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Field assessment, control and identification of common foliage diseases of pine in New Zealand

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Contents

Objectives

This guide provides information for foresters to identify common foliage diseases of pines and list available methods of control. Specifically,

1. Symptoms of the four common pine foliage diseases are described and shown
2. The period of symptom expression and commonly affected regions for each disease are provided
3. Control measures and recommendations for each disease are listed.

Background

In parts of New Zealand, shelterbelts, woodlots, and commercial plantations suffer from dothistroma needle blight, cyclaneusma needle cast, physiological needle blight (PNB), or red needle cast (RNC). In some regions all four diseases are present. Seasonal development of these diseases differs between diseases, locations, and seasons and years. Many factors, some still to be confirmed, contribute to outbreaks (for instance rainfall, temperature, tree age, silvicultural treatment).

Dothistroma needle blight can be controlled by applying a copper fungicide in October or November. Timing depends in the location and or season with spray applied earlier in warmer areas. Cyclaneusma is more difficult to control. Susceptible trees can be removed during thinning operations if thinning is undertaken when the disease is showing and the thinning crew can recognise the disease. Red needle cast and PNB might be controlled by application of a phosphite spray and research is underway to determine this.

Control of needle disease is dependent on the correct identification of the disease. For instance, applying copper spray to control cyclaneusma needle cast is a waste of time and resources. The aim of this guide is to enable farm foresters and other forest growers to be able to identify a needle disease with confidence.

Field assessment

Process. There is a process that should be followed when assessing foliage diseases:

- Agree on the purpose of the assessment
- Identify the disease correctly
- Assess trees consistently using the most appropriate method
- Be aware of conditions

It is vital that the disease is correctly identified because control methods vary for different diseases. Disease symptoms differ at different times of the year and on different hosts and assessors should be aware of that. Details on disease identification are provided later in this guide.

Assessments are carried out for a number of reasons and the purpose will influence the assessment method chosen. For instance, if one wishes to report an overall level of disease a rating of absent, low, medium, or high may be sufficient. However, if one wants more accurate data on which to make a decision on whether to undertake control measures or not, a more sensitive estimate of disease would be needed.

Conditions will also influence assessment. Large trees are more difficult to assess because often it is difficult to get an unobstructed view of the crown. Large trees are more prone to natural needle death, particularly in the lower part of the crown, due to suppression and lack of light. It can be difficult differentiating between defoliation due to suppression and that due to infection by pathogens. Aspect can influence disease assessment because light, prevailing wind, inoculum source, proximity of neighbouring trees can differ from one side of a tree to the other. Likewise, assessment scores may vary depending on the amount of light or the direction the assessor is looking. It is more difficult to see diseased foliage when looking into the brightest part of the sky and easier to see disease when the brightest part is behind you.

Assessment. The objective of any assessment is to estimate the amount of disease in the tree crown. It is important to assess only current infection. Therefore, bare branches caused by needles lost from past disease, regardless of cause (i.e. red needle cast, dothistroma needle blight), are ignored (see Figure 2).

Disease level on individual trees is assessed as the percentage of the total unsuppressed foliage present on the tree that is diseased. The proportion of infected to uninfected foliage is estimated and given as a percentage in 5% steps, i.e., 5, 10, 15, 20, 25, etc. A score of 40% indicates that 40% of the foliage present is diseased.

The assessment method described above is the method which is most commonly used. The annual aerial survey for dothistroma needle blight undertaken by many forest owners in New Zealand is based on this method. An evaluation of the accuracy of the assessment is provided by van der Pas, Kimberley, and Kershaw (1984).

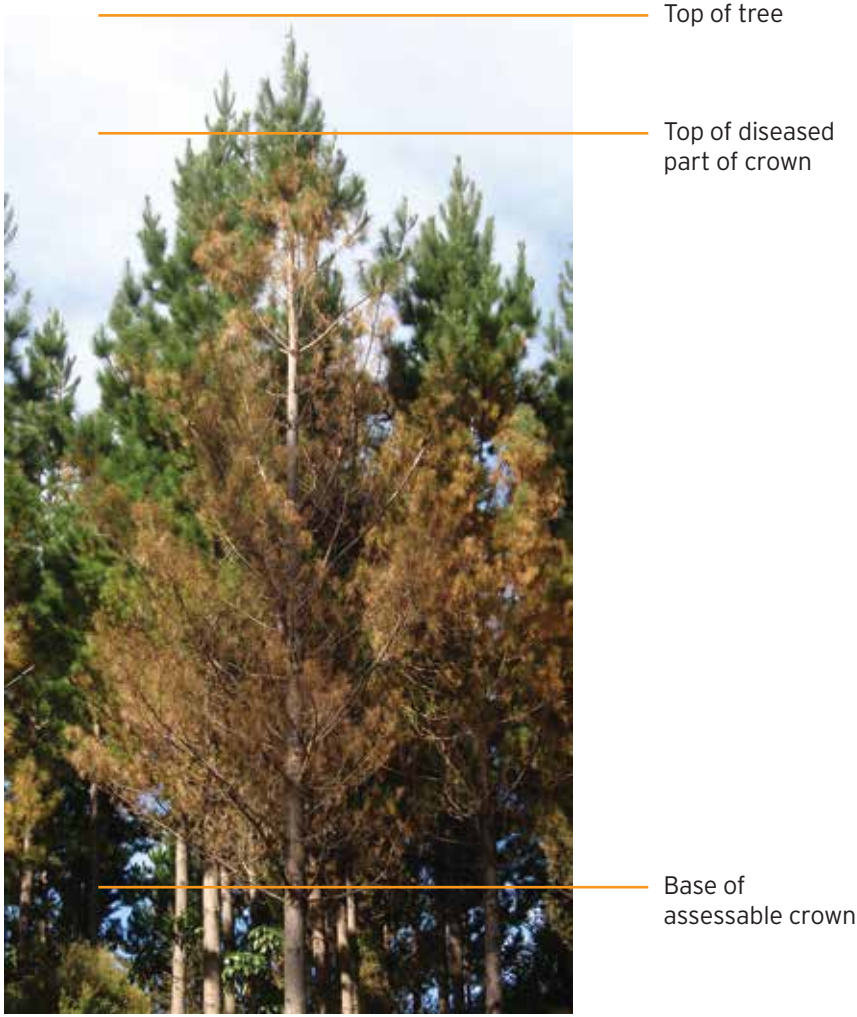


Figure 1. *A tree with red needle cast. This tree is not difficult to assess, 95% of the foliage on this tree is diseased.*

In a young plantation, before canopy closure, **all** foliage of the tree contributes to tree growth and therefore should be assessed. In closed-canopy stands, only the unsuppressed part of the crown (the part of the crown above the canopy closure points) of a tree should be assessed.

Assessment of severity of infection on individual trees is based on the observation that the pathogen usually infects and causes defoliation of the lower part of the crown first.

The number of trees that should be assessed during a ground based inspection will vary depending on the accuracy needed. Sometimes, where to assess is just as important as what to assess. For instance, disease levels in a moist gully may be much higher than in the remainder of the plantation. In order to obtain an accurate estimate of the amount of disease in a plantation, variation due to microsite (due to topography, terrain, and stand treatment) needs to be considered and planned for. Once the variation within a plantation is understood, an average of about 50 trees is usually sufficient to get a reliable estimate that will allow an informed decision on whether to initiate treatment or not.

Figure 2. *Mid-rotation tree with severe needle loss due to an unspecified cause.*

Control options

One of the main aims of disease assessment is to determine if disease has reached a level that warrants some form of treatment – what is termed the intervention threshold. The threshold varies depending on the value of the trees, the disease and the cost of control. If trees are valuable then the intervention threshold will be lower than that of less valuable trees. Different diseases cause different levels of growth loss, i.e. trees with 30% of their foliage affected by dothistroma needle blight will lose more growth than trees affected by cyclaneusma needle cast at the same levels.

Table 1 shows appropriate intervention levels for each of the four diseases based on their effect on growth.

Disease	Pruned stand	Unpruned stand intervention	Intervention
Physiological needle blight	35	45	Spray with phosphite
Red needle cast	30	40	Spray with phosphite
Cyclaneusma	35	45	Remove diseased trees during thinning
Dothistroma	20	25	Spray with cuprous oxide

Table 1. *Threshold disease levels that warrant intervention (% of diseased foliage)*[1]

Red needle cast and physiological needle blight. Chemical control options for red needle cast are still being developed. Provisional results of research carried out to date indicate that phosphite is a potentially effective chemical to control red needle cast. Efficacy and persistence increase as dose increases but the optimum dose and timing of application still need to be worked out.

Cyclaneusma needle cast. Chemical control of cyclaneusma needle cast is possible, but it is not economic. One would have to apply chemical at least 3 or 4 times in one season and the spray cost would not be recovered by the extra volume produced. Instead, owners of small plantations or woodlots should be able to control the disease by taking advantage of the fact that trees tend to be either very susceptible to the disease or not (Figure 3). The disease usually first appears when trees are about 6 years old, so if thinning is carried out when symptoms are most apparent (around spring time) highly susceptible trees can be selected and removed.

[1] Assuming produce from the pruned stand is sold at a premium to the unpruned stand.

Figure 3. *Yellow trees with typical cyclaneusma needle cast symptoms scattered among unaffected trees.*

Dothistroma needle blight. The photos on the following page (Figure 4) show young trees with different levels of dothistroma needle blight. The top left tree looks healthy but is given a score of 1% because it is extremely rare for a tree to be free of disease. At the other extreme the tree at the bottom right of page 9 has almost all of its foliage diseased and is scored at 95%. All trees on the top row on the next page do not warrant control measures because disease levels are too low – the cost of control would not be recovered by the additional increment gained.

At present, only dothistroma needle blight is controlled operationally. Copper spray is applied when average disease levels reach 20%, but some companies take a risk adverse approach and spray at lower disease levels. Stands are generally sprayed 3 or 4 times before they reach the age of 15 years, after that natural resistance to dothistroma occurs.

The Dothistroma Control Committee is responsible for organising spray operations, specifically:

(1) Buying bulk lots of copper fungicide and spray oil at competitive rates;
(2) Organising and letting contracts for the aerial application of the fungicide;
(3) Monitoring the quality of the fungicide.
(4) Reviewing any new techniques or developments from research;

The Committee comprises representatives from the New Zealand Forest Owners' Association, Ministry for Primary Industries, Scion, and the Farm Forestry Association. The Secretary of the Dothistroma Control Committee can be contacted at the following address:

Dothistroma Control Committee
P. O. Box 1035, Rotorua.

A guide on the assessment and control of dothistroma needle blight is available at: http://www.nzfoa.org.nz/images/stories/pdfs/content/fhrc_reports/2002-01.pdf

1% of foliage diseased

5%

20%

20%

Figure 4. *Trees with various levels of dothistroma needle blight severity.*

35%

65%

70%

95%

Identification guide

Red Needle Cast
Pages 14 to 19

Physiological Needle Blight
Pages 20 to 23

Dothistroma Needle Blight
Pages 24 to 27

Cyclaneusma Needle Cast
Pages 28 to 30

Note: *Red needle cast, cyclaneusma needle cast and even dothistroma needle blight can all look similar at certain stages of their development* (see page 11).

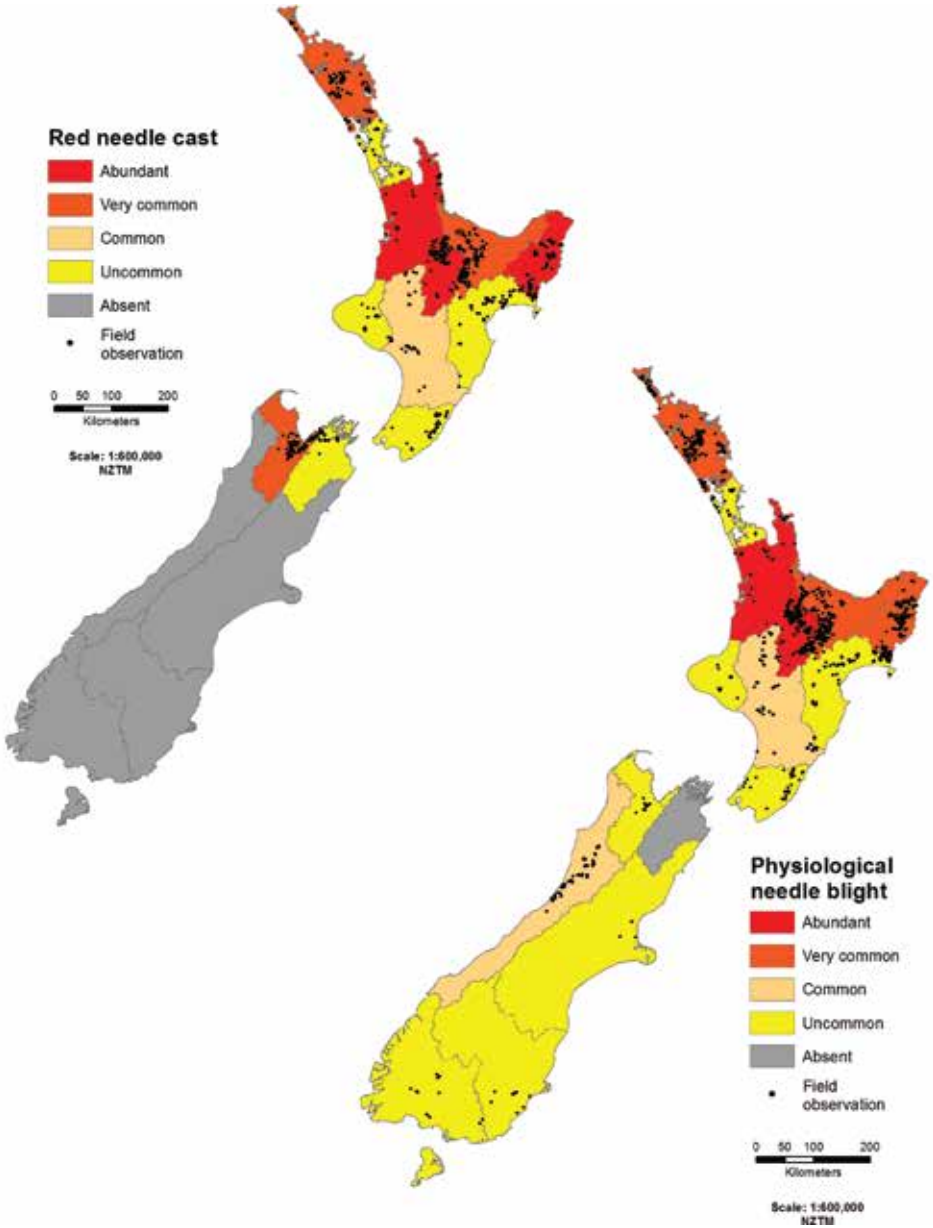
Dothistroma needle blight

Red needle cast

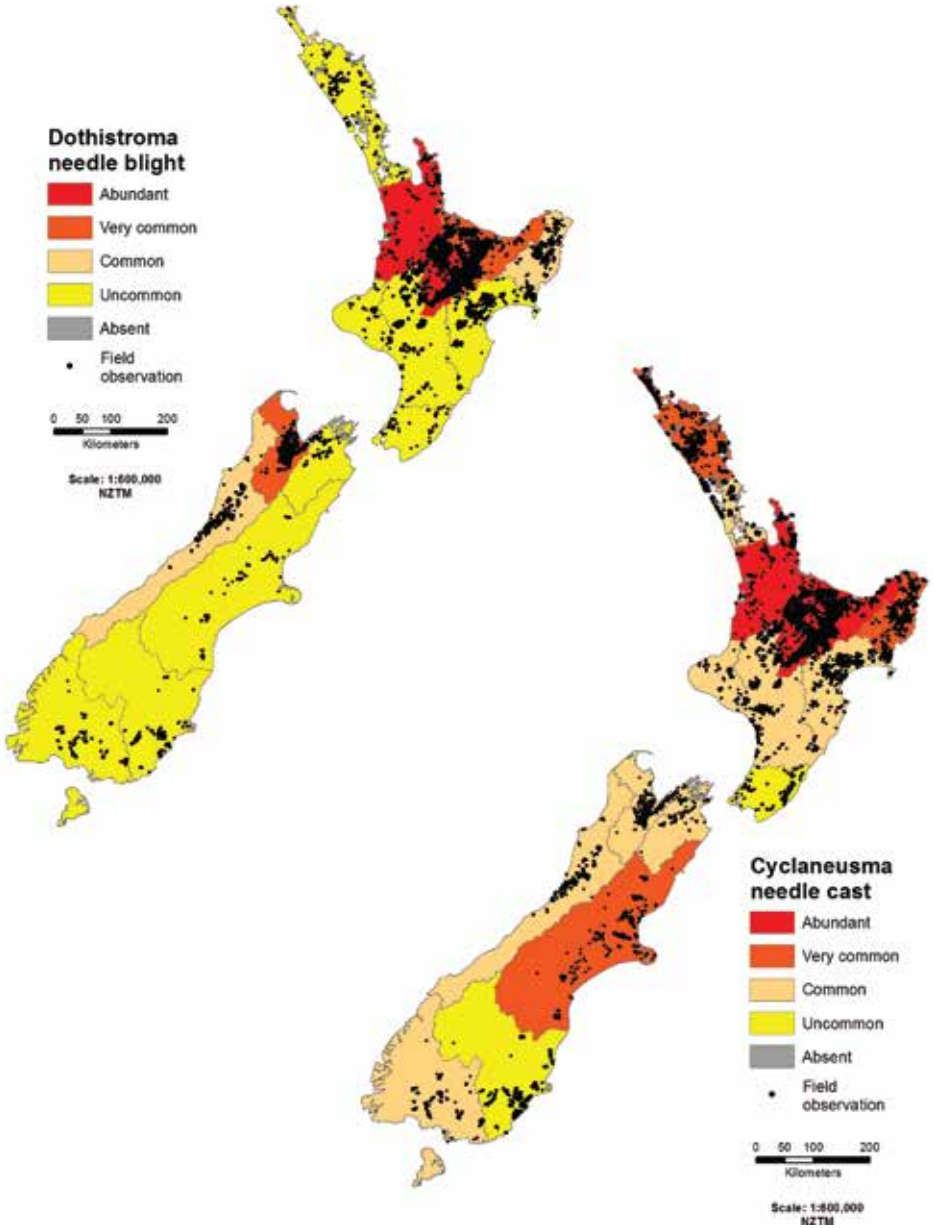
Cyclaneusma needle cast

The three diseases: dothistroma needle blight, red needle cast and cyclaneusma needle cast can look similar from a distance.

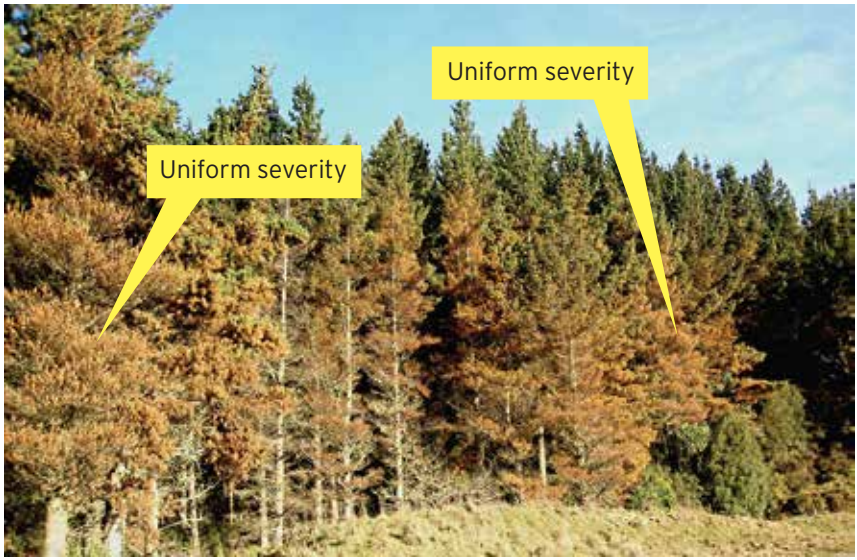
Disease locations



Disease locations



Red Needle Cast (RNC)

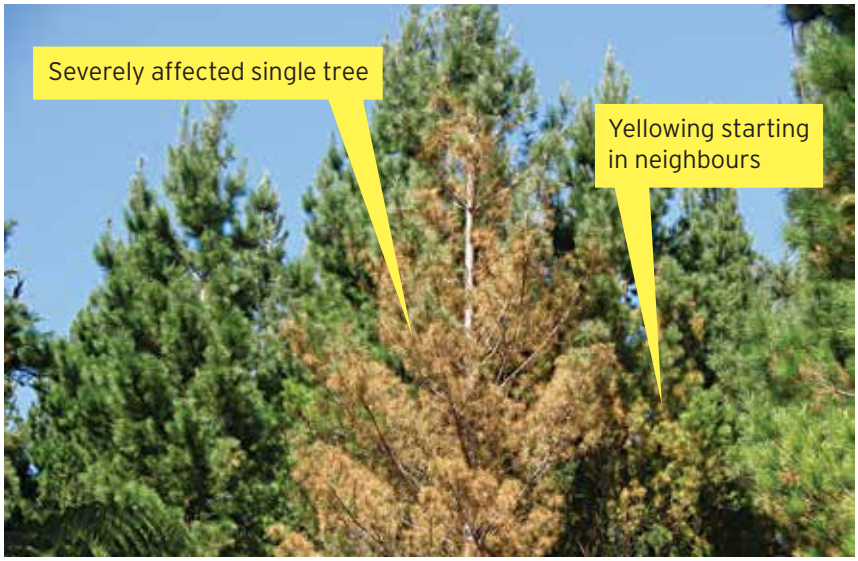


Stand affected by red needle cast. Note uniform severity and varying stages of disease development.

Primary diagnostic features of RNC

- Needles have distinct olive, or olive with black, resinous bands in initial stage
- Needles turn yellow and then red-brown
- At the yellow stage, can be very difficult to differentiate between cyclaneusma needle cast
- Needles remain rigid, but are easily removed from branch
- The entire tree crown may be affected
- Symptoms may start any time between March and September
- Peak disease occurs from July–September, depending on the region
- Symptoms are rare during summer
- Needles are cast or blown off the branch within a few months of symptoms
- After the needles are cast the tree crown appears very thin
- Affects trees of all ages.

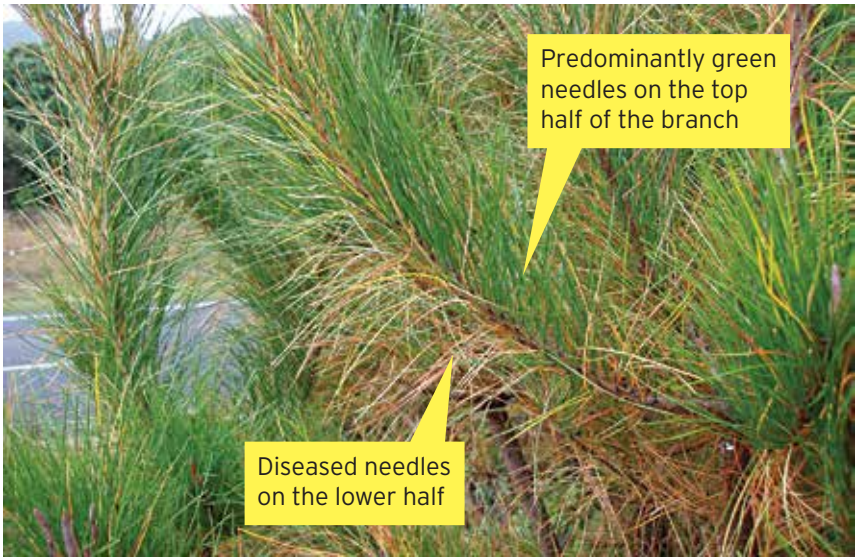
Red Needle Cast (RNC)



Single severely affected tree in mid-March.

Symptoms can develop and quickly change. Same tree six weeks later, early June.

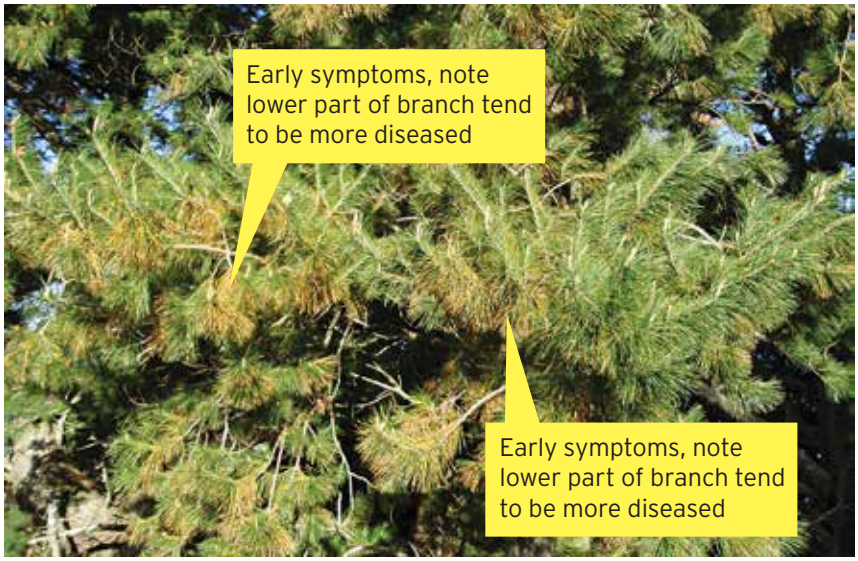
Red Needle Cast (RNC)



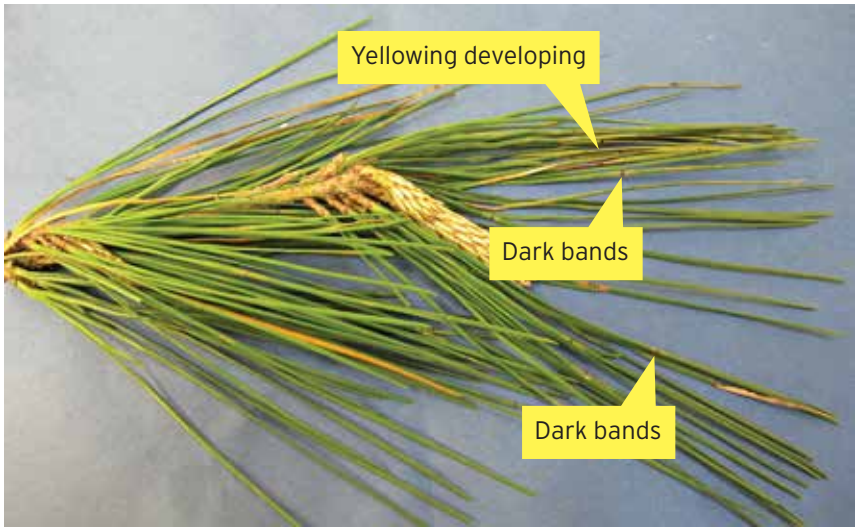
Early symptoms, yellow and brown needles.

More advanced symptoms, nearly all needles turning red-brown.

Red Needle Cast (RNC)

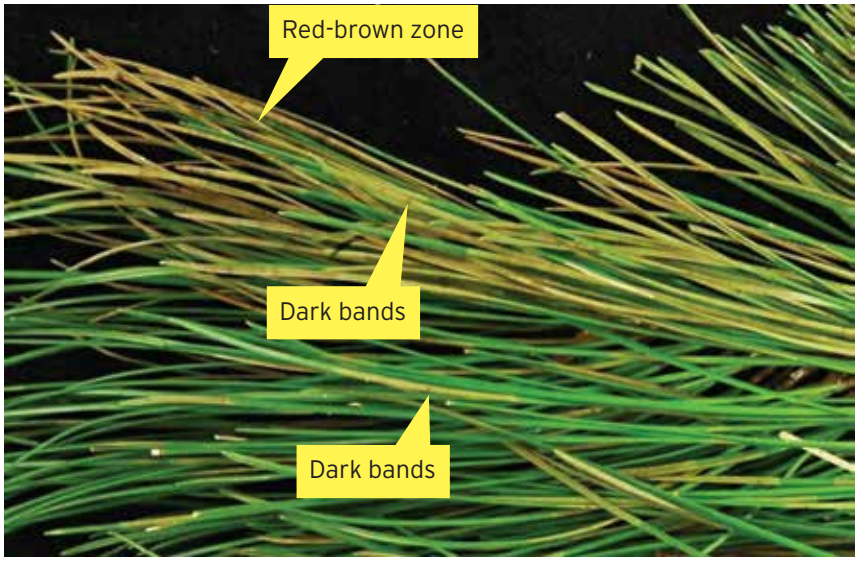


Branch in late August (mottled yellow needles starting to develop).



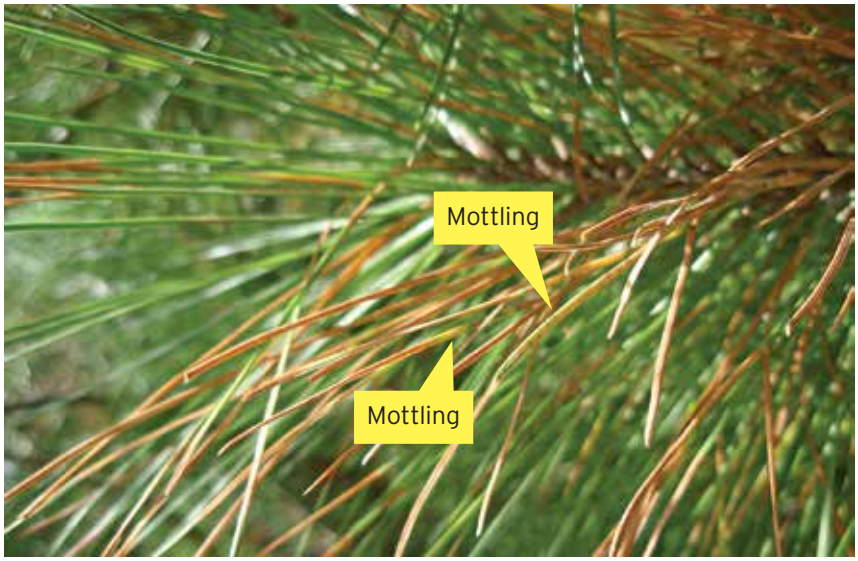
Black banding which may be apparent at the onset of RNC (common on top right needles).

Red Needle Cast (RNC)



Close up view of black banding, within a larger yellowish or khaki/olive coloured band, typical of the onset of RNC

Red Needle Cast (RNC)



Primarily red needles, but some yellowing and mottling has occurred.

General view of previous photo.

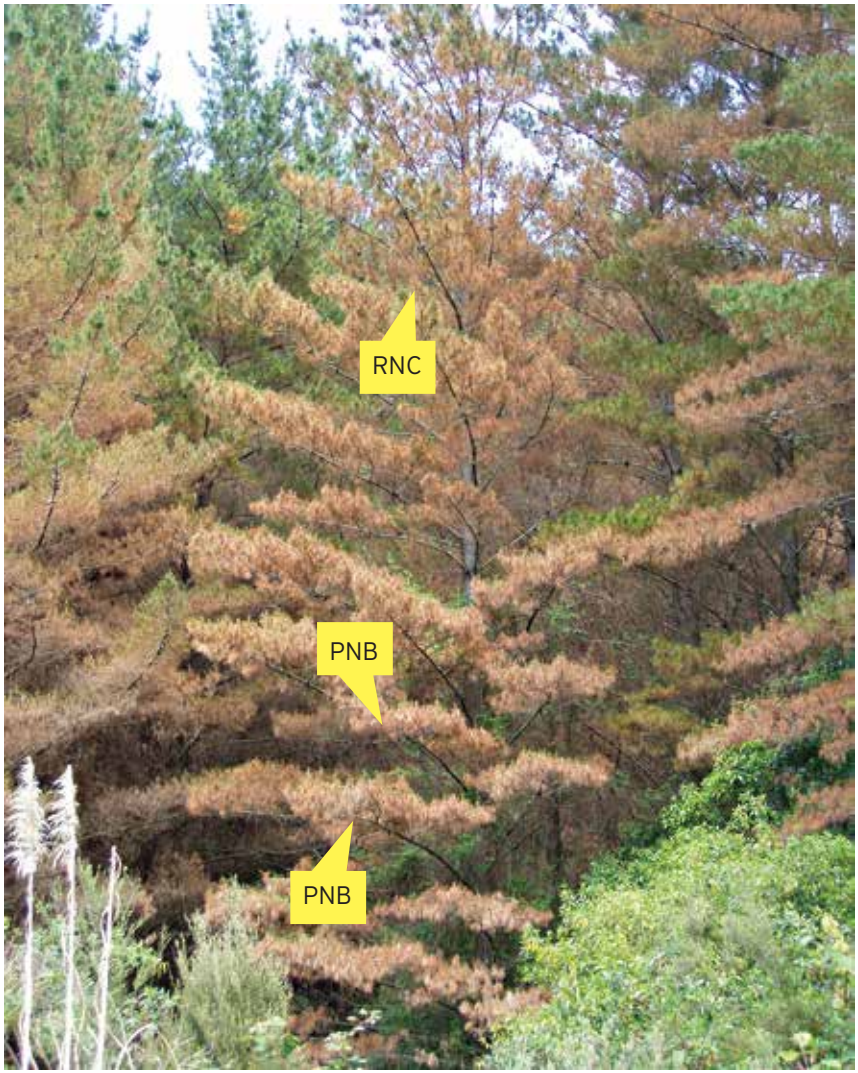
Physiological Needle Blight (PNB)

PNB with advanced-stage, grey foliage in the foreground and less-advanced, red stage foliage in the upper part of the photo.

Primary diagnostic features of PNB

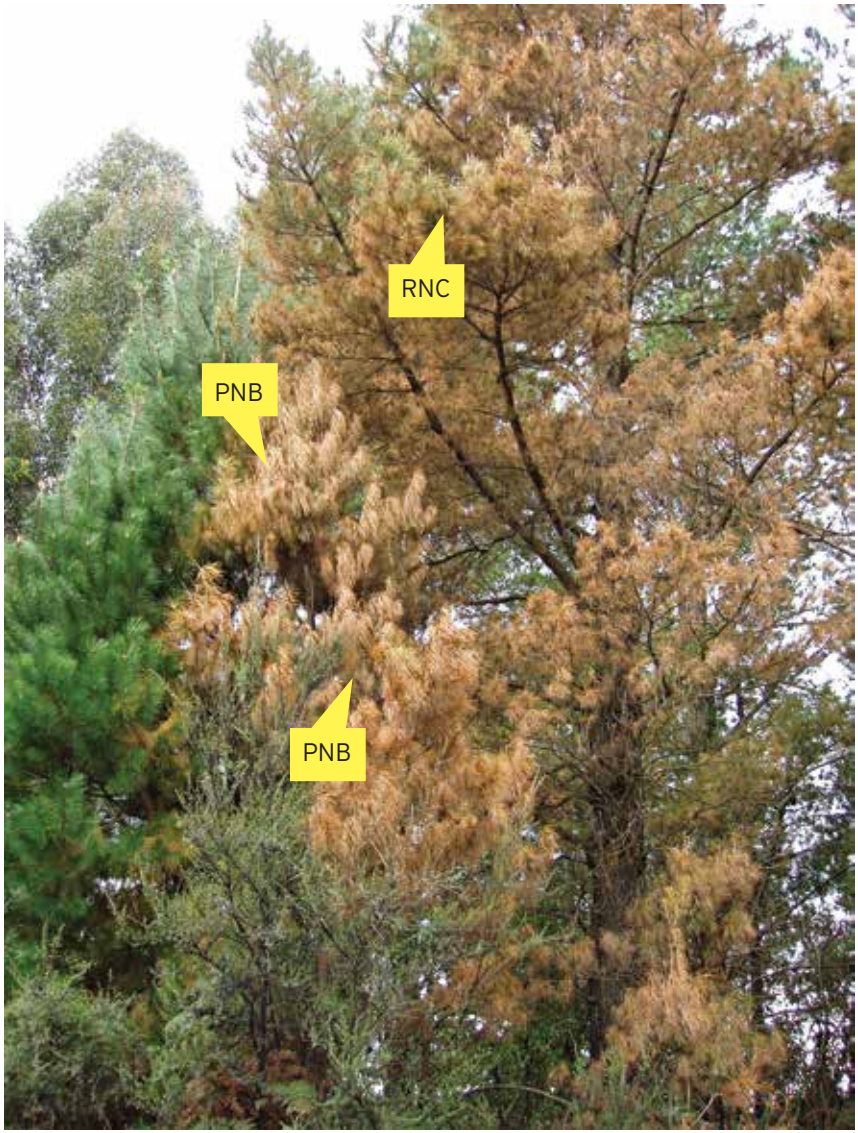
- Needles have distinct olive, or olive with black, resinous bands in initial stage
- Symptoms develop on foliage that flushed in the previous year
- Needles turn red-brown
- Needles droop and wilt, and are not easily removed from branch
- The entire tree crown may be affected
- Symptoms may start any time between May and November, but disease peaks about October-November, later than RNC
- On affected branches nearly all the foliage shows symptoms
- The needles remain on the tree for at least one year, by which time they have turned grey
- Generally, trees older than 14 years are affected.

Physiological Needle Blight (PNB)



The middle tree displays both RNC and PNB symptoms. The upper crown has RNC (more yellow in colour, foliage not wilting) while the lower crown has the wilting foliage typical of PNB (more red-brown in colour, needles wilting and drooping). This is uncommon but presented here to show the differences between RNC and PNB.

Physiological Needle Blight (PNB)



PNB on tree in foreground clearly showing wilted foliage in front of a larger tree affected by RNC (presented here to show the differences between RNC and PNB).

PNB - individual branch view

Branch in mid-October (drooping red-brown needles, limited new flush).

Branch showing severe PNB from previous season. Note the affected foliage remaining on the branch.

Dothistroma Needle Blight (DNB)

Close up of needles showing brick red bands and black fruiting bodies within the bands where spores are released.

Primary diagnostic features of DNB

- Needles turn red-brown
- There is a clear distinction between the red zone and the remainder of the needle
- The lower half of the crown is usually affected, in severe cases the entire crown can turn red-brown
- Needles remain rigid, and are not easily removed from branch
- Symptoms start on the new flush of needles about December or January and disease development continues through to winter when it slows but doesn't stop
- The needles remain on the tree after they die
- Peak disease occurs about September
- Affects pines from planting age up to about 15 years old

Dothistroma Needle Blight (DNB)

Disease is most severe on the parts of the tree nearest the ground and infection moves up the tree from there. Repeated defoliation will result in lower branches dying. Infection within a stand is uniform, with some tree to tree variation.

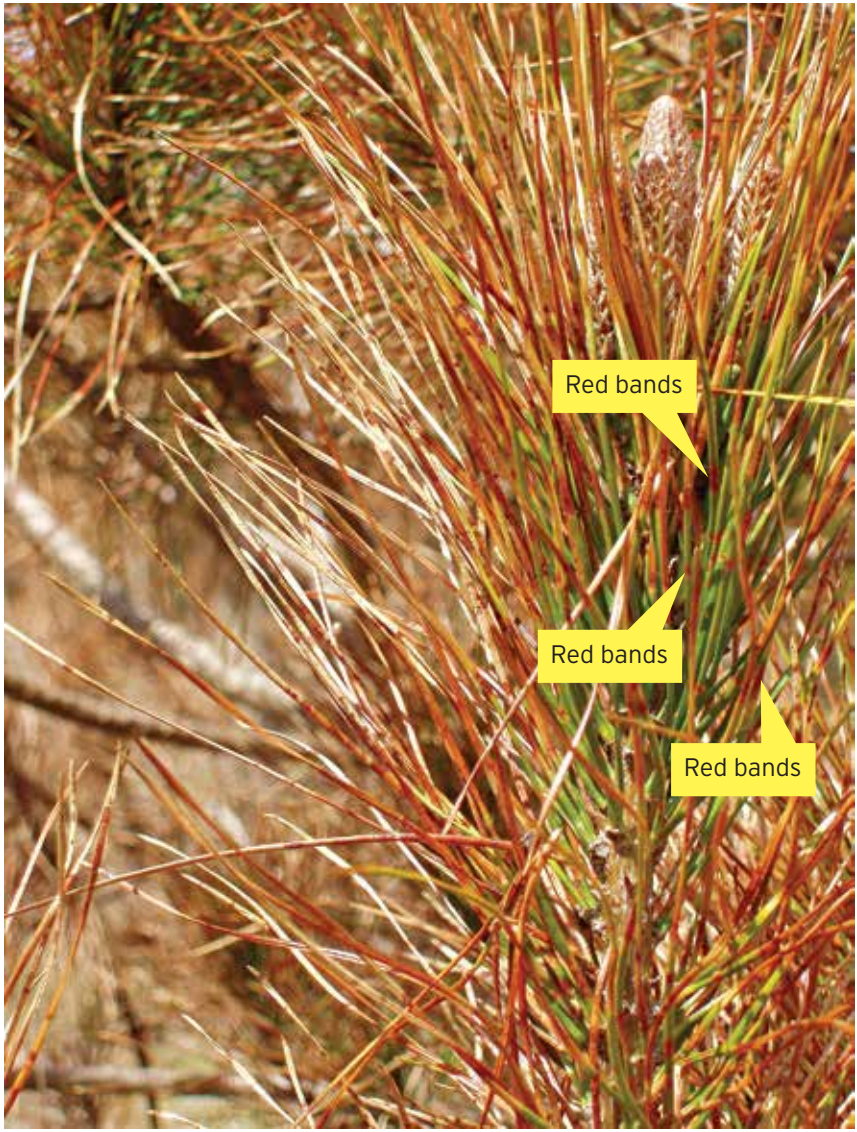
Heavily infected branches. Often dothistroma displays a "halo" effect because the ends of needles are affected more than the inner parts which stay mainly green.

Dothistroma Needle Blight (DNB)

Note rust red foliage.

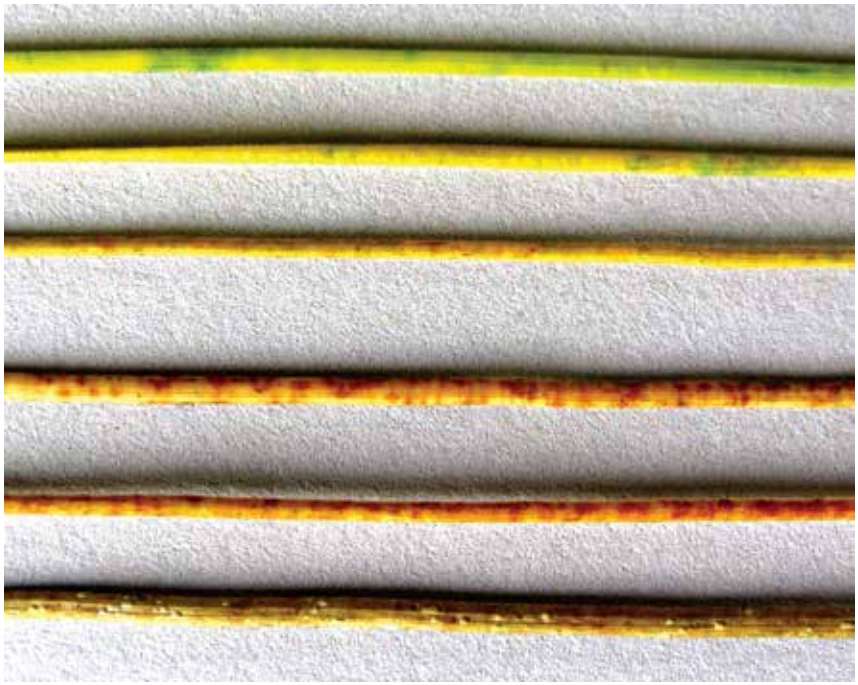
Typical infection on the distal part of the needles.

Dothistroma Needle Blight (DNB)



Red bands clearly visible (some are marked by arrow). Needles on the left of the photo are showing advanced symptoms and have turned pale brown, but the red bands are still obvious.

Cyclaneusma Needle Cast (CNC)



Stages of cyclaneusma needle cast development (from top to bottom) from green to yellow to brown with transverse stripes developing.

Primary diagnostic features of CNC

- Affected trees are scattered among unaffected trees – disease is not uniform in a stand unless the trees are genetically identical.
- Needles turn mottled yellow and then brown.
- Needles often have transverse bands develop during the later stages of disease development.
- Needles remain rigid, and are very easily removed from branch.
- The entire tree crown may be affected.
- Symptoms start September or October, with a second (usually less severe) cast occurring around April.
- After the needles are cast the tree crown appears very thin.
- Trees aged between about 6 and 20 years are affected.

Cyclaneusma Needle Cast (CNC)

A tree with severe cyclaneusma needle cast on the left beside an unaffected individual on its right.

Cyclaneusma Needle Cast (CNC)

The pruned tree showing yellowing typical of cyclaneusma needle cast.

Branches affected by cyclaneusma needle cast.

Symptoms associated with the four needle diseases of *Pinus radiata*

Symptom	Cyclaneusma Needle Cast (CNC)	Physiological Needle Blight (PNB)	Red Needle Cast (RNC)	Dothistroma Needle Blight (DNB)
Time of year expressed	September to November	June to November	April to October	All year, first appears on current foliage about December
Incidence and severity	Scattered individuals, up to 90% severity on very susceptible trees	Localised distribution, very high incidence in affected parts of a stand	Localised/general distribution, almost every tree in affected parts of a stand	General distribution, almost every tree in affected parts, but tree to tree variation is apparent.
Needle colour	Yellow, then gold, then brown	Red, then red-brown, then grey	Oily green band, then yellow, then red	Brick red bands on green needles with black spots usually seen within the bands.
Needle wilt	No wilt	Wilt common at late stage of disease development	No wilt	Needles may wilt, but usually wither and turn brown/grey
Needle retention	Needles detach very readily	Needles retained	Needles detach readily	Needles die completely and are retained
Cambium and bark	No damage, no lesions, no resin	No damage, lesions, or resin	No damage, no lesions, resin blobs sometimes seen at needle base	No damage, no lesions, no resin
Tree age	Six to 20 years	Generally over 15 years	All ages, but generally over three years	From planting up to about 15 years