NOTE

STEM VOLUME LOSS DUE TO SEVERE *DIPLODIA* INFECTION IN A YOUNG *PINUS RADIATA* STAND

D. CURRIE and E. TOES*

Abstract

In a 6-year-old stand of Pinus radiata *in Tarawera Forest 14% of the trees were lightly, 22% moderately, and 64% heavily infected by* Diplodia pinea. *Most of the heavily infected trees were also badly malformed. Only 6% of the trees were acceptable for harvesting under the limitation of a minimum 3.7 m defect-free butt log as specified by Tasman Pulp and Paper Company's mill.*

Mean height and diameter of the trees were inversely related to infection levels and thus the degree of malformation. Total volume of the stand was estimated to be 17 m³/ha, merchantable volume 10 m³/ha, and the potential merchantable volume (in the absence of infection) 27 m³/ha. A reduction of 63% in potential merchantable volume was thus estimated. These results represent an extremely severe case of tree malformation in a localised area.

INTRODUCTION

Stem malformation after leader death in young *Pinus radiata* D. Don has long been a matter of concern in plantations on the pumice plateau in central North Island (Birch, 1936; Burdon and Smith, 1970). The worst incidences of tree malformation often occur on enclosed valley sites, and recent investigation showed that recurrent infection and death of elongating shoots may be the main cause of such malformation (Chou, 1976).

There has been little information available on the relationship between malformation levels and levels of *Diplodia* infection, nor are the effects of malformation on loss of tree volume known. This paper reports the result of an investigation of these factors in a 6-year-old *P. radiata* stand in a localised area where *Diplodia* infection has been notoriously severe for the last 10 years.

*Forest Research Institute, P.B., Rotorua.

MATERIALS AND METHODS

Study Area

The 6 ha stand of *P. radiata* was established in 1971 (2.1 × 2.1 m spacing) in Compartment 14, Tarawera Forest. The stand consists of 41 rows with, after heavy mortality, an average of 149 living trees per row, and has received no silvicultural treatment.

Sampling

All trees in every 5th row were assessed for malformation and infection level, and measurements were made of tree heights and diameters. A total of 9 rows was thus examined. An additional 16 rows of trees (sampling the 2nd and 3rd row out of every 5) were assessed only for malformation and infection levels.

Infection Level Assessment

The level of infection of each tree was assessed by a visual estimation of the percentage of shoots with dieback symptoms. Three groups were established as follows:

(1) Light Infection (L), less than 20% of all shoots on a tree showing dieback.

(2) Moderate Infection (M), 20-50% of all the shoots on a tree showing dieback.

(3) Heavy Infection (H), more than 50% of all the shoots on a tree showing dieback.

Malformation Assessment

The degree of malformation was assessed by dividing the trees into 6 different classes, based on the location of the lowest stem defect:

Class 1: Trees with no defect within first 4 m butt log.
Class 2: Trees with first defect between 3 and 4 m.
Class 3: Trees with first defect between 2 and 3 m.
Class 4: Trees with less than 2 m defect-free butt log.
Class 5: Trees with no merchantable butt log but able to produce some wood, for example, by on-site chipping.
Class 6: Shrub-like trees with no potential merchantable value.

Figure 1 illustrates an example of serious defect.

FIG. 1: *Multiforked tree resulting from death of terminal leader, which is still present in the fork (arrowed). Repeated forking has followed.*

Measurement of Height and Diameter

Tree height was measured using a standard height pole, while diameter at breast height was measured with a tape.

TABLE 1: FREQUENCY DISTRIBUTION (%) AND VOLUMETRIC DATA OF TREES BELONGING TO DIFFERENT INFECTION LEVELS AND MALFORMATION CLASSES IN A 6-YEAR-OLD *P. RADIATA* STAND
(Total No. trees investigated 6089)
(Volumetric data are presented by malformation class only)

	Malformation Class						
	1	*2*	*3*	*4*	*5*	*6*	*Total*
Infection level:							
Light (L)	2.8	2.3	4.7	2.9	0.8	0.2	13.7
Moderate (M)	2.1	2.3	7.1	8.0	2.5	0.7	22.7
Heavy (H)	0.9	1.5	11.1	25.0	12.8	12.3	63.6
Total	5.8	6.1	22.9	35.9	16.1	13.2	100
Mean height (m)	6.1*	6.2	5.6	4.9	4.4	3.4	—
Mean diameter (cm)	10.9*	12.1	10.5	9.2	7.2	—	—
Mean volume (m^3)	0.027	0.032	0.023	0.017	0.010	—	—
Mean merchantable volume (m^3)	0.027	0.028	0.017	0.007	0.003	—	—
Total volume (m^3/ha)	1.59	1.98	5.34	6.19	1.64	—	16.74
Total merchantable volume (m^3/ha)	1.59	1.74	3.94	2.55	0.49	—	10.31
Total merchantable volume as % of total volume	100	88	74	41	30	—	—

*Class 1 has slightly lower means than Class 2, mainly because a number of very suppressed trees had no malformation.

Tree Volume and Merchantable Volume

Mean tree height and diameter were calculated for each infection level and malformation class and used to estimate mean volumes.* Volumes were not estimated for Class 6 as diameters could not be measured. Goulding and Murray's (1976) polynomial taper equation (which is compatible with the T10 formula) was used to estimate mean merchantable volume for each group. Merchantable volume was defined as the amount of utilisable wood volume below the first defect on the butt log. The loss in merchantable wood was estimated by assuming that all wood volume above the first defect was lost.

RESULTS

The percentage of trees falling into each malformation class and infection level are shown in Table 1, along with volumetric data by malformation classes.

The total stocking in the stand was 6089 living trees, which represents only 45% of the trees initially planted. All the trees were infected, 14% lightly, 22% moderately and 64% heavily. Mean tree volumes for the three infection levels (not shown in the table) were, respectively, 0.027, 0.023 and 0.016. The majority of the heavily infected trees were also badly malformed, while most of the lightly infected trees were not seriously malformed. Only 6% of the trees (malformation Class 1) were acceptable for harvesting in terms of Tasman Pulp and Paper Company's specification of a minimum of 3.7 m defect-free butt log.

Mean height, diameter and volume of the trees had a general inverse relation to the degree of malformation and to the incidence of infection. Differences were significant at the 0.01% level.

The total volume of the stand was estimated to be 17 m^3/ha, and the total merchantable volume 10 m^3/ha. The potential merchantable volume, if all trees had been of Class 1L (mean tree volume of 0.027 m^3), was estimated to be 27 m^3/ha. Thus the actual merchantable volume was only one-third that of the potential merchantable volume.

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*The formula used was that for *P. radiata* in Rotorua Conservancy (T.10):

$$\log_e V = 1.711 \log_e D + 1.196 \log_e [H^2/(H - 1.4)] - 10.189$$

where V = total stem volume i.b. in m^3

D = d.b.h.o.b. in cm.

H = total height in m.

DISCUSSION AND CONCLUSION

A close association between degree of *Diplodia* infection, tree malformation and loss of merchantable tree volume is shown by this investigation. Malformation associated with *Diplodia* infection could reduce the merchantable volume in the stand by up to 63%. The loss in stocking in the stand was also considerable (55%) although the extent to which this was caused by *Diplodia* is not known. It should be emphasised that the stand studied represents an extreme case of severe *Diplodia* infection and tree malformation in a high dieback hazard area; it is by no means typical of the whole Tarawera Forest.

It should be noted that the volume loss reported for young trees may not accurately indicate productivity reduction at the end of the rotation period. It would be valuable to repeat the investigation in the same stand in 5 or 10 years' time.

It is interesting to note that 54 of the 6089 trees showed heavy *Diplodia* infection, but were not seriously malformed, while 11 of the trees, while only lightly infected, were badly malformed. The former case is suggestive of disease tolerance and these trees may constitute valuable material for a genetic improvement programme. The cause of the latter is uncertain but the likelihood must exist that some of the malformation results from agents other than *Diplodia* infection.

ACKNOWLEDGEMENTS

Dr C. K. S. Chou is thanked for suggesting this investigation and for his interest throughout the study. Thanks are also due to J. Ellis for assistance with the mensuration and to R. Scott for advice on statistical analysis.

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