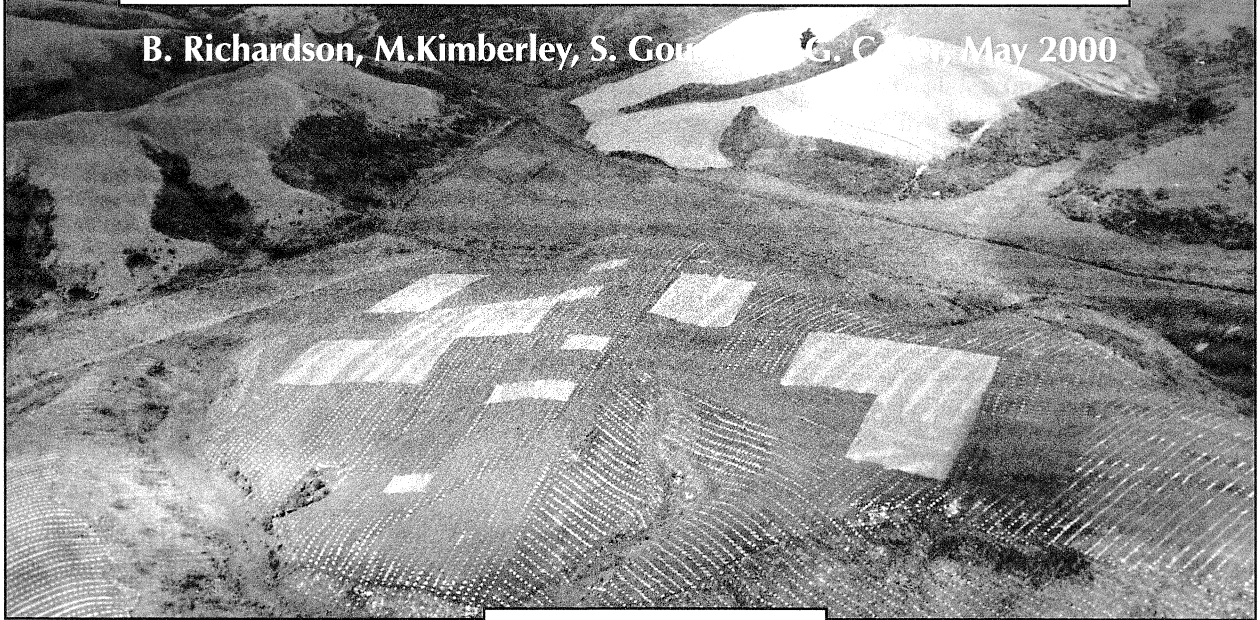
RADIATA PINE GROWTH RESPONSE TO WEED CONTROL at TOKOITI FOREST

- Results after five years



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INTRODUCTION

Information is required to identify environmentally sensitive weed control treatments that minimise costs and herbicide use while maintaining adequate crop survival and growth rates.

Two trials were established on a fertile pasture site to determine the growth response of radiata pine to weed control treatments of varying area and duration.

Ultimately, this will enable calculation of the most cost-effective and environmentally safe treatment options.

METHODS

The experiments were established in winter 1994 on exposed, rolling, ex-pasture coastal land in Tokoiti Forest, South Otago. One experiment was designed to test short-term (7-10 year) growth responses to a number of weed control treatments. The other was designed to measure long-term (rotation length) responses to a subset of these treatments. The site had high soil fertility, an average annual rainfall of around 800 mm, and a predominant vegetation cover of improved agricultural grasses with some thistles.

Both trials were planted with one year old, bare rooted GF26, radiata pine seedlings. A range of treatments were applied in the following spring, comprising combinations of area and duration of weed control (Table 1). To determine maximum productivity, an additional weed-free plus fertiliser treatment was included in the long-term experiment. Weed control was achieved with a range of herbicides: Versatill, Gallant, Velpar, and Gardoprim.

Table 1. Treatments applied in the two trials.

AREA OF WEED CONTROL	DURATION OF WEED CONTROL		
	1st YEAR	1st and 2nd YEAR	EVERY YEAR
NO WEED CONTROL			✓
1 METRE diameter spot	✓	✓+	
1.5 METRE diameter spot	✓	✓	
2 METRE diameter spot	✓	✓+	
TOTAL WEED CONTROL			✓+
TOTAL + fertiliser			+

✓ = Short term trial   + = Long term trial

Tree height, ground level diameter (gld) survival, degree of multi-leadering, and the size of weed-free areas around individual trees were measured annually. At age 4, both gld and dbh measurements were taken in the long-term trial. At age 5, only dbh was measured in this experiment.

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RESULTS

Results presented below are mainly from the short-term trial. Basic growth trends were similar in both experiments, but a high degree of multi-leadering in the long-term experiment has made the data more difficult to interpret.

Mortality

Tree mortality was highest (40%) where there was no weed control and lowest (8%) with a 1 m diameter spot maintained for 2 years (Figure 1). However, there was no strong pattern of mortality with respect to area and duration of weed control. High mortality (23%) with complete weed control indicated that factors other than weed competition (e.g. wind exposure, browsing) were also influencing growth.

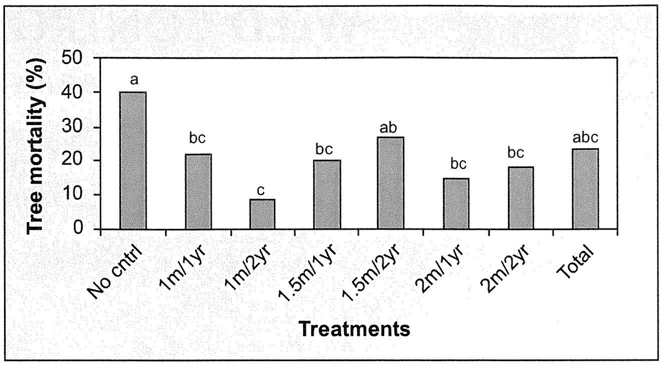
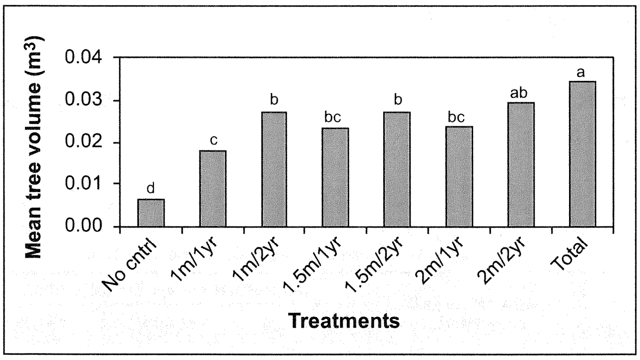


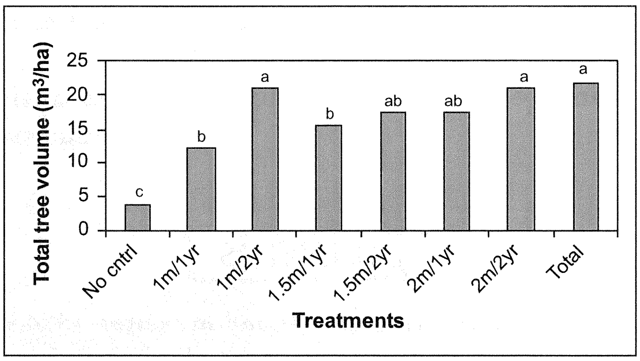
Figure 1: *Effect of weed control treatments on mean tree mortality, 5 years after planting.*
Bars topped by the same letter are not significantly different.

Tree height, diameter, and volume growth

Effects on growth were similar with respect to mean tree height, diameter, volume or total volume per hectare (including mortality effects), therefore only results for mean and total volumes have been illustrated. Mean tree growth, assessed using any parameter, was lowest in the no weed control treatment (Figures 2a,b). Even the smallest amount of weed control (a 1 m diameter spot maintained for 1 year) produced large growth benefits. There was a general trend for increasing growth with increasing area and duration of weed control. However, there was no significant difference in mean tree volume between total weed control and a 2 m spot maintained for 2 years. Taking mortality into account (Figure 2b), only 3 treatments produced lower total stem volumes than plots with complete weed control. For a given spot size, tree volume was always greater with a second year of weed control, but this effect was only significant for a 1 m spot.



(a)



(b)

Figure 2: *Effect of weed control treatments on (a) mean tree volume and (b) total tree stem volume (per hectare).*
Bars topped by the same letter are not significantly different.

Multi-leadering

The incidence of multi-leadering was highest with total weed control and a 2 m spot for 2 years (Figure3). This was probably related to rabbit or hare browsing in the first year. In addition, the lack of shade on the lower part of the tree in weed-free plots encouraged vigorous growth of the lower branches. This effect may have been particularly important because the seedlings were planted deeply, sometimes resulting in steeply angled side branches.

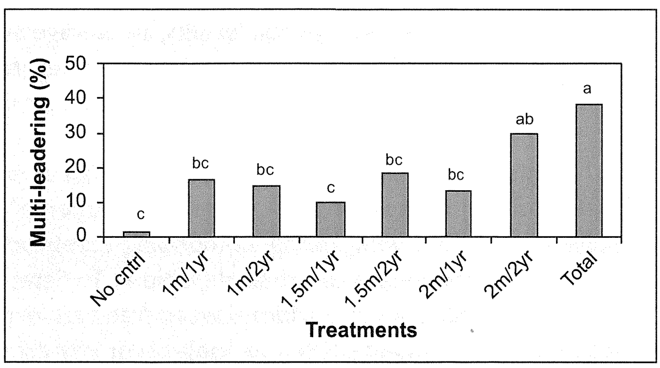


Figure 3: *Effect of weed control treatments on percentage multi-leadering. Bars topped by the same letter are not significantly different.*

Growth trends over time

Modelling of growth trends over time allowed calculation of the time difference (in years) between trees given a particular treatment and trees given complete weed control. In other words, this represents the years of growth lost by trees in a given treatment compared to trees in the best possible treatment (total weed control).

Treatment effects on tree growth trends are only discussed in relation to total tree volume (including mortality effects), but conclusions were similar with any of the important growth parameters. After five years, trees in the untreated control treatment had lost between 1.6-1.7 years of volume growth compared to the weed-free treatment (Figure 4). By age 5 years, growth curves in all treatments were tending to horizontal, indicating that trees in the weed control treatments were growing at similar rates to weed-free trees of a similar size. In other words, there would be no growth gain from maintaining weed control beyond this point in time – growth curves are following parallel trajectories.

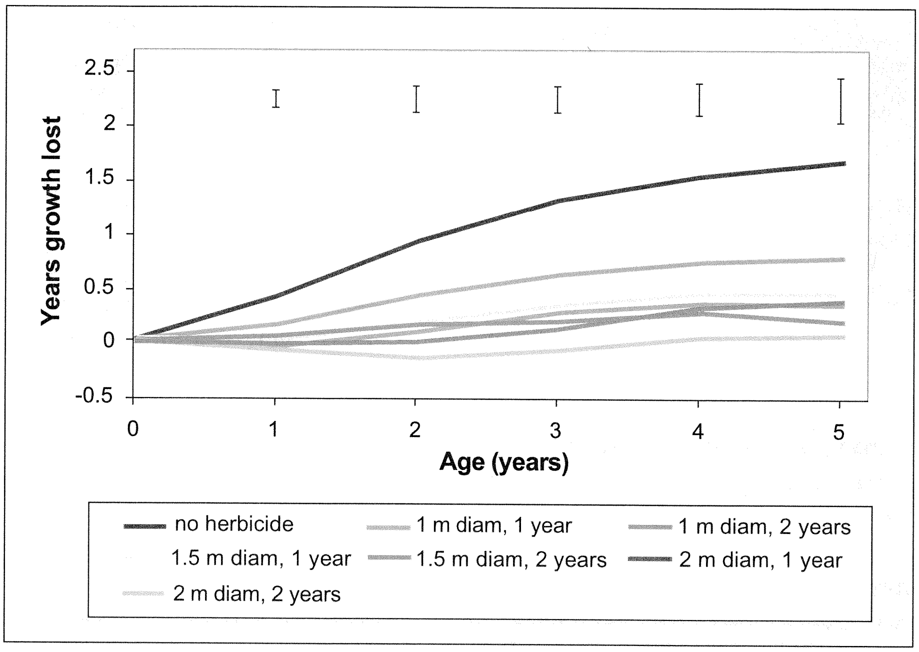


***Figure 4:** Stem volume per hectare growth loss, expressed as years, in weed control treatments compared to the weed-free treatment. Least significant differences are indicated by bars.*

Any weed control treatment resulted in improved total volume production per hectare (Figure 4). Economic analysis, where stand growth is projected to the end of the rotation, would be required to determine the most cost-effective treatment. However, balancing treatment costs against time gain suggests that either a 1.5 m spot maintained for 1 year or a 1 m spot maintained for 2 years would be good candidates.

Long-term trial

Analysis of the long-term experiment in previous years indicated that the only treatment effect was a small, but statistically significant, decrease in tree volume with the 1 m spot treatment maintained for 2 years. However, by age 5 years, this difference was no longer apparent, possibly because of: (i) increased variability introduced by the switch from gld measurements to dbh; and (ii) the effects of competing leaders in the weed-free treatments suppressing growth of the main leader. Similar results were observed in the short-term experiment, where by age 5 years, there were no significant differences among treatments common to the long-term trial.

The objective of the long-term experiment was to measure effects of weed control treatments through a complete rotation. With no significant differences among the applied treatments, these objectives cannot be met and there is no reason for continuing with this experiment. In retrospect, it would have been better to compare total weed control to a 1 m spot/1 year treatment to ensure a large treatment difference that could be followed over time.

CONCLUSIONS

Measurements of tree growth after five years on a fertile pasture site in South Otago showed:

- Weed control was essential to ensure maximum survival and growth of radiata pine seedlings.
- Total weed control, significantly increased multi leadering compared with less intensive weed control treatments.
- A 1 m weed-free spot maintained for two consecutive seasons following planting resulted in higher productivity than an equivalent treatment maintained for 1 year. With larger spot sizes, a second year of weed control produced marginal benefits.
- Without weed control, tree volume growth was approximately 1.6 years behind trees given complete weed control.
- Spot vegetation control around newly planted radiata pine seedlings resulted in similar tree growth to total control (time difference about 0.5 years or less), as long as the area and duration of weed control was greater than a 1 m spot maintained for 1 year.
- The effects of vegetation control on tree growth more-or-less stabilised by age 5 years. In other words, trees from the vegetation control treatments are growing at a similar rate to weed free trees of the same size.
- Economic analyses would be required to identify the most cost-effective treatments, but at this stage it appears that either a 1.5 spot maintained for 1 year or a 1 m spot maintained for 2 years would be good candidates.
- It is recommended that the long-term trial is abandoned as treatment differences are not large enough to meet the objectives of the experiment. The short-term trial only requires one or two more measurements.

Acknowledgments

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