# THE INFLUENCE OF DISEASE AND INSECT PROBLEMS ON MANAGEMENT PRACTICE IN KAINGAROA FOREST

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ABSTRACT

Both the wood wasp **Sirex noctilio** and **Dothistroma pini**, the needle cast disease, have had a significant influence on management of **Pinus radiata** in Kaingaroa Forest. Neither have caused a serious reduction in the growth of that species. The **S. noctilio** epidemic of 1949/50 acted as a beneficial natural thinning of the first crop stands which would otherwise have been grossly overstocked today.

**Sirex noctilio** provided the impetus to thin the radiata young crop together with criteria for the selection of regimes. The serious **D. pini** infection of **P. ponderosa** and **P. nigra** and the concurrent ill health of other old crop species has forced the introduction of severe thinning practice in the radiata young crop to bring forward their age of clearfelling so that the cut in the first crop can be accelerated.

## INTRODUCTION

Kaingaroa has sustained two major diseases in radiata pine. *Sirex noctilio* was contained by biological control while aerial spraying of copped-based fungicides has brought the *Dothistroma pini* needle cast disease under control. At the time of their initial impact on the forest both of these pathogens were the cause of grave concern, and there were those who saw in them the catastrophic consequence of exotic monoculture. Both have had a significant effect on the management of our major species but neither has caused a measurable reduction in production. In fact, the sirex epidemic of 1949/50 has proved to have been a blessing in disguise and dothistroma is not without its beneficial side effects.

## *SIREX NOCTILIO*

*Sirex noctilio* had been established in New Zealand long before the epidemic of 1949/50. It was first identified in the Wairarapa in 1904 and it had been recognised as a serious forest pest as long ago as the late 1920s when biological control was initiated by the successful introduction of *Rhyssa persuasoria.* Occasional reports of serious mortality attributed to sirex are on record from all regions of New Zealand before 1946, but in that year, in the central North Island, a set of circumstances combined to provide favourable conditions for the insect on a massive scale.

At that time the huge area of exotic plantations, which had been planted in the period during and immediately before the Great Depression, were almost completely untended. In 1946 the older stands in the north of the forest were around 20 years of age and were grossly overstocked with stockings of between 1500 and 1700 stems/ha and with basal areas of 45-70 $m^2$/ha.

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For 12 years before 1945/46 there had been above average summer rainfall with an average of just under 150 mm per month. In the summer of 1945/46 there was a sudden and prolonged drought in which the total rainfall between November and March was just over 200 mm. The following two summers were less severely dry but were significantly below average in rainfall.

As an indirect result of the 1946 drought there occurred in that year one of New Zealand's most serious forest fires which swept through close to 12 000 ha of pine forest just north of Taupo. This fire stopped immediately short of the south-western boundary of Kaingaroa.

The debris from the forest fire, the overstocked stands under severe moisture stress, and a period of three years during which conditions were most favourable for the survival of the insect larvae, all led to an explosion of the *S. noctilio* populations in the forests of the Bay of Plenty. By 1948 they had reached epidemic proportion and in the late summer and winter of 1949 heavy mortality was experienced. During the peak of the epidemic in 1949 and 1950 massive clouds of insects could be seen above the trees, almost every stem in the forest was exuding resin from insect attack and mortality was widespread, especially in the north of the forest, in the oldest and most heavily stocked stands.

There is a very clear trend of decreasing mortality from the north of the forest to the south. This is undoubtedly a reflection of the decreasing stand density. Not only is there a difference of five to six years between the northern and southern stands, but this age difference is effectively inflated by site index (mean top height at 20 years), which decreases from 27-30 metres in the north to 18 to 21 metres in the south. Density in the southern stands generally had not reached 45 square metres of basal area and individual trees were under less moisture stress. While insect attack was probably just as severe, and is readily detected in log sections, mortality was relatively light.

Today the stockings in the remaining old crop stands demonstrate this trend of decreasing mortality. In the northernmost and oldest cutting section the average is 230 stems/ha (1925 planting) while in Matea average stocking is 560 stems/ha (1929-32 planting).

After 1950 the summer rainfall returned to normal and the insect populations dropped rapidly in numbers. Further insect parasites of sirex were introduced (*Ibalia leucospoides*) and since 1955 no widespread mortality has occurred again.

The epidemic of 1949/50 demonstrated the need to thin and it provided the criteria for the formulation of thinning regimes in young stands of radiata pine. Assessments in the infected old stands had shown that mortality became significant where stand density exceeded 45 $m^2$/ha and it was the Forest Research Institute's recommendation that thinning should be carried out to avoid exceeding this maximum (R. Zondag, pers. com.).

The tending regime for radiata pine in the first working plan period from 1955 to 1959 was proposed by Ure in 1952. In planted stands the stocking resulting from planting at a spacing of 2 × 2 m or 2.5 × 2 m was reduced to 590 stems/ha following the final pruning at 12-14 m mean crop height. This stocking provides for a commercial thinning or thinnings or for an early pulpwood clearfelling (which were not specified).

Today the influence of the sirex epidemic is looked upon as beneficial. The trees

which were killed by the insect were the subdominant element of the crop. Very seldom were there groups of trees killed. The attack was therefore a heavy thinning from below and it was achieved at zero cost. In the, now overstocked, stands in the south of the forest the constant attrition from wind damage is a testimonial to the benefits of the wood wasp.

## *DOTHISTROMA PINI*

This fungus causes needle cast on all pine species. Its rapid spread throughout the vast forests of the Bay of Plenty in the mid-1960s was one of the sensations of the time. It was the cause of the establishment of the Forest Owners' Association which is a body representing most of the afforestation companies of New Zealand and which coordinates the massive aerial spraying operations which have largely controlled this disease.

It was first discovered, in Kaingaroa, in 1963, but its importance was not fully evident until the end of 1965. During 1964 and 1965 Forest Biology Survey staff had identified the disease in a large number of radiata pine stands and in a lesser number of stands of *P. nigra* and *P. ponderosa,* but the large number of such sightings referred to infection recognised by experienced observers and only in a handful of stands were there well defined epicentres of the disease. Furthermore, in spite of the preponderance of *P. radiata* in the early reports, it was in stands of *P. ponderosa* and *P. nigra* that the disease first became noticeable to the layman. By December 1965 there were three well defined infection centres in which stands of *P. nigra* and *P. ponderosa* had scattered epicentres of severe infection. As far as radiata pine was concerned susceptibility to the disease was clearly related to age and only in young stands was serious infection discovered. During 1966 there was frantic organisation of a spraying operation for infected stands, and the first of the aerial surveys which are now carried out annually to document the spread of the disease and to formulate the aerial spraying programmes.

The Forest Research Institute benefitted from the findings of research carried out in Kenya into the chemical control of the disease and it was soon established that copper-based chemicals were extremely effective as prophylactic fungicides. Cuprous oxide and copper oxychloride have become the standard chemicals in *D. pini* control. They are aerially applied at the rate of 2.2 kg (active copper) in 50 litres of water per hectare. Spraying is carried out in mid summer and in the first year some 6000 ha were sprayed. At that time the prescription for the spraying required a double application, once in November and again in January, and 4.4 kg active copper per hectare was applied. This meant that some 12 000 ha of spraying was carried out in that first year.

Since 1966 it has been established that the disease is readily controlled on young radiata pine stands, that infection levels of less than 25% (of green crown removed) do not significantly affect growth, and that a single application in November will control the disease for at least 4 years. Thinning itself is an effective control operation and once stands reach 10 years of age natural resistance has removed the need for further spraying. Today few radiata pine stands are sprayed more than twice and most spraying is restricted to stands less than 4 years of age when susceptibility is greatest. In some respects infection is beneficial as the defoliation of the basal branches marginally reduces pruning cost and substantially improves visibility and ease of selection. Annual spray programmes (as at 31 March 1975) are around 1200 ha, but additional spraying may be required in years with abnormally heavy summer rainfall.

The situation is less satisfactory in the more susceptible stands of *P. nigra* and *P. ponderosa.* In radiata pine stands infection moves upward through the crown slowly whereas in the other two species the whole crown is affected very quickly. In *P. nigra* and *P. ponderosa* resistance does not increase with age but it varies greatly with provenance and, unfortunately, it is the best strains of both which have least natural resistance. Double applications of spray in December and February are required to control the disease and control seldom lasts for more than two years.

One of the major problems in the management of Kaingaroa is the grossly uneven age class distribution. Approximately 90% of the forest was planted between 1925 and 1937, after which there was very little establishment carried out until 1955 when the first large scale utilisation was undertaken following the commencement of operation of the Tasman integrated plant at Kawerau. Before the advent of dothistroma the large resource of *P. ponderosa* and *P. nigra* (10 000 ha and 7700 ha respectively) had been looked upon as the forest's main long rotation species, which would serve as the "bridge" between the time when the radiata pine first crop was largely exhausted and when the radiata young crop was of sufficient age to provide the continuity of supply. This critical period will be from the mid 1980s until the early1990s by which time the clearfelling age of the old crop will be more than 60 years. The retention of radiata to such ages was not considered to be desirable because of the increasing danger of windthrow, the excessive piece sizes that would be an embarrassment to existing plant, and the possibility of substantial heartwood formation. It was for this reason that the slower growing species were chosen to provide the bulk of supply in this period, and in the 1960s a substantial area of the oldest stands of *P. ponderosa* and *P. nigra* had been thinned on these grounds. *Dothistroma pini* has forced us to review our long term cutting plans. Initially it was hoped that, while the disease would severely reduce increment, it might not cause excessive mortality. In the early years there was a cyclic pattern of infection in the most susceptible strains; infection rate would increase to around 80% and then return to about 30%. This phenomenon was attributed to the shedding of infected needles before the flush so that the innoculum in the spring was reduced. However this supreme optimism was shattered in 1971 when *Armillaria melea* caused sudden mortality in two compartments of *P. ponderosa.* The widespread presence of this fungus throughout Kaingaroa, together with several other secondary pathogens (including *Sirex noctilio),* led to the final acceptance that the only sure cure for the disease in these two species was accelerated clearfelling. In 1972 a large export sale of Corsican pine was made to Japan and the cut in ponderosa for Tasman was increased and directed to the most susceptible stands. In the summer of 1973 and 1974 the aerial spraying of the two species was recommenced.

## OTHER DISEASES

The summer of 1972/73 was almost as dry as that of 1947 and it was preceded and followed by years in which the average summer rainfall was below average (November to March 1970/71, 615 mm; 71/72, 849 mm; 72/73, 379 mm; 73/74, 419 mm). In 1972 it was noticed that the health of Douglas fir had deteriorated drastically and in 1973 heavy mortality in *Pinus contorta* was followed by serious windthrow. In Douglas fir *Phaeocryptopus gauemanii* in combination with looper caterpillar attacks was the

agent of infection* but so far no pathogen has been isolated in the *P. contorta* stands. It has been suggested that the primary cause of ill health has been the exposure of overstocked stands to relatively severe moisture stress, and this may also have accounted for the *A. melea* infection in the severely defoliated *P. ponderosa* stands. The health of Douglas fir has noticeably improved following the excessively wet winter of 1974, and we have reason to hope that the serious increment losses may diminish. Nevertheless the remainder of the old crop is in a precarious state of health, and we have accepted the urgent need to revise our thinning regimes in the radiata pine young crop, to bring forward the age of clearfelling. This will permit the accelerated clearfelling of the old crop. The current growth study, which is the subject of another paper, is aimed at establishing a regime for radiata pine which will provide the best compromise between optimum volume production and financial return, but it is inevitable that, on a proportion of our resource, severe thinning will be required to increase piece size at the expense of yield.

At the present time an investigation is being undertaken by cutting plan simulation in an endeavour to determine the extent to which this extreme treatment is required.

* In a 12-month period between 1972 and 1973 there was an estimated loss of increment in Douglas fir amounting to 1.5M $m^3$ in the total resource of 12900 ha.