

An assessment of pine pitch canker in Radiata pine

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Perspective

This assessment of the potential impact of pine pitch canker on radiata pine plantations outside the USA is made from a silvicultural and management viewpoint. It is based on the author's long experience studying radiata pine, on his reading round the subject, his general knowledge of how diseases have previously impacted plantations, a brief visit to Año Nuevo in California in November 1999 and discussions with Professor Bill Libby in California. The author acknowledges he is a silviculturist and not a pathologist and that it is very difficult to predict what the outcome might be, if the disease became established in radiata pine plantations outside the USA.

What do we know?

The canker is caused by the fungus, *Fusarium subglutinans* sp. *pini*, (now called *F. circinatum*) and there are apparently many strains.

Pitch pine canker was first described on radiata pine in California in 1987, although it is likely to have arrived earlier than that.

It spread rapidly North and South along the coast over the next 10 years between latitude 34 and 38 degrees N. It had been expected to spread via other species north into Canada, but the spread north seems to have stopped. Radiata pine planted near Acarta in Northern California is currently free of the disease (personal observations Nov 1999). It is still not present in the Southern half of the Cambria stands of radiata pine.

During this time of rapid spread it was noticeable that it appeared close to car parks and forest recreational areas, suggesting that human activity was involved in the spread.

In the last three years there has been only one significant further movement in California and that was to Dixon which is further inland. But this area is also known to have plants and animals in common to coastal environments.

Within an area the spread can take different forms.



Healthy and dead young regenerations of Radiata pine, Año Nuevo, November 1999.

Thus in Monterey it tended to appear in patches while at Año Nuevo it "flashed" across the population.

In California there are at least 10 beetles plus spittle bugs involved in the spread. This may account for the differences in the way it was observed spreading in Californian radiata pine. There are suggestions that parasites of the beetles may also spread the disease and because they may hunt for beetles to parasitise they could be very effective vectors.

In addition it can be spread in soil and with water ponding (in Christmas tree farms). In southern pines in the SE of USA older studies did not implicate insects to the same degree but instead suggested spores carried in rain splash and air currents infecting wounds. However, there are reports associated with damage caused by tip moth (*Rhyaciona* spp). Again the spread in southern pines was rapid and tended to be coastal – it has now stabilised. Disease resistant clones are being used in the SE.

The attack may be seen on twigs, branches, stems, cones and roots of radiata pine. Attack to twigs is very apparent as it quickly results in reddish foliage above the infected point and subsequent death of the twig and unusually fast shedding of the dead needles. It is unclear



Pitch pine attack.



A young tree attacked by pitch pine canker, Año Nuevo.

if resinosis is the cause of the twig dying distal to the infection point, or if it is just a good diagnostic symptom of infection. Stem infection causes severe bleeding which in turn can attract other insects (eg *Ips*) so causing the death of the top of the tree or the tree itself.

Initially found about 60-70% of the trees attacked with about 30% deaths.

There are differences in the amount of infection between sites – less in natural stands, more in inhabited areas and worst on golf courses.

Very recent studies are showing evidence of Systemic Acquired Resistance (SAR), the first such recorded report for a conifer.

Other laboratory studies have shown that all pines are susceptible to attack except for *P. brutia*. However, radiata pine is one of the most susceptible species along with knobcone and bishop pine.

About 2-3% of radiata trees seem to be resistant. Dr Tom Gordon who has tested about 2400 clones has found that 60 have remained free after double inoculations. The earliest-found have been cloned and these have remained free of the disease after one year in the laboratory or nursery and five years planted in field tests surrounded by infected trees. However a few have recently developed symptoms apparently from a previously-unknown virulent strain. The “new” strain has been isolated and will be used in tests of the other previously resistant clones.

Despite known repeated introduction of the disease to inland stands of pines it has not taken hold (with the exception of the Dixon site).

There is only one instance of Douglas-fir being infected (twigs) but these appear to be an inland variety of Douglas-fir. Nearby coastal varieties remain symptomless.

However, there is a possibility the disease could be carried on Douglas-fir seed and the disease vectored into a new area by symptom-less Douglas-fir seedlings..

The disease is sometimes found inside radiata seed and not only on the outside, but the frequency is lower.

What we do not understand

How the disease would react in radiata stands outside its natural habitat

What is special about coastal environments that make these stands so susceptible to the disease? Is this same factor or factors the reason for the disease being found in the Inland Dixon site? Conversely what factors result in it not spreading to inland sites? How does this translate to its possible spread if spread to other countries?

Why has the spread north apparently stopped? What are the factors (e.g. climatic) that are involved?

If insects are the major vectors in California, why are they not so important in the South-eastern states?

How important is spread in soil or by water relative to insects?

Are the strains of the disease in the SE the same as in California? Evidence is contradictory. Did the disease in California come from the SE?

Why did infection follow different patterns in Californian radiata pine stands? Is it different insect

vectors, as suggested?

What are factors involved in differences between sites? Why do golf courses show high rates of infection? Is fertility of the site important?

Are larger animals (squirrels, deer etc) important vectors? These do not seem to have been studied.

What is the nature of the apparent resistance by some individuals? Dr Gordon suggests it is not a single gene but this needs further work.

Assessment

Pitch pine canker is a serious disease and it would be a setback to plantation forestry if was introduced to a country with large areas of radiata pine plantations. It is apparent that radiata pine is highly susceptible compared to many other pines. But it is difficult to predict how fast it would spread through plantations as conditions controlling its spread (vectors and growing conditions) may be different to those in California. We can only speculate at this time.

Nevertheless, my assessment is that mature stands would not be at severe risk and could probably be harvested as normal, probably without a great loss in volume. Younger stands of radiata pine might suffer from many trees suffering dieback, increased malformation and deaths, particularly if bark beetles such as *Ips* are present. This would seem to be the biggest risk facing growers. If the spread was airborne, as in the southern pines, then pruning could aggravate the problem. There would also be increased mortality in young trees, particularly if resistant strains are not being planted and where bark beetles such as *Hylastes* are present.

Overall, therefore I suspect that growers of radiata pine would learn to live with the problem just as we have with other diseases such as diplodia or dothistroma. We would probably find areas or regions where the disease was worse and in these places would have to weigh up whether to replant radiata pine or to switch to another tree species. We already know, for example, that radiata pine is not suitable for regions with humid summer heat because of disease and here other pines are to be preferred. The good news is that systematic acquired resistance occurs and it seems possible to breed resistance to pitch pine canker in radiata pine.

Finally, in thinking about pine pitch canker we should remember there are equally devastating diseases of radiata pine about, such as western gall rust and fusiform rust around. Yet these have not turned up in our plantations despite the increase travel from places where these are common.

Response

At the present time the following strategies should be adopted:

Ensure there are stringent quarantine measures to try and prevent the disease from being brought in from the USA and other countries where it is present (eg Japan, Mexico, South Africa)

Be very cautious about importing Douglas-fir seed, especially from California as it may be a carrier of the

disease. It is possible to test imported seed for presence of the disease. Recognise that testing each seed is expensive and probably kills the embryo. It may only take one infected seed to introduce the disease!

Send seed of selected best strains of radiata pine for controlled testing to California. This would assist breeding programmes and the rapid deployment of resistant strains if the disease did become established.

Support ongoing research in the USA. Fortunately the USA is increasing its research efforts on the disease and this should allow a better understanding of factors controlling the diseases spread and development of control measures.

Continue or increase research on alternative back-up species to radiata pine.

Professor Bill Libby suggested that traditional tree breeding methods were likely to be best for developing

resistant strains because susceptibility appears to be quantitatively (i.e. polygenetically) inherited. He was of the opinion that some of the newer biotechnology techniques such as marker-assisted selection and gene insertion or deletion may not assist greatly. However, tissue culture and embryogenesis would appear, to the author, as being helpful in that they could be used to multiply up resistant clones or lines of radiata pine.

Further information

For those needing further information the following are useful starting points:

Dick, M. 1998. *Pitch pine canker – the threat to New Zealand*. N.Z. Forestry 42 (4): 30-34.

http://frap.cdf.ca.gov/pitch_canker/pitchcan.html

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Plantation establishment - QA indicator plots

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Introduction

In manufacturing, uniformity is the key to success. Any product that is not of uniform quality soon loses its appeal for the production of evenly sized trees for high volume recovery of quality wood. Unlike most manufacturing processes mistakes made during establishment of forests (early manufacturing stage) are not easily identified or rectified and prove very costly because of the long term nature of the investment (25 to 30 years for Radiata pine).

Therefore, quality assurance procedures that are effective in raising standards and revealing weaknesses in establishment operations are of considerable value.

Difficulty of identifying initial growth defects

Variations in, and quality of, soils, site, climate, tree stocks, site preparation and planting make it difficult to identify reasons for initial growth defects. Research trials show that weaknesses in any one facet of stock production or establishment procedures can adversely affect initial growth and in some cases significantly reduce final crop value.

Even if initial growth is good, uncontrollable high winds can have devastating effects on young stands, toppling being a major problem on exposed sites (Mason, E.G. and Trewin, A.R.D., 1987: *Toppling of Radiata pine*, NZFS, What's New in Forest Research No. 147.).

When there is no clear indication of why crops fail, responsibility falls on the forest manager to show that establishment prescriptions and quality control procedures were good. Investors, faced with financial loss, naturally question management efficiency and, if dissatisfied, claim compensation. When this happens, litigation is often protracted as expert witnesses, representing both parties, frequently disagree on reasons for failures. The need for a reliable method of gauging efficiency of forest establishment operations which can be used throughout the industry is therefore, apparent.

Indicator Plots

In the 1980s researchers planted "Indicator Plots" in forests throughout New Zealand to demonstrate the benefits of improved nursery lifting, packaging and handling practices (Trewin, A.R.D., 1978: *Pine seedlings – handle with care*. NZFS, What's New In Forest Research no. 69). The physical evidence of high survivals and vigorous growth in plots persuaded foresters to up-grade establishment procedures. Subsequently it was recommended that Indicator Plots, representing exact nursery and field prescriptions, be used by establishment personnel to check the efficiency of production plantings (Trewin & van Dorsser, 1985, *The Integration of Manual and Mechanical Operations Involved in Raising and Planting Bare-root seedlings of Radiata Pine in New Zealand*).

One forester using Indicator Plots reported:

"When actual operational establishment of Radiata pine is compared side-by-side with potential (ideal) implementation of our prescription techniques for lifting, dispatch, and planting, it is found that first year growth of seedlings established on an operational basis fall short of potential. Loss of potential growth amounts to 2.8mm in diameter (21% of potential), 15cm in height (18% of potential and 44% of potential bulk growth). Survival is also down to 92% of potential survivals."

The following year, improvements in nursery culling and handling of stocks raised survivals from 92% to 99% with associated improvements in growth uniformity matching that of Indicator Plots.

QA Indicator Plots – a gauge of efficiency

A number of forestry managers in New Zealand and Australia now use QA Indicator Plots to check the quality of production plantings. As a preliminary quality control measure they have a consultant check stock specifications in supply nurseries before placing orders. Once planting starts the consultant visits the field samples stock to ensure