PINUS RADIATA GROWTH BENEFITS FROM SPOT WEED CONTROL IN KINLEITH FOREST

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ABSTRACT

The effects of combinations of area treated with herbicide and duration of spot weed control on radiata pine (*Pinus radiata* D. Don) growth were examined. Two years after planting, large differences in tree volume were attributable to treatment even in trees that had received only first year weed control. After three years, height and diameter growth were both greatest where complete weed control had been maintained for at least 2 years. The most practical treatment for this site would be a spot diameter of 1.6 - 2.0 m, maintained weed-free for at least two years.
Keywords: weed control, competition, spot spraying, herbicide, *Pinus radiata*

INTRODUCTION

Spot herbicide applications, in which only a limited amount of ground area around individual trees is treated, is a widely accepted practice during radiata pine forest establishment. Spot spraying is most appropriate on sites covered predominantly with herbaceous vegetation. Two important management issues related to spot spraying are definition of (1) the optimum treated area (or spot size) and (2) the optimum duration of weed control. These factors dictate the proportion of a site that has to be treated, the number of times the application must be repeated and therefore the amount of herbicide required.

To date, no generally accepted conclusions have been drawn about the area and duration of herbaceous weed control for optimum radiata pine growth and survival in New Zealand (Balneaves 1987; Balneaves and Henley 1992; Clinton and Mead 1990; West 1984). The most cost-effective and environmentally-acceptable treatments will vary with local soil type, climate, and competitor species (Richardson *et al*. 1993). This paper presents radiata pine growth data from a trial designed to define the optimal area and duration of weed control for a high elevation site in Kinleith Forest in the Central North Island. Treatment effects after the first year have been reported by Richardson *et al*. (1996). Results after the second and third years are described here.

METHODS

The trial site, in an area of Kinleith Forest from which radiata pine had been harvested in 1992, was 584 m above sea level, and located on a light, pumice soil. Mean annual rainfall was 1585 mm. In January 1993, the site was broadcast-sprayed using a mixture of glyphosate (3.2 kg/ha); metsulfuron (0.1 kg/ha); an organosilicone surfactant (Silwet L-77, 0.3 litres/ha); and a foaming agent (Delfoam (Yates NZ Ltd), 0.35 litres/ha). Radiata pine was planted at a 6 x 6 m spacing in August 1993, and in October 1993 the site was oversown with a mixture of 10 kg/ha annual ryegrass (*Lolium multiflorum* L.), 3 kg/ha lotus (*Lotus uliginosus*), 1.5 kg/ha browntop *(Agrostis capillaris* L.), and 1.5 kg/ha cocksfoot (*Dactylis glomerata* L.). Experimental spot spraying was undertaken each spring by forestry contractors using a herbicide spray mixture containing haloxyfop (0.5 kg/ha), clopyralid (0.6 kg/ha), and simazine (10 kg/ha).

Treatments were applied to single-tree plots. An originally planned randomised block design incorporating 30 replicates of 11 treatments had to be abandoned due to lack

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of precision in achievement of the specified spot diameters. The longest axis of each spot and also the axis at right angles to it were measured each year, the mean of these two values being used to represent the actual spot diameter. Diameter values were grouped into spot size classes within each year of application. Each combination of spot diameter/ duration was replicated 6 - 123 times. Table 1 shows the treatment combinations that were available for assessment in Years 2 and 3. Treatments with spot diameters greater than 3 m were referred to as “complete weed control”. In the winters of 1995 and 1996, the vigour of each tree was scored on a scale of 1 (healthy) to 5 (moribund), using a system designed to incorporate all visible disorders. At the same time, tree height and ground-level stem diameter were measured. In the third year, broom cover within a radius of 1 m from each tree was estimated.

The effects of treatment on tree survival and growth characteristics (height; diameter; volume calculated as the square of the diameter multiplied by height) were determined using analysis of variance and a least significant difference test using the SAS statistical package (SAS Institute Inc., 1987). A natural logarithm transformation was used to stabilise the variance of the stem volume data. Initial tree size was included as a covariate in all analyses. Percentage broom ground cover and tree health were used as covariates in the third year only, when broom (*Cytisus scoparius* L.) was observed in some plots and a limited amount of defoliation by *Helicoverpa armigera* (Hubner) was noted.

RESULTS

Tree growth and survival

From the second year, tree height, diameter and volume were influenced by treatment (P = 0.0001 in all cases; Table 1). Diameter was affected to a greater extent than height growth. In the second year, tree volume was greatest where complete weed control had been achieved over the first two years. The absence of a significant difference between this treatment and complete control for one year was considered to be an artefact related to the large standard error associated with a sample of only 6 plots. Tree volume was similar where one years complete weed control, or 1.6-3.0 m diameter spots had been maintained for one or two years. Tree volume was minimised with no weed control in the first year, irrespective of second year treatment.

TABLE 1: Mean *Pinus radiata* height and diameter growth for each year of the experiment after spot applications of herbicide.

Spot diameter classes (m) applied in: 1993	1994	1995	Number of plots	Height (m)	Diameter (mm)	Volume (cm^3)
			Winter 1995			
0.0	0.0	-	91	0.89c[1]	15.3e	334d
0.0	>3.0	-	18	0.83c	15.2de	287d
0.1 - 1.5	0.0	-	67	0.93c	17.8d	401c
1.6 - 3.0	0.0	-	59	1.01b	20.7c	525b
1.6 - 3.0	1.6 - 3.0	-	64	1.08b	22.8b	674b
>3.0	0.0	-	6	1.17ab	23.0bc	656ab
>3.0	>3.0	-	87	1.18a	28.1a	980a
			Winter 1996			
0.0	0.0	0.0	91	1.68d	32.2d	2224c
0.0	>3.0	>3.0	10	1.64cd	34.8cd	3181c
0.1 - 1.5	0.0	0.0	67	1.74cd	34.1d	2538c
1.6 - 3.0	0.0	0.0	59	1.81bc	39.8bc	3374b
1.6 - 3.0	1.6 - 3.0	0.0	58	1.91b	42.5b	4359b
>3.0	>3.0	>3.0	87	2.10a	54.6a	8674a

[1]Values in a column followed by the same letter are not significantly different at the 5% level according to Fisher’s Protected LSD test.

In the third year, growth trends observed in the second year were maintained. Tree volume was greatest where complete weed control had been achieved over the three

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years and was approximately double that of the next best treatments, complete weed control for Year 1 or Years 1 and 2. Volume was minimised by no weed control over three years, no weed control in the first year followed by complete weed control for two years, or by a small spot diameter maintained in the first year only (Table 1).

Tree health score (affected mainly by defoliation caused by *H. armigera*) ($P = 0.0001$) and broom percentage cover ($P < 0.05$) were significant covariates in Year 3. Analysis of covariance revealed a strong treatment effect on defoliation ($P = 0.0001$), which tended to be most pronounced where the intensity of weed control was least. Broom, which grew significantly in Year 3, was shown to have a negative effect on tree growth if it was growing in close proximity.

DISCUSSION

The small gain in tree growth observed one year after planting in complete weed control treatments (Richardson *et al*. 1996) suggests that factors other than weed competition were limiting growth. Second year results indicated a growth benefit from first year weed control that was not detected until the end of the second year. This delayed growth benefit could have resulted from a short period of reduced competition in the second year or may have simply represented slow response to treatment during the first year. It is clear that short term growth trends must be treated with extreme caution. Balneaves and Henley (1992) reached a similar conclusion from a trial in the South Island.

Table 1 shows that omission of weed control in Year 1 caused growth losses that were not overcome by treatments in Years 2 and 3. Timely treatment is clearly of the utmost importance. Although West (1984) suggested that on moist sites in the Bay of Plenty, one year weed-free would be required for most cost-effective management, his results were based on a maximum spot diameter of 1 m. This is not always sufficient even for the first year after planting (Richardson *et al*. 1996) and further benefits result from second year weed control.

No reliable basis for predicting the optimal spot size in terms of end-of-rotation tree growth gains was suggested by this study. Height and diameter growth after 3 years can be maximised by complete weed control maintained for at least 2 years, but this will counteract benefits from oversowing cutover sites (Richardson *et al*. 1996; West and Dean 1995) and will increase treatment costs. At the Kinleith site, small spots less than 1.5 m diameter applied in the first year produced only small growth benefits. Increasing spot size to 1.6-3.0 in the first year resulted in significantly greater volume growth and repetition in the second year caused a further growth benefit although not a statistically significant difference. In order to balance treatment costs against growth gains and benefits from oversowing, the most practical recommendation for typical tree spacing (around 3 x 4 m) would be to apply a spot of between 1.6 and 2.0 m diameter and maintain it weed free for at least two years.

ACKNOWLEDGEMENTS

The authors thank staff of Carter Holt Harvey Forests Ltd, particularly Anna Pattison and Peter Thomson, for undertaking all of the experimental work and for allowing us to use the data. We also acknowledge the support of the New Zealand Site Management Cooperative for developing the original experimental design, and the Foundation for Research, Science and Technology for funding this work.

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