FEASIBILITY OF THINNING ADVANCED STANDS OF NATURALLY REGENERATED RADIATA PINE IN PLANTATIONS IN NORTH-EAST VICTORIA

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Summary. Dense thickets (>10,000 plants ha^{-1}) of natural regeneration are a feature of many Victorian radiata pine plantations. Thinning of such thickets is necessary to prevent stem collapse, to ensure efficient extraction of the future crop and to optimise the yield of sawlogs. Evaluation of the feasibility of thinning thickets of over 20 year-old natural regeneration was carried out in north-eastern Victoria in 1987. The results of the study show that on some sites (Site Index >22 m), it is possible to economically thin these thickets by basal stem injection with herbicides. Alternative options of thicket management are discussed.

INTRODUCTION

Plantations of radiata pine, *Pinus radiata*, are often re-colonised by large numbers (>10,000 plants ha^{-1}) of self-sown seedlings following clear-felling (3). Chemical (5, 6), mechanical (10), and manual (7) methods have been used in the past to kill these unwanted seedlings, and to re-establish radiata pine stands either by planting, or by early thinning.

Where no remedial action is taken, the thickets of radiata pine continue to grow unmanaged. Mutal competition in thickets may reduce the number of trees to less than 10,000 plants ha^{-1}, but many of the surviving, slender trees, are often unstable in wind, and may eventually collapse. The dense growth also forms a physical barrier which adds to the cost of felling the trees in such sites.

The aim of this research was to determine: (a) if the dense thickets of radiata pine are capable of self-thinning; (b) if the number of dominant, by definition wind stable trees (4) in advanced thickets is high enough to ensure a viable final crop; (c) if, when released, the retained trees will remain firm in wind, and; (d) what are the costs of thinning natural regeneration in relation to the thinning method applied?

METHODS

The study was undertaken in the Ovens Plantation, in north-eastern Victoria. The 38 year-old stand of radiata pine with a top height of 20 m at age 20 years was clear-felled in 1963 and the debris was left unburnt on the site. Natural regeneration occurred and within two years of clear-felling the stand density was >10,000 plants ha^{-1} (2), and by 1986 the total number of living trees still remained above 2,000 trees ha^{-1}. Although by 1986 the top height of the new stand (22.5 m at age 22) varied little from that of the parent stand, the new stand contained 84% of trees which, because of their relatively high slenderness ratio SR (height (m)/diameter breast height over-bark, DBHOB (m)) of 120, appeared prone to stem collapse (1).

Five plots, each 20x20 m were marked at random within the study area. The number and DBHOB of living trees were recorded and used to differenciate between the wind stable and wind unstable trees (4). In each plot 20 straight, relatively evenly spaced, wind stable (SR<120), dominant trees (500 trees ha^{-1}) were selected for further study of the thinned stand. Other

trees were either treated (killed) with chemicals, felled by chainsaw or retained as the control treatment (Table 1).

Table 1. Details of treatments applied to a 22 year-old stand of radiata pine in the Ovens Plantation in January 1986

Treatment	Plant density (trees ha^{-1})	DBHOB		Tree stability threshold DBHOB (SR 120)[a] (cm)
		All trees (cm)	20 retained trees (cm)	
Fosamine	7,250	8.2	18.8	15.8
Glyphosate	3,950	11.9	21.8	17.2
MCPA	6,375	8.6	19.5	16.1
Felled	6,100	9.6	20.0	16.7
Control	5,400	9.1	20.2	15.9

[a]Because height of the stand only and not the height of each individual tree was used, the threshold diameter was estimated as 0.74 of the top height (4).

Fosamine, glyphosate and MCPA (amine) were injected into the trees at 7 cm intervals around the base of each stem at 0.5, 0.4 and 0.5 g a.i. respectively.

Time taken to treat the plots (man hrs ha^{-1}), and quantity of herbicide used (L ha^{-1}) were recorded, and the total cost of each treatment was calculated. The latter was compared with the cost of alternative treatments applied at Ovens Plantation in the past (5, 6, 7, 8). The effects of each treatment on the diameter and wind stability of the retained trees were assessed one year after treatment.

RESULTS AND DISCUSSION

By 1986, 84% of the trees studied were too small for use as pulpwood. The remaining 16% were dominant, straight trees with SR between 91 and 102, indicating their moderate to low risk of wind damage. The number of dominant trees (>500 ha^{-1}) was sufficient to form the final crop. The volume of retained, 22 year-old trees varied between 230 and 310 m^3ha^{-1}. If the trees were clear-felled, their current royalty would vary between 5,775 and \$7,750 ha^{-1}. Assuming a volume increment as little as 2.4 m^3ha^{-1}p.a. in 10 years the value of the log produce would vary from \$6,375 to 8,350 ha^{-1}.

Due to the uneven distribution of the natural regeneration within the study, the number of thinned trees varied between the treatments (Table 2).

Table 2. Number of trees removed, time involved, amount of herbicide used and cost or treatments applied to 22 year-old stand of radiata pine in the Ovens Plantation in January 1986.

Treatment	Trees removed (trees ha^{-1})	Herbicide Application (hrs ha^{-1})	Herbicide Application (kg a.i. ha^{-1})	Initial cost[a] ($ ha^{-1})
Fosamine	6,750	59	10.3	1,038
Glyphosate	3,450	45	5.9	799
MCPA	5,875	52	10.7	569
Felled	5,100	150	-	1,517
Control	-	-	-	0

[a] Includes 33% overhead for the component of the cost of labour.

There was little difference between the time taken and the quantities of herbicides used for the fosamine and MCPA treatments.

Trees injected with glyphosate were fewer but the royalty cost of about 5,000 trees ha^{-1} would have been close to $1,000 ha^{-1}.

The costs of treatments applied in the past and those carried out in 1986 projected at simple interest of 10% to the end of the 35 year-old rotation are:

1. Fosamine applied to 0.5 year-old trees $576 ha^{-1} (8)
2. Fosamine applied to 3 year-old trees $8,196 ha^{-1} (6)
3. Brushcutter on 3 year-old trees $592 ha^{-1} (7)
4. Handslasher on 3 year-old trees $945 ha^{-1} (7)
5. Fosamine injected into 22 year-old trees $2,387 ha^{-1}
6. Glyphosate injected into 22 year-old trees $2,300 ha^{-1}
7. MCPA injected into 22 year-old trees $1,309 ha^{-1}
8. Chainsaw on 22 year-old trees $3,489.

The above costs indicate that it is economical to control the unwanted thickets at an early age (0.5 years) by spraying with fosamine. Costwise, use of brushcutter is feasible when the thickets are about three years old and the height of the retained trees exceeds 3 m. Of the four treatments tested in 1987, felling by chainsaw was the most expensive. Of the herbicides, fosamine and glyphosate were the most expensive and MCPA the least expensive treatment. Fosamine and glyphosate are both cost-effective and relatively safe and acceptable to the user.

In 1987 fosamine injection resulted in 'flash-back' of up to 10% of the retained trees. Six percent of trees survived when injected with fosamine and four and two percent survived when injected with glyphosate and MCPA respectively. There was no significant difference in the first year DBHOB increment between the treatments. By 1987 trees retained in herbicide treated plots remained straight and wind firm. However, permanent bending of smaller trees (DBHOB<10 cm) occurred in the control plot. In the long-term, such bending could result in self-thinning of a stand and a reduction of final stocking.

This study indicates that:

1. It is likely that due to mutual competition radiata pine thickets starting with more than 10,000 plants ha^{-1} will, by age 22 years, thin themselves to 4,000-7,000 trees ha^{-1}.

2. In the over 22 year-old thickets the number of dominant trees with moderate risk of stem collagpse (SR<120) will exceed 500 trees ha^{-1}, enough to produce a final crop of merchantable logs.

3. Provided that the root anchorage is adequate and barring extremes of inclement weather, when released, more that 500 trees ha^{-1} will retain their wind stability and straight form.

4. If carried out not less than 10-15 years before the end of the rotation age of a stand, the non-commercial thinning of the 20 year-old and older thickets by one of the chemicals tested is a viablable silvicultural option.

5. Although thinning radiata pine thickets at an age of 0.5 years and 3 years is the cheapest, thinning of over 20 year-old thickets by basal stem injection with herbicides may be still economically feasible.

6. On wind-firm sites, leaving thickets unthinned until the end of a rotation may be feasible, but the economics of such an option remain to be tested.

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