Root diseases

Fomes root and butt rot – Ganoderma root and butt rot

Hosts

Usually infects conifers and occasionally on hardwoods. Red pine is highly susceptible in North America as is Norway spruce in Europe. It is much severe in arable soils which contain much nitrogen that favours the fungus. Drought also seems to favour the fungus.

Symptoms

When young trees are killed, thin, tissue-Paper-like mycelium felts, not noticeably veined, from between the bark and wood, small dirty-white outgrowths occur on the underside of the roots. No rhizomorphs develop. Presumable the mycelium grows little, if at all, in the soil. In the incipient stage, decayed wood is pinkish to dull-violet colour, depending on the species of the wood, but still hard and firm. In the advanced stage, the wood shows small elongated pockets sometimes with black spots or flecks in the centre, the pockets being separated by areas of firm, brownish wood. The pockets finally run together, forming a mass of spongy or stringy white fibres flecked with black. Resin flow may occur from the butt. The perennial conks, which vary from bracket-shaped to flat layers, depending on their position, have a biscuit –coloured sterile margin. The conks usually occur on the crotches of the root collar partially hidden by the litter or even on roots abutting on cavities in the soil.

Pathogen

The fungus ***Fomes annosus*** **(*Ganoderma applanatum*)** (Basidiomycota, polyporales) causes this disease, which is also called (spongy sap rot) and (brown root and butt rot).

Control

- Keep stands vigorous
- Grow susceptible species in mixture with resistant species
- Reduce root contact by applying wider spacing

- Delay thinning to allow conifers become more resistant with age
- Brush the stumps a tar and creosote mixture immediately after filling to prevent the infection of stumps by wind-borne spores
- Use antagonistic fungi against *A. annosus* to colonize stumps

Phytophthora root rot

Hosts

Phytophthora root rot, a form of dieback, is a disease that affects many native plants and ecosystems, important crops and horticultural plants in Australia and throughout the world.

Its global spread has been the consequence of trade and human migration. In Australia, the disease infects an especially large range of mainly woody perennial plant species and is also a major threat to some rare and endangered species.

The disease is common in moist, water-retentive soils. Low soil temperatures and high clay content also increase the risk. Seedling stands can be severely damaged, but losses may also occur in established fields. Pines, cedar, chestnut, are main hosts of the disease.

The pathogen

The disease caused by many species of ***Phytophthora*** (Oomycota, Perenossporales). For example:

Phytohthora lateralis on cedar trees

P. cinnamomi on chestnut

Ecology

P. cinnamomi fungus grows through the root system (and sometimes the stem) of a plant, destroying it and preventing the plant from absorbing water and nutrients. The first symptom of a plant infected by phytophthora root rot is wilting and yellowing of the foliage. The foliage then dries out and the young feeder roots darken. Infected plants usually die from lack of water and nutrients, although some can survive the disease. Once the fungus has spread through the root system of a plant, it releases zoospores (asexual spores) into the surrounding soil, if the conditions are warm and

moist. The spores easily spread through storm water and drainage water. During drought or when temperatures are cooler, *P. cinnamomi* produces two different types of spores — chlamydospores and oospores — which can survive for long periods of time in soil or dead plant material. When conditions become more favourable for the spores, they will germinate and infect new plants. Major human activities that may spread phytophthora root rot include road building, timber harvesting, mine exploration, the nursery trade and bushwalking. While phytophthora root rot does not usually cause severe damage in undisturbed vegetation in areas where annual rainfall is less than 600 mm, it can cause severe epidemics in areas with higher rainfall. Many Australian native plants are susceptible to *P. cinnamomi*, including a number of threatened species and many that are currently not threatened. The fungus has often been found in eucalyptus trees, grevilleas and banksias, native peas, heaths, hibbertias, club mosses, ferns, cycads, conifers, rushes, grasses and lilies. An outbreak of phytophthora root rot can also affect native animal species, by destroying the plants that provide them with food and shelter.

Symptoms

The first over ground symptom, after the infection of root system, is gradual fading of the foliage until it becomes tan or light brown, crisp, and dry. A cinnamon-brown discolouration of the infected cambium and inner bark extends upward from the root collar a short distance. The fungus spreads locally by the movement of surface water and soil. Infected trees occur in irregular patches from a few feet to many feet in diameter. Trees up to 50 years old are attacked and killed.

Control

1- The best control is actually careful attention to seedbed preparation. Avoid compaction and low spots that may accumulate water.

2- Limit of the spread of the fungus and reduce its impact. The fungus must be tackled using a management plan based on quarantine, Quarantine is important in reducing the spread of *P. cinnamomi* into areas of high conservation value.

3- Hygiene and treatment with the chemical phosphite.

Stem diseases: Galls and witch's-brooms

Plant galls

Galls are the peculiar swellings, bumps and growths that develop on different parts of plants after being invaded by some very unique organisms. Galls have a range of causers, including viruses, fungi, bacteria, insects and mites, and they appear on more than half of all plant families. The study of plant galls is called cecidology.

There is a huge variety of galls, and the way they are induced and develop also varies. Usually the gall causer in some way attacks or penetrates the plant's growing tissues and causes the host to reorganise its cells and to develop an abnormal growth. The chemistry behind this is not fully understood, although it is thought to be due to complex interactions between hormones and other chemicals. Galls have such recognisable forms that the causer can often be easily identified from the growth alone.

Gall induced by the rust fungus (*Gymnosporangium clavariiforme*) on a hawthorn leaf (*Crataegus monogyna*) on Dundreggan. The tufts are tubes that release the fungal spores, which then re-infect juniper.

Some galls causers rely on more than one host. A fungus known as *Gymnosporangium clavariiforme* produces strange orange tentacle-like growths on juniper (*Juniperus communis*). The spores from these then infect the leaves of

hawthorn (*Crataegus monogyna*), resulting in more galls, which are very different in their growth form, and these then re-infect juniper, and so on. This clearly demonstrates the fact that, the greater the plant diversity there is in an ecosystem, the more species will be supported overall.

Crown gall

Crown gall, a disease of roots and stems, occurs on a large number of plants. it is probably most serious on cherries, apples, and a few other tree fruits. It is also a problem on roses and several other ornamental trees and shrubs. Crown gall and the very similar cane gall also affect raspberries and blackberries.

Symptoms

Galls vary considerably in size from 1/4 inch to a foot or more in diameter, with the majority being a few inches across. Young galls are soft on the surface and have a light, tan-colored, frosty appearance. As the galls become older, they grow darker, turning almost black, and usually are hard and woody.

There often is no visible effect on the plant other than the galls, but when galls are numerous or a large gall has girdled the stem, the plant may become stunted and sickly, with small, red or yellow leaves. Top symptoms alone are inconclusive, but the presence of galls confirms the identity of the disease.

The pathogen

Crown gall is caused by the bacterium, ***Agrobacterium tumefaciens***. Cane gall of brambles is caused by a closely related bacterium, *Agrobacterium rubi*. Some scientists consider both species to be widely distributed in soil. The organisms are capable of surviving in soil for at least a year and possibly longer.

The bacteria can enter the plant only through wounds, and much infection in nurseries is through grafting and budding scars. Mechanical injuries of crown and roots by cultivation equipment, animals, and insects are also important entry points.

A. tumefaciens is widely studied for its remarkable biology not only because it causes disease in over 140 genera of broadleaf plants, including fruit trees, grapes, roses and walnut trees, but also because it is considered one of the most important tools for plant biotechnology: It is the only organism known to routinely engage in inter-kingdom lateral gene transfer. ***A. tumefaciens*** infects host plants by transferring a portion of its own DNA into plant cells, and this integrated bacterial DNA is expressed in the plant cells, leading diseased plants to develop tumors and produce resources that benefit the pathogen.

Control

1- Elimination of infected trees from the nursery. Plants having suspicious swellings at graft unions or near the soil line should be discarded.

2- Treated of nursery soil in which crown gall has occurred with a suitable fumigant, such as chloropicrin or methyl bromide.

3- Growing a non-susceptible crop, such as grass, for three years will almost eliminate the organism from the soil.

4- Sterilizing the grafting and budding tools in a disinfectant solution of 20 percent commercial bleach or a 1/2 percent solution of potassium permanganate will reduce the spread of bacteria in budding and grafting operations.

5- Painting the galls of tree fruits and nuts with Gallex has helped reduce the incidence of crown gall.

6- Biological control by inoculating newly grafted, recently lifted transplants or cuttings with a bacterium that is closely related to the one causing crown gall. This prevents the crown gall bacterium from infecting wounds on the plant.

Witches and woodland sprites

Witches' broom fungus (*Taphrina betulina*) on a birch tree in winter in Glen Affric.

While some galls are well hidden and hard to spot, others are much more conspicuous. Have you ever looked up into a birch tree (*Betula spp.*) and noticed what looked like large, dense birds' nests? In some cases these may well be nests, but very often they are actually galls called witches' brooms. These are caused by a fungus (*Taphrina betulina*), which stimulates the tree to produce numerous extra shoots, resulting in a dense nest-like cluster. The fungus can then feed on the shoots. Such growths have puzzled people for centuries, and it was once believed that they were caused by witches flying over the tree!

If you spot an odd-looking growth on a dog rose (Rosa canina) it could well be a Robin's pincushion gall, caused by a wasp (*Diplolepis rosae*). There was once a belief in England that these were caused by the woodland sprite, Robin Goodfellow or Puck. It is hardly surprising that people ascribed supernatural causes to some galls – they look pretty strange, and their causes aren't exactly obvious!

Yellow Witches' Broom

Order: Uredinales

Family: Lymantriidae

Latin Name: *Melampsorella caryophyllacearum Schr*[illegible]*ter*

Common Names: Yellow Witches' Broom

Introduction

This rust fungus causes abnormal shoot growth on balsam fir. Usually not severe, but can be a serious problem in Christmas tree plantations especially when balsam fir is grown on heavy agricultural soils where chickweed is common.

Damage Symptoms

Trees with visible brooms. Needles that are stunted, turn from green to pale green to yellow, then die and drop off. Branches affected by the brooms are deformed by galls and cankers.

Control Options

Large scale control programs in forest plantations are not practical. Christmas tree lot control would be two-pronged:

1. Remove the brooms while they are still small. In the case of large brooms, the whole tree should be removed and destroyed. Also, search for mature balsam fir around the plantation and remove the brooms.
2. Remove the alternate host (chickweed) by means of a herbicide.

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Branch wilt

Hendersonula Branch Wilt

This disease, also known as sooty canker or limb wilt, is caused by the fungus, ***Hendersonula toruloidea***, a wound pathogen that invades citrus bark that has been damaged by freezing injury, sunburn, or mechanical injury but does not infect uninjured bark tissue. This fungus has a wide host range and causes disease in many plants unrelated to citrus. This disease, also known as sooty canker or limb wilt, is caused by the fungus, ***Hendersonula toruloidea***, a wound pathogen that invades citrus bark that has been damaged by freezing injury, sunburn, or mechanical injury but does not infect uninjured bark tissue. This fungus has a wide host range and causes disease in many plants unrelated to citrus.

Sooty mass of spores of the branch wilt fungus under bark.

Biology of the pathogen

The fungus produces only conidia and thus has a very simple life cycle. The small conidia, produced in black, powdery masses under bark, are easily wind disseminated. These spores, which arise from segmented hyphae, are carried to damaged bark tissue where they germinate and initiate infection. The mycelium grows into living tissue. Infected sapwood is stained gray to black in color.

Pathogen

Fungus, ***Hendersonula toruloidea*** (now classified as ***Nattrassia mangiferae*** or a species of *Fusicoccum*)

Host

Ash, citrus, mulberry, walnut, fig, oleander, wisteria, sycamore, apple, apricot, chinaberry, poplar and other smooth or thin bark trees.

Symptoms:

The most common symptom of sooty canker is the sooty, black growth that develops beneath bark tissue. This black canker is due to the presence of masses of black, fungal spores that appear under the bark and on the surface of the canker. Because the fungus grows into and kills sapwood, the leaves on branches with cankers wilt, turn brown, and die. Branches die back to the cankered area. Scattered branches are usually affected. Most cankers develop on unshaded trunks or limbs that face toward the sun. Sunburned trunks and limbs are highly susceptible to infection.

Control:

Sooty canker can be controlled when infections are confined to limbs and upper branches. Smaller infected branches should be removed when symptoms appear. Since sunburned bark is the primary infection site, large limbs should be pruned only when trees are dormant.When removing infected limbs, cut back to at least one foot below the canker. The cut area and pruning tools should be treated with a solution of one part household bleach and nine parts water. Pruning wounds should be painted with a copper fungicide to prevent infection. Reapply the copper compound to the wound each spring to insure adequate protection against infection. Control becomes increasingly difficult as the disease progresses into the scaffold branches and is virtually impossible once the main trunk is infected. Tree vigor should be maintained through proper fertilization and deep watering on a regular schedule. Severe pruning of larger branches and limbs of trees should be avoided. Whitewash, applied to exposed lower trunk areas, will reduce the possibilities of infection. This material reflects radiation and reduces bark temperature.