

Table 2. Signs and symptoms of the major root diseases of B.C.

***Armillaria* (DRA)**

Evidence	Stand level	Tree level
Symptoms	<ul style="list-style-type: none"> ▪ mixture of broadleaved species in conifer stands ▪ openings in stand canopy filled with dead and dying conifers and shrub species ▪ snags and broken stems common ▪ disease centers are often diffusely spread across the landscape, often causing changes in forest cover ▪ poor tree growth and lack of stand vigour ▪ bark beetle attack 	<ul style="list-style-type: none"> ▪ crown symptoms include chlorotic and thinning foliage, reduced leader growth, and distress cone crop, followed by red foliage stage at death ▪ basal resinosis (minor to copious resin flow at the base of stem) ▪ advanced decay is stringy and yellowish with black zone lines, but generally indistinct and non-diagnostic ▪ bent top
Signs	N/A	<ul style="list-style-type: none"> ▪ cream to white-coloured, fan-shaped mycelial felts between wood and bark (on cambium), and within bark of roots and root collar just below resinous bark ▪ on dead trees; mycelial fan etchings on the inner bark usually associated with resin ▪ honey-coloured mushrooms with ringed stem (annulus) in clumps at tree base during wet, warm summer or fall (late August to early October) ▪ black shoestring-like rhizomorphs in or around bark of roots generally with 60° branching (can be confused with <i>A. sinapina</i>, a saprophyte which has 90° branching)

Laminated (DRL)**Evidence****Stand level****Tree level**

Symptoms

- mixture of broadleaved species in conifer stand, possible species shift to western redcedar and western hemlock
 - distinct, small to large openings in stand canopy often producing forest cover changes
 - patches of randomly oriented windthrown stems
 - poor tree growth and lack of stand vigour
 - bark beetle attack
- crown symptoms include chlorotic and thinning foliage, reduced leader growth, and distress cone crop, commonly followed by red foliage stage at death
 - internal symptoms include areas of red-brown stained heartwood (note staining disappears within two to three weeks after harvesting)
 - windthrown trees with few or no roots, resulting in root balls

Signs

N/A

- small pits (pinhead sized holes) develop in wood; annual rings separate into sheets (lamina)
- red-brown, hair-like mycelium between sheets of decayed wood
- cream to mauve-coloured ectotrophic mycelium on surface of roots and root collar under duff
- cinnamon-coloured hair-like (setal) hyphae growing in bark cracks often near root collar
- fruiting bodies (rare) on upturned roots and on the undersides of decayed logs

Tomentosus (DRT)

Evidence	Stand level	Tree level
Symptoms	<ul style="list-style-type: none">▪ mixture of broadleaved species in conifer stands with possible species shift to alpine fir▪ distinct, small to large openings in stand canopy often producing forest cover changes▪ patches of randomly oriented windthrown stems▪ poor tree growth and lack of stand vigour▪ bark beetle attack	<ul style="list-style-type: none">▪ crown symptoms include chlorotic and thinning foliage, reduced leader growth, and distress cone crop, but do not include red foliage stage at death (except in association with spruce beetle attack)▪ windthrown spruce trees lack fine root mass (sharp contrast with large platelike root system of healthy spruce blowdown)▪ internal symptoms including pink to red-brown coloured stain of heartwood
Signs	N/A	<ul style="list-style-type: none">▪ canoe-shaped white pitting of the heartwood which extends to bark with age▪ honeycomb pattern of decay pits when viewing root or stem in cross section▪ pitting follows annual rings but wood does not separate into laminar sheets▪ leathery mushroom-like fruiting bodies with tan upper surface and cream coloured porous under surface produced periodically in summer and fall near decayed roots

Blackstain (DRB)

Evidence	Stand level	Tree level
Symptoms	<ul style="list-style-type: none">▪ small groups of dead or dying lodgepole pine (with Pl type) or Douglas-fir (with Fd type)▪ infection centers have the appearance of a sudden (insect-like) attack▪ bark beetle attack	<ul style="list-style-type: none">▪ crown symptoms include chlorotic and thinning foliage (low needle retention), "lions tail" foliage pattern, (especially on Pw) and reduced leader growth, commonly followed by red foliage stage at death▪ insect vector activity at root collar or on roots▪ can be in association with low level inoculum of other diseases such as <i>Armillaria</i> and <i>Phellinus</i>
Signs	N/A	<ul style="list-style-type: none">▪ black stain in the earlywood of the last several growth rings in lower bole and roots▪ no fruiting body produced▪ no decay produced

***Annosus* (DRN)**

Evidence	Stand level	Tree level
Symptoms	<ul style="list-style-type: none">▪ mixture of broadleaved species in conifer stands▪ small openings in stand canopy with oldest dead trees near center often surrounding a cut stump▪ poor tree growth and lack of stand vigour▪ bark beetle attack	<ul style="list-style-type: none">▪ crown symptoms include chlorotic and thinning foliage, reduced leader growth, and distress cone crop (these symptoms are unreliable except when the disease is very advanced)▪ windthrown trees with broken roots and retaining fine root mass▪ internal symptoms may include reddish "water soaked" discoloration of heartwood
Signs	N/A	<ul style="list-style-type: none">▪ advanced decay appears white to yellowish, stringy to somewhat laminate and spongy, may contain elongate white pits with black flecks sometimes present▪ creamy-yellow pustules on roots (above and below ground)▪ fruiting bodies are button shape mounds on roots below forest floor, to bracket type conks found inside hollowed stems