KEY DISEASES OF CONIFERS

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Conifera in Forests

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Conifers in Landscapes

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

KEY DISEASES

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

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.
NEEDLE DISEASES: SPREAD

EXAMPLES OF NEEDLE DISEASES

**Needlecasts**
- Rhabdocline Needlecast
- Canavirgella Needlecast
- Rhizosphaera Needlecast

**Needle Rusts**
- Repeating Spruce Needle Rust
RHABDOCLINE NEEDLECAST

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

Tree with Rhabdocline Needlecast in Late Winter
Rhabdocline Needlecast

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.
Early Rhabdocline Symptoms: Chlorotic Spots in Late Summer

Look-Alike: Cooley Adelgid Feeding Damage

Needle bending and discoloration (yellow spots).
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.

Spring symptoms- diagnostic brown bands on needles.
Distinctive Banding Pattern

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.
Diagnostic symptoms - lower epidermis splits longitudinally.

Bare twigs after needles drop in spring.
CANAVIRGELLA NEEDLECAST

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

Canavirgella Needlecast

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

Infected tree appears off-colored.
Infected trees adjacent to apparently healthy trees.
Diagnostic symptoms - not all needles within a fascicle are infected.

Ozone: all needles within a fascicle affected to same level.
Individual needles within a fascicle may have different amounts of symptomatic tissue.

Diagnostic, long, black fruiting bodies develop in symptomatic needles in late spring.
Bases of infected needles remain green and needles break off before fascicles drop.

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.
RHIZOSPHAERA NEEDLECAST

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

Symptoms on 1-year spruce needles in late winter.
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.
Fruiting bodies on infected needles.

Black fruiting bodies push out white, wax “caps” of stomates.
Spores ooze from fruiting bodies.

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.
Rhizosphaera Needlecast

Fungus usually attacks needles on the lower branches first.
AUTOECIOUS (REPEATING)
SPRUCE NEEDLE RUST:

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

**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.
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.

Early symptoms of infection appear as chlorotic spots in winter or early spring.
Rust pustules visible at bud swell in spring.

Pustules break open on 1 yr needles.
Rust pustules breaking open.

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.
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)

Management of Needle Diseases (cont’d):

- Fungicide sprays.
  - Coverage is important.
  - Begin applications when new growth is emerging (~½” long).
  - Sprays should continue at label intervals until needles are fully elongated and conditions are no longer favorable for disease.
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

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.
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

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.
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.

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

Diplodia Blight: Douglas-fir
Infected shoot with resin on surface.

Diplodia Blight - Discoloration of dead tip.
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.

Cytospora Canker-Sunken Cankers

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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.
Fruiting Bodies with Oozing Spores

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.
Symptoms of Cytospora Canker

Cytospora Canker
Dead branches remain on tree
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.

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
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.

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)
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.

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.
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.

Pine Wilt:
Symptoms and spread in a tree.
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.

Pine Wilt Nematode

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Key Diseases of Conifers

Dr. Sharon M. Douglas

Pine Sawyer Beetle

Pine Wilt Symptoms

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Pine with Pine Wilt

Austrian Pine with Pine Wilt

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Austrian Pine with Drought Stress

Illustrates the importance of accurate diagnosis!

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.
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.

EXAMPLES OF ROOT DISEASES

- Armillaria Root Rot
- Phytophthora Root Rot
ARMILLARIA ROOT ROT

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

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.
Armillaria Root Rot - Pine

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

Diagnostic white fungal growth under bark of infected trees.
Armillaria Root Rot - Signs

- Rhizomorphs ("shoestrings"), are not usually found on conifers.
- Fruiting bodies ("honey mushrooms")

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.
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.

Armillaria Root Rot:
Spread within the landscape.
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 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.
Phytophthora root rot may be confused with:

- Mechanical damage
- Soil compaction
- Nematode damage
- Other root diseases
Phytophthora Root Rot - Fir

Root rot symptoms throughout field.
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.

Cracking and resin-flow on outer bark at base of infected tree.
Diagnostic cinnamon-brown discoloration of the cambium.

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.
Phytophthora Root Rot- Drainage Pattern

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.
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

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
Presentation will be posted on:

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