THE COST/BENEFIT OF USING HEXAZINONE FOR SELECTIVE GRASS CONTROL IN RADIATA PINE IN CANTERBURY

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ABSTRACT

A silvicultural stand model was used to compare net sawlog break-even stumpages of three post-planting grass weed control treatments: (1) no spraying, (2) spot spraying, and (3) aerial broadcast spraying, at a spray rate of 2 kg/ha hexazinone, for Pinus radiata *(D. Don) over one rotation in Canterbury. For each spray treatment an untended (Site Index 24 m) and a tended (Site Index 29 m) regime were evaluated. For both regimes spot spraying was the most economic, and aerial spraying was the least economic, post-planting grass control treatment. The break-even stumpage for spot spraying was also least sensitive to changes in the early growth gain achieved by grass control, and also to the effects of possible follow-up spraying.*

INTRODUCTION

Forest managers are frequently sceptical of the relevance of research results to their problems. Research results are often based on small, carefully manipulated and maintained plots. Managers see conclusions derived from these plots as having little validity in the context of a forest where day-to-day monitoring is less intense.

The benefits of grass control during radiata pine (*Pinus radiata* D. Don) establishment is a typical example of this problem. Many forest managers in Canterbury remain unconvinced of the need for grass control, despite much research effort. Grass control requires an immediate increase in expenditure; however, improvements in tree survival, initial growth, and crop quality only become evident with the lapse of time.

One method of evaluating the merits of a change in operational procedures is cost/benefit analysis. Traditionally, cost/benefit analyses have relied on the discounted cash flow analysis technique to evaluate treatments. The Silvicultural Stand Model (SILMOD) recently developed by the Radiata Pine Task Force (Sutton, 1984) is a refined cost/benefit analysis tool. SILMOD combines those quantitative and qualitative factors that deter-

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mine timber quality — as influenced by the interaction of site, silvicultural, and processing variables — with discounted cash flow analysis to derive financial criteria for treatment evaluation.

METHOD

This paper explores the economic impact on the growth of radiata pine of three grass control treatments over one rotation: untreated (control), post-plant spot spraying, and post-plant aerial spraying. The herbicide used was hexazinone at 2 kg/ha, selected on the basis of its cost effectiveness (Balneaves, 1982).

Two hypothetical first-rotation stands on sites of differing productivity were proposed. One stand, on Site Index* (S.I.) 24 m, received no tending. The other stand, on S.I. 29 m, received intensive tending similar to that described by Fenton (1972) — *i.e.*, two thinnings to a final crop stocking of 200 stems/ha with pruning in three lifts to 6.1 m. Initial stocking for both regimes was 1250 stems/ha with clearfelling occurring at age 26 years. Sawlog and pulp log volume estimates were calculated to top diameter limits of 20 cm and 10 cm, respectively.

The two tending regimes were chosen to reflect the extremes of silviculture for sawlog production present in the Canterbury region. To minimise the risk of serious wind damage, rotation length was determined by the time required to produce a pruned tree of minimum sawlog dimensions (*i.e.*, 50 cm d.b.h.). Sites exceeding S.I. 24 m are unlikely to be encountered in Canterbury forests, but because it can be difficult to justify pruning economically on a low quality site (S.I. 24 m), a more productive site (S.I. 29 m) was chosen for the tended regime.

Where possible SILMOD inputs applicable to the Canterbury region were used; otherwise, central North Island volcanic plateau functions were substituted. Relativity was preserved by using the same functions for each spray treatment and tending regime. Similarly, when default or calculated values were not generated by SILMOD, identical values were used for each treatment and regime.

Initial growth data used for SILMOD runs were obtained from unsprayed and sprayed plots in a replicated trial in Canterbury measured at the time of first thinning. The site index of the trial site was estimated to be 22 m, but no previous crop of radiata pine had been grown on the trial site (J. M. Balneaves,

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*Site Index — stand mean top height at age 20 years.

TABLE 1: MEAN GROWTH DATA FOR UNSPRAYED AND SPRAYED TREATMENTS AT FIRST THINNING (SITE INDEX 22 m)

	Unsprayed	*Sprayed*
Age (year, month)	6, May	4, May
Stocking (stems/ha)	1250	1250
Height (m)	5.4	5.2
Diameter (mm)	85	88

pers. comm.). At first thinning, growth in the sprayed stand was approximately two years ahead of growth in the unsprayed stand (Table 1).

Although this analysis assumed the growth gain achieved by grass control to be independent of site index, the effect of site index on the growth gain attributable to grass control requires further investigation. For example, West (1984) reported height differences in 5-year-old radiata pine at Putaruru, Rotorua and Taradale ranging from 1.2 m to 2.0 m. Site indicies for these three sites were estimated to range from 29 m to 33 m, but grass species as well as environmental conditions differed between sites.

The length of time for which the growth gain attributable to grass control at establishment of radiata pine is sustained has not been measured. Preest (1977), however, reported that, for Douglas fir, trees given the advantage of weed control retained their early growth gain for the entire rotation. This analysis assumed that early growth gains induced in radiata pine by grass control at establishment were not lost subsequently, and that growth response was independent of spray application method.

The planting, pruning, and thinning costs used in the present study were derived from Fraser and Calderon (pers. comm., 1977). These costs were adjusted for stocking differences before being updated using the Producers Price Index (Group 3, Forestry and Logging Input, Dec. 1977 to Dec. 1982) (Dept. of Statistics, 1982). Burning and spraying costs were taken from Balneaves (1982). All costs were rounded up to the nearest dollar.

Operation costs were compounded from the time at which the operation actually occurred, with year 0 taken to begin from the time of burning. A discount rate of 10% has been used as prescribed for new government projects (Anon., 1971).

RESULTS

Treatment effects were assessed by comparing net sawlog break-even stumpages (*i.e.*, the residual sawlog value that breaks

TABLE 2: SUMMARY OF YIELDS/ha AT CLEARFELLING FOR UNSPRAYED AND SPRAYED TREATMENTS UNDER UNTENDED AND INTENSIVELY TENDED REGIMES

	Untended		*Tended*	
	Unsprayed	*Sprayed*	*Unsprayed*	*Sprayed*
Age at clearfelling (yr)	26	26	26	26
Site Index (m)	24	24	29	29
Height (m)	26.9	29.5	28.4	31.6
Breast height diameter-over bark (cm)	28.8	30.7	47.1	50.1
Total stem volume (m^3/ha)	646	752	328	410
Utilisable volume (m^3/ha)	464	568	254	315
Sawlog volume (m^3/ha)	272	413	230	300
Pulplog volume (m^3/ha)	192	155	21	15

even with compounded growing costs), since sawlog production is the objective of both tending regimes. Furthermore, no log stumpage or sawn timber price assumptions are required to derive break-even stumpages. Within each tending option, the treatment having the smallest break-even stumpage is financially the best treatment.

Crop characteristics at clearfelling are presented by the spray treatment and tending regime indicated in Table 2.

Break-even stumpages for a 26-year rotation for untended and tended regimes are given in Table 3 by spray treatment. Break-even stumpages for all treatments in the untended regime are lower than for the tended regime (Table 3), because tending costs outweigh the effects of a more productive site for the tended regime.

Under both tending regimes spot spraying has the lowest break-even stumpage, and the aerially sprayed treatment has the highest (Table 3); therefore, compounded spot spraying costs have not exceeded the reduction in break-even stumpage resulting from the growth gain produced by spraying, whereas compounded aerial spraying costs have.

DISCUSSION

In this study rotation length was not determined by a least cost criterion, although comparison of treatment break-even stumpages is not strictly valid unless rotation length is economically optimal. It is considered unlikely, however, that treatment relativity will change for economically optimal rotation lengths, although cost differences between treatments may be overstated.

Rainfall during the growing season in Canterbury is relatively low. It usually averages 300-400 mm over spring and summer

TABLE 3: BREAK-EVEN STUMPAGES ($/m³) FOR UNTENDED AND INTENSIVELY TENDED REGIMES BY SPRAY TREATMENT

	Untended	*Tended*
Unsprayed	22.54	40.81
Spot Sprayed	17.27	35.90
Aerial Sprayed	22.80	43.51

(September to February) compared with 600-750 mm in the central North Island (N.Z. Meteorological Service, 1979). On the drier Canterbury sites tree survival is unlikely to be satisfactory if grass competition is not eliminated during plantation establishment and eventual crop tree quality may suffer. Blanking has been shown to be an effective method of overcoming poor survival and improving crop tree quality (Chavasse, 1981).

The maximum amount that spraying should cost equals the reduction in compounded growing costs achieved by the growth gain due to spraying — *i.e.*, $7.21/m³ and $7.57/m³ for the untended and tended regimes, respectively (Table 3 and Table 4, A). When estimated sawlog yields for sprayed stands are taken into account, these differences in break-even stumpages are equivalent to maximum discounted grass control costs of approximately $230/ha and $170/ha.

The effect of halving the growth gain from spraying is shown in Table 4, B. Only spot spraying of tended stands remains a financially viable treatment. Spot spraying is less sensitive to a reduction in the growth gain available from spraying than aerial spraying, because spraying costs are considerably lower.

The duration of grass control provided by a single post-planting spray may need to be extended. Break-even stumpages for a follow-up spray one year after the initial spray and at the same

TABLE 4: BREAK-EVEN STUMPAGES ($/m³) FOR UNTENDED AND INTENSIVELY TENDED REGIMES IN RESPONSE TO SPRAY TREATMENT VARIATION

	Untended	*Tended*
A. Sprayed, less spray costs	15.33	33.24
B. Halved growth gain:		
Spot sprayed	22.69	40.39
Aerial sprayed	30.26	49.18
C. Follow-up spray sequence:		
Spot, spot	18.87	38.11
Spot, aerial	23.44	44.39
Aerial, spot	24.40	45.71
Aerial, aerial	28.97	51.99

cost and chemical rate as the initial application are displayed in Table 4, C. These break-even stumpages are not a test of a single spray application as opposed to two consecutive spray applications on growth, but are essentially a test of increased spraying cost instead.

The only follow-up spray treatment that has a break-even stumpage less than the break-even stumpage of the unsprayed treatment occurs when two spot sprays are carried out under both tending regimes (Tables 3 and 4, C). Break-even stumpages higher than those for the unsprayed treatments result when at least one of the two sprays is aerially applied. Financially, spot spraying in each of two consecutive years is the most favourable follow-up spray treatment.

CONCLUSIONS

The break-even stumpages for the post-planting spot spray treatment of hexazinone at 2 kg/ha and the unsprayed treatment were lower than the aerial spray treatment for each tending extreme. Spot spraying was the most favourable grass control treatment examined because of its low cost. Spot spraying was also the least sensitive spray treatment when the input data were altered to reflect two potential management situations — *i.e.*, halving the growth gain resulting from spraying, and the use of follow-up spray applications.

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EFFECTS OF SITE AND SILVICULTURE ON WOOD DENSITY OF DOUGLAS FIR GROWN IN CANTERBURY CONSERVANCY

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ABSTRACT

Douglas fir has some attraction as a species for afforestation in the Canterbury foothills because of its wind firmness and growth characteristics. Wood density has been examined in a variety of stands from the plains to Arthurs Pass (700 m), and the mean value of 410 kg/m³ basic density for forest-grown trees indicates very satisfactory intrinsic wood properties for this timber. Response to thinning and to growth rate in general, suggests that thinning of Douglas fir in Canterbury can be carried out from age 15 years onward (other factors being equal) without detriment to wood density.

INTRODUCTION

The hazards of forestry in Canterbury are well documented and have been summarised by Berg (1978). Strong Foehn winds coupled with shallow soils overlying compacted gravels make severe windthrow a recurrent problem. On the plains low rainfall and shallow soils result in top height at 20 years for *Pinus radiata* being as low as 20 m, and although foothill forests are more productive they are still below the national average. Moreover gorse can be a severe weed problem on foothill forests.

Despite these difficulties, forests in Canterbury have the advantage of proximity to a domestic market and to an export port at Timaru. Consequently, although the future of forestry on the plains engenders some doubts, prospects for further developments in the foothills look reasonably good.

The question of species selection for future afforestation has drawn attention to Douglas fir (*Pseudotsuga menziesii*) as a tree generally notable for its wind firmness (Wilson, 1976). It may be true that the moisture limitations of the plains and weed problems on the foothills will severely restrict the use of this species (Tustin, as quoted by Berg, 1978), but as O'Neill pointed out (*loc. cit*) the biological hazards of putting total trust in radiata

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