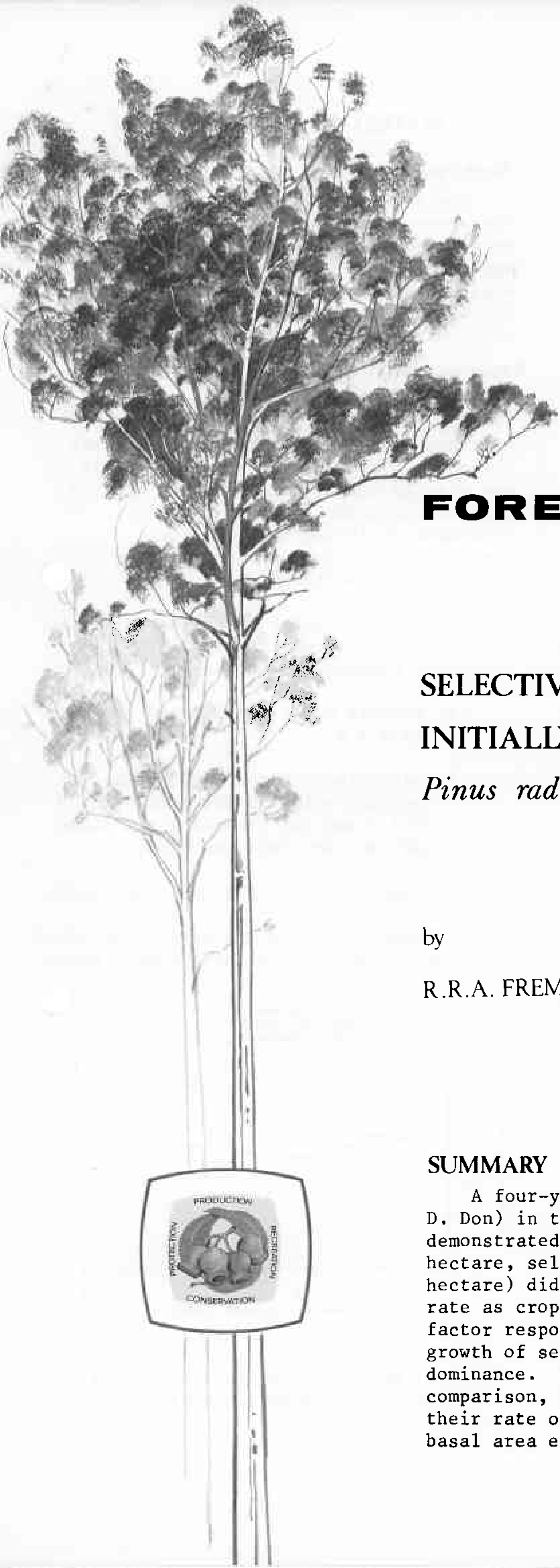

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FORESTS DEPARTMENT
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SELECTIVE LOW PRUNING IN INITIALLY WIDE SPACED *Pinus radiata* IN WESTERN AUSTRALIA

by

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SUMMARY

A four-year-old stand of monterey pine (*Pinus radiata* D. Don) in the Donnybrook Sunkland of Western Australia demonstrated that, at a stocking of 1100 stems per hectare, selectively pruned crop trees (125 stems per hectare) did not recover diameter growth at the same rate as crop trees in a totally pruned stand. The main factor responsible for reducing the rate of diameter growth of selectively pruned trees was their loss of dominance. This loss appeared to be absolute. In comparison, crop trees in totally pruned plots increased their rate of growth, such that after four years the basal area equalled that of the unpruned crop trees.

INTRODUCTION

Standard procedure in plantations of monterey pine (*Pinus radiata* D. Don) in Western Australia is to plant 1100 stems per hectare, then thin to waste when the trees are aged four years, and prune the remaining trees (nominally 750 stems per hectare) to a height of two metres. When the trees are six or seven years old, 125 stems per hectare are selected and pruned to a height of five metres. The first commercial thinning is scheduled when the trees are 11 years old (approximately 20 m in height). Although it is generally accepted that this regime maximizes growth in selected trees, opponents claim that tree form is sacrificed because of increased branch size caused by early wide spacing. It is also argued that a potential source of valuable round-log material is wasted through early non-commercial thinning. To satisfy these objections it would be necessary to retain the stand at the initial stocking until a commercial operation were feasible (approximately 12 years old). Since the ultimate objective of the Forests Department is to grow high quality sawlogs (Forests Department of Western Australia, 1977), pruning of at least 125 stems per hectare is necessary.

The demonstrated loss of dominance in selectively pruned *P. radiata* by Sutton and Crowe (1975) and Brown (1962) relate only to stands in excess of 1700 stems per hectare. It is argued that in stands planted at 1100 stems per hectare, unequal competition caused by live pruning will be minimized, as the trees are not expected to be under competitive stress at the time of first pruning. Alternatively, indiscriminate pruning of all trees in the stand maintains the dominant status of final crop trees. However, in the absence of thinning, the cost of total pruning is increased. It is necessary to prune at age four, for soon after this the branches become too thick for easy pruning. Furthermore, pruning at four years old restricts the tree's knotty core, maximizing the amount of knot-free wood.

This study was undertaken to test the hypothesis that low pruning of 125 stems per hectare would not cause loss of dominance and normal recovery would occur in four-year-old *P. radiata* standing at 1100 stems per hectare in the Sunkland.

MATERIALS AND METHODS

Study area

The experiment was conducted in a four-year-old stand of *P. radiata* located on grey sands in the Donnybrook Sunkland, approximately 230 km south of Perth. This area was selected because the pines had exhibited good growth and there were no signs of nutritional disorders.

Experimental procedure

As the study area was planted at 1700 stems per hectare, it was necessary to reduce the stocking to 1100 stems per hectare by removing every third tree in the planted line. This thinning was not expected to affect the response to treatment as it was unlikely that competition had occurred in the four years since planting.

A randomized block design was selected allowing for six replicates of the following treatments:

(1) totally pruned (all trees pruned to 2.1 m),

(2) selectively pruned (125 stems per hectare selected and pruned to 2.1 m and the remaining 975 stems per hectare left unpruned),

(3) control (all trees left unpruned).

Eighteen 0.10 ha plots were established allowing for an internal measurement plot.

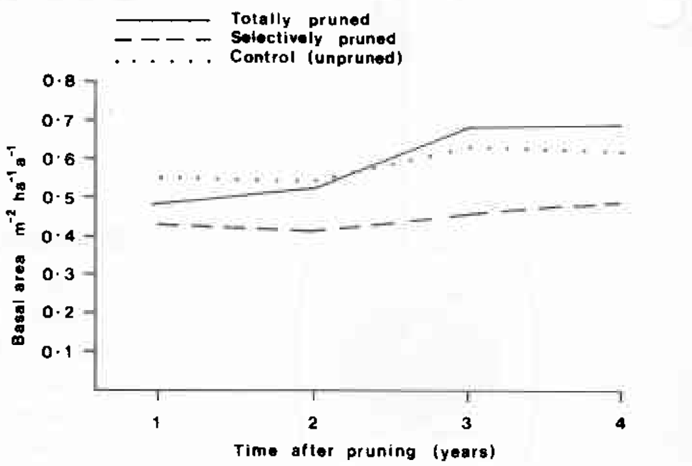

FIGURE 1: Mean basal area increment of *P. radiata* in the Sunkland following pruning.

of 0.056 hectares. Seven dominant trees (125 stems per hectare) were selected in each measurement plot and permanently marked. Diameter measurements at breast height over bark (d.b.h.o.b.) were recorded for each selected tree. Plot means were calculated and ranked in order of magnitude. The ranked list was then divided into six sections (replicates) and treatments were randomly allocated within these replicates. The mean d.b.h.o.b. for totally pruned, selectively pruned and control plots was 11.1 cm, 11.1 cm and 11.2 cm respectively.

Pruning using shears was completed in December 1975.

Diameter measurements were recorded for each of the crop trees at annual intervals over four years. Heights of trees were also measured in 1975 and 1977. These data were analyzed by analysis of variance.

Crop trees were assessed for relative status and incidence of malformation at nine years of age and the results analyzed by the chi-squared test.

RESULTS

One year after treatment, there were significant differences ($p \geq 0.05$) between the diameter increments of all treatments (Table 1).

In the second year after treatment, crop trees in totally pruned plots regained normal growth rates, indicating that the decline in growth caused by this pruning treatment was effective for one year only. Mean basal area increment (Fig. 1) revealed a significant increase ($p \geq 0.05$) in growth in the third year for trees in totally pruned plots. Selectively pruned trees grew at a slower rate than trees in other treatments.

TABLE 1

Growth data for *P. radiata* crop trees (125 stems·ha^{-1}), in the Sunkland, following three pruning treatments.

Treatment	d.b.h.o.b. increment (cm) 1975/76	1976/77	1977/78	1978/79	Diameter 4 years after treatment (cm)	Basal area 4 years after treatment (m^2·ha ^{1})
Totally pruned	2.0(a)	1.9(a)	2.0(a)	1.8(b)	18.8(a)	3.58(a)
Selectively pruned	1.8(b)	1.6(b)	1.5(b)	1.4(a)	17.4(b)	3.99(b)
Unpruned (Control)	2.3(c)	1.9(a)	1.9(a)	1.7(ab)	18.9(a)	3.58(a)

Data not having the same letter are significantly different at p = 0.05 level.

TABLE 2

Status of crop trees (126 stems·ha$^-$) of *P. radiata* in the Sunkland, four years after pruning.

Treatment	Status: Dominants (stems·ha^{-1})	Others (stems·ha^{-1})
Totally pruned	89 (a)	36 (a)
Selectively pruned	36 (b)	89 (b)
Unpruned (Control)	80 (a)	45 (a)

Date not having the same letter are significantly different at p = 0.001 level.

Four years after pruning, 71% of the selectively pruned crop trees had lost their dominant status, compared with 29% for the totally pruned treatment and 36% for the unpruned treatment (Table 2). This loss appeared to be absolute. Totally pruned plots and unpruned plots now had the same basal areas. The basal areas in selectively pruned plots were significantly lower ($p \geq 0.05$) than the other two treatments (Table 1).

Pruning appeared to have no significant effect on height growth of crop trees at either four or six years old (Table 3).

Malformation

Selectively pruned trees had more stem malformations than trees in either totally pruned or unpruned treatments (Table 4). Forks and multileaders were the major form of stem irregularity and it is likely that apical dieback was the most probable cause. Seventy-four per cent of observed malformations occurred in co-dominant and sub-dominant trees.

DISCUSSION

It is unlikely that selective pruning of crop trees, in the absence of thinning, can be justified. To minimize the effect of loss of dominance, 71% more trees than required should be selected for initial pruning to two metres. However, as 36% of crop trees in the unpruned control lost dominance, it can be assumed that the loss of dominance on only 35% of selectively pruned trees can be attributed to pruning.

As there is likely to be a change in relative dominance, the primary basis for selection should be stem straightness. The second consideration should be the condition of the apical shoot and the third, the crop tree's dominance (Sutton, 1973).

Malformations can be expected in 30 to 40% of selectively pruned trees, but confined mainly to co-dominant and sub-dominant trees. A similar result was obtained by Sutton (1973). This may be a physiological characteristic peculiar to trees of this status, or dominant trees may be more capable of out-growing stem irregularities than trees of lower status. Therefore, to allow adequate selection, ensuring a final crop of 125 acceptable stems per hectare, 500 stems per hectare should be selected for initial pruning. This number may need to be increased if thinning is delayed beyond the final stage of pruning.

The rapid recovery of growth of crop trees where all stems are pruned is surprising. McKinnell (1974), in his study at Brunswick, Western Australia, concluded that increment loss caused by pruning was absolute. Although no specific explanation for the greater recovery in the Sunkland exists, the answer may lie in the differences between the two sites. The main limiting factor for successful growth of *P. radiata* in the Sunkland is nutrient availability. Soils in this region are predominantly heavily leached sands with an inherently low nutrient status, and require fertilizers. In contrast, soils at Brunswick do not require the addition of fertilizers to sustain growth. Therefore, in the Sunkland it is possible that, when all trees are

TABLE 3

Heights of crop trees of *P. radiata* in the Sunkland, following pruning.

Treatment	Height at age 4 Years (m)	Height at age 6 years (m)
Totally pruned	8.9	13.3
Selectively pruned	8.8	13.4
Unpruned (Control)	8.8	13.5

TABLE 4

Number of malformed crop trees (125 stems·ha^{-1}) of *P. radiata* in the Sunkland, four years after low pruning.

Treatment	No. of malformed trees (stems·ha^{-1})	No. of normal trees (stems·ha^{-1})
Totally pruned	18 (a)	107 (a)
Selectively pruned	42 (b)	83 (b)
Unpruned (Control)	15 (a)	110 (a)

Data not having the same letter are significantly different at p = 0.05 level.

pruned, the resulting slash contributes significently to the amount of recycled nutrients, especially as all the material removed was active and rich in nutrients.

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