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Soil A Horizon Development Beneath *Eucalyptus regnans*.

B. D. Murphy, T.W. Payn and S. Rofe

NZFRI

Report No. 29 August 1996

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EXECUTIVE SUMMARY

Variation in growth patterns of Eucalyptus regnans *(F. Muell.) on sites in the central North Island led to examination of the A soil horizon within a Kinleith Forest block, as depth of the topsoil appears to have a negative correlation with growth. To better understand this relationship, A horizon soil depth and* E. regnans *stocking were mapped over landform and aspect combinations. Depth of the A horizon relates weakly to aspect, landform and predominant understorey vegetation. Deeper A horizons are found on eastern and southern slopes, in particular on toeslope and basin landforms, suggesting influence of soil temperature, moisture and colluvial modification. Evaluation of solar radiation interception for the site reveals that relatively lower insolation on east and south slopes of major landforms appears to contribute the development of deeper horizons on those aspects, particular in the winter period. It may also affect root development of* E. regnans *in the growing season by warming soil temperatures to allow early root expansion in spring on better insolated sites.*

INTRODUCTION

The suitability of *Eucalyptus regnans* (F. Muell.) for short-fibre pulp plantations in New Zealand, combined with its outstanding growth rates on optimum sites had led in recent decades to the planting of over 8,000 hectares by various forestry interests (Bathgate *et al* 1993). However potential of the species has not been fully realised in the field. Of particular concern has been the apparent microsite effect on growth, with clusters of large trees located amongst trees of poorer growth. This is particularly disconcerting for forest managers, the within stand variability unacceptable to any pulp regime programme.

This led to research to attempt to identify the causal elements, concentrating on environmental factors as the source of variation. This had the assumption that the problem is not caused by inherent genetic variability, over which these projects have no control. Development of multiple-regression growth models to help explain this microsite effect on growth yielded some clues to the problem. Of particular concern was the apparent negative effect on growth with increasing depth of the A soil horizon on Kinleith sites (Payn & Oliver 1994). Increasing the scale of the study to the central North Island region confirmed this relationship (Murphy 1996). This is an apparent anomaly, as often this horizon is important as a source of nutrient cycling in eucalypts. Frederick *et al* (1985) found that leaf fall for *E. regnans* averages about 5.2 tonnes/ha/annum, and that leaves were the major source of all nutrients (except for copper) returned to the soil.

The hypothesis under study is that a thicker A soil horizon progressively develops in lower quality sites (ie gullies, colder aspects) over the course of the crop rotation, due to slower organic cycling in those microsites. This may have a two-fold effect, 1) by disturbing the normal nutrient-recycling processes associated with species such as *E. regnans*, and 2) creating soil conditions that are unsuitable for the growth and survival of the root systems. Gully bottoms in particular have been noted for their very poor *E. regnans* growth, to the extent that Bathgate *et al* (1993) described them as 'extreme sites' where few live trees existed. This contrasts with Booth and Pryor (1991) who state 'where the species is successful, it is often restricted to particularly favourable microsites, such as gullies with sheltered conditions and deep soils.' The apparent contrast in these statements might be tempered by the difference in soil moisture conditions found in gullies typical of Australian and New Zealand sites.

An examination by Guo (1993) on the effect of microsite factors on *E. regnans* in the Kinleith region concluded that topography and understorey had no apparent effects on tree growth, and that the recent Taupo soils had relatively low inorganic phosphorus concentrations. Fine roots and mycorrhiza did correlate with soil types and topography, and were absent in wetter environments.

Therefore the aim of this project was to examine the depth of A horizon across different landform and aspect combinations, in an attempt to determine where and why the depth was varying. It was hoped these variables could be used to explain how growth of *E. regnans* may be affected, and if possible, conclude which microsites are unsuitable for the species.

METHOD

Site Description

The study site was the Jeff Road forestry block (owned by Carter Holt Harvey Ltd) in Kinleith Forest, about 5 kilometres north of Tokoroa (Figure 1). This block contains 14-16 year old *E. regnans* of Franklin (Tasmania) seed source. These were originally planted at 1152 - 1496 spha, and subsequently thinned to between 650 - 712 spha by age three. Fertilisation was believed to include 30 g of Urea per tree, with another 60 g between planting lines at establishment, followed by an aerial application of 250 kg Urea ha^{-1} in the second growing season. Site preparation included V-blading and mounding where vehicle access was possible (Payn & Oliver 1994).

The Jeff Rd block is a cutover site, previously planted with *P. radiata*. Payn and Oliver (1994) described the area as mainly rolling with short slopes of about 20 degrees. Altitude is roughly 260 m.a.s.l and the region has an annual rainfall of approximately 1500 mm, with a tendency towards winter maxima.

The most recent soils in this area are derived from air fall tephra of Taupo origin. The B horizon typically consists of Taupo pumice overlying Rotorua ash. The thickness of Taupo pumice can be affected by topography, with upper slopes sometimes missing Taupo ash, and relatively thicker layers deposited at the bottom of slopes and in basins (Guo 1993: Payn & Oliver 1994). The suitability of the block for this study included its variable topography (landform and aspect combinations), being relatively free of blackberry (*Rubus fruticosus*) enabling suitable access, and existence of the topographical data in a GIS database (courtesy of Carter Holt Harvey Ltd.)

Landforms and Transects

The Jeff Rd block was surveyed using topographical maps and aerial photos to determine areas of terrain that would allow for examination of a variety of landform (see below) and aspect combinations. Aerial photos were also useful in that they indicated areas with poor stocking, hinting at areas unsuitable for *E. regnans*. In particular, the major hill and basin systems were investigated as these often contained suitable combinations, ie moving from the top of a hill site downwards in any compass direction usually yielded several landform types.

Desirable terrain contained some or all of the following landforms: flat, crest, topslope, terrace, midslope, toeslope and basin (defined in Appendix 1). At the approximate centerpoint of each site, transect lines were run along the four main compass bearings, attempting to cover as many landforms as possible along individual transects. In cases where the surface of a major terrain form continued for several hundred metres, a central transect was run across that surface and transects running at right angles to this plane were then taken at 50 m intervals (for an example see Figure 6). Using marker pegs and string to delineate the transects, spade sampling was used to measure the A soil horizon at 10 m intervals along each transect, or over 5 m where landforms changed over short distances. A total of 190 depth samples were taken over 30 transects. Two sets of transects covering major terrain features were later chosen for a GIS treatment (see below).