

IPM Series: Pine

Symptoms	Possible Causes	Notes
Needle Yellowing	Spruce Mites Pine Tortoise Scale Pine Needle Scale Bark Beetles Air Pollution Iron Chlorosis Needle Shed	Spring: old needles only; Fall: current season's growth May also see honeydew and sooty mold and large attending ants White scale covers on needles, yellowing in heavy infestations Top of tree affected first On close inspection damage appears as fine stippling Overall yellowing Some interior needles are naturally dropped in the fall
Needle Browning	Scale Insects Spruce Mites Bark Beetles Borers Needle Casts and Blights De-icing Salt Damage Fertilizer Burn Drought Winter Burn Air Pollution	Advanced symptoms of insect and disease damage Tap branches on white paper to look for period sized mites Top of tree affected first Look for holes of various sizes and oozing pitch Symptoms range from dark brown to black spots to general browning and premature needle drop Dieback of new growth and burning of needle tips the following spring Tips of needles brown first as a result of root damage Dry sites, shallow soils, newly transplanted trees Damage on windward side of tree Tip browning results from necrotic banding of the middle of needles. The needle bases usually remain green
Needle Stippling (pin-point yellow spots)	Spruce Mites Air Pollution	Tap branches on white paper to look for period sized mites Tip browning results from necrotic banding of the middle of needles. The needle bases usually remain green
Spots on Needles	Scale Insects Needle Cast Diseases Needle Rusts	Yellow spots, look for needle scales on needles, will scrape off Mostly dark brown to black spots, dieback can occur beyond lesions Orange-yellow spots, powdery
Needle Drop	Spruce Mites Needle Cast Diseases Cultural Problems Seasonal	Advanced mite damage Severe disease damage Poor establishment, drought, etc. Normal fall needle drop
Needles Eaten, Chewed or Webbed	Sawflies Bagworms Pine Tube Moth Pine Webworm	Resemble caterpillars, feed in groups Silk bags covered with needles on branches, terminals are defoliated first Bundle of needles webbed together to form a tube Early damage, mined needles; later, caterpillars make nests of silk and frass around terminal twigs

Dead Terminals	Pine Shoot Moths White Pine Weevil Sphaeropsis Tip Blight Cenangium Twig Blight	Caterpillars bore into terminal growth and kill it Adults and larvae feed in terminal leader Excessive pitch on terminals and pinpoint spots on needles Dying of terminal of buds and reddening of needles
Sooty Mold, Honeydew on Needles	Aphids Pine Tortoise Scale	Small insects feed on needles, green or black with white spots, honeydew Ants, honeydew and sooty mold near branch terminals
Frothy Mass on Twigs	Pine Spittlebug	Frothy masses of spittle on twigs in May and June
White Material on Bark	Pine Bark Adelgid	Fluffy white wax on branches and trunk in spring
Branch Dieback	Sphaeropsis Tip Blight Bark Beetles and Borers Rust Diseases Northern Pine Weevil Various Cankers Root Damage or Root Rots	Advanced stages of this disease, lower branches typically die first Look for holes of various sizes and oozing pitch Swollen areas on trunk or branches, orange-yellow blister-like or gall-like areas on bark Heavy infestations may girdle and kill seedlings and branches of larger trees. Branch dieback occurs after most of the spring feeding is finished Dark, elongated lesions with roughened bark, occasionally spore producing structures are present May see resin flow at base of tree, overall decline, shorter needles, off color
Pitch or Resin Flow	Bark Beetles or Borers Tip Blight Cankers Root Rots	General reaction to damage, i.e. insect attack (borers) or diseases (tip blights, cankers, root rots)
Wilting	Pine Wilt Nematode Drought Root Damage Wet Sites	Sudden drying out, needles droop downward, branches become brittle Dry sites, shallow soils, newly transplanted trees May see resin flow at base of tree, overall decline, shorter needles, off color Blackened roots
Poor Growth	Overly Wet or Dry Sites Poor Site Conditions Poor Plant Material Proccera Root Rot	Roots stunted or poor root development, may be blackened Compacted, heavy clay and/or poorly drained soils; shade Undersized root ball, girdling roots Root rot, resinous flow at soil line, overall decline, shorter needles, off color

Culture and Environmental Problems

Pines, especially white pine, are widely planted and are used as wind breaks and privacy screening around homes throughout Maryland. As a result, pines are sometimes planted in marginal or poor planting sites which lead to less than optimal growth or sometimes failure. Poor quality planting stock is also sometimes a problem when demand is high and plant supply is limited. Many cultural and pest problems on pines can be avoided by selection of high quality plants and proper placement in the landscape. Carefully inspect plants before purchase and reject plants with circling or kinked roots. Also avoid plants with root systems too small for the size of the tree, especially trees that have never been root pruned or trees hastily dug from old farm fields. Pines should be planted in sites with moderate moisture and well drained, acidic soil. Pines are shallow rooted and require supplemental irrigation during drought. White pines will not tolerate poorly drained sites.

Typical urban planting sites (i.e. new home lots) often consist of shallow compacted sub soil, restricted root growth sites and areas with poor drainage. These conditions will contribute to environmental stresses which can lead to insect and disease problems at some later date.

Normal Fall Needle Shed



Normal fall needle shed

Many pines will exhibit older needle yellowing in the fall which is normal needle shed. This second year needle yellowing which occurs towards the interior of the tree may occur all at once and may be quite dramatic. This needle yellowing is normal fall color and precedes needle drop.

De-icing Salt Damage



Significant damage from deicing salt in winter can occur on pines planted along roadways or exposed to salt spray at the seashore. This can lead to dieback of new growth and burning of

needle tips the following spring while the needle bases remain green. Repeated exposure can cause deformed growth and dieback.

Air Pollution Injury *Ozone, Sulfur Dioxide and Fluorides*

Ozone is the most damaging air pollutant in Maryland and shows up as tip browning on needles. This tip browning results from necrotic banding of medium aged tissue along the middle of needles which is the most sensitive. Tip burn symptoms affect all of the needles equally on a branch.



Air pollution injury

These dead needle tips may also break off over time giving the appearance of shorter than normal needles. Sulfur dioxide injury on young needles appears as reddish brown needle tips, but later in the season may appear as bands of necrotic tissue on the needles. Injured needles may remain on the tree for some time. Fluoride injury generally appears as tip burn with a distinct margin between living and dead tissue.

Pest Problems

Aphids



Aphids are small, soft-bodied insects that feed by sucking the sap from plants. Evidence of aphid feeding may be indicated by sticky honeydew and sooty mold (a black coating). On pines they are generally found feeding on

the needles. Most that occur on pine average 1/8 inch (3 mm) in size. They are oval or pear-shaped, have long antennae, and have a pair of tube-like projections called cornicles on the back of the abdomen. Adults may be winged or wingless. The aphids over winter on needles and bark as small, black, oval eggs.

Several species occur on pines in Maryland. The white pine aphid, *Cinara strobi* feeds only on white pine. Winged adults are 1/16 inch (4 mm) long. The body is shiny dark brown to black, with a white stripe down the middle of the back and powdery white spots on the sides. The eggs over winter on the needles. Heavy infestations of this aphid may kill young trees or branches of large trees. Several other species of *Cinara*, *Eulachnus Essigella* and *Schizolachnus* infest other species of pine.

Control: Aphids are usually controlled in early summer by predators and parasites. If aphid damage, honeydew or sooty mold is objectionable, sprays of insecticidal soap should kill the aphids and minimize the harmful impacts on predators and parasites. Dormant oil sprays may be applied if large numbers of over wintering eggs are detected.

Pine Bark Adelgid *Pineus strobi*



This pest is indicated by the presence of fluffy white wax on the bark of trunks and branches of pines in early spring. Adults are about 1/8 inch (3 mm) long, black, broadly oval, have short legs, are usually wingless and covered with fluffy white wax. This adelgid prefers to feed on white pine, but may also be found on Scotch and Austrian pine. This insect does little damage to healthy trees and generally does not warrant control.

Pine Spittlebug *Aphrophora paralella*

This insect is indicated by frothy masses of spittle on the twigs of pine in May and June. Nymphs or the immature spittlebugs are found beneath the spittle. They are black, with whitish abdomens. Adults are about 1/4 inch (6 mm) long, and tan with two irregular whitish bands on each wing. They may be found feeding in the same location as the nymphs in July - August. The pine spittlebug sucks sap from the



Spittle from spittlebug



Spittlebug nymph

twigs. Scotch pine is its preferred host, but it may also be found on pitch, eastern white, Virginia, jack, slash, loblolly, Japanese and mugo pines.

Control: Light infestations may be controlled by hand-picking. Heavy infestations in successive years may kill Scotch pine. When needed, spray the spittle masses with a contact insecticide in May.

Pine Needle Scale *Chionaspis pinifoliae*

White scale covers are found on green needles. The adult female covers are 1/8 inch (3 mm) long white, oystershell-shaped and only found on needles. Male covers resemble female covers, but are smaller. Crawlers or immature scales are reddish in color, very tiny and hatch in May and July. During May and July turn over scale covers and look for the presence of eggs or crawlers. Crawlers are active when they first hatch. They disperse from the egg mass in search of a suitable place to feed where they then settle. Holes in the scale covers indicate the presence of parasites or predators. This scale infests most cone-bearing conifers, but prefers white, mugo, Scotch, and Austrian pine. The scale overwinters as red eggs under scale covers.



Pine Needle Scale

Light infestations do not cause serious damage. Heavy infestations may cause yellowing of needles, stunting and dieback. Trees along roads and against buildings often suffer from severe attacks.

Control: This scale is often controlled by wasp parasites and lady beetles. If control is warranted, use a summer rate of horticultural oil or insecticidal soap on crawlers. A dormant rate of horticultural oil may be used to control this scale during the dormant season.

Cryptomeria Scale *Aspidiotus cryptomeriae*

This scale is found on the needles of pines, hemlock, and fir. Adult female covers are 1/16 inch (4 mm), elongate and oval. When newly formed they are translucent and eventually turn light brown. Male covers are similar but smaller. There are two generations in Maryland. Yellow crawlers are present in June and September. Cryptomeria scale overwinters as immature

scales (second instars). Damage on pine appears as yellowish blotches on needles. Heavy infestations may result in dieback of branches.

Control: Same as for Pine needle scale.

Pine Tortoise Scale *Toumeyella parvicornis*



Pine tortoise scale differs from other scale insects that occur on pine. Mature female covers are 1/4 inch long, hemispherical and dark brown to black with light brown to cream colored mottling. Males are small and inconspicuous. This soft scale attacks Scotch, jack, Virginia, Austrian, Swiss mountain, red, white loblolly, shortleaf, slash and Chinese pines. It has one generation and overwinters as

immatures on twigs. The damage symptoms first appear as honeydew, followed by sooty mold build up on branches. Needles turn yellow and branches eventually die. Small pines on exposed sites may be most susceptible and may be killed. To monitor for this pest, look for ants (seeking honeydew), honeydew, and sooty mold near branch terminals. In the spring the large females are found at the base of needles on twigs. Crawlers usually hatch the last two weeks of June.

Control: Dormant oil sprays are effective in reducing overwintering populations. Summer rate of horticultural oil or insecticidal soap sprays may be used in late June to kill crawlers. If infestations are very heavy, a contact insecticide may be used in April to mid May.

Bagworm *Thyridopteryx ephemeraeformis*

Bagworms are the larval or caterpillar stage of moths. After hatching they spin a cocoon-like bag to which they attach pieces of leaves or needles from the plants they feed upon. The bags are 1/8 inch (3 mm) in size at first and eventually reach 1-2 inches when mature. Eggs hatch in early June and larvae feed throughout the summer. They pupate in late summer inside the bags. Male moths emerge in late summer and fly to bags containing wingless female moths. After mating the female moth lays 200 to 1,000 eggs in the bag and dies. The eggs overwinter in the bags. Heavy populations of bagworms may defoliate branches, entire plants or trees. Conifers may be killed.



Control: In June, look for small bags, especially where large bags from the previous season are present. They are most often found on outer foliage in full sun. In light infestations, hand pick and destroy the bags. If populations are high spray the plants with *Bacillus thuringiensis* between June 15 and July 15. In fall and winter, hand pick and destroy bags containing overwintering eggs.

Pine Shoot Moths

Nantucket Pine Tip Moth, *Rhyacionia frustrana*, European Pine Shoot Moth, *Rhyacionia buoliana*

Damage from these shoot borers is indicated by several terminal needles browning, with the eventual browning and death of the terminal shoot. Adult moths are very similar. The Nantucket pine tip moth adult is 1/4 inch long, and silvery gray with rust colored patches. Mature larvae are 3/8 inch long and tan with brown heads. Pupae are brown and overwinter in the brown tips. Upon hatching larvae bore into needles, then buds and eventually into the stem. This activity causes terminal shoots to die and turn brown. This moth will attack nearly all pines in Maryland except for eastern white. It usually attacks pines less than 6 feet high, growing in the open in full sun. It will prune

Control: Prune out and dead buds and dying shoots when detected. Spraying for either of these borers is difficult because pheromone traps are needed to determine when to apply insecticides. This is not practical for most homeowners.



European Pine Shoot Moth larva



European Pine Shoot Moth

Pine Tube Moth *Argyrotaenia pinatubana*



Pine tube moth tube



Pine tube moth larva

Damage from this moth appears as a bundle of needles (5-20) webbed together to form a tube. The terminal ends of the needles are eaten and some of the needles in the tube turn yellow. Heavily infested trees have a ragged appearance. The adult moth is tan and about 3/8 inch long. Larvae are 1/2 inch long, and pale yellowish green with brown heads when full grown. It only occasionally causes noticeable damage to eastern white pine. There are two generations and pupae overwinter in needle tubes on the tree. Caterpillars begin needle formation in May and again in July.

Control: Control is rarely necessary. On small trees hand pick and destroy the pine tubes. For heavy infestations on a large tree, spray with a labeled insecticide or consult a licensed arborist.

Pine Webworm *Tetralopha robustella*

This insect causes only aesthetic damage. The young caterpillars mine the needles. Older caterpillars eat needles and build and hide in nests made of frass and silk around terminal twigs.



Nantucket Pine Tip Moth Adult



Nantucket Pine Tip Moth larva



Nantucket Pine Tip Moth Damage

trees back, but rarely kill. There are at least two generations per year in Maryland.

The European Pine Shoot Moth is similar in appearance, 3/8 inch long, with orange red front wings marked with silvery cross bands. The mature larvae are 3/4 inch long, dark brown with black heads and thoracic legs. Larvae overwinter in buds. A single larva will damage several buds

before pupating to an adult moth in June. The buds may die or develop abnormally. Trees that are grown in the open and under 10 feet tall are most susceptible. This moth will attack most pines grown in Maryland including eastern white. There is one generation a year.

The nests are 3-6 inches long and may contain several larvae. Adults are about 1/2 inch long, gray and black. The mature larvae are 3/4 inch long, yellowish brown, with two dark brown stripes along each side. They attack nearly all pines grown in Maryland. There is one generation a year and pupae overwinter in the soil under trees. Larvae begin mining needles in early June. Nest development begins in late June-July.



when larvae are large. Even though sawfly larvae resemble caterpillars, they are not. B.t. will not kill them.

Other Pine Sawflies There are approximately 10 other species of sawflies that attack pines in Maryland. Their appearance will vary somewhat, but their behavior and control is the same as the Redheaded pine sawfly.



Southern pine beetle (top)

Black turpentine beetle (bottom)

Control: This is a minor landscape pest. Manually remove and destroy nests on terminals as soon as they are noticed.

Sawflies Redheaded Pine Sawfly *Neodiprion lecontei*



Redheaded Pine Sawfly

Larvae resembling caterpillars feed in groups and eat the needles from terminal branches. Large infestations may defoliate and kill small pines. The adult sawflies are 1/2 inch, brownish, stout bodied and resemble bees. The mature larvae are 1 inch long, have reddish heads, and a yellowish-white body with 6 rows of irregular black spots. There are two generations per year and prepupae overwinter in the soil. This sawfly prefers to feed on jack, red, shortleaf, loblolly, slash, longleaf, pitch, Swiss mountain, and mugo pines. It may occasionally attack white pine and other conifers. The female deposits her eggs in needles which results in rows of tan spots. The egg spots and larvae are present from May - June and again from August - October. The larvae feed in groups and are usually found defoliating terminal branches. Stressed trees are most often attacked.



Sawfly egg scars



Pine sawfly adult

Control: Hand pick and destroy isolated infestations. Heavy infestations on many trees or large trees may be sprayed with a summer oil when larvae are small or a contact insecticide



Southern pine beetle larva

Bark Beetles

Trees under attack by bark beetles fade from the top down. The color will turn from bright green to light green, yellow and finally reddish brown. The extent of damage to the tree depends on the species of beetle. Several species of bark beetles may attack a tree at the same time. The initial signs of attack are pitch tubes and/or boring dust. The pitch tubes are small masses of pitch, which are usually whitish in color and often mixed with reddish boring dust or frass. Some species of beetles produce only boring dust when attacking a tree.

Most bark beetles feed and reproduce in the cambium of the tree. Depending on the species, there may be a single or several generations a year, with adult beetles present throughout the growing season. Species that attack pines in Maryland include the Southern Pine Beetle, *Dendroctonus frontalis*, Black Turpentine Beetle, *D. terebrans*, and Engraver Beetles or *Ips* species. For more specific information see #HG1, **Bark Beetles That Attack Conifers in Maryland.**

Control: Bark beetles generally attack stressed trees. Therefore the best control is to keep trees healthy. Provide adequate water during times of summer drought. Dead or dying trees should be removed. If the trees are to be used for firewood, strip the bark, and/or tarp the logs. If the tree has been sprayed with an insecticide, do not use it for firewood. Spraying is generally not recommended to control bark beetles.

White Pine Weevil *Pissodes strobi*



This weevil attacks and kills the main leader on pines. Adult weevils are about 1/4 inch long, oval and brown with a long snout, and two white spots that may run together on the back of the wing covers. The larvae are 3/8 inch long, C-shaped, legless and white with brown heads. The adults chew holes in leaders near the terminal buds to feed. This causes pitch to flow. They then lay eggs in some of the holes. This activity occurs from March through May. Hatching larvae bore in the leader causing stunting and death. Damage becomes obvious beginning in June. Small trees may be killed. There is one generation a year and adults overwinter in the duff under pines. White pine weevil prefers to attack eastern white pine and Norway spruce, but may attack many other pines and spruces.

Control: Prune out flagging or dying terminals. Split them open to be sure weevil larvae are present. Some diseases have similar symptoms. In June prune out and destroy all affected terminals. A residual insecticide may be sprayed on trees in March or April before egg laying to control adults.

Northern Pine Weevil *Pissodes approximatus*



This weevil is similar in appearance to the white pine weevil except that the two spots on the back rarely overlap. Adult weevils chew patches of bark from twigs and branches with pitch forming at the feeding sites. Heavy infestations may girdle and kill seedlings and branches of larger trees. Branch dieback occurs after most of the spring feeding is finished. There is one generation a year and larvae pupate in cocoons constructed of chips under bark of recently cut and dying, standing trees. This weevil prefers to feed on red and Scotch pines, but may attack most other pines.

Control: Recently transplanted trees are susceptible to attack. Make sure they receive adequate water until established. To prevent larval development, remove or debark cut or dying landscape pines and spruces. If adult feeding damage is detected, spray branches in March - April or September to control adults.

Spruce spider mites *Oligonychus ununguis*



Spider mite damage appears as tiny yellow stippling on needles. The needles turn yellow, and then brown. The damage is usually first observed on the older needles at the base of the tree, eventually moving up the tree. Lower branches may lose all of their needles, except new growth on spruce. Small trees may be killed and large trees may have some dieback. This spider mite prefers cooler temperatures and is active in the spring (March - June) and fall (September - November). Spider mites are very tiny, about 1/2 mm. They have 8 legs and are yellowish green when young. When mature and fully fed they are grayish black with a tan area behind the mouthparts. The eggs are circular and reddish brown. There are several generations a year and eggs overwinter on the bark and needles. This mite prefers spruce, pine hemlock and arborvitae, but will attack other conifers. To check for mites on a pine, tap branches over white paper and look for the dark slow moving mites. Also look for predator mites which are fast moving, and tiny round, black lady beetles that feed on the mites.

Control: If more than 10% of the tree is damaged and no predators are found, control may be needed. Use a dormant oil in winter to control overwintering eggs, if they are abundant. (They may be seen clearly with a hand lens.) During the growing season, a summer rate of horticultural oil or insecticidal soap may be used.

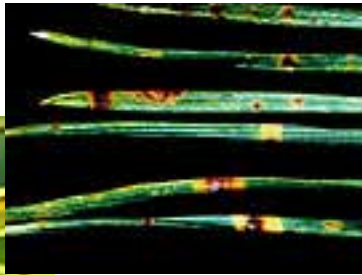
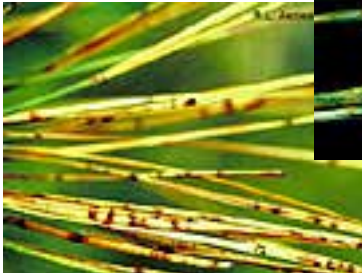
Diseases

Needle Blight and Needle Cast Diseases:
***Biffusella* spp., *Calonectria* sp., *Dothistroma* sp., *Ploioderma* spp., *Lophodermella* spp., *Cyclaneusma* sp., and *Mycospharella* sp.**

Needle cast diseases are caused by various fungi that infect the new needles on pines. Although the needles become infected symptoms of disease often are not visible until the following winter or spring season. Infected needles may then turn yellow or brown with characteristic dark fungal fruiting structures. These diseased interior needles usually are shed prematurely giving the tree a sparse thin appearance. Often the only needles

remaining are the current seasons new growth. The following is a brief list of some commonly seen rusts on evergreens in Maryland. These needle diseases rarely affect white pines.

Lophodermella
on pine



Dothistroma
on pine

The three most common needle cast fungi genera in Maryland on pines are *Lophodermium*, which attacks a large number of pines but in particular Scotch and Austrian, *Ploioderma*, which attacks most hard pines but especially Austrian, and *Cyclaneusma*, which attacks mostly Scotch and Austrian pines.

Control: Although these diseases can be serious in Christmas tree plantings or nurseries they are rarely a severe problem in the home landscape. It is important to identify which needle disease is affecting the tree by taking or sending in a sample to a plant clinic because the controls will vary according to the fungal species causing the infection. Older trees rarely warrant spraying. Pruning out severely infected branches is the best control method on branches that show sparse growth. Labeled fungicides can be used on small trees when the needles are half grown and again about two weeks later, or more often depending on the disease.

Pine Rusts:

Cronartium spp., Coleosporium spp., and Endocronartium sp.



Pine Gall Rust



Pine needle rust

Rust disease infections cause yellow-orange lesions that are filled with powdery spores on the needles or stems. The most serious rust disease is caused by White Pine Blister Rust, which can kill infected pines, produces brightly colored orange-red

growths or galls on branches or trunks. This rust requires the alternate hosts gooseberry or currants before it can spread to white pine. Commander blister rust, Fusiform rust, Pine-oak rust and Pine needle rust are other rust diseases of pines. The alternate host for Commander blister rust is false toad-flax. The alternate hosts for Fusiform and Pine-oak rusts are several species of oak. The alternate host for Pine needle rust are asters and goldenrod.

Control: Management options for these rust diseases involve separating alternate hosts by a distance of one to two miles (when practical), pruning of galls before they release their spores, removal of severely infected trees and the use of alternate plant material. Fungicides are not effective control options

Tip Blight

Sphaeropsis sapinea



Symptoms become evident in June or July when new growth begins to turn brown. Damage from this pathogen usually is more severe near the base of the tree but can spread upwards through the crown. The dead needles will remain attached to the infected tips and resin flow is very obvious. After several seasons, branches will become disfigured will die as old needles fall off while no new growth survives.

Control: Old dead branches should be removed and if chipped should not be used for mulch under pines. Several fungicides are labeled, but more than one season is necessary for control. Sprays must be applied to new growth until needles are full sized. Registered fungicides include fixed copper fungicides and Bordeaux mixture. Removal of old stressed trees is advisable especially if young healthy trees are in the vicinity.

Cenangium Twig Blight, Cenangium ferruginosum

Symptoms begin with dying terminals and reddening or browning of needle bases. There is clearly delimited area between dead and living bark. Dead needles fall during the summer with little resin production on dying branches.

Control: Infected twigs and branches should be pruned out during dry weather. Since this disease typically affects stressed pines proper cultural practices are recommended to lessen chances for infection.

Pine Wood Nematode *Bursaphelenchus xylophilus*

This nematode is not soil borne but is instead carried from dying trees to healthy pines by long horned beetles. The beetles feed on healthy pines during the months of June and July and introduce the nematodes into the vascular system of the tree. The nematodes are then transported throughout the tree in the resin ducts where they cause damage to the vascular system. Wilt symptoms are evident in August and September. The nematodes can also be introduced into stressed trees when the long horned beetles lay eggs in the trunk.



Control: No chemical controls are available and removal of infected trees is recommended to prevent disease spread to healthy trees. Also avoid planting trees in dry sites that contribute to stress conditions.

Cankers:

Various Fungi - *Atropellis spp.*, *Dasyscypha sp.*, *Sphaeropsis sp.*, *Phomopsis sp.*, *Cytospora spp.* and *Valsa spp.*

A large number of cankers occur on all pines that cause dieback. These are more common on stressed trees planted in marginal sites or infect poorly maintained trees. Young cankers are slightly darker in color than adjacent healthy bark and appear slightly sunken. As cankers enlarge they kill the living woody tissue within the branch or trunk. Canker growth may cause the bark along the edges to crack and fall away, exposing the dead wood underneath. After a canker enlarges enough to girdle a branch or trunk, the portion beyond the canker dies. Small twigs are killed more quickly than larger branches. Symptoms may include progressive upper branch dieback, disfigured branch growth, or target shaped areas on trunks with concentric rings of dead bark.

Control: There are no chemical controls for cankers and they cannot be stopped once they become extensive. Pruning off af-

ected branches back to healthy wood is the only control measure available. Stressed trees should be fertilized and watered during drought to promote better tree vigor.

Procera Root Disease and Annosum Root Rot *Leptographium procerum*, *Heterobasidium annosum*

Procera root disease appears to be associated with trees planted in heavy, wet, poorly drained soils. Initial symptoms start in wet springs with delayed bud break and reduced candle elongation. By early to mid summer needles become wilted, and begin to fade to a lighter green color, before eventually browning. Dying needles usually remain on the tree. The bark and wood become spongy and develop resin pockets that ooze sap when punctured. Resin may also ooze through the bark at the base of the tree and exposed roots become resin soaked. Trees planted in wet soils with basal resin flow appear to be diagnostic of this disease.

Annosum root rot infected trees have a lighter than normal needle color with shorter than average growth. Roots become resin soaked but later become decayed with masses of string white decayed tissue. This root decay contributes to wind thrown tree damage and leaning trees after heavy storms. Reddish brown conks with white margins may appear at the base of the tree on the bark. This disease tends to be more prevalent on sandy soils that have a low seasonal water table.

Control: Avoid planting in poorly drained soils or in low spots that collect water runoff. Also avoid planting trees too deeply or burying the collar zone (where the roots and stem join) when back filling after planting especially in heavy soils.

At the opposite extreme, also avoid planting in dry sites, that have a widely fluctuating water table during dry summers. Provide irrigation during dry periods when trees could be stressed during establishment.

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