

KEY DISEASES OF CONIFERS



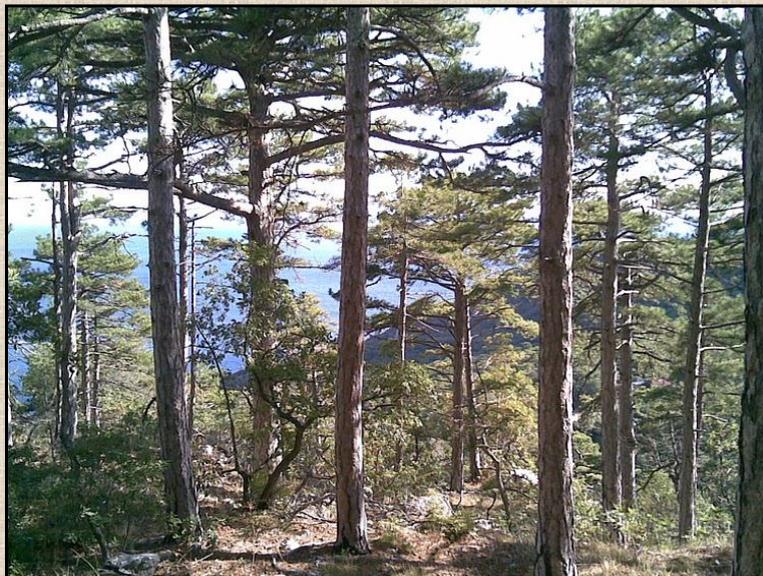
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New Haven, CT*



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Conifers in Forests



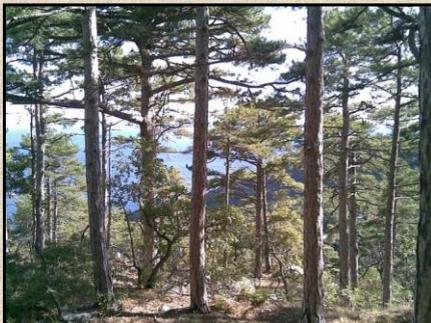
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Conifers in Landscapes



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Different Diseases



Forest



Landscape



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CONIFER HEALTH PROBLEMS

I. ABIOTIC (non-living agents)-

1. Cultural
2. Environmental

II. BIOTIC (living agents)-

1. Fungi
2. Fungus-like Organisms
3. Nematodes



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KEY DISEASES

- Needle Diseases
- Blight and Canker Diseases
- Vascular Diseases
- Root Diseases



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NEEDLE DISEASES

- High value trees lose quality.
 - Premature needle drop results in loss of aesthetics and disfigurement.
- Impact survival and vigor.
 - Conifers rely on several years of needles for their photosynthetic needs.
 - Partial defoliation for several years can weaken and disfigure trees.
 - Complete defoliation can be fatal.



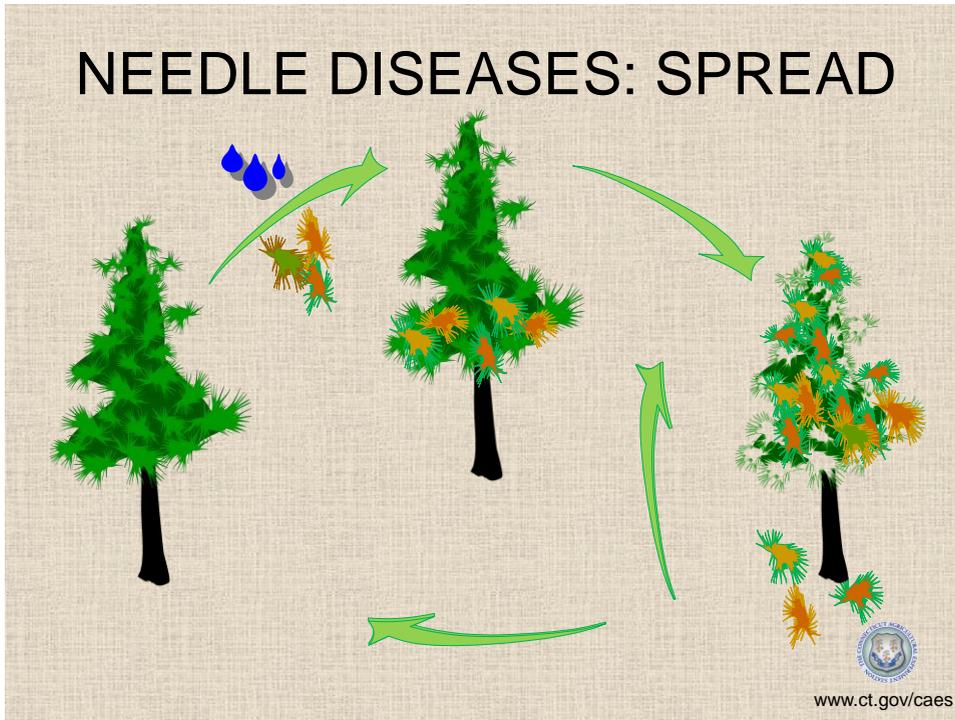
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NEEDLE DISEASES (cont'd)

- Usually not severe enough to warrant fungicide protection every year.
- Localized outbreaks occur when environmental conditions are favorable (cool, wet, spring weather when new growth is emerging).
- Conifers under stress from cultural, site, or other environmental factors are usually more susceptible.



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- ## EXAMPLES OF NEEDLE DISEASES
- Needlecasts
- Rhabdocline Needlecast
 - Canavirgella Needlecast
 - Rhizosphaera Needlecast
- Needle Rusts
- Repeating Spruce Needle Rust
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RHABDOCLINE NEEDLECAST

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



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Tree with Rhabdocline Needlecast in Late Winter



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Rhabdocline Needlecast



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Symptoms and Spread

- Symptoms first appear 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.



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Early Rhabdocline Symptoms: Chlorotic Spots in Late Summer



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Look-Alike: Cooley Adelgid Feeding Damage



Needle bending and discoloration (yellow spots).



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Symptoms and Spread (cont'd):

- The chlorotic spots gradually turn reddish-brown and enlarge during the winter.
- Infected trees appear off-colored from a distance in late winter or early spring.
- Diagnostic symptoms as visible in spring--infected needles have distinct brown bands.



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Spring symptoms- diagnostic brown bands on needles.



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Distinctive Banding Pattern



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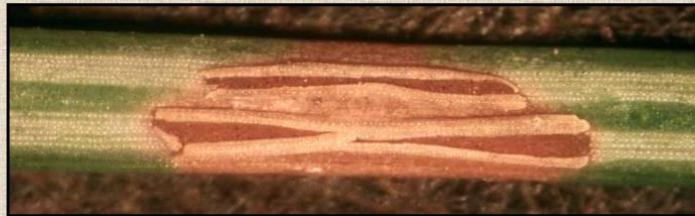
Symptoms and Spread (cont'd):

- As temperatures warm in spring, the fungus grows in the needle and splits the epidermis.
- Spores are released during wet weather and infect newly emerging needles.
- Symptoms do not appear until fall or late winter.
- Needles desiccate after they split and drop prematurely.
- Infected trees have outer shell of needles.



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Diagnostic symptoms-lower epidermis splits longitudinally.



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Bare twigs after needles drop in spring.



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CANAVIRGELLA NEEDLECAST

- **Causal Agent:** *Canavirgella banfieldii* (fungus)
- **Hosts:** Eastern white pine and Macedonian white pine



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Canavirgella Needlecast

- First reported in Pennsylvania in 1996.
 - Previously confused with acute ozone injury, stress, and other needlecast diseases.
- First detected in Connecticut in 1998.
- ***Unusually widespread throughout New England in 2010.***



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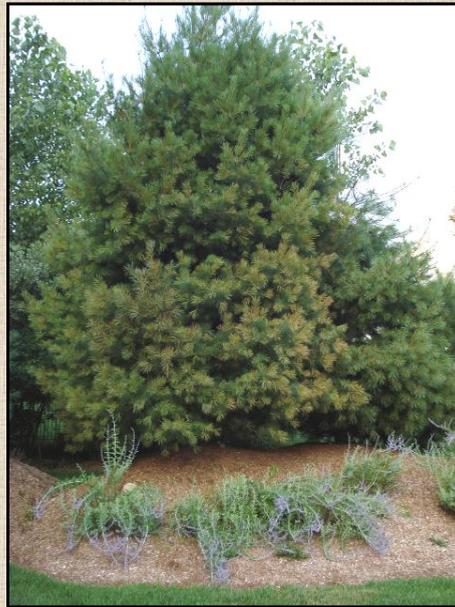
Symptoms and Spread

- Initial symptoms appear on the tips of infected current-season needles in late summer, fall, or winter.
- Needles are yellowish-tan and develop a distinct tan-brown color.
- Trees appear off-colored from a distance, when compared with healthy trees.



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Infected tree appears off-colored.



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Infected trees adjacent to apparently healthy trees.



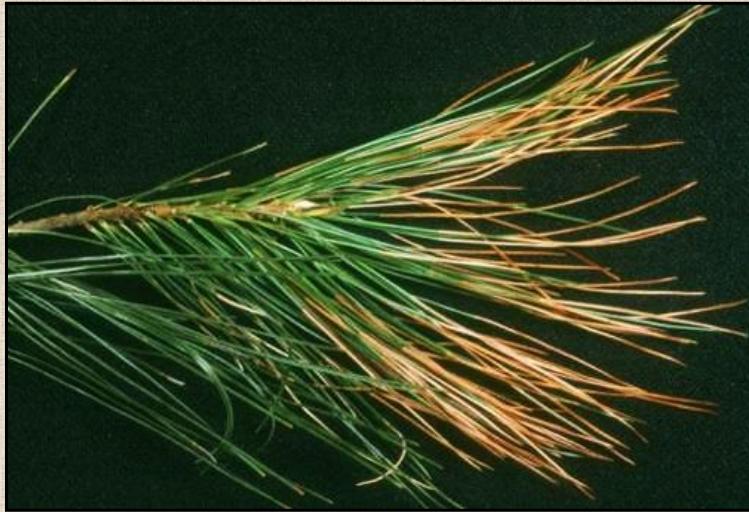
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Christmas Tree Plantation- WV



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Diagnostic symptoms-not all needles
within a fascicle are infected.



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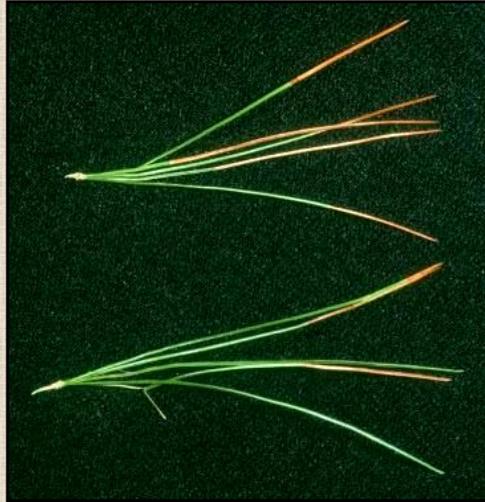
Ozone: all needles within a fascicle
affected to same level.



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Individual needles within a fascicle may have different amounts of symptomatic tissue.



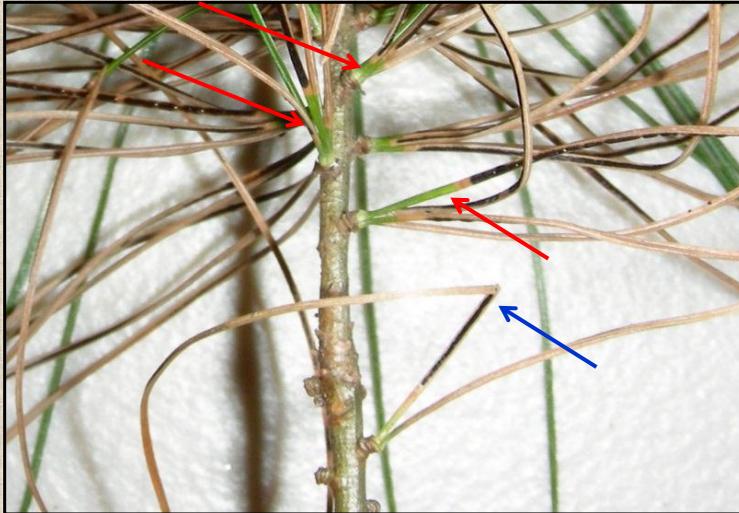
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Diagnostic, long, black fruiting bodies develop in symptomatic needles in late spring.



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Bases of infected needles remain green
and needles break off before fascicles drop.



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Symptoms and Spread (cont'd):

- Spores are released and infect new, elongating needles during periods of wet weather in spring.
- Last year's symptomatic needles dry out, break, and drop during summer.
- Infected trees have an outer shell of new, but infected, asymptomatic needles.



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Thin canopy after infected needles
have dropped in early summer.



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RHIZOSPHAERA NEEDLECAST

- **Causal Agent:** *Rhizosphaera kalkhoffii* (fungus)
- **Hosts:** Spruce (Colorado, occasionally white spruce)



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Symptoms and Spread

- First appear in late summer or fall after infection.
 - Infected current-year needles appear mottled or speckled.
- Diagnostic symptoms develop in late winter or early spring when infected needles turn brown or lavender-brown (Colorado spruce).



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Symptoms on 1-year spruce needles in late winter.



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Discolored 1-year needles



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Symptoms and Spread (cont'd):

- Fruiting bodies emerge through stomates and spores are wind- or rain-splashed to newly emerging needles.
- Infections occur, but symptoms do not develop until later in the season.
- Infection periods can be long, since spores are released from spring to autumn.



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Fruiting bodies on infected needles.



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Black fruiting bodies push out white, wax "caps" of stomates.



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Spores ooze from fruiting bodies.



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Symptoms and Spread (cont'd):

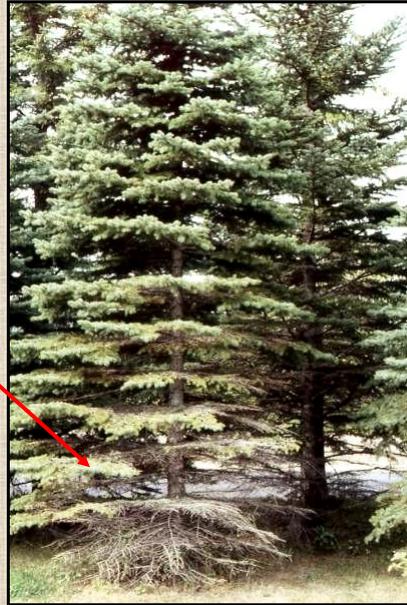
- Fungus usually attacks needles on the lower branches first, since they stay wet for longer periods.
- Usually only new, emerging needles are infected, but needles of any age can be infected on stressed trees.
- More severe on drought-stressed trees.
- Infected trees have an outer shell of needles.



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Rhizosphaera Needlecast

Fungus usually attacks needles on the lower branches first.



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Rhizosphaera Needlecast



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AUTOECIOUS (REPEATING) SPRUCE NEEDLE RUST:

- **Causal Agent:** *Chrysomyxa weirii* (fungus)
- **Hosts:** Spruce, especially Colorado (and occasionally white spruce)



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Symptoms and Spread

- 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 (fruiting bodies) that contain yellow-orange spores.
- These spores produce another type of spore that is wind- and rain-splashed onto newly emerging needles of the same tree or of adjacent trees in late spring.



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Symptoms and Spread (cont'd):

- Newly emerging needles are infected in spring, but symptoms are usually not visible until the following winter or early spring.
- Blisters can appear on both one- and two-year-old needles.
- Infected needles usually drop prematurely.
- Heavily infected trees an overall yellow-orange appearance from a distance in spring.



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Early symptoms of infection appear as chlorotic spots in winter or early spring.



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Rust pustules visible at bud swell in spring.



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Pustules break open on 1 yr needles.



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Rust pustules breaking open.



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Management of Needle Diseases:

- Maintain tree vigor by selecting the site and following sound cultural and planting practices.
- Prune and remove any dead or dying branches. Work with healthy trees first.
 - Avoid working with infected trees when wet.
- Remove severely symptomatic trees.



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Management of Needle Diseases (cont'd):

- Use resistant varieties when possible.
Species and seed sources can vary.
 - Rhabdocline: Shuswap and Pillar Lake (most resistant)
 - Canavirgella: resistance varies significantly from seed source and from tree to tree.
 - Rhizosphaera: black, Norway, and Serbian spruce (most resistant)



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Management of Needle Diseases (cont'd):

- Fungicide sprays.
 - Coverage is important.
 - Begin applications when new growth is emerging (~1/2" long).
 - Sprays should continue at label intervals until needles are fully elongated and conditions are no longer favorable for disease.



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Management of Needle Diseases (cont'd):

- Depending on diagnosis, examples of fungicides registered* for use include :
 - Chlorothalonil (Daconil Weather Stik, Docket, Manicure)
 - Copper hydroxide + mancozeb (Junction)
 - Copper salts of fatty and rosin acids (Camelot)
 - Mancozeb (Dithane, Fore, Mancozeb, Protect)
 - Thiophanate methyl + chlorothalonil (Spectro 90 WDG)

*varies by state



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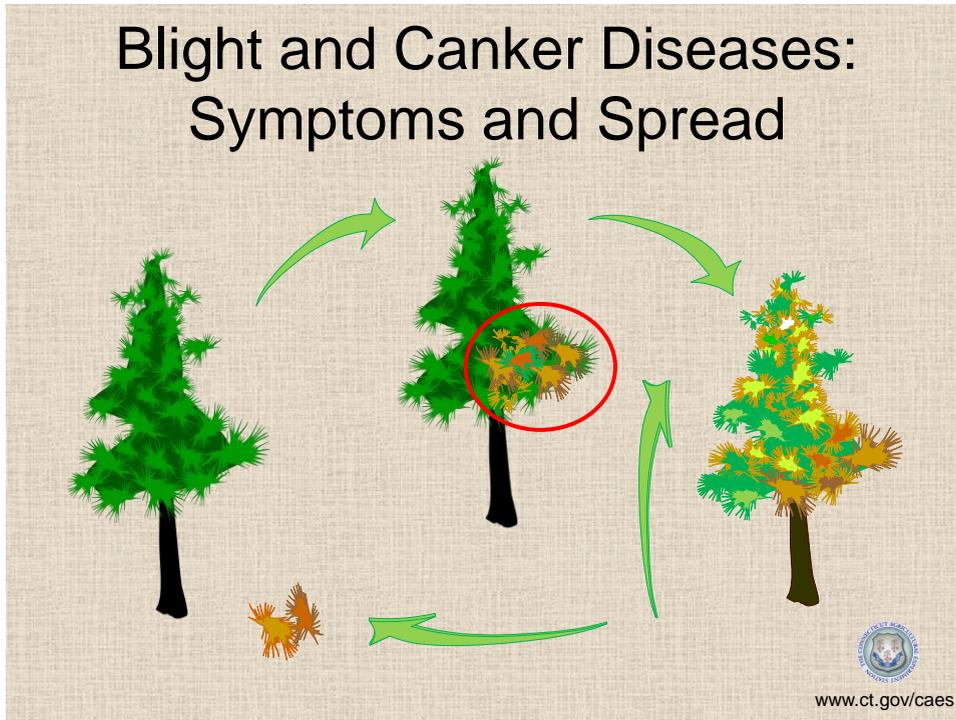
BLIGHT AND CANKER DISEASES

- Can result in moderate to severe damage, disfigurement, dieback, and tree death.
- Usually very difficult to manage, especially on trees under stress.



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Blight and Canker Diseases: Symptoms and Spread



EXAMPLES OF BLIGHT AND CANKER DISEASES

- Diplodia Blight
- Leucostoma (Cytospora) Canker

DIPLODIA BLIGHT

- **Causal Agent:** *Diplodia pinea* (fungus)
- **Hosts:** Pine (especially 2-3 needled), Douglas-fir, cedar, and spruce



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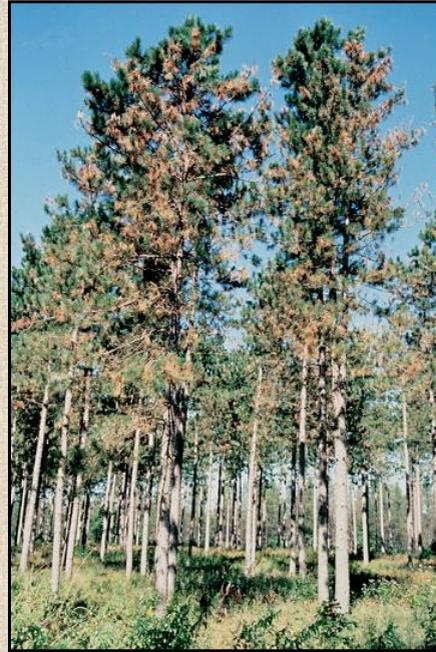
Symptoms and Spread

- Symptoms first appear on current season's shoots and needles.
- The fungus infects and rapidly kills young, succulent shoots and needles before they elongate.
- Heavily infected trees are tan or off-colored from a distance.



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Diplodia Blight



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Austrian Pine with Diplodia Blight



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Symptoms and Spread (cont'd):

- Diagnostic symptoms--stunted shoots with short, straw-colored needles and excessive resin flow.
- Fruiting structures of the fungus develop in the base of the infected needles.
 - Small, black structures with conical beaks.
- Spores of the fungus are spread during periods of rain—disease favored by wet spring weather, especially prolonged budbreak.



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Symptoms and Spread (cont'd):

- Drought-stressed trees are highly susceptible.
 - Unable to effectively “wall-off” the fungus.
- **Recent research:**
 - The fungus causes latent infections that go undetected until the tree is exposed to periods of stress, at which time the fungus is activated and typical dieback symptoms develop.



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Diagnostic Symptoms- Stunted shoots and short needles at infected tips.



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Diplodia Blight: Douglas-fir



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Infected shoot with resin on surface.



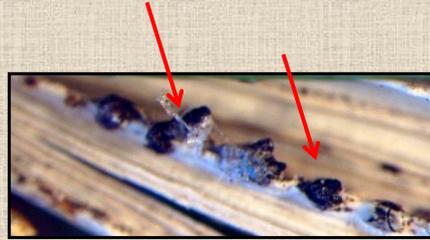
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Diplodia Blight- Discoloration of dead tip.



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Stunted Needles and Fruiting Bodies



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LEUCOSTOMA (CYTOSPORA) CANKER

- **Causal Agent:** *Leucostoma kuzei* (formerly *Cytospora*) (fungus)
- **Hosts:** Spruce (Colorado and Norway) and many conifers, including pine, hemlock, Douglas-fir, fir, and arborvitae



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Symptoms and Spread

- Symptoms include progressive dieback of twigs and branches, usually starting on older, lower limbs and then progressing up the tree.
- Infections result in cankers that appear as slightly sunken areas on branches or the main trunk.
- Resin is often associated with the cankers.



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Cytospora Canker-Sunken Cankers



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Cytospora Canker



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Symptoms and Spread (cont'd):

- Fruiting bodies develop in cankered areas and spores are released and infect during wet weather.
- If infected branches are not pruned, cankers enlarge as the fungus continues to grow in the infected tissue.



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Fruiting Bodies with Oozing Spores



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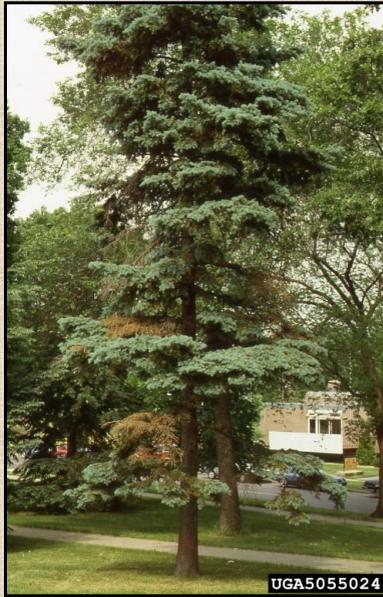
Symptoms and Spread (cont'd):

- Dead twigs and branches can remain on the tree for many years.
- Older, Colorado spruce growing out of its natural range are particularly vulnerable.
- Drought-stressed trees are also susceptible.



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Symptoms of Cytospora Canker



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Cytospora Canker Dead branches remain on tree



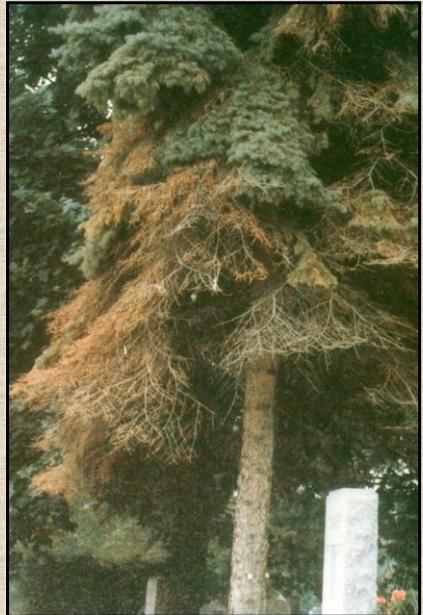

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Cytospora Canker



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Cytospora Canker



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Management of Blight and Canker Diseases:

- Avoid stress and maintain vigor by site selection and sound cultural and planting practices.
- Prune dead or dying branches when bark is dry.
- Remove severely symptomatic trees.
- Fungicides are not effective for *Cytospora* canker.



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Management of Blight and Canker Diseases (cont'd):

- Fungicides* for *Diplodia* Blight:
 - First application should be made before any bud sheaths have broken.
 - Two or three additional applications can be made at label intervals, as necessary.
 - Copper hydroxide + mancozeb (Junction), mancozeb (Dithane, Protect) and thiophanate-methyl (Allban Flo, 3336 F, 3336 WP).

*varies by state



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VASCULAR DISEASES

- These diseases involve infections of vascular tissues (xylem or phloem) that result in systemic infection and tree death.
- There is only one vascular disease of concern for conifers in the landscape.



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PINE WILT (PINE WOOD NEMATODE)

- **Causal Agent:** *Bursaphelenchus xylophilus* (nematode)
- **Vector:** Pine sawyer beetles (*Monochamus* spp.)
- **Hosts:** Pine, especially Scots and Austrian (nematodes have been found in logs of larch, balsam fir, spruce, and deodar and Atlas cedar)



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Symptoms and Spread

- Non-specific -- general wilting, yellowing, and browning of needles followed by death of the tree.
- The wood of infected trees is dry and lacks resin.
- Highly susceptible species may die within 30-90 days after initial symptoms, whereas other species require two seasons.



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Symptoms and Spread (cont'd):

- Needles usually remain attached for several months following death of the tree.
- Tree age influences the risk of pine wilt—trees 10 year or older are at higher risk.
- More problematic on trees that are drought-stressed, especially Scots and Austrian pine.



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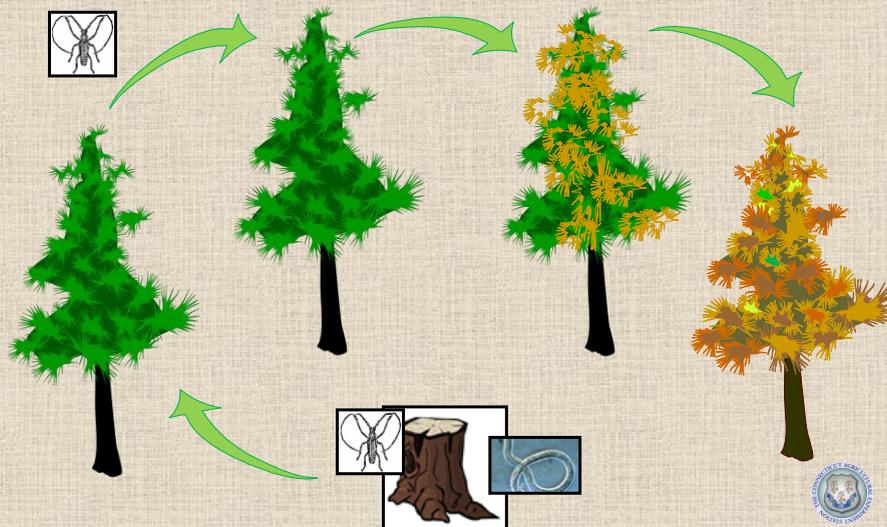
Symptoms and Spread (cont'd):

- Adult pine sawyer beetles carrying nematodes fly to healthy trees for maturation feeding and to dead trees for laying eggs.
- Healthy trees- Nematodes enter wounds made by beetles—they feed and multiply in resin canals, which kills the tree.
- Dead or dying trees- Nematodes present in dead trees feed on blue-strain fungi. Beetles lay eggs that develop into larvae and pupae. Nematodes enter the pupae before the adult beetles emerge.



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Pine Wilt: Symptoms and spread in a tree.



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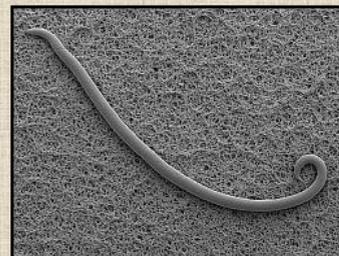
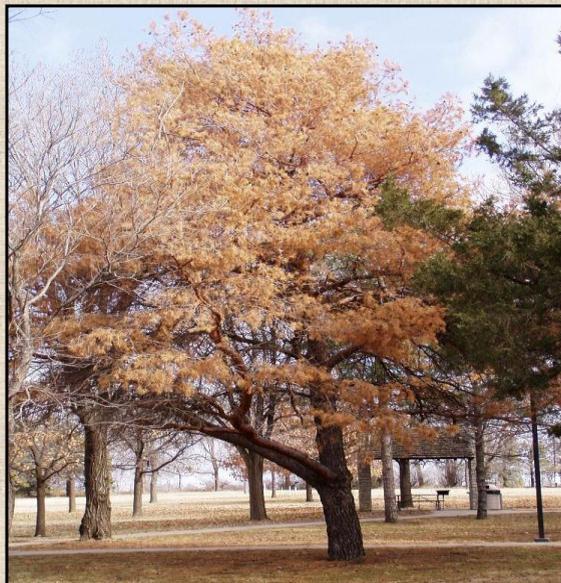
Why is this disease becoming more prevalent?

- Pines in many areas are more frequently stressed by drought.
- High summer temperatures are favorable for explosive reproduction by the pinewood nematode.



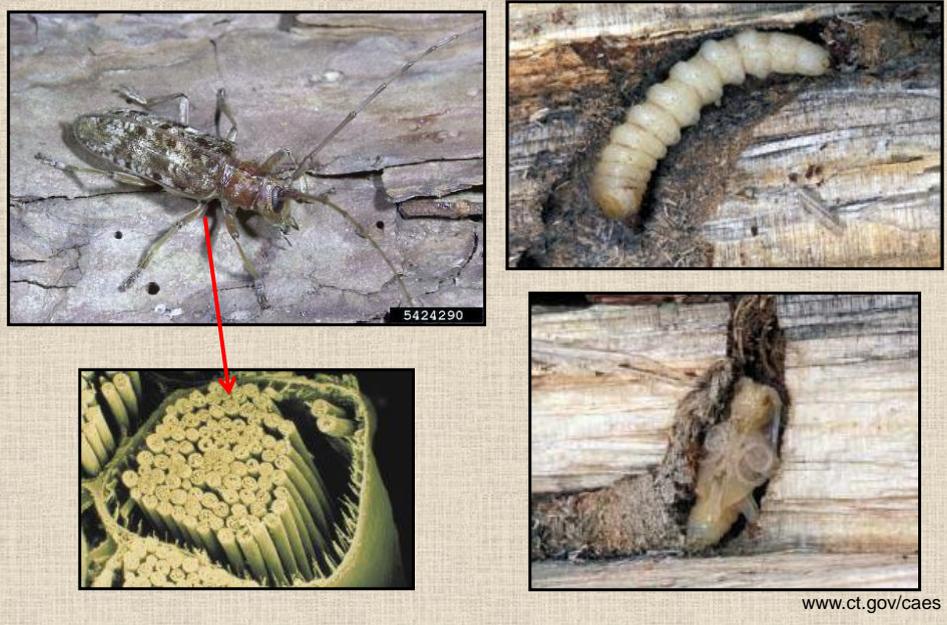
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Pine Wilt Nematode



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Pine Sawyer Beetle



Pine Wilt Symptoms



Pine with Pine Wilt



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Austrian Pine with Pine Wilt



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Austrian Pine with Drought Stress



Illustrates the
importance of
accurate diagnosis!



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Management of Pine Wilt:

- Avoid stress and maintain vigor by site selection and sound cultural and planting practices.
- Remove and chip symptomatic, infected trees, dead trees, stumps, or firewood.
- Plant less susceptible species when possible (not Scots or Austrian pine).
- Insecticides and nematicides have proved to be impractical and ineffective.



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ROOT DISEASES

- Root diseases are probably the most difficult diseases that arborists encounter.
- Diagnosis can be difficult and management is challenging because the causal agents can survive for many years in the soil.
- Usually result in tree death.



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EXAMPLES OF ROOT DISEASES

- Armillaria Root Rot
- Phytophthora Root Rot



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ARMILLARIA ROOT ROT

- **Causal Agent:** *Armillaria* spp. (fungi, complex of species)
- **Hosts:** All types of conifers



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Symptoms and Spread

- Above-ground symptoms are not very distinctive.
 - Suppressed growth, yellowed or undersized needles, premature needle drop, branch dieback, and even sudden death of trees in mid-summer.
- Infections often stimulate heavy flow of resin on bark at the base of the tree.



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Armillaria Root Rot-Pine



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Armillaria Root
Rot-
resin visible at
base of infected
tree.



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Symptoms and Spread (cont'd):

- Often recognized by signs rather than symptoms.
 - White fan of fungal growth found directly under the bark of a diseased tree.
 - Fleshy, honey-colored mushrooms that form in autumn at the base of an infected tree or stump.
 - Dark brown rhizomorphs (very coarse shoestring-like threads) may be found under the bark or on the surface of the roots or trunks of hardwoods. (These are rarely found on conifers.)



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Diagnostic white fungal growth under bark of infected trees.



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Armillaria Root Rot- Signs



Rhizomorphs (“shoestrings”), are not usually found on conifers.



Fruiting bodies
 (“honey mushrooms”)



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Symptoms and Spread (cont'd):

- *Armillaria* invades the bark and cambium of the roots and the root collar and kills the roots.
- The fungus grows out from infected roots through the soil and penetrates non-woody roots, working its way to the cambium layer and into the root crown where it girdles the tree.



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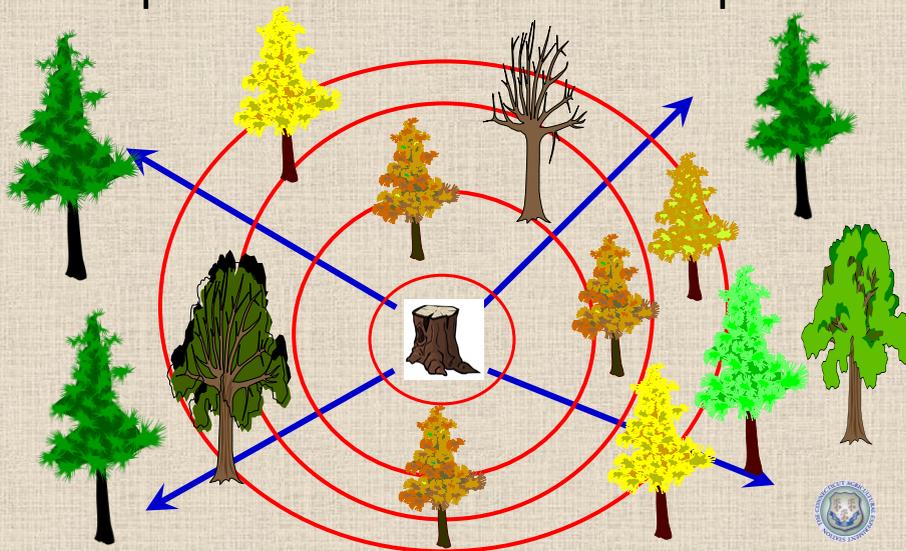
Symptoms and Spread (cont'd):

- **The fungus can live for many years in decaying stumps or woody roots in the soil.**
- Patterns of damage are often focused around old tree stumps, so diseased trees often occur in groups.
- Problematic on weakened or stressed trees, particularly trees under drought-stress or growing in shallow sites.
- Once infected, trees eventually die.



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Armillaria Root Rot: Spread within the landscape.



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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.



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Symptoms and Spread

- Above-ground symptoms are not very distinctive.
- Trees start to decline, have suppressed growth, poor vigor, yellowed or undersized needles, premature needle drop, branch dieback, and wilt.
- Often kills trees, especially young trees.



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Phytophthora root rot may be confused with:

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



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Phytophthora Root Rot

Leyland Cypress



Fir



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Phytophthora Root Rot- Fir



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Root rot symptoms throughout field.



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Symptoms and Spread (cont'd):

- Diagnostic symptoms can be seen at the root-crown area or roots of infected trees.
- 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.



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



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Diagnostic cinnamon-brown discoloration of the cambium.



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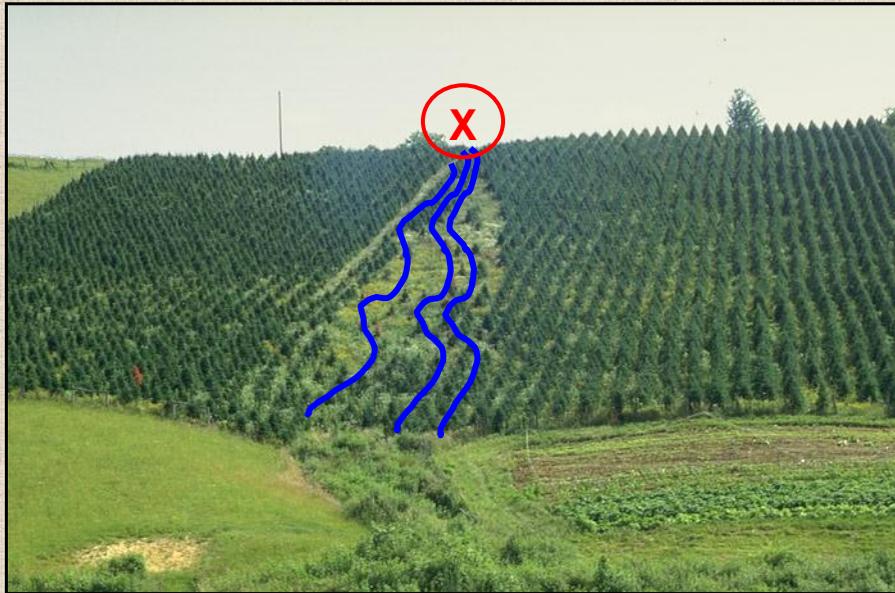
Symptoms and Spread (cont'd):

- Often associated with drainage problems and wet sites.
- The pathogen (previously called a “water mold”) is soil-borne, and produces swimming spores that move in water.
 - The longer the soil is saturated, the more severe the infection.
 - The greater the number of periods of saturated soil, the more severe the infection.
- The pathogen can form resting structures--can survive in soil for many years.



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Phytophthora Root Rot- Drainage Pattern



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Management of Root Diseases:

- Maintain vigor using sound cultural and planting practices.
- Avoid planting in poorly drained sites or take steps to modify or improve drainage.
- Remove symptomatic trees.
- For Armillaria:
 - Remove stumps and woody roots greater than ½ inch in diameter.



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Management of Root Diseases (cont'd):

- For Phytophthora:
 - Plant in raised beds or berms above the level of flooded soil.
- Select resistant species when appropriate.
 - For Phytophthora Root Rot
 - Most susceptible: Noble, white (concolor), and Fraser fir
 - Least susceptible: Nordmann, grand, Nikko, and Canaan fir



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Management of Root Diseases (cont'd):

- Fungicides- Armillaria
 - No fungicides are effective.
- Fungicides*- Phytophthora
 - 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).

*varies with state



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Presentation will be posted on:



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