RECOGNIZING AND MANAGING PHYTOPHTHORA ROOT ROT… AND OTHER CONIFER DISEASES

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DISEASE

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

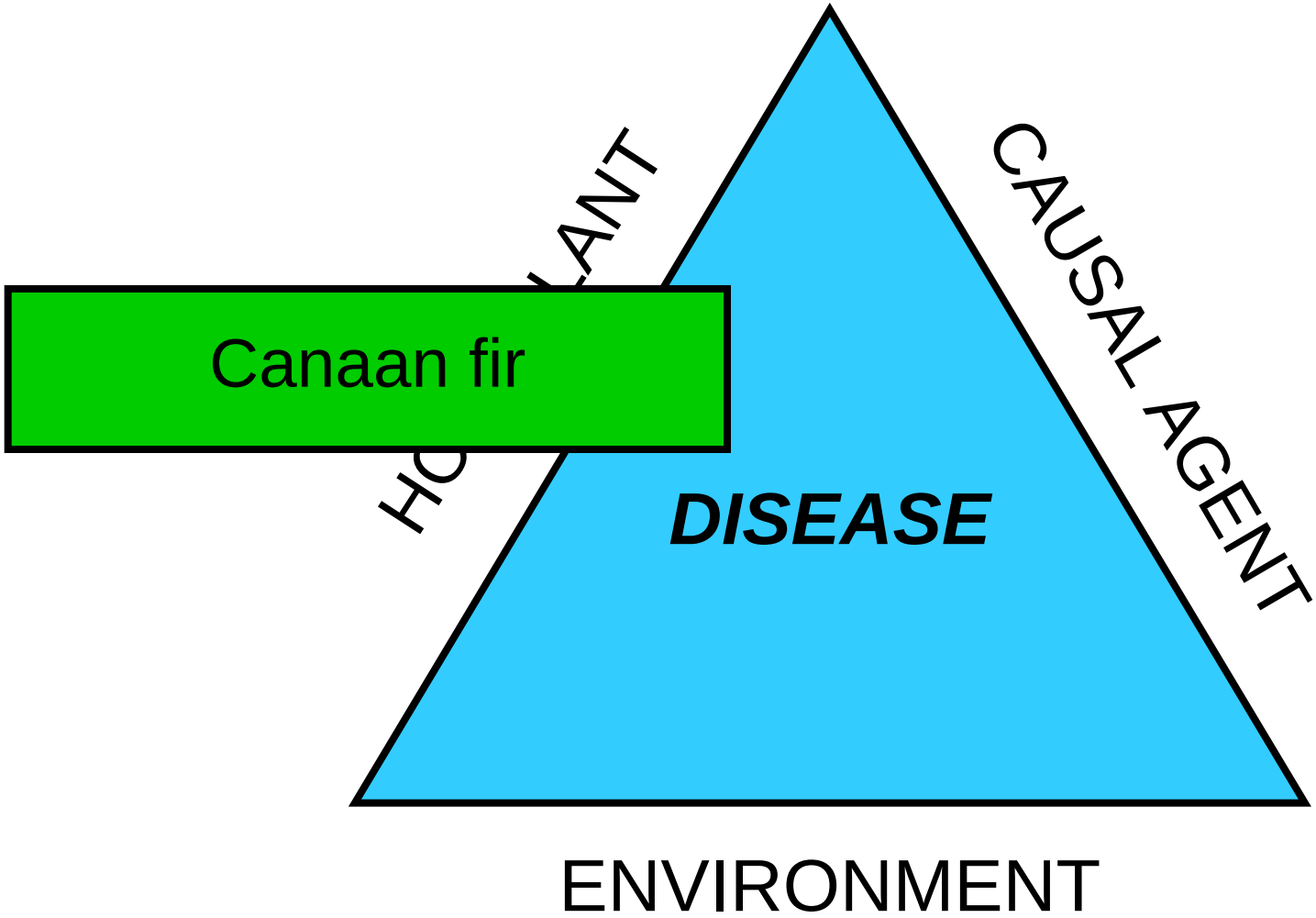
Dynamic
Continuous

INJURY

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

Lightning
Frost

DISEASE TRIANGLE



Canaan fir

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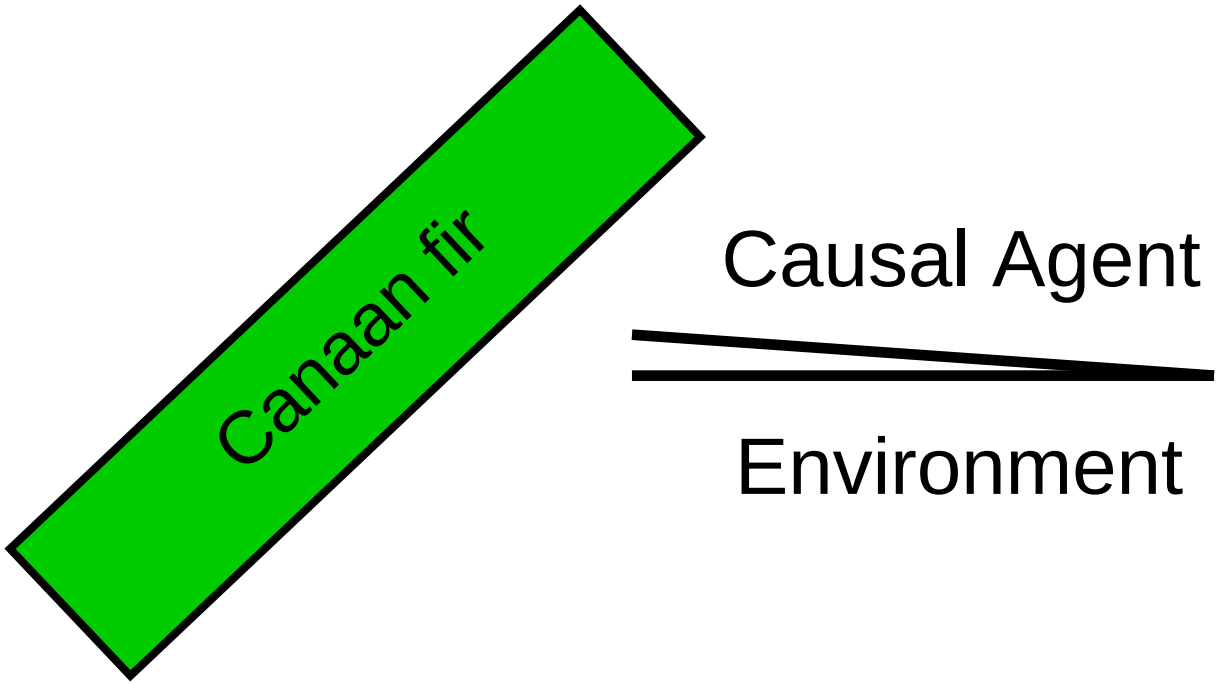
DISEASE TRIANGLE



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TREE 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
4. Phytoplasmas
5. Nematodes

DISEASE MANAGEMENT

- Accurately identify the disease.

Sirococcus Blight

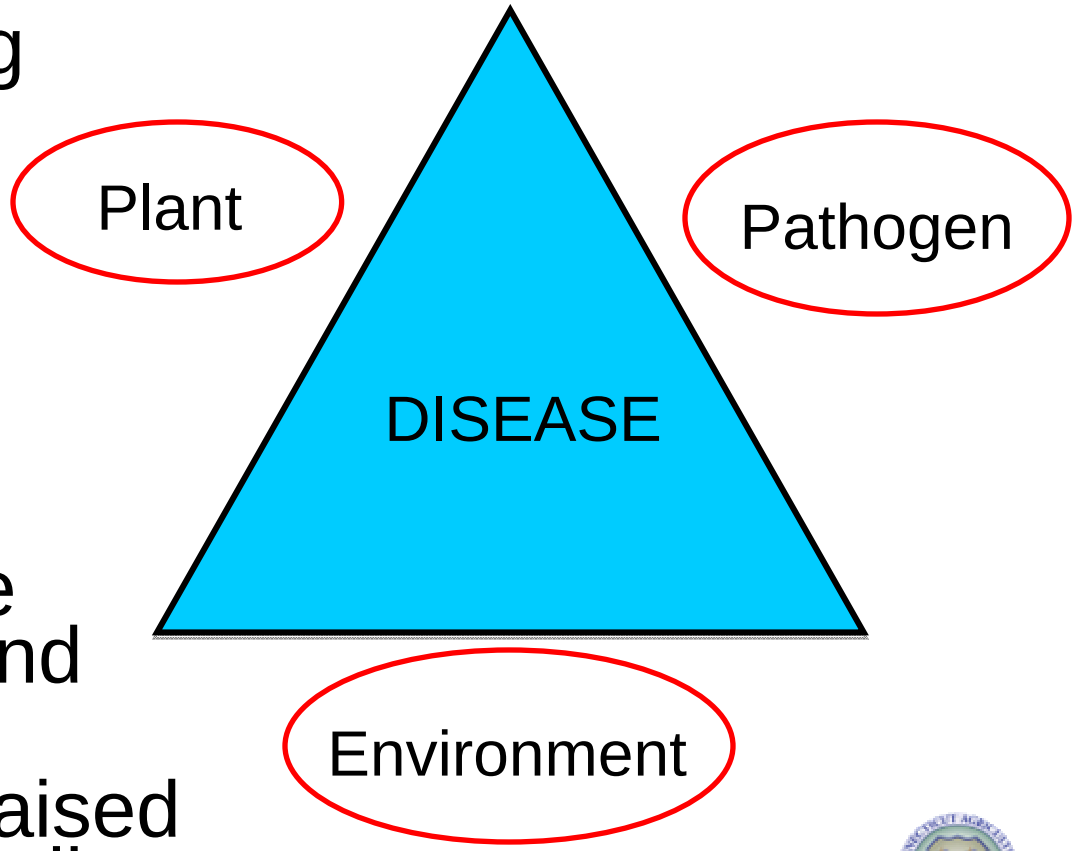
Rhizosphaera Needlecast

DISEASE MANAGEMENT

- Develop an integrated management program.

Integrated Plant Health Management for Diseases of Conifers

- Pathogen
  - Sanitation/Pruning
  - Fungicides
- Plant
  - Resistant species
  - Optimize health
- Environment
  - Spacing to reduce needle wetness and RH
  - Site selection or raised beds to avoid standing water



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BIOTIC PROBLEMS

- Phytophthora Root Rot
- Rhabdocline Needlecast
- Autoecious (Repeating) Spruce Needle Rust

PHYTOPHTHORA ROOT ROT

- Causal Agent: *Phytophthora* spp. (fungus-like organism, water mold)
- Hosts: true fir, spruce, pine, and Douglas-fir
  - Young trees are more susceptible than older trees.

Symptoms of Phytophthora Root Rot

- Above-ground symptoms are not very distinctive.
  - Suppressed growth, poor vigor, yellowed or undersized needles, premature needle drop, branch dieback, wilt, and death of trees.
- Diagnostic symptoms can be seen at the root-crown area or roots of infected trees.
  - Discolored roots that lack root hairs.
  - Extensive resin-flow on outer bark or cracking in the root-crown area.
  - Characteristic and distinctive cinnamon-brown discoloration when cuts are made into the wood in root-crown area.

Symptoms of Phytophthora Root Rot (cont'd):

- Often associated with drainage problems and wet sites.
- The pathogen (previously called a "water mold") is soil borne, and produces motile spores that readily move in water.
- Declining trees often follow drainage patterns in plantations, especially in chronically low, wet areas or on hills.
  - Infections occur after periods of standing water or follow drainage patterns.

Phytophthora root rot may be confused with:

- Mechanical damage
- Soil compaction
- Nematode damage
- Other root diseases

Phytophthora Root Rot- Conifers

Water is a key factor for infection.

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Necrotic and chlorotic seedlings in rows where water has accumulated after transplanting.

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Phytophthora root rot in a 2+0 bed with drainage issues.

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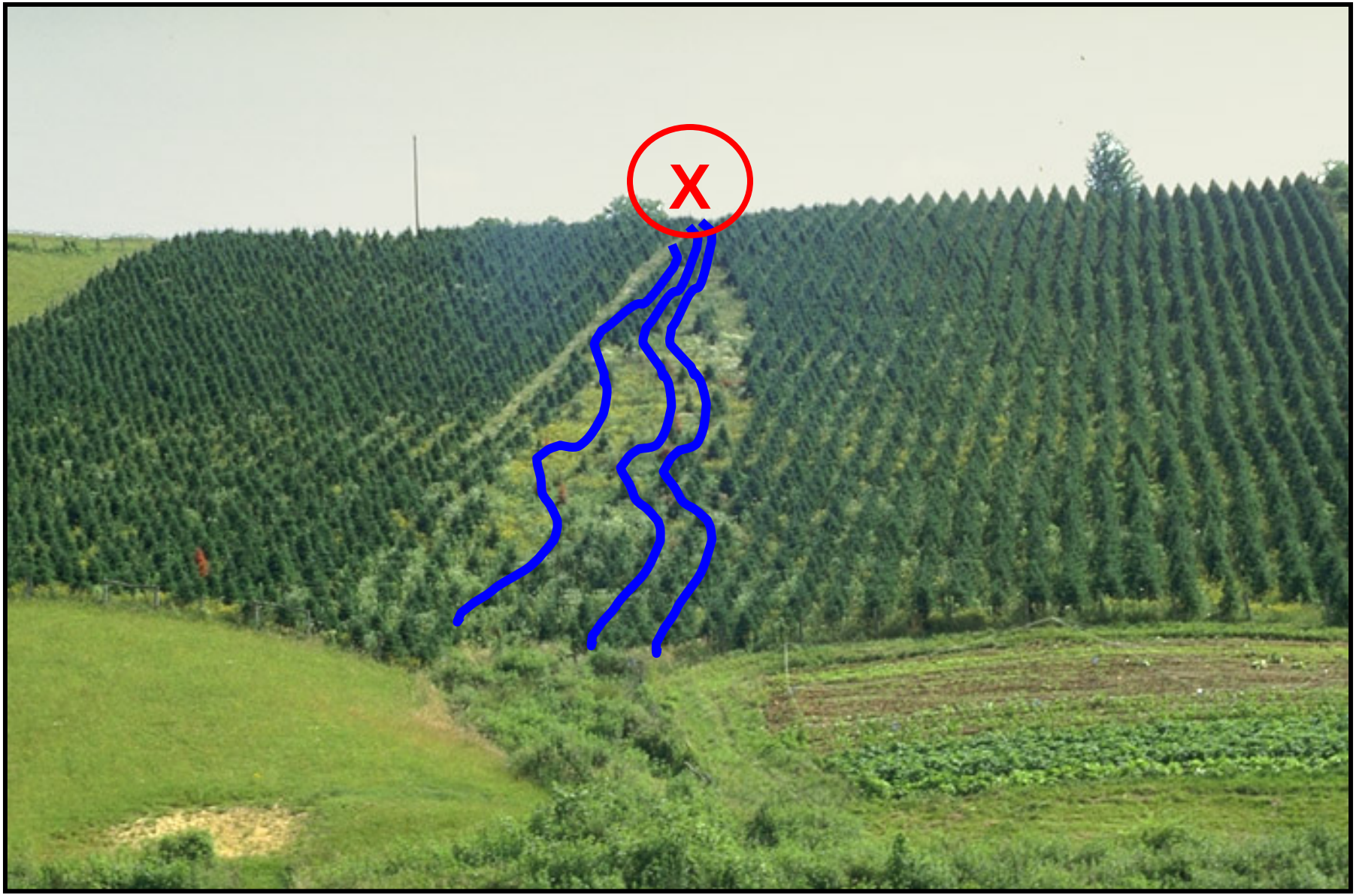
Phytophthora Root Rot- Drainage Pattern



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Phytophthora—the pathogen

- Depending on the species, two types of resistant resting structures (chlamydospores and oospores) can form in infected roots.
  - Allow the pathogen to survive in the soil during unfavorable periods of time.
- In warm and saturated soils (even for a few hours), chlamydospores and oospores germinate to form sporangia.

Phytophthora—the pathogen (cont'd):

- Sporangia form and release swimming zoospores.
- Zoospores "swim" in free water and are attracted to nearby roots, especially root tips or injured roots.
- Zoospores invade root hairs and roots.

Phytophthora—the pathogen (cont'd):

- Once in the roots, the pathogen grows and spreads to the root crown or collar.
- This causes discoloration and death of the cambium and phloem.
  - Can lead to root rot and to cankers up the stem or to girdling basal cankers.

Pathogen Movement

- Short Distance Movement:
  - Zoospores swim short distances through the water-filled soil pores and find susceptible plant tissues, based on chemical attraction.
- Long Distance Movement:
  - Zoospores swim to the soil surface, where they are carried relatively long distances by runoff water and contaminate new soils or irrigation ponds.

Phytophthora's requirement for standing water cannot be overemphasized.

- For example:
  - Planting in raised beds or berms above the level of flooded soil:
    - 4 inches above the flooded zone-- zoospore activity is reduced by 90%.
    - 10 inches or higher above the flooded zone-- no zoospore activity.

Factors That Influence Disease Development

- Many of the factors that influence disease development are unknown.
- *What we do know:*
  - Saturated soils deprive roots of oxygen and limit the tree's ability to resist infection.
  - Saturated soils are also necessary for zoospore activity.

Factors That Influence Disease Development (cont'd)

- The <u>longer</u> the soil is saturated, the more severe the infection.
- The <u>greater the number</u> of periods of saturated soil, the more severe the infection.

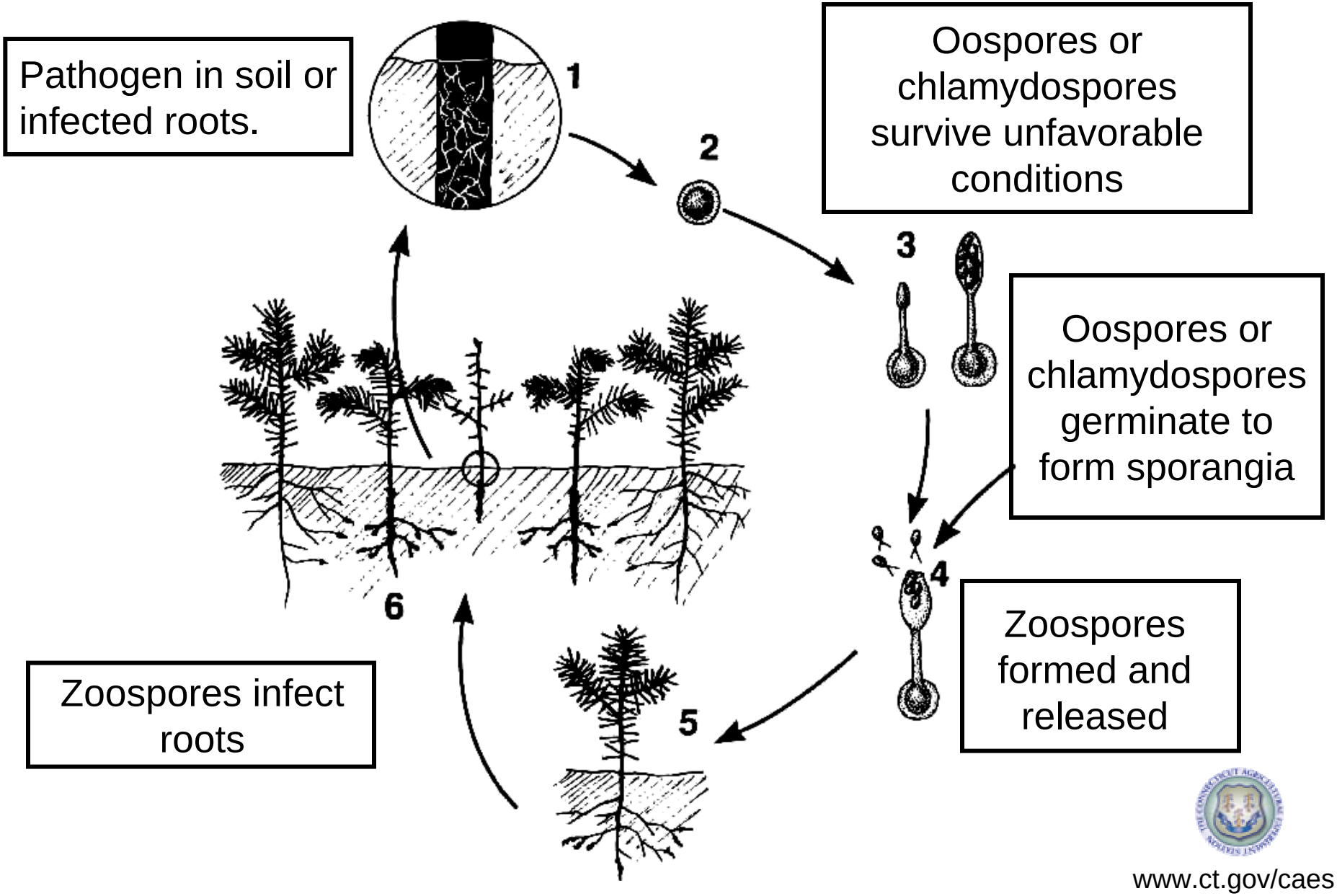
Factors That Influence Disease Development (cont'd)

- The optimum temperature for disease development varies with *Phytophthora* species.
- Optimum soil temperatures:
  - Range of **59 -77°F** for most infections, although cooler temperatures can be conducive as well.

Factors That Influence Disease Development (cont'd)

- Roots are most susceptible to infection during the spring and autumn-
  - Same time that soil temperatures are most favorable for zoospore production and activity.
- When trees are dormant, rootstock susceptibility and pathogen activity are both low.

Life Cycle of Phytophthora



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Sporangium of *Phytophthora*

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Oospore of *Phytophthora*

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Chlamydospores of *Phytophthora*

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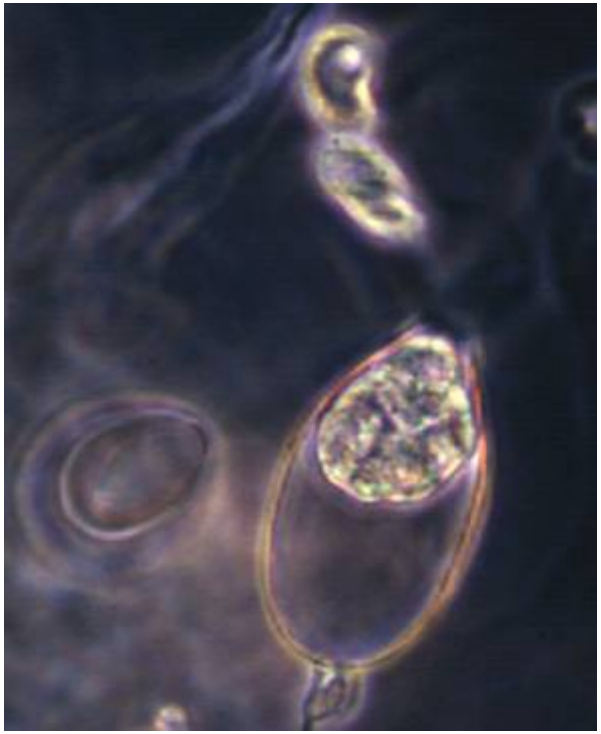
Release of Zoospores

Sporangium

Zoospores form inside the sporangium vesicle



Zoospores are released and swim in soil water

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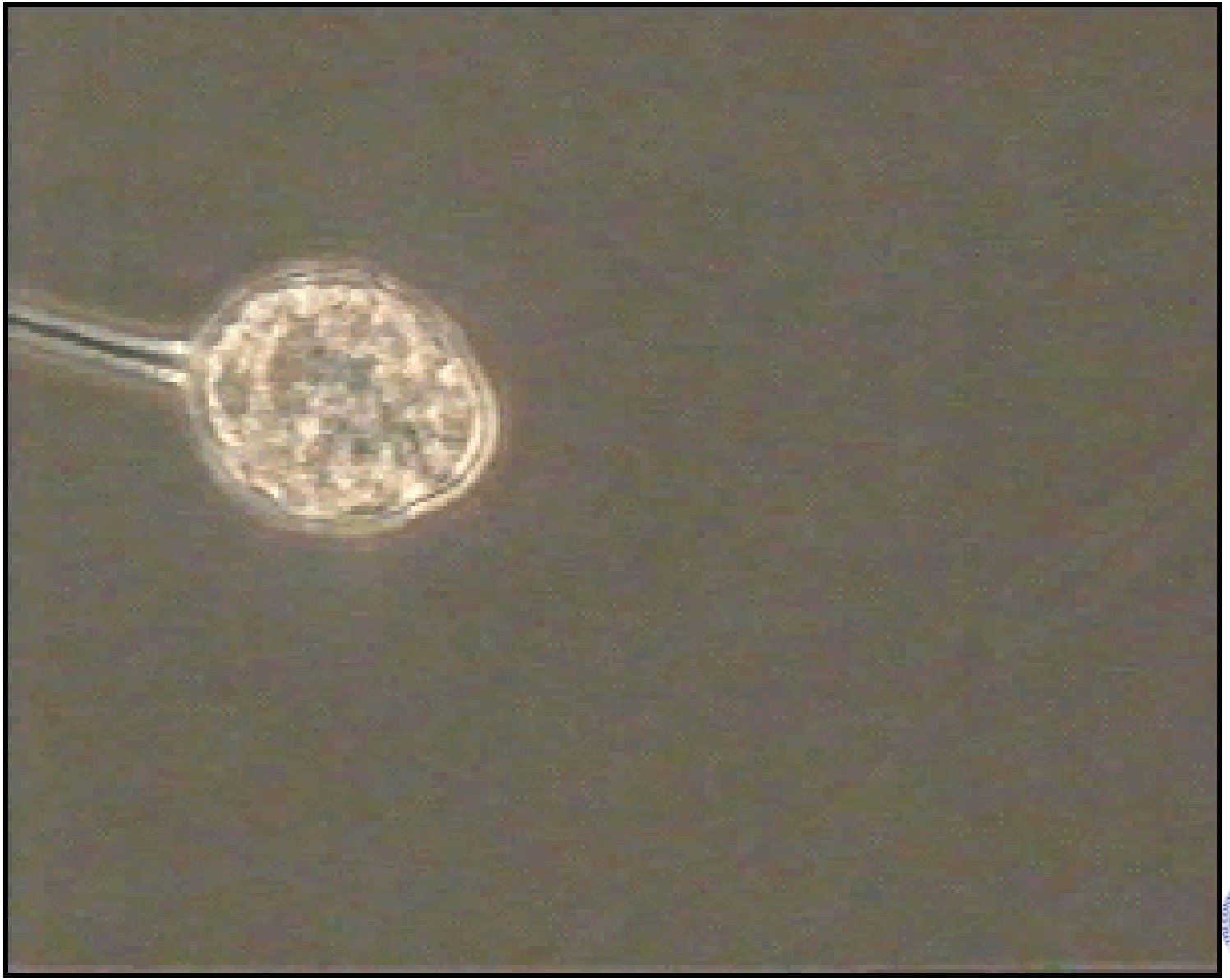
Release of motile zoospores



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Progression of symptoms of *Phytophthora* root rot.

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Wilting and necrosis of inoculated Fraser fir seedlings

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Seedlings with Phytophthora root rot

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Phytophthora Root Rot- Noble Fir

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Phytophthora Root Rot- Noble Fir

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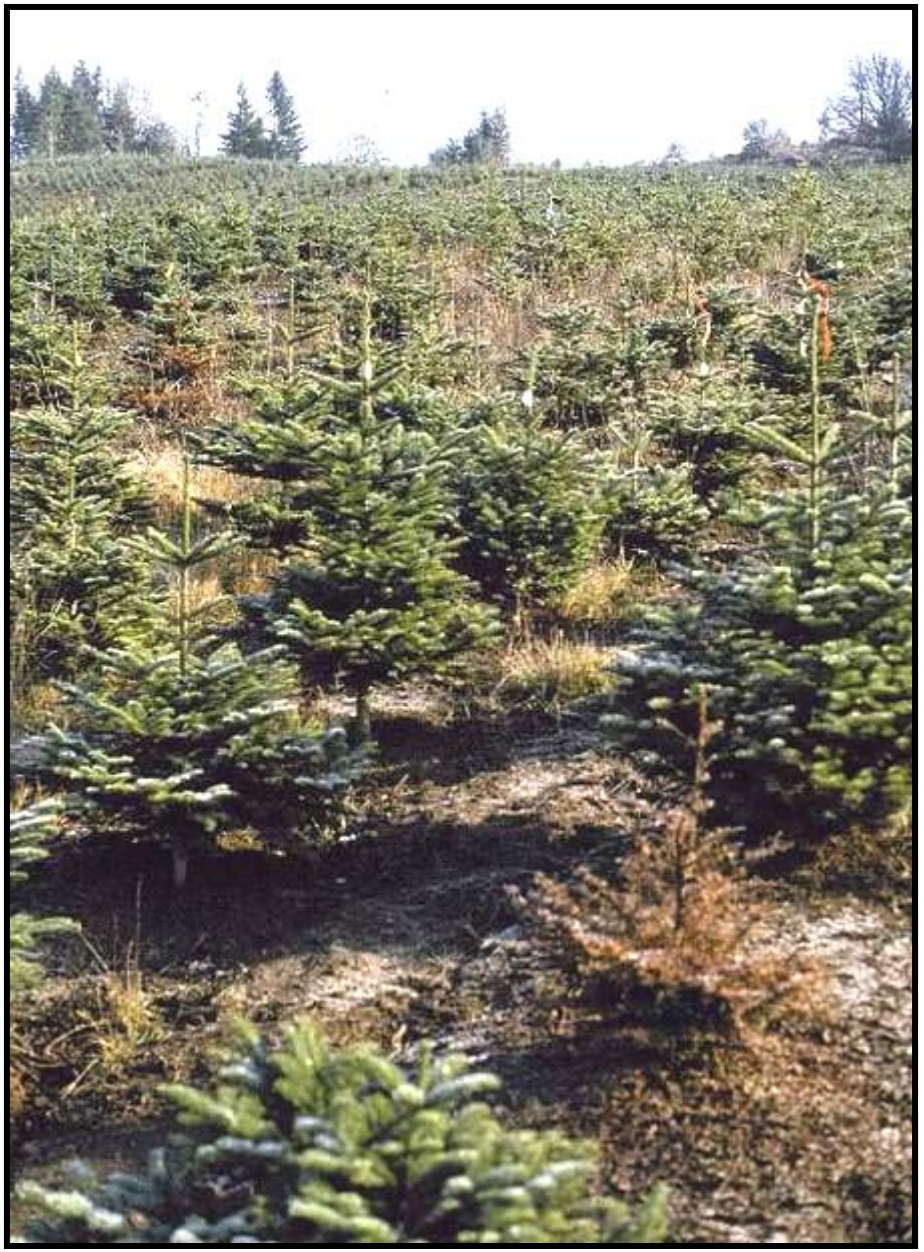
Root rot symptoms throughout field.

Severe Phytophthora Root Rot- Fraser Fir

Field with clay hardpan 12-15” below the surface- water is held around the roots, which provides conditions for infection.

Random Dieback in a Block



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Cracking and resin-flow on outer bark at base of infected tree.

Diagnostic discoloration of the cambium.

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Stem canker moving up the side of a noble fir tree.

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Diagnostic discoloration of the inner bark and cambium.

Management of Phytophthora Root Rot:

- Use pathogen-free, healthy stock and carefully inspect transplants prior to planting.
- Avoid planting in poorly drained sites or take steps to modify or improve drainage.
- Maintain vigor by proper fertilization (based on soil tests) and planting practices.

Management of Phytophthora Root Rot (cont'd):

- Rogue and remove symptomatic trees.
- Once Phytophthora root rot is detected in a block, work in that block last and decontaminate equipment and boots to minimize spread to other areas.
- Avoid 2nd or 3rd rotations of susceptible species.
- Select resistant species.

Relative susceptibility of true firs to Phytophthora Root Rot

- Extremely susceptible: Noble, white (concolor) and Shasta firs
- Highly susceptible: Fraser fir
- Intermediately susceptible: balsam, Veitch, Momi, Korean, and European silver firs
- Least susceptible: Turkish, Nordmann, grand, Nikko, and Canaan firs

Management of Phytophthora Root Rot (cont'd):

- Fungicides:
  - Fungicides are not curative--infected trees cannot be cured.
  - Healthy, uninfected plants adjacent to symptomatic plants can be *protected* with fungicides.
  - Fosetyl-Al (Aliette), mefenoxam (Subdue MAXX), and phosphorous acid or mono- and di-potassium salts of phosphorous acid (Alude, Magellan, Fosphite).

Management of Phytophthora Root Rot-- NC Study

- Bottom Line:
  Without adequate drainage, fungicides
  aren't very effective.

Promising Research- Mulches

- NC Study: Mulched organic materials (e.g., from hard wood trees, shrubs, and other plant material) as top applications to Fraser fir plantings.
- Preliminary results:
  - Average disease ratings were significantly lower in mulched compared to unmulched plots in 5 different sites.
  - Analyzing soil and mulch for chemical and biological properties.
  - Future--Combo of mulch and fungicides??

Promising Research- Resistance

- Several researchers are looking at additional species, clones, and seed sources of Himalayan fir, Toros fir, Siberian fir, King Boris fir, Greek fir, and Chinese fir for possible *Phytophthora* resistance.
- Other researchers are looking at grafting susceptible species onto resistant rootstocks.

RHABDOCLINE NEEDLECAST

- Causal Agent: *Rhabdocline* spp. (fungus)
- Hosts: Douglas-fir

Symptoms

- First apparent in late fall or early winter as yellow spots or flecks on one or both surfaces of current-season needles.
  - Often confused with feeding damage from the Cooley spruce gall adelgid.
- The chlorotic spots gradually turn reddish-brown and enlarge.
- Discolored needles are most conspicuous in early spring.

Symptoms (cont'd):

- Distinctive diagnostic symptom is the sharp border between the healthy green tissue and the infected brown tissue.
- In late spring, fruiting structures develop beneath the epidermis on the lower surface of the needle.
- The epidermis eventually splits open, usually in two longitudinal lines, and exposes the spores of the fungus.

Symptoms (cont'd):

- Spores are carried by rain and wind to newly expanding needles.
- Symptoms are often most severe in the lower portion of the tree where air circulation is poor.
- One infection cycle per year.

Rhabdocline Needlecast

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Rhabdocline Needlecast

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Discoloration and banding of current season needles in spring.

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Diagnostic banding pattern in late winter or early spring

Spring symptoms- brown bands

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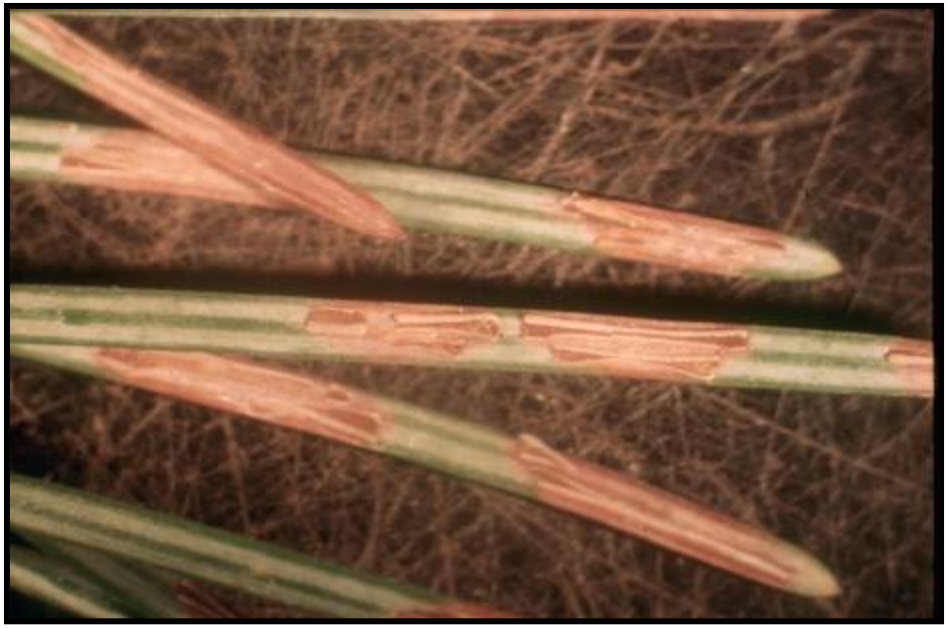
Diagnostic symptoms-lower epidermis splits longitudinally

Diagnostic symptoms-lower epidermis splits longitudinally



Bare twigs after needles drop in spring

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Spores of the Rhabdocline fungus

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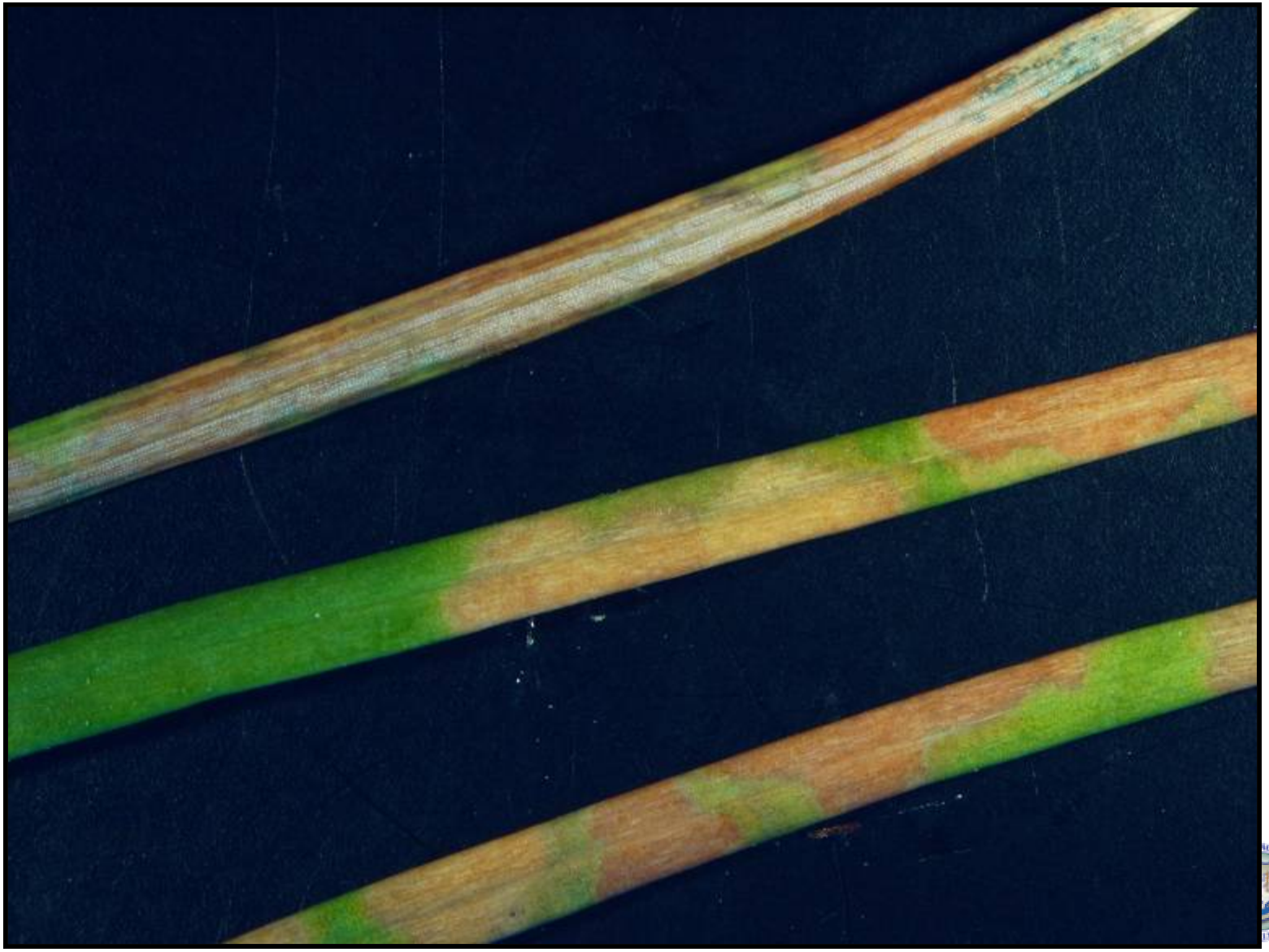
“Pre-diagnostic” symptoms



Early season detection--fungal mycelium growing inside the needle.

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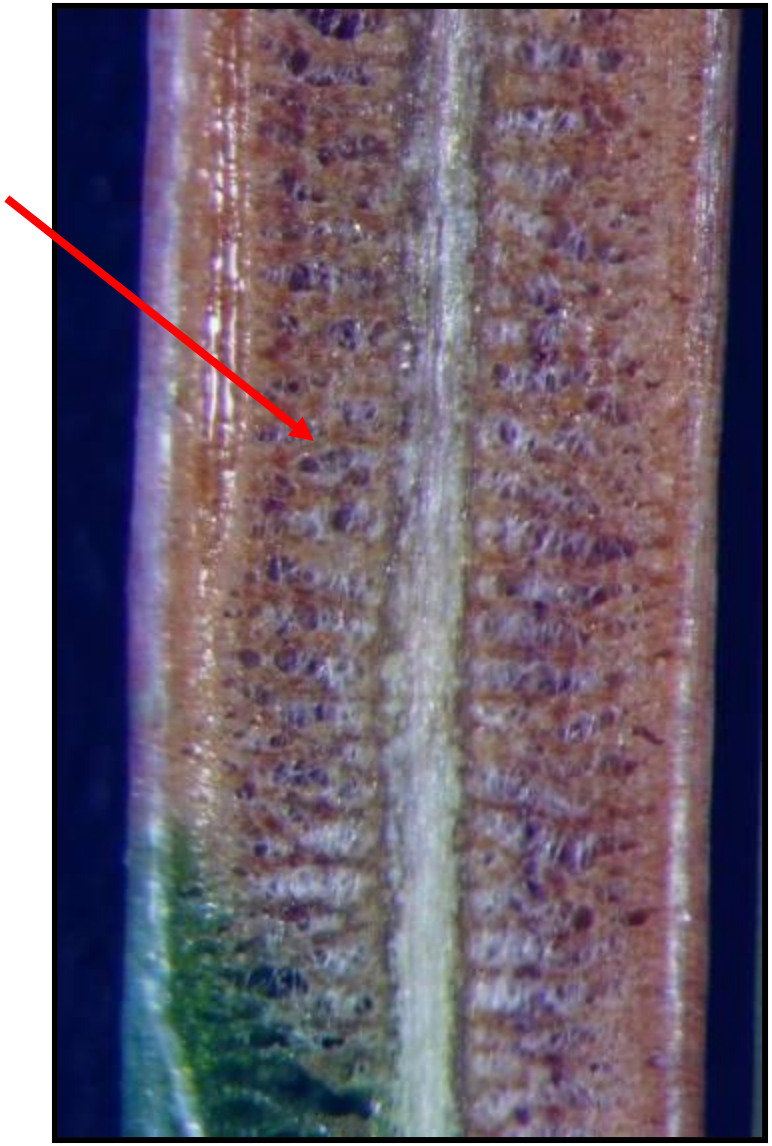
Early season detection

Infected



Healthy

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Management of Rhabdocline Needlecast:

- Use pathogen-free stock and maintain tree vigor.
- Select an appropriate planting site (slopes with good air drainage) and control weeds to promote air drainage and drying conditions for lower branches.
- Rogue severely symptomatic trees.

Management of Rhabdocline Needlecast (cont'd):

- Practice good sanitation.
  - Prune and remove any dead or dying branches.
- Not necessary to remove prunings for Rhabdocline-the fungus does not develop on branches cut from tree.
- Work with healthy trees first.
  - Avoid working with trees when they are wet.
- Use resistant varieties when possible.
  - Species and seed sources can vary.

Management of Rhabdocline Needlecast (cont'd):

- Most resistant: Shuswap and Pillar Lake.
- Moderately resistant: Santa Fe, Silver Creek, and Coville.
- Most susceptible: San Isabel, Lincoln, Apache, Cibola, Kaibob, and Coconino.

Management of Rhabdocline Needlecast (cont'd):

- Fungicide sprays.
  - Coverage is **very** important!
  - Begin applications when new growth is emerging (~½" long).
  - Sprays should continue (7-14 day intervals) until needles are fully elongated and conditions are no longer favorable for disease.

Management of Rhabdocline Needlecast (cont'd):

- Chlorothalonil (Bravo, Daconil 2787, Daconil Ultrex, Daconil Weather Stik)
- Chlorothalonil + fenarimol (TwoSome)
- Thiophanate methyl + chlorothalonil + mancozeb (Spectro 90 WDG)
- Mancozeb (Dithane, Protect)

AUTOECIOUS (REPEATING) NEEDLE RUST:

- Causal Agent: *Chrysomyxa weirii* (fungus)
- Hosts: white, black, and blue spruce

Symptoms

- First appear as yellow spots or flecks on one-year-old (occasionally two-year-old) needles in late winter and early spring.
- Spots develop into pustules or blisters (telia) that contain yellow-orange spores (teliospores).
- The teliospores then produce another type of spore (basidiospores)-
  - These are blown by wind and splashed by rain onto newly emerging needles of the same tree or of adjacent trees.

Symptoms (cont'd):

- New infections occur when needles are tender and immature in spring.
- Infections usually aren't visible until the following spring.
  - Diagnostic yellow spots and blisters develop and swell.

Symptoms (cont'd):

- Blisters of *C. weirii* can be extensive and appear on both one- and two-year-old needles.
  - Heavily infected trees appear yellow-orange from a distance in spring.
- Infected needles usually drop prematurely.

Off-colored 1 yr-old needles in late winter.

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Early symptoms of infection

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Rust pustules visible in spring at bud swell.

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Rust pustules breaking open

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Close-up of rust spores

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Teliospores

Management of Repeating Spruce Needle Rust:

- Use healthy stock and maintain tree vigor.
- Fertilize at the proper time and rate as determined by a soil test--avoid excessive nitrogen and late- summer and early-fall fertilization.
- Rogue and remove heavily infected trees to reduce inoculum.
- Work with healthy trees first.
  - Avoid working with trees when they are wet.

Management of Repeating Spruce Needle Rust (cont'd):

- Fungicide sprays.
  - **Coverage and timing** are **very** important.
- Although rust is not specifically listed on the label, chlorothalonil (Daconil 2787, Daconil Ultrex, Daconil Weather Stik, Bravo) is labeled for spruce and is effective for control.
  - The first application should be made when 10% of the trees have broken some buds.

Management of Repeating Spruce Needle Rust (cont'd):

- Applications should then be made at weekly intervals until needles are mature or until symptomatic needles have dropped to the ground.
- This is usually 3 sprays but in years where bud break is slow and the weather is cool and there is enough free moisture on the needles for infection (as in 2009), up to 5 sprays may be necessary.

Presentation will be posted on:

Thank you.

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