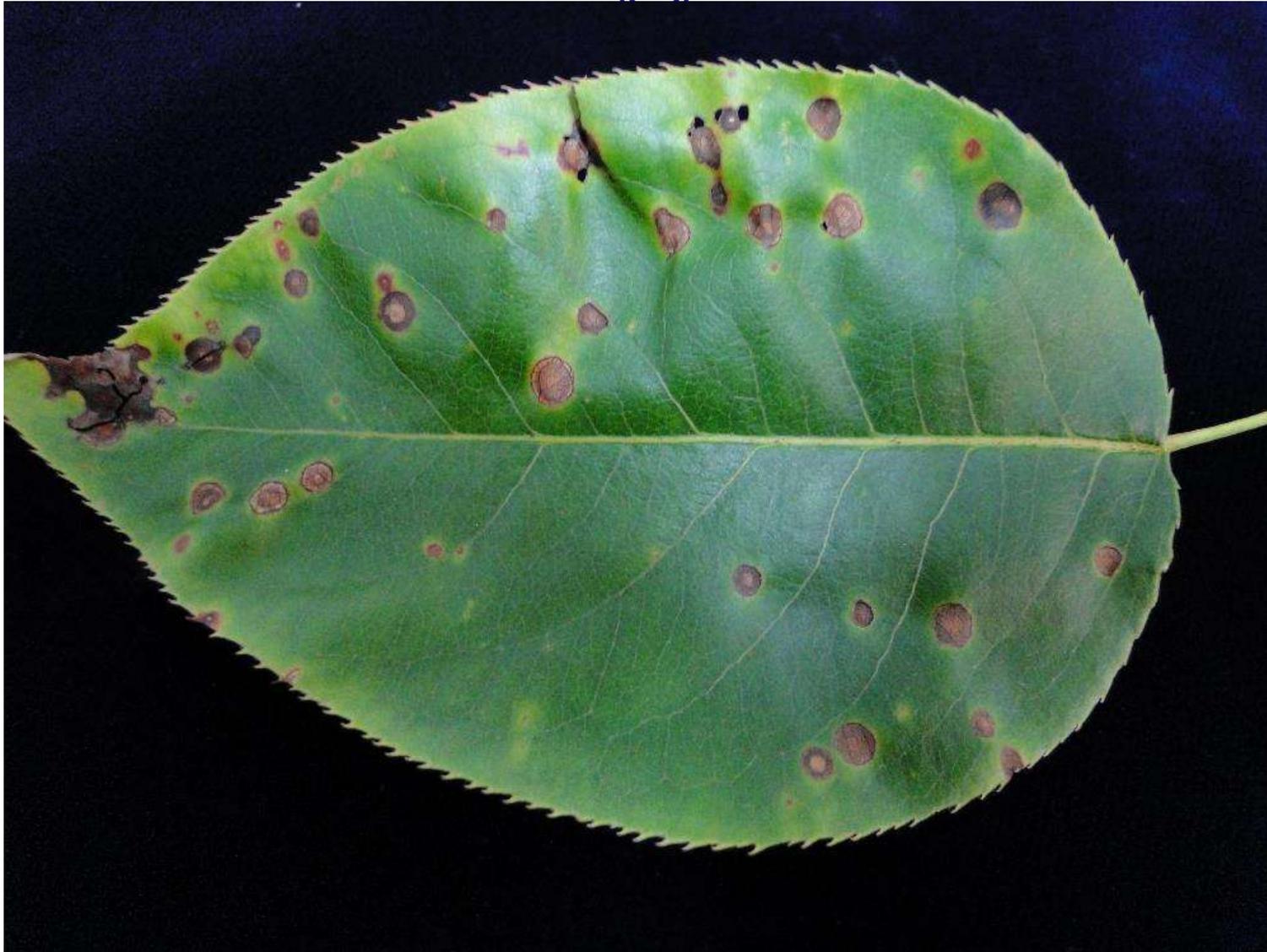
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Leaf blister of oak

Foliar Diseases

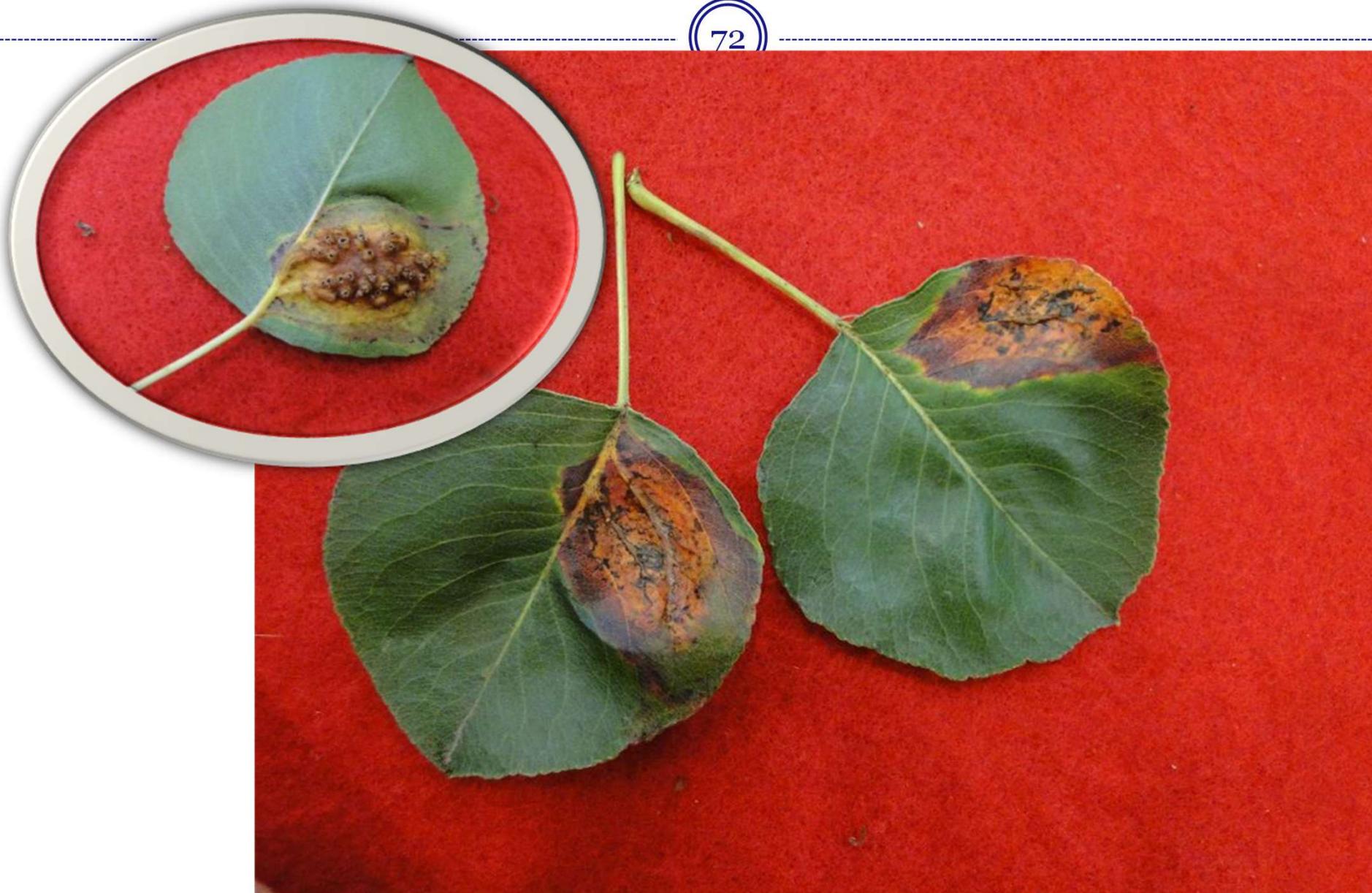
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Fabraea leaf spot of pear

Foliar Diseases

72



Pear trellis rust

Foliar Diseases



Powdery mildew of pear

Foliar Diseases

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Powdery mildew of sycamore

Foliar Diseases

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Anthracnose of sycamore

Foliar Diseases



Rhizosphaera needle cast of spruce

Foliar Diseases

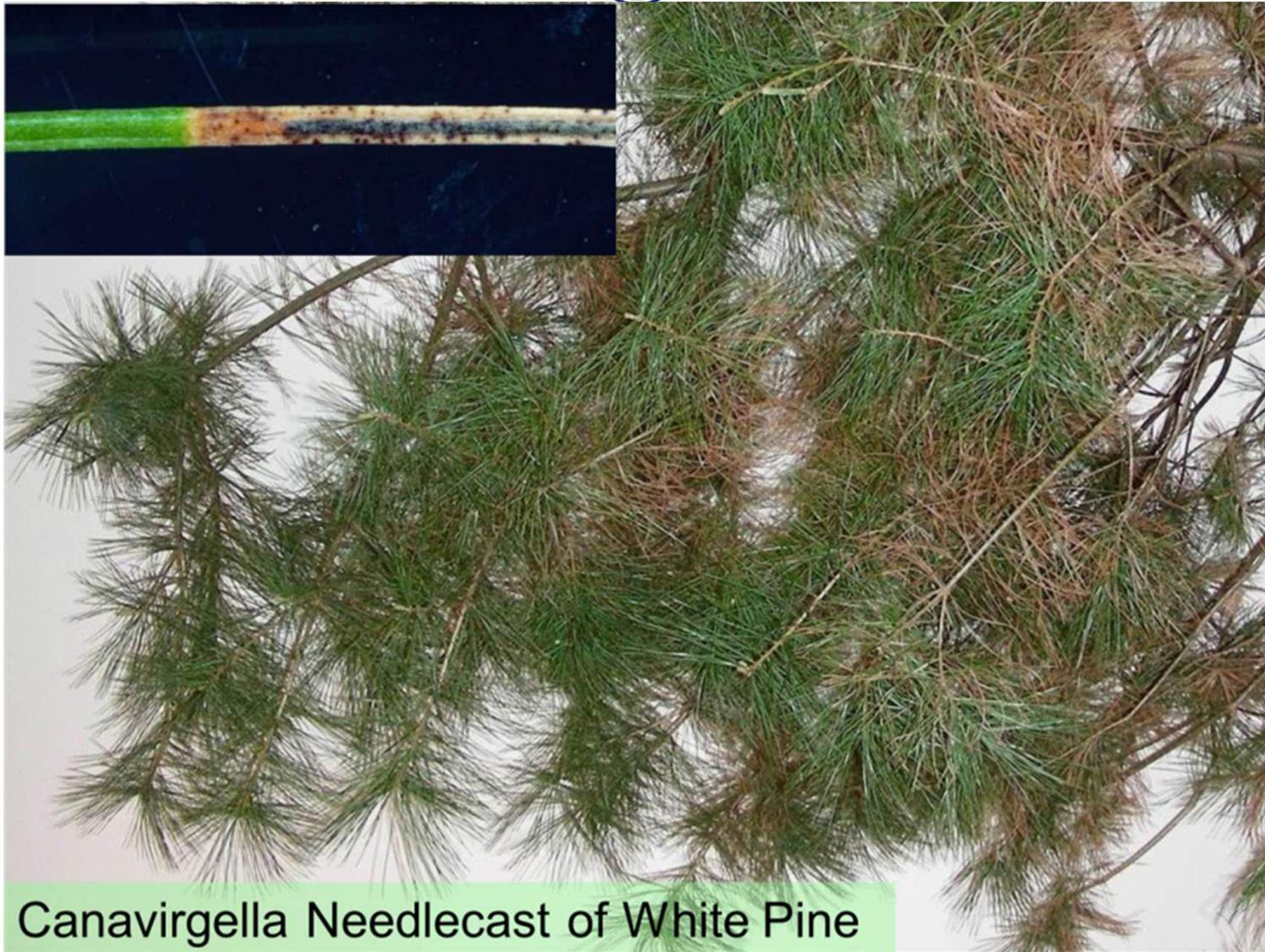
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Stigmina needle cast of spruce

Foliar Diseases

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Canavirgella Needlecast of White Pine

Canavirgella needle cast of white pine

Foliar Diseases

79



Bifusella needle cast of white pine

Foliar Diseases



Septorioides needle blight of white pine

Foliar Diseases

81



Lophodermium Needle Cast of Black Pine

Lophodermium needle cast of pines

Development of Foliage Diseases

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- Local infection
- Over-winter in infected leaves (needles), dormant buds, and alternate hosts
- Transmitted by wind, rain-splash, and insects
- Wet and humid weather conditions
- Poor air circulation
- Environmental stress

Management of Foliage Diseases

83

- Plant resistant species and varieties
- Maintain tree vigor
- Rake and remove fallen leaves (needles)
- Adequate spacing
- Proper pruning
- Fungicide application - preventative

Blight

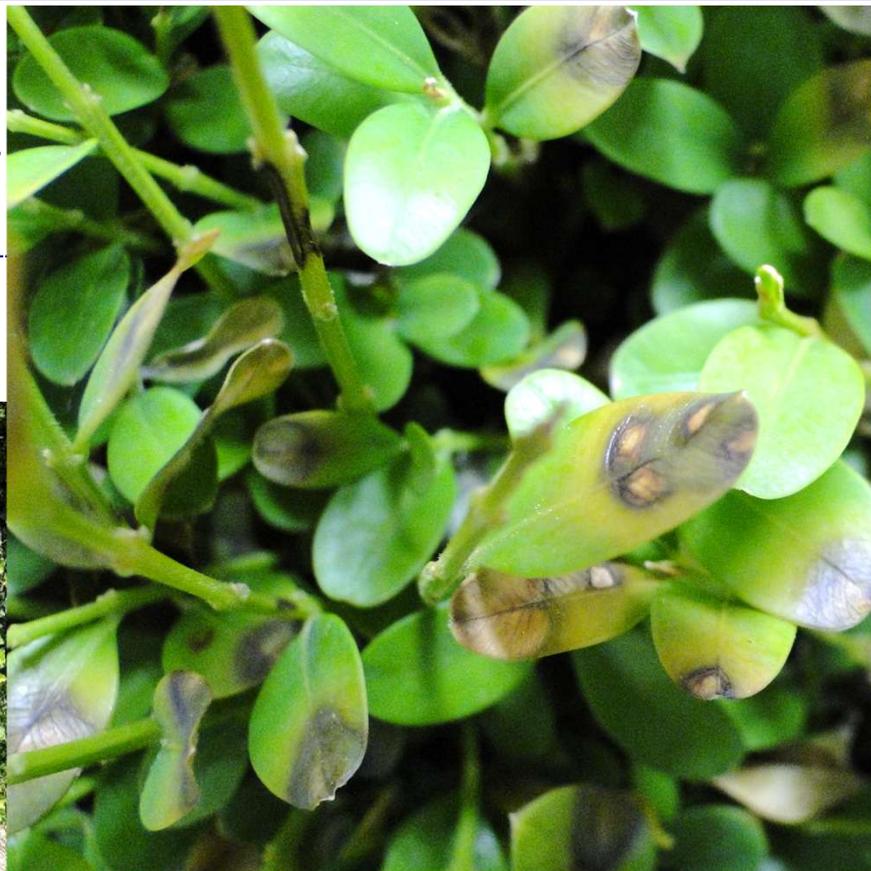
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Apple fire blight

Blight

85



Boxwood blight

Blight



Volutella blight of boxwood

Blight

87



Bacterial blight of lilac

Blight

Diplodia Blight of Pine

88



Diplodia blight of pine

Blight

89

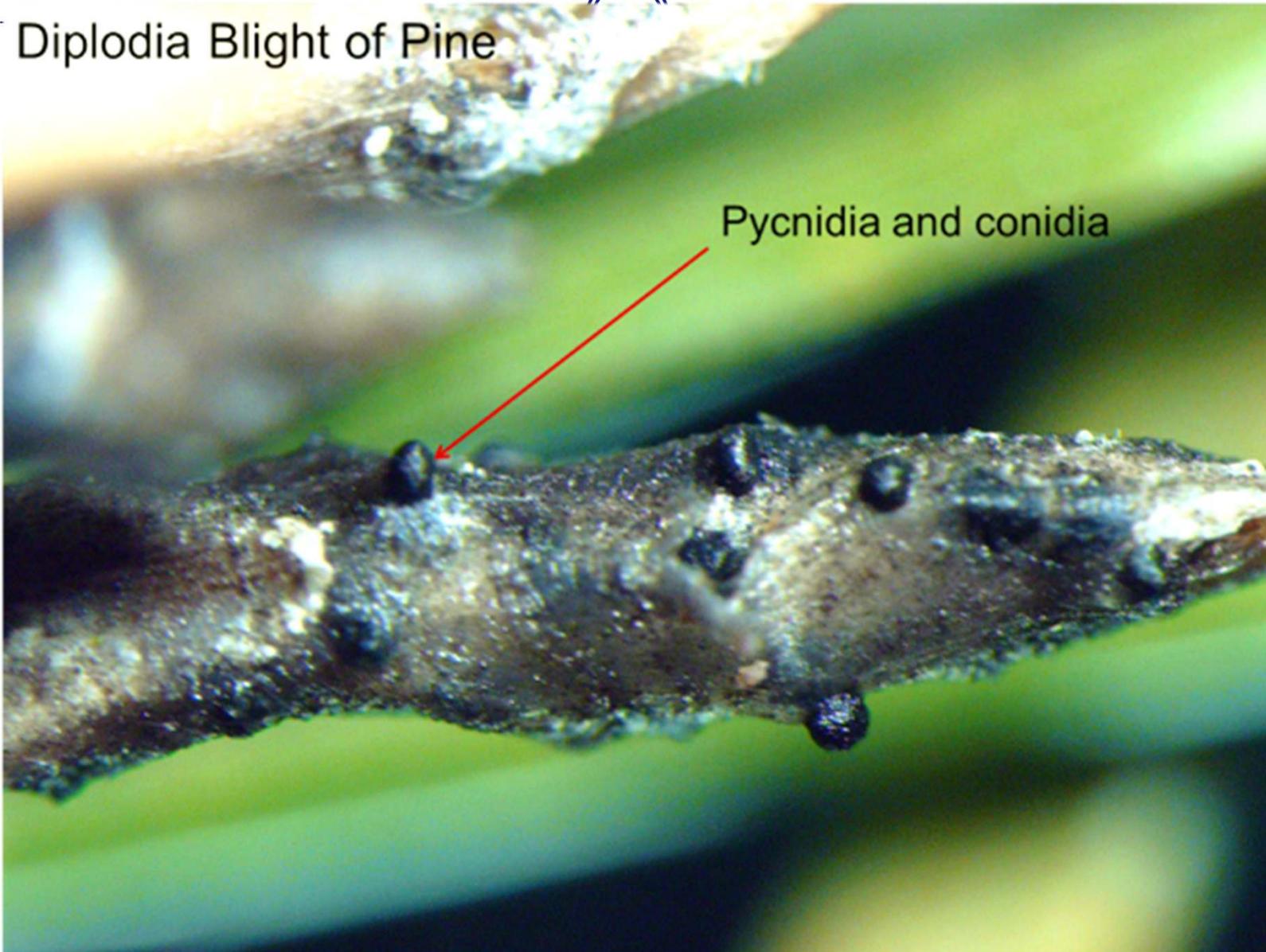


Diplodia Blight of Pine

Diplodia blight of pine

Blight

Diplodia Blight of Pine



Pycnidia and conidia

Diplodia blight of pine

Blight



Diplodia blight of pine

Development of Blight

92

- Sudden damages of leaves and growing tips
- Infected when new leaves, flowers and shoots emerge
- Favored by wet weather conditions
- Local infection on leaves or shoots

Management of Blight

93

- Resistant species and cultivars
- Maintain plant vigor
- Protect trees from winter injury and insect damage
- Prune, remove, and destroy diseased portions
- Proper spacing
- Fungicide application - preventative

Canker



Botryosphaeria canker of maple

Canker

05



Botryosphaeria canker of hornbeam

Canker

06



Botryosphaeria canker of rhododendron

Canker

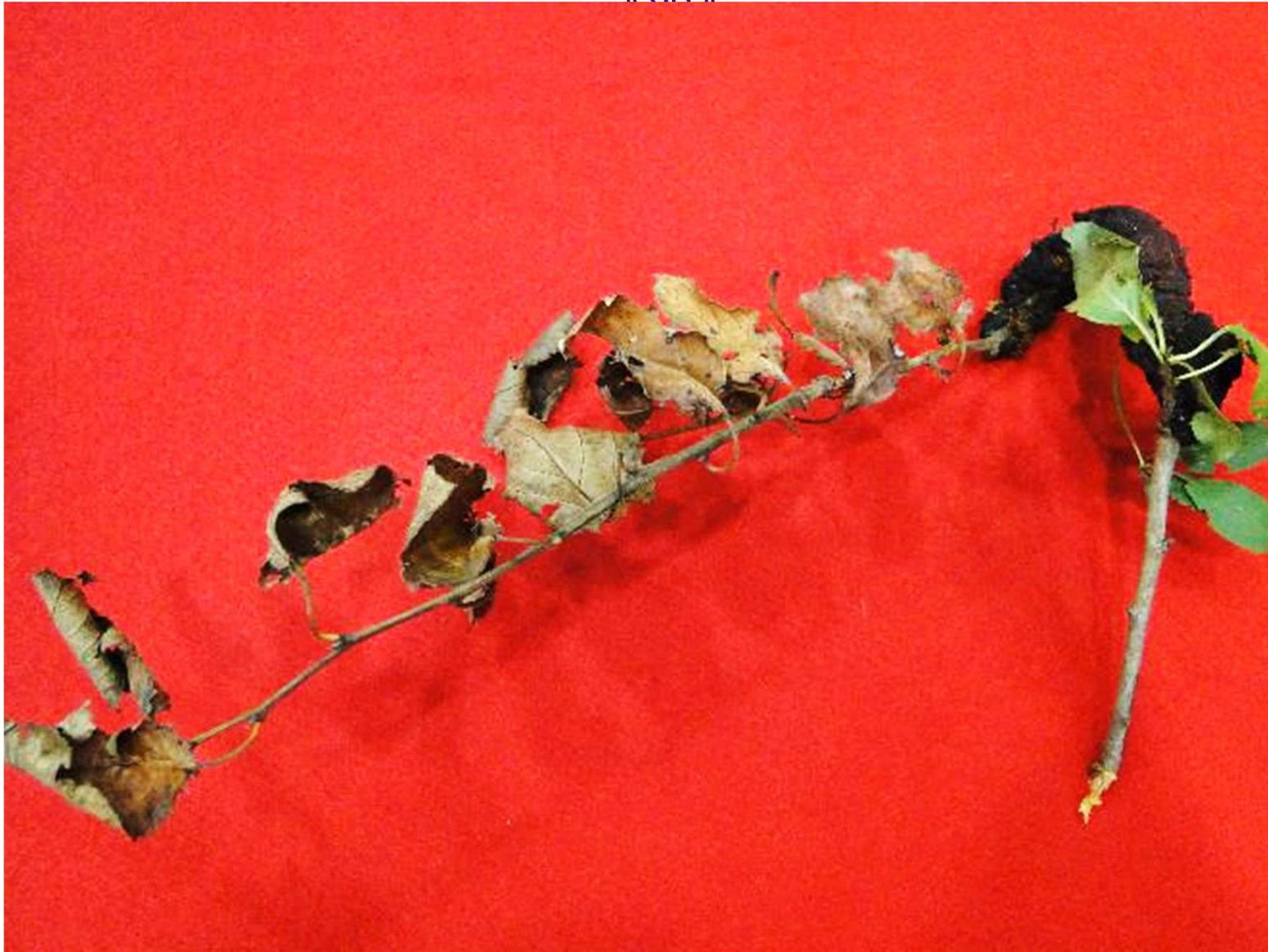
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Botryosphaeria canker of oak

Canker

08



Black knot of cherry

Canker



Chestnut blight

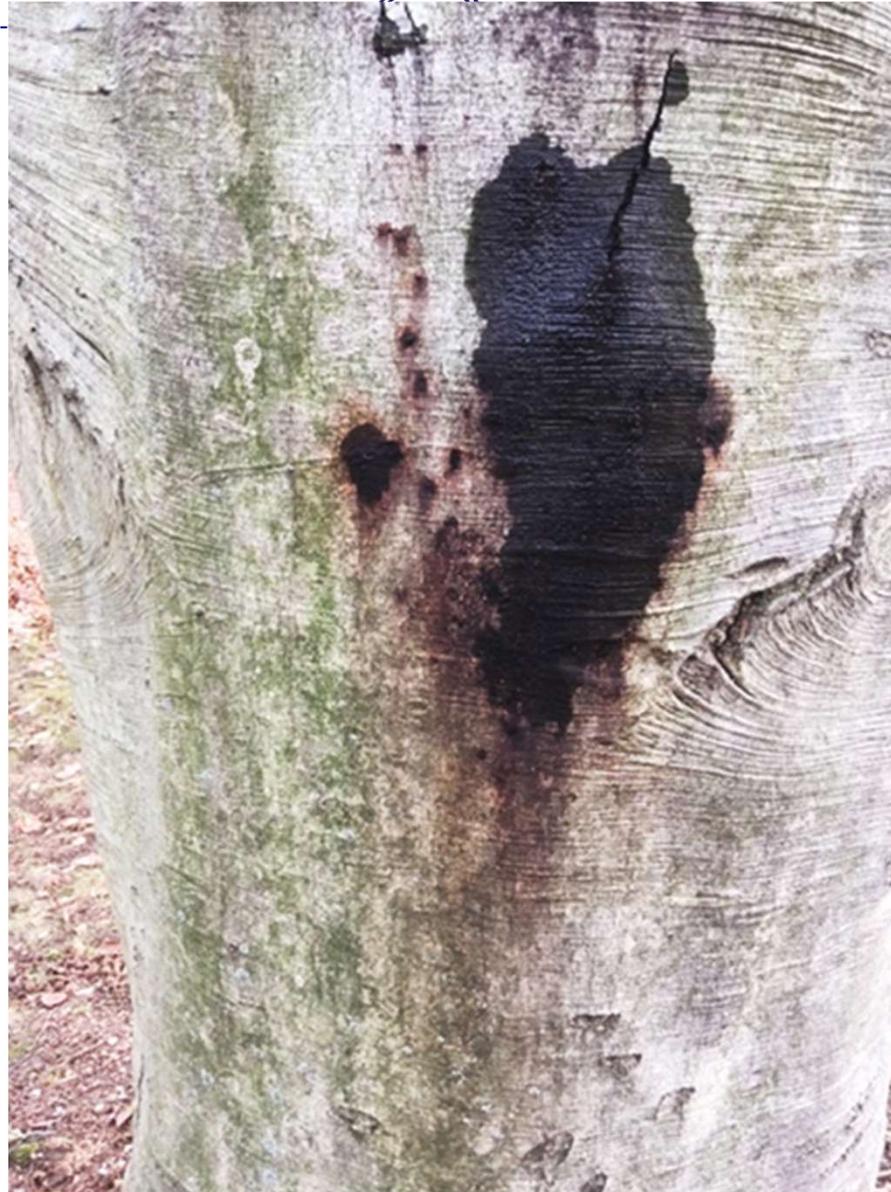
Canker

100



Beech bark disease

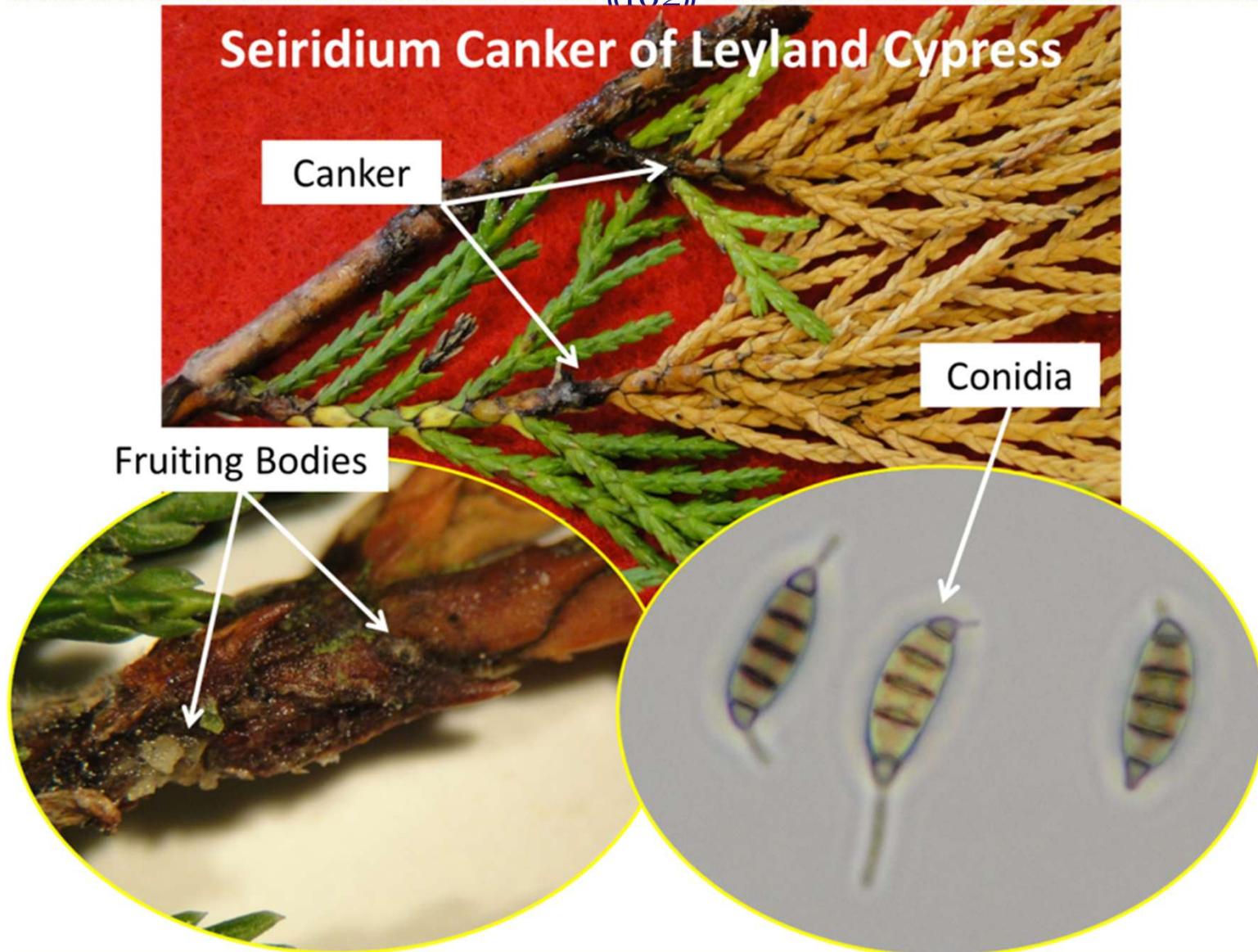
Canker



Bleeding canker of beech

Canker

102



Seiridium canker of Leyland cypress

Development of Canker Diseases

103

- Local infection
- On branches, limbs, or trunks
- Infect through injury (frost, pruning wounds, broken branches, and insect injury)
- Transmitted through water splash, insect, and pruning tools
- Overwinter on infected trees (perennial canker)
- Stressed trees are more vulnerable

Management of Canker Diseases

104

- Fungicide treatments are not effective
- Prune and destroy symptomatic branches
- Avoid wounds and pay careful attention to pruning techniques
- Maintain tree vigor by managing water and nutrients

Vascular Diseases

105



Verticillium wilt of maple

Vascular Diseases

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Dutch elm disease

Vascular Diseases

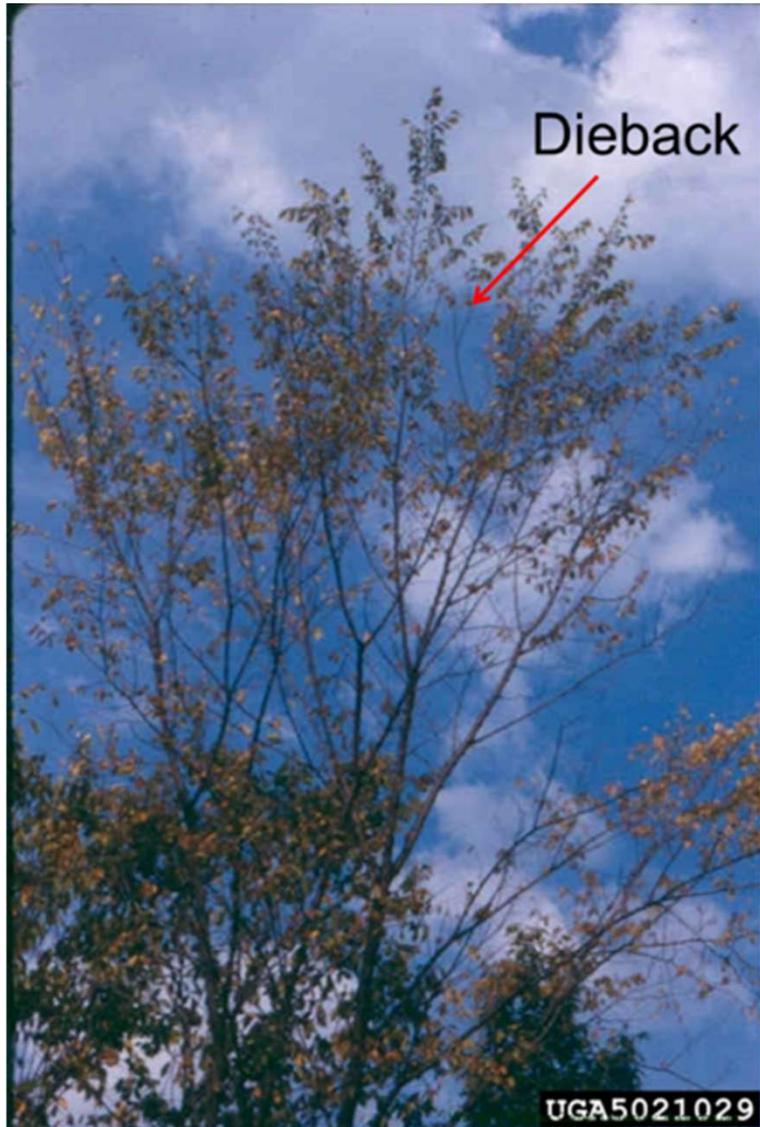
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Dutch elm disease

Vascular Diseases

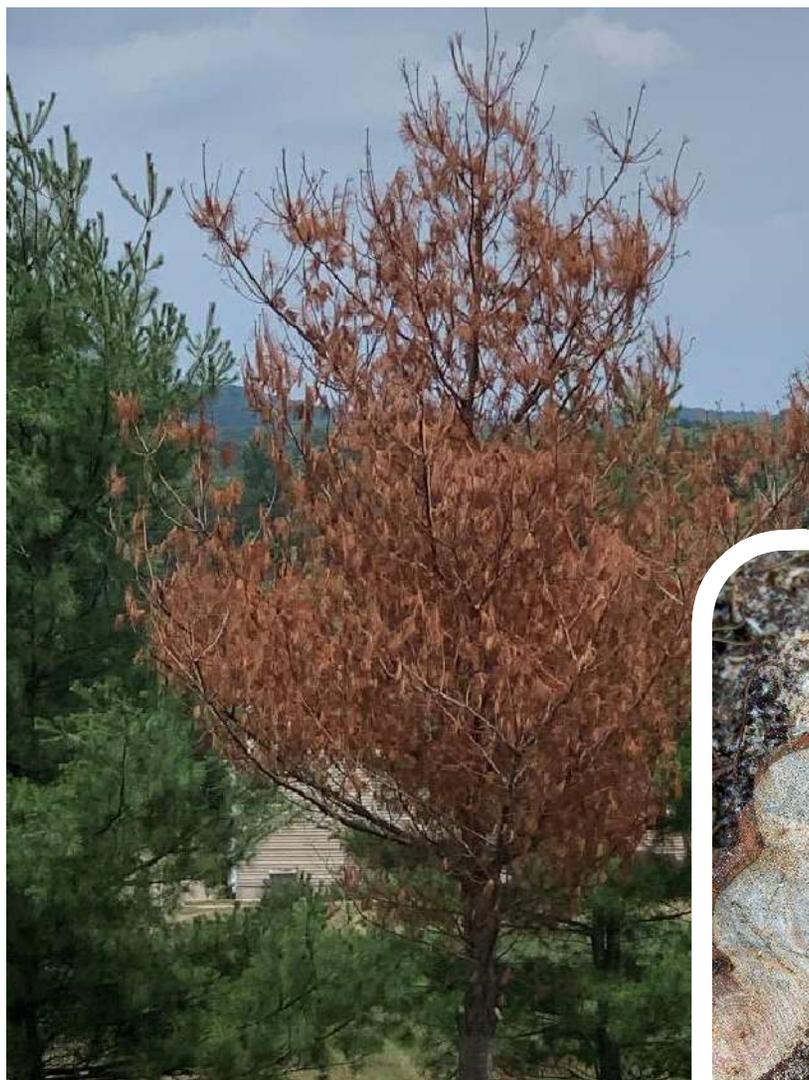
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Elm yellow

Vascular Diseases

109



Pine wilt

Development of Vascular Diseases

110

- Systemic diseases
- Infected through wounds on roots, stems, or branches
- affect water and nutrient transportation
- Survive and overwinter in infected trees and soil
- Transmitted via soil, insect, pruning tools, or root grafts

Management of Vascular Diseases

111

- Plant resistant species/varieties when possible
- Maintain plant vigor by cultural practices
- Prune/remove affected branches/limbs (DED)
- Disinfect pruning tools
- Control insects
- Fungicide injection or drench - preventative

Root Rot

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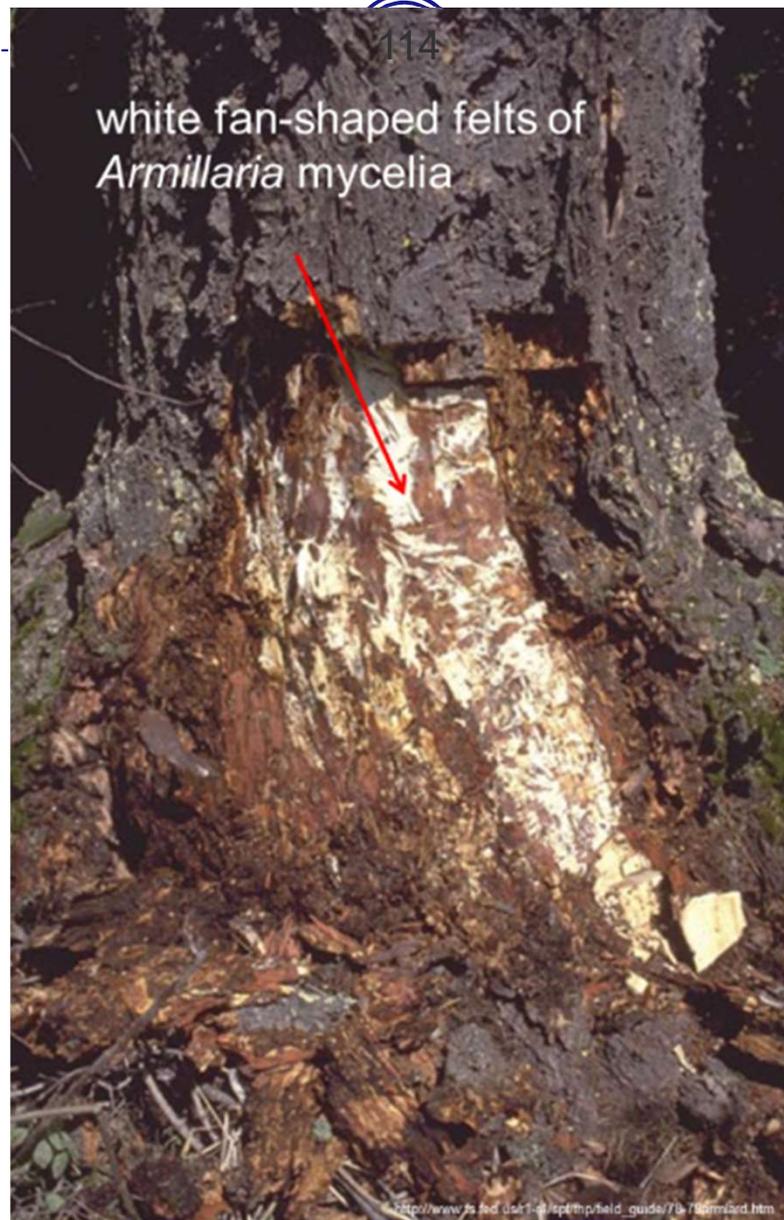
Armillaria root rot of Douglas fir

Root Rot



Armillaria root rot of Douglas fir

Root Rot



Armillaria root rot of Douglas fir

Root Rot

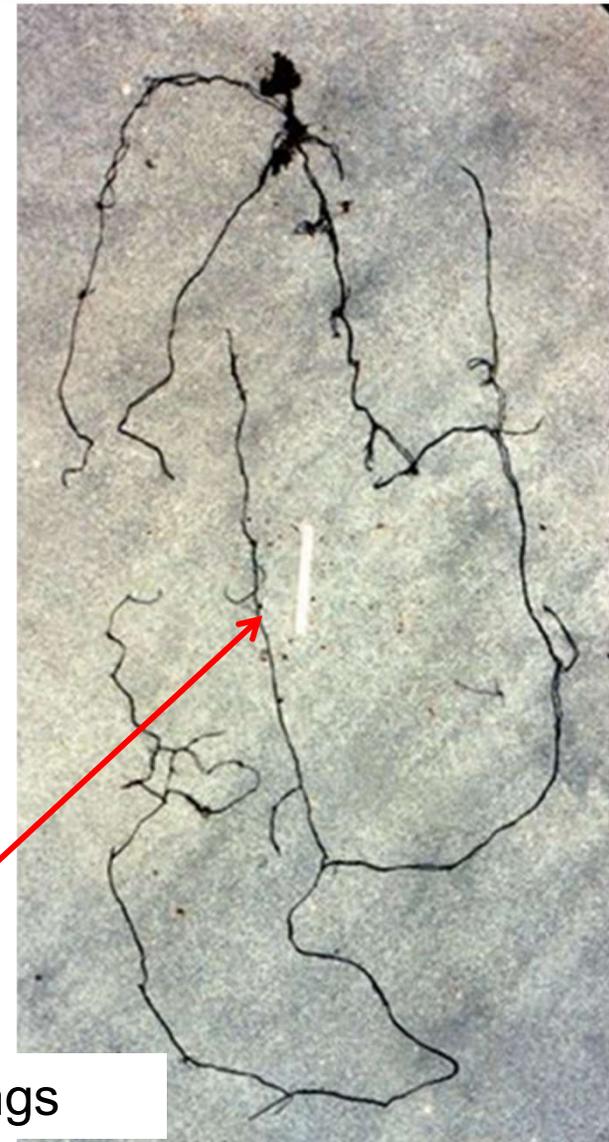
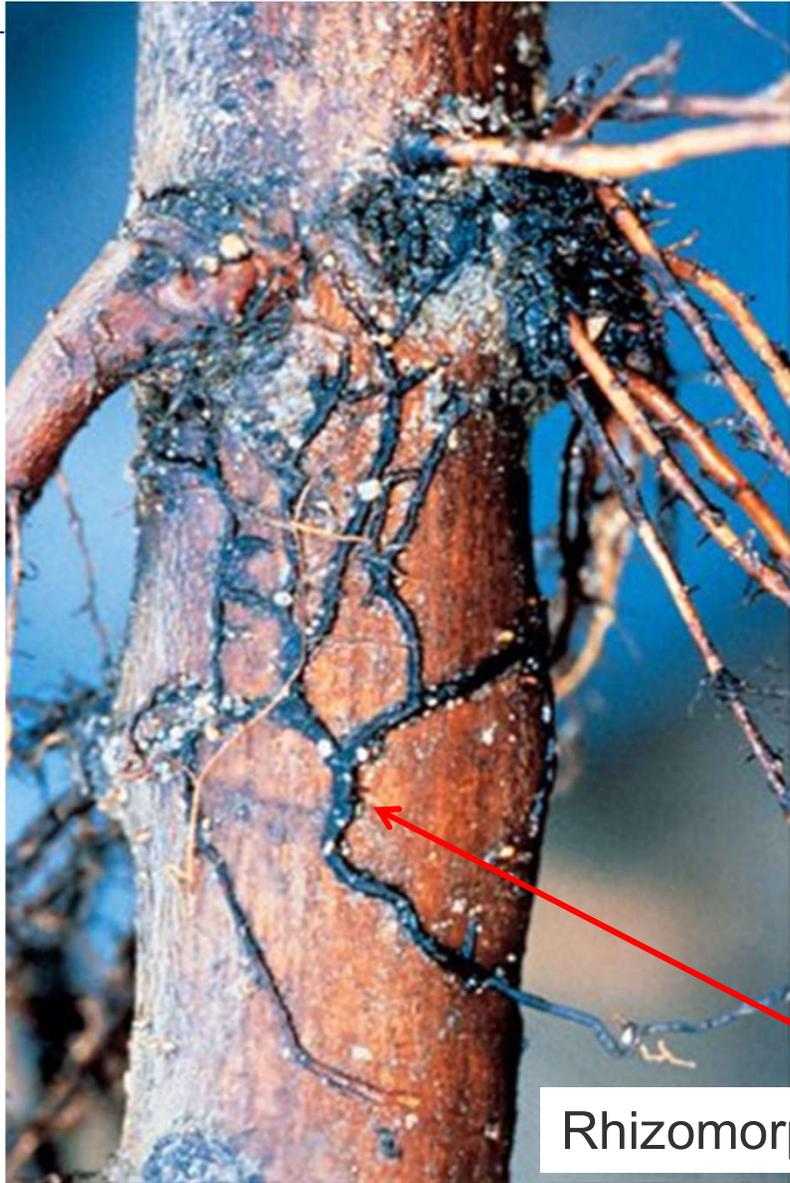
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Armillaria root rot of Douglas fir

Root Rot

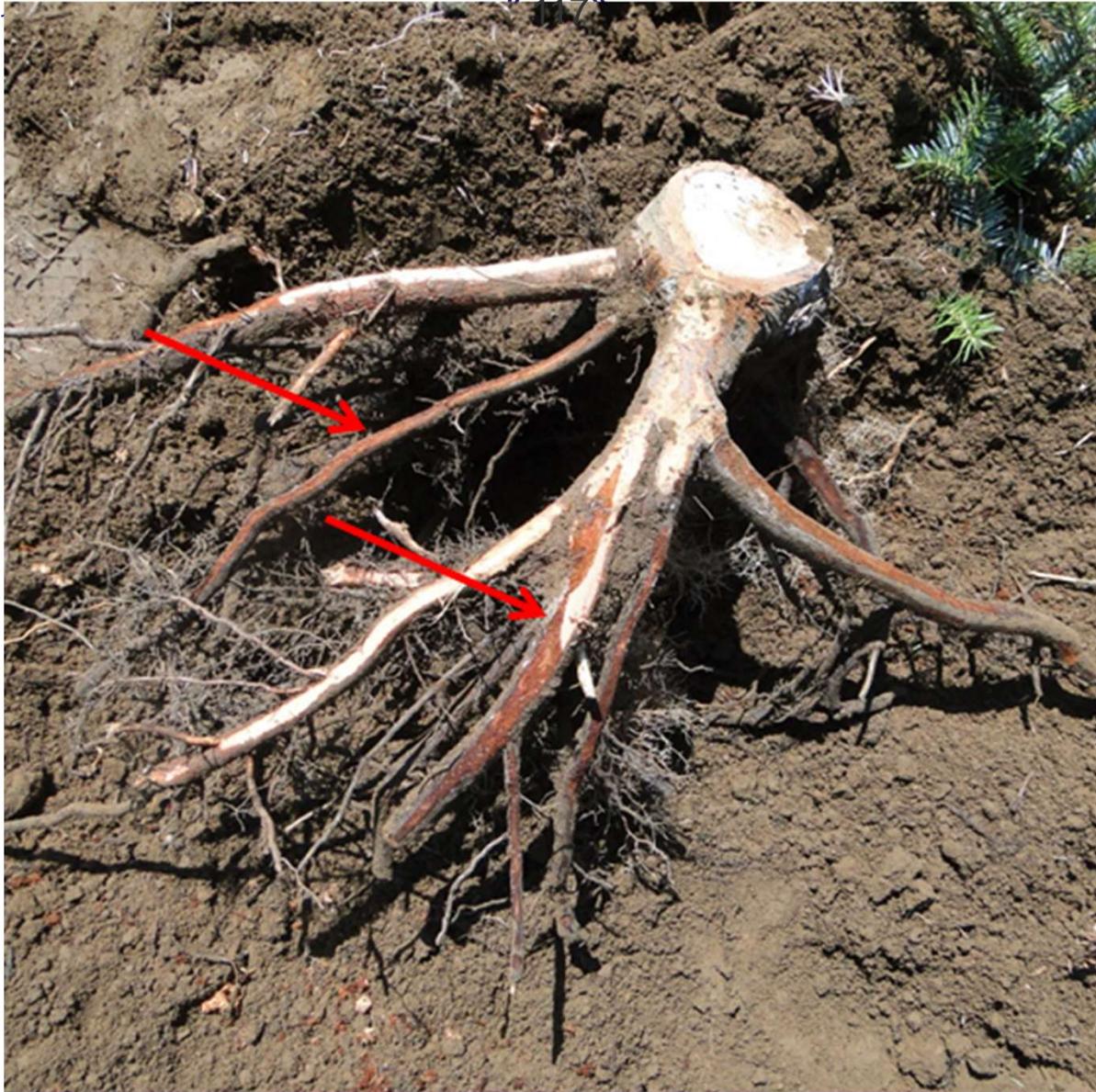
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Rhizomorphs - shoestrings

Armillaria root rot of Douglas fir

Root Rot



Phytophthora root rot of fir

Root Rot

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Phytophthora root rot of fir

Root Rot



Phytophthora root rot of fir

Root Rot

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Phytophthora root rot of yew

Development of Root Rot Diseases

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- Overwinter in diseased roots and soil
- Transmitted via soil, running water, insects
- Favored by poorly drained and compacted soil

Management of Root Rot Diseases

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- No cures once infected
- Avoid soil moisture extremes (drought or wet)
- Maintain tree vigor
- Remove and destroy affected trees
- Use resistant species
- Fungicide injection or drench - prevention