Cyclaneusma occurs near the stem in the central crown, is bright yellow, and affects scattered and susceptible trees particularly following mild winters with uniform rainfall. Although this fungi causes growth loss, there is no known cost-effective solution except for tree selection at thinning.

Armillaria is a root-rot fungi and can cause considerable mortality, particularly on logged native forest (podocarp / tawa forests) sites or second-rotation exotic plantations. In 2 to 5 year old pines, needles will droop, turn yellow, and finally brick red.

Animal damage - Browsing animals are generally less of a problem than with other pine species, both because radiata pine is not especially palatable and because seedlings recover well from browsing damage. In Taranaki possums and goats can be troublesome if they are abundant causing leader dieback either by stripping off bark or by creating entry points for fungus. Good control programmes reduce the incidence of such damage. Pines can also be soaked or sprayed with egg paste to prevent browsing damage.

Deficiencies

The main deficiencies encountered are:

1 **Nitrogen:** all-over yellowing of tree, narrow crowns, small branches, and short needles;
2 **Phosphorus:** short foliage of normal colour with yellowing of tips in late summer;
3 **Potassium:** bright yellowing on the mid-lower part of the tree on last season's foliage;
4 **Magnesium:** golden yellowing of the tree on last season's foliage, particular in dry areas;
5 **Boron:** death of the leader and shoots of top branches, generally mid to late summer;
6 **Copper:** causes severe twisting ("wobbles") of leaders and branches.

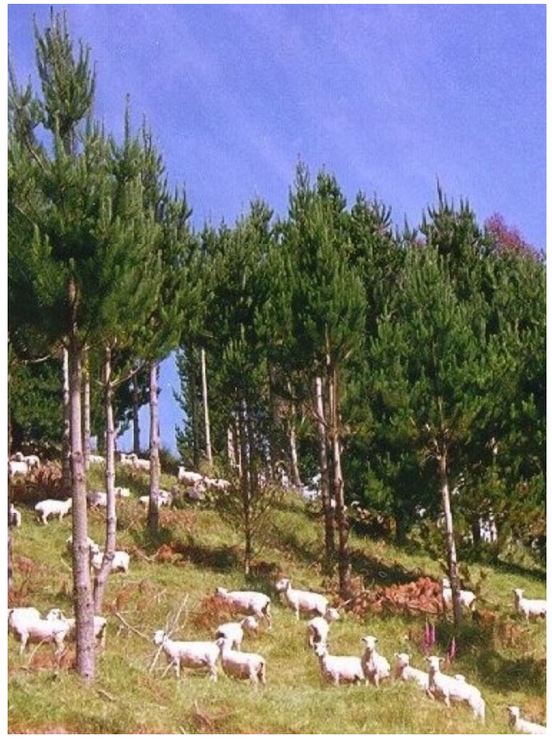
Log and wood properties

Trees are felled and cut into logs at the forest before transport to the mill or wharf. A mature radiata pine can be expected to produce at least three or even five logs of various lengths and qualities. Log product specifications for domestic and export markets include such features as: acceptable log lengths; minimum and maximum diameters for the small end (SED) and large end (LED) of logs; presence or absence of branches and maximum branch size; permissible sweep (log curvature); presence of stain, rot, damage and deformities on the stem; centrality of pith and roundness of the stem. Many more log specifications are utilised in different localities depending on the markets being supplied.

Radiata pine logs tend to be free of internal defects and growth stress. The pine is a light-coloured softwood of even texture and medium wood density, consisting at maturity of 80% sapwood and 20% heartwood.

Its properties allow an enormous range of end uses. The texture makes it easy machining, peeling and slicing for veneers, nailing, gluing, painting and varnishing. While the wood can be split easily enough, it does not split readily in the course of nailing. Its high permeability makes for rapid seasoning and easy treatment with preservatives. It is also suitable for both chemical and mechanical pulping processes.

Radiata pine is a very versatile and durable material, and given appropriate treatment is suitable for a wide range of exterior and internal use.



Forest grazing – modifying a forestry regime to enable understorey grazing

For further advice or information contact:

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Radiata pine
(Pinus radiata, Monterey pine)

Sustainable Land Management Programme 6

TARANAKI REGIONAL COUNCIL

Introduction

Radiata pine is a major contributor to the New Zealand economy. Forest plantations of the species covered more than 1.3 million hectares in 1996, which is about 90% of total forest plantation in this country. Forest products contribute $2.65 billion to the economy - compared to meat $2.6 billion, dairy $2.8 billion and wool $1.1 billion.

Radiata pine was introduced to New Zealand from the Monterey Peninsula, USA in 1859. Seed was initially imported mainly for aesthetic purposes, but by the mid-1870's the pine was being used more for shelterbelts and woodlots and less as a specimen tree. New Zealand became self-sufficient in radiata pine seed from the early 1880's.

Local bodies and private operators began to establish commercial plantations from the 1890's, and the 1920's saw radiata pine become the main species for large scale state afforestation undertaken to replace dwindling native timber reserves. At the same time research began into utilisation of the timber, and this research laid the foundation for sawmilling from 1939 onwards, and for pulping and papermaking from the 1950's.

Site selection

The choice of a suitable site for radiata pine is arguably more important than the choice of a suitable regime. Important factors to consider are:

1. Growth Potential

This is nationally recognised by site index, defined as the mean height at age 20 years of the largest-diameter 100 trees per hectare. This determines the likely volume and quality of timber at harvest.

A high site index area will tend to produce trees that are straighter, with little taper, longer internodes, smaller branches, and less nodal swelling than trees from a low site index area, other factors being equal.

In Taranaki, site indices normally range from 25 to 32m depending on altitude and exposure.

2. Weed type and incidence

Weed competition results in growth losses to the crop, and can make silviculture operations slow, costly, and unpleasant. Weeds to avoid are gorse, broom, bracken, pampas, barberry, honeysuckle, blackberry, and buddleia. Weeds such as thistles do not reduce tree growth.

Pasture will compete against juvenile trees but is easily controlled, and competition declines in importance once trees are established.

3. Logging and roading costs

Typically, the severity of the terrain dictates the logging method, which in turn reflects on the logging cost. Ideally, terrain should be flat to rolling (0-12°) for skidders (purpose-made rubber-tyred machine); rolling to steep (12°-20°) for crawler tractors; or steep to very steep (20°-35°+) for larger crawler tractors (earth disturbance may be environmentally unacceptable) and cable systems (haulers). Helicopters provide the least environmental impact and are becoming more common for exotic forest extraction.

It often pays to employ an experienced logging and roading expert to assess hill country sites prior to planting. Road construction may be the major cost, along with the final logging operation of the woodlot.

4. Transport cost

This is the distance of road travel to reach the point of log sale (ie, sawmill, export port). Generally a cubic metre of green radiata pine weighs about 1 tonne. So to transport 1 m3 100km in Taranaki costs an average of $20. Rail could

Farm forestry plantation

be advantageous, as this is often substantially cheaper than road. However, the sale of the crop can be made prior to or at harvest, in which case the purchaser incurs the transport cost.

5. Risk

Radiata pine is a maritime species, from a warm climate, and this is often overlooked in planning. As with any investment, risk is an important consideration.

Regions like the Taranaki hill country are particularly prone to damage from soil slipping. While erosion of hillsides can be significantly reduced by planting trees, these sites may still be prone to slipping or toppling of larger trees.

Within each location there is often a need to minimise the climate risk:

1 Shady faces with deep fine-textured soils may decrease the effects of drought.
2 Ridge tops are usually windier than gullies, and northerly facing slopes are warmer.
3 Wind damage is by the far the most widespread direct climatic hazard.
4 Snow dumping is not normally a significant problem below altitudes of 500m.
5 Frosts of -7°C can cause damage or even kill young trees.
6 The incidence of cyclonic storms or volcanic eruptions may also need to be considered.

Other factors to consider are: fire risk (locations near camping grounds, rubbish tips); social constraints (scenic or historical significance) and other local government restrictions (planting near overhead power lines, slope class, distance from waterways etc).

An example of the contrast between forestry and steep pastoral land after a severe storm event

Genetics

Today a radiata pine seedling is very different genetically to the original introductions. An improved crop is more uniform, will grow faster, have increased log straightness, less stem malformation, a more multinodal branch habit (except for the long-internode breed), and improved crown health than previous years.

In New Zealand there is a system which gives comparative rankings of genetic improvement. There are four recognised breeds:

GF - Growth and Form
LI - Long Internode (special purpose breed)
DR - Dothistroma Resistant (fungal disease)
HD - High Wood Density (special purpose breed)

The breed identity code reflects the prime breeding goal(s) pursued by the breed, although growth rate and form are pursued throughout. Each seedlot can then be described as a seedlot number. An example of a seedlot number is:

Pinus radiata GF17 90.162

This number denotes radiata pine, of the Growth and Form breed (GF), Improvement Rating 17, collected in 1990, with a seedlot number 162 for that year. A certificate can be gained with each seedlot, proving the tree material quality.

Physiologically aged cuttings are often considered an advantage to seedlings. Aged cuttings are collected from tree stands or nursery beds and are propagated from older material (1-5 years old). They develop roots in the nursery and superficially resemble seedlings. The cutting then appears to recognise a "biological clock" so that a cutting from a 3 year-old tree knows that it is 3 years old and grows differently from a seedling. Advantages are smaller branching, less forking, straighter stems, they are sturdier, less likely to have distorted roots at planting, and are expected to have less taper and bark thickness.

Planting bare-rooted trees

Ordering - Trees should be ordered at least 9 months in advance. If aged cuttings or high GF-rated stock are required, several years notice may be necessary.

Timing - For cold sites, planting occurs in late winter or early spring. Drier sites (eg, sand dunes) it is wise to plant early in winter to ensure that trees are fully established before a drought arrives.

Planting Tools - The best tool for planting is a tree-planting spade, designed specifically for the job.

Successful planting - Before planting, site preparation is carried out to control competing vegetation. Cultivation of planting spots is essential for good root placement at planting. If the soil is hard, good cultivation (preferably mechanical) is necessary to allow roots to penetrate laterally for nutrition and vertically for anchorage.

A planting spade is used to cultivate the ground to a full blade depth and area (40 x 40cm). This is necessary to "freshen" the soil (ie, release nutrients) and to allow good root penetration.
A planting hole is created that is wide enough to take the roots.

- Place the roots in the bottom of the hole.
- Replace the earth around the roots.
- Pull the plant up through the fill, approximately 10cm, to ensure that roots are straight.
- Continue to hold the top of the tree after pull-up and firm the soil around the stem with the soles of your boots (holding the stem while firming-in prevents the soil bending the roots).

Planting sites should be kept clear of competing vegetation for at least one year after planting. Spot-spraying with a suitable herbicide, to create a weed-free planting area, is common practice.

Blanking (replacement of dead or unhealthy trees by new seedlings) can be undertaken soon after planting. If blanking is delayed a full year, these trees never catch up and are often culled at thinning.

Tending (Silviculture) regimes

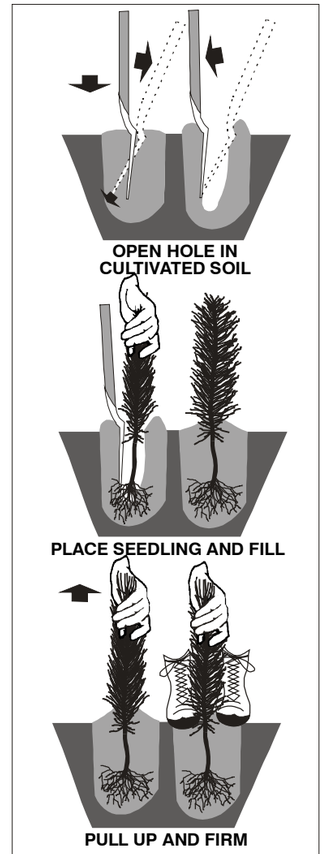
Various tending regimes have evolved according to site conditions, end uses, proximity to markets and the circumstances of the grower. Crucial decisions are required within the first 10 years of the rotation. Initial stocking, tree form and the need for precise timing of pruning and thinning must be considered. No tending at all can be more profitable than badly timed tending.

Direct regimes (ie, where the stand is thinned directly to final crop at the completion of pruning) centre around producing valuable butt logs, and with the help of pruning give high yields of knot-free clearwood. Agroforestry regimes (growing the trees on pastoral farmland and continuing to graze understorey) are considered direct regimes also.

Indirect regimes (in which trees are held, following pruning, for a later production thinning) are often designed to control branch size within acceptable limits for framing or for clear wood.

A typical tending regime for Taranaki hill country is:

Site index	28 metres
Planting stock	Pinus radiata GF17
Planting space	1000 stems / ha (5m x 2m)
1st prune to 2.2m	Year 4
1st thin to 500 st/ha	Year 4
2nd prune to 4.5m	Year 6
2nd thin to 300 st/ha	Year 7
3rd prune to 6.5m	Year 8-9
Final spacing	300 st / ha
Rotation length	28 years (average)
Recoverable volume	677 m3 / ha (including pulp)



**Source: Radiata Pine Growers' Manual. J.P. Maclaren, FRI Bulletin 184, 1993.*

There are many variations of planting and management regimes, which can be applied depending upon desired crop type and market orientation. The regime specified above is primarily aimed at producing clear butt logs and is most suitable for Taranaki Hill Country.

Pests and diseases

Fungal diseases - Fungal diseases are currently regarded as a more serious hazard than insect attacks or other animal pests. Except in dry conditions (less than 800mm rainfall), radiata pine is susceptible to two main fungal diseases: **Dothistroma** and **Cyclaneusma**.

Dothistroma causes severe defoliation (with consequent growth loss) on stands up to 12-15 years, particularly in high rainfall areas, or where air movement is restricted and high humidity is maintained.

Infected foliage shows a brown pine needle colour in the lower part of the tree, and on closer examination, are found to have distinct reddish bands. Increased air movement through heavy pruning and thinning will reduce attack. However, dothistroma can be overcome with an aerial application of copper oxychloride spray on average three to five times in a rotation. A single application lasts 2-3 years.