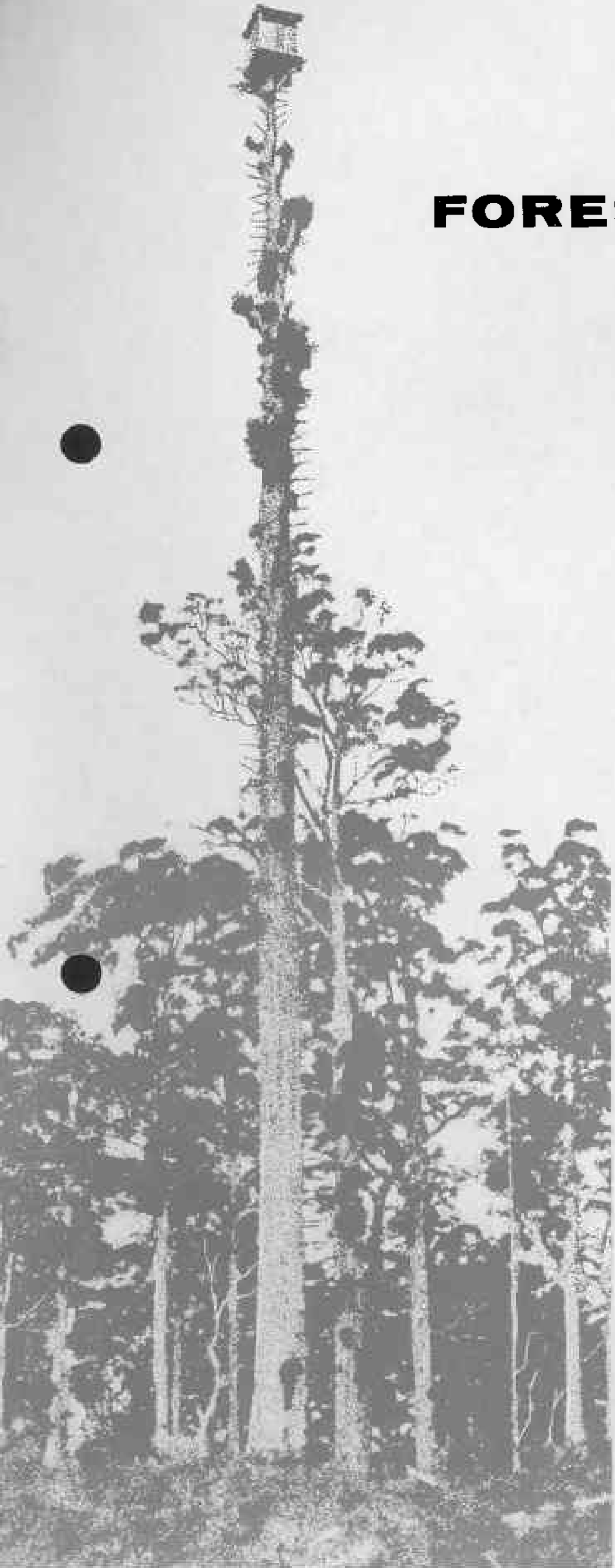
Research Paper No. 6
1971



FORESTS DEPARTMENT
OF WESTERN AUSTRALIA
54 BARRACK ST., PERTH

EARLY RESPONSES TO THINNING IN STANDS OF PINUS PINASTER

by

E. R. HOPKINS

SUMMARY

Cambial growth was measured with dendrometers on crop trees immediately after release in a nineteen year-old stand of *Pinus pinaster* AIT. Measurements covered residual stand densities ranging from 160 to 31 square feet basal area over bark per acre and were replicated on the sites of both highest and lowest productivity. For analysis, increments were separated into four seasons of three months' duration.

Girth response was immediate following release and was three times greater for the 31 sq. feet residual density class than for the 160 sq. feet density. Significant differences in seasonal growth between years could be largely related to rainfall variability. The major period of increment was spring, and heavy thinning improved cambial growth in both this season and the drier period of the year. The greatest response to heavy thinning was in the drier seasons.

Response to thinning in all density classes was similar on both the best and poorest sites.

INTRODUCTION

In winter 1965 a basal area thinning series was established in a nineteen year-old stand of *Pinus pinaster* AIT in South Lane Poole Block, Gnangara. Prior to this treatment the stand, of original six by six foot spacing, had received only a light cull thinning during pruning operations.

The trial consists of five residual basal area treatments, viz. 160, 107, 71, 47 and 31 sq. feet basal area over bark per acre replicated twice within each of five homogeneity blocks ranging from the highest to the lowest site quality within the stand (Table 1). Prior to thinning, the ten most desirable stems per 0.1 acre plot were marked for retention as a final crop. Trees were removed to the prescribed basal area residual giving first priority to the removal of stems required to release the final crop. Second and third objectives in thinning were to remove undesirable stems and to achieve uniform spacing over the plot

It will be five years before the released trees in the lower stand density treatments will adequately represent their new environment. Initial results for the trial will not be processed until this condition is reached. Dendrometers were fixed to trees in certain of the plots however, to complement previous studies of the influence of season and stand density on cambial development. This report presents results of dendrometer measurements recorded during the thirty month period immediately following thinning.

STUDY METHOD

Aluminium girth band dendrometers were fixed at height five feet to five final crop trees in each of the thirty plots. Plot selection provided for two replications of the five stand density treatments in each of three site blocks (Table 1). In practice one plot was banded incorrectly and a replicate for the 160 sq. feet basal area over bark residual in Site III was not available. For statistical analysis this density class was omitted from all three site classes. The missing value was computed and included in comparisons of responses by density classes within site blocks.

Measurements were made at fortnightly intervals, commencing in November 1965 and terminating in January 1968. Increment per period was recorded as the sum of the increments on the five bands per plot. Although this summation cannot be related precisely to increment in basal area, it is adequate for the purpose of this study, i.e. to determine trends of cambial activity.

Results were analysed for each of the two years January 1966 to January 1967 and January 1967 to January 1968 and within each year the following three monthly seasons were separated:

January	14	to	April	7—	A
April	7	to	July	29—	B
July	29	to	November	4—	C
November	4	to	January	13—	D

RESULTS

Differences and means for main effects were found to be highly significant. Interactions between site and density (S x D), density within season (D x P) and seasons within years (P x Y) were also highly significant. Differences between replications and other interactions were not found to be significant.

Within the present study, the significant interactions are of major interest.

TABLE 1
PLOT DISTRIBUTION MEASURED IN THE STUDY.

Residual B.A.O.B. sq. ft.	Replication 1		Replication 2		
	Plot No.	Crop Tree Ht. (ft.)	Plot No.	Crop Tree Ht. (ft.)	
160	43	57.0	9	54.4	Site I
107	50	60.3	33	57.3	
71	24	57.4	3	59.8	
47	35	56.5	31	55.9	
31	52	54.4	37	54.4	
160	16	50.5	18	49.5	Site II
107	21	55.6	23	55.9	
71	40	53.1	8	53.4	
47	46	53.5	7	54.0	
31	49	52.3	51	53.1	
160	—	—	41	47.4	Site III
107	28	47.0	29	48.2	
71	27	48.8	6	42.9	
47	34	44.1	30	46.1	
31	20	49.0	19	46.9	

Season

Data summarizing the seasonal variation measured within years and density classes are contained in Tables 3 and 4.

The highly significant interaction for seasons within years and seasons within density classes are associated with season variation in rainfall (Fig. 1). In 1966 rainfall was only 24 inches as opposed to 37 inches in 1967 (Table 5). Increment in the 1966 A-period (Table 3) followed 3.5 inches of rainfall in the preceding two months, while the lower increment of the 1967 A-period followed only 1.1 inch of rainfall in the preceeding two months. The relatively higher growth for the 1967 B-period is also associated with a higher precipitation of 28 inches (Table 5) compared to 16 inches for the corresponding 1966 B-period. Both increment and rainfall are comparable in the C-periods. Relatively higher increment in the 1967 D-period is again associated with higher within season and total year precipitation.

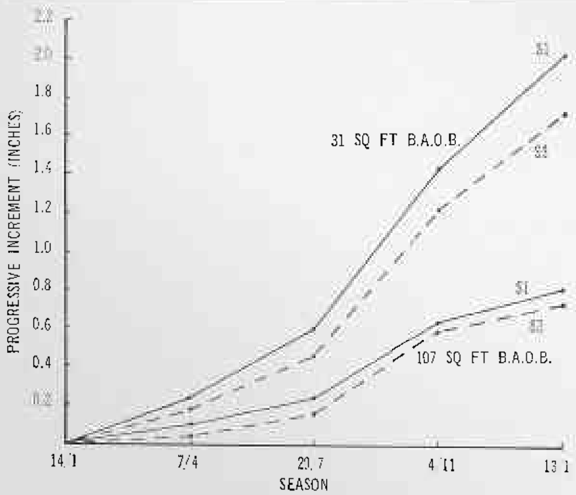


FIGURE 1: *Progressive girth increment of a final crop tree for extremes of site and stand density classes.*

The most favourable period for growth was period C (spring). The percentage relationship between the increment for growth in this period and the total yearly growth within the 107, 71, 47 and 31 sq. feet residual basal area over bark classes (Table 4), 52, 52, 49 and 42 respectively, indicates that heavy thinning has particularly favoured growth in the drier seasons of the year. This possibility is substantiated by examining the relationship between increments of the 107 sq. ft. and the 31 sq. ft. density classes in Table 4. By seasons the values are 35, 39, 50 and 29 per cent respectively. The increment advantage of the heavily thinned stands is greater during the summer (periods D and A) and autumn. Apart from this beneficial interaction with season, heavy thinning also has a very real effect on growth of final crop trees during the most favourable growing season (C).

Stand Density

Increment increased progressively with increase in thinning intensity (Tables 4 and 6) and cambial growth for the 31 sq. ft. basal area over bark residual was almost treble that of the 160 residual (Table 6). The highly significant interaction obtained for density by site class is associated with abnormally high increments in the 107 and 31 residual densities in Site III. The cause of these high values may be traced to two unrepresentative plots amongst the eight of this site group included in the analysis. It is expected that these apparently abnormal values will be adequately buffered by the increased replication in future analysis of the whole thinning series. For the present the possibility that a greater thinning response occurred on the poorer site cannot be proved incorrect.

Allowing for the probable abnormality of these two plot values it is still evident that the response to thinning follows a similar trend for all sites (Fig. 1).

The increase in radial growth with heavier thinning is not consistent between density classes. In practice the five treatment densities were obtained by reducing each progressively by one-third. From data in Table 6 the increment advantage between classes can be computed as follows:

(i) Reduction of 160 to 107 sq. ft.
= 14 per cent increase on 160

(ii) Reduction of 107 to 71 sq. ft.
= 31 per cent increase on 107

(iii) Reduction of 71 to 47 sq. ft.
= 53 per cent increase on 71

(iv) Reduction of 47 to 31 sq. ft.
= 24 per cent increase on 47

TABLE 2

MEAN VALUES OBTAINED FOR THE MAIN EFFECTS.

RESULTS ARE EXPRESSED IN INCHES OF GIRTH INCREMENT PER TREE PER ANNUM.

Density	Site	Season	Year
160 sq. ft. — 0.66 107 sq. ft. — 0.74 71 sq. ft. — 1.06 47 sq. ft. — 1.50 31 sq. ft. — 1.86	I. — 1.42 II. — 1.31 III. — 1.15	A — 0.14 B — 0.22 C — 0.62 D — 0.32	1966 — 1.20 1967 — 1.39

TABLE 3

AVERAGE GIRTH INCREMENT IN INCHES OF A FINAL CROP TREE FOR SEASONS WITHIN YEARS.

Year	A	B	C	D	Total
	14/1 - 7/4	7/4 - 29/7	29/7 - 4/11	4/11 - 13/1	
1966	0.22	0.12	0.60	0.26	1.20
1967	0.08	0.31	0.63	0.37	1.39

TABLE 4

AVERAGE GIRTH INCREMENT (INCHES) OF A FINAL CROP TREE WITHIN DIFFERENT STAND DENSITIES BY SEASON.

Stand Density B.A.O.B. sq. ft.	Season			
	14/1 - 7/4 A	7/4 - 29/7 B	29/7 - 4/11 C	4/11 - 13/1 D
107	0.08	0.13	0.39	0.15
71	0.11	0.17	0.55	0.23
47	0.18	0.23	0.73	0.36
31	0.23	0.33	0.78	0.52

TABLE 5

DISTRIBUTION OF RAINFALL (INCHES) IN THE TWO YEARS UNDER STUDY.

Month	1966		Period Total	1967		Period Total
	Wet Days	Total		Wet Days	Total	
January	0	0.00		1	0.18	
February	2	0.10	0.54	3	0.23	0.74
March	3	0.44		2	0.33	
April	11	1.69		8	2.68	
May	10	1.95	15.75	16	11.51	27.92
June	16	5.68		14	8.09	
July	17	6.43		16	5.64	
August	11	2.05		14	4.10	
September	12	3.51	7.07	3	1.32	6.95
October	8	1.51		5	1.53	
November	3	0.58	1.13	3	0.46	1.48
December	1	0.55		4	1.02	
Total	94	24.49		89	37.09	

TABLE 6

AVERAGE GROWTH INCREMENT OF A FINAL CROP TREE WITHIN DENSITY CLASSES FOR THREE SITE CONDITIONS.

Density Class B.A.O.B. sq. ft. Per Acre	Site Group			Mean	Percentage of 160 sq. ft. Density
	I	II	III		
160	0.76	0.61	0.61	0.66	100
107	0.78	0.71	0.75	0.75	114
71	1.04	1.02	0.87	0.98	148
47	1.74	1.52	1.25	1.50	228
31	2.06	1.79	1.75	1.87	283

These results suggest that the optimum early response of final crop trees is obtained in thinning from the 71 to 47 sq. ft.

DISCUSSION

Response of the final crop selection to thinning has been immediate. During the first summer period, six to nine months following release, increment by density classes was 0.13, 0.17, 0.26, 0.31 inches for the 107, 71, 47 and 31 sq. ft. residual densities. Both in the present and previous studies, this response can be directly associated with increased availability of soil moisture.

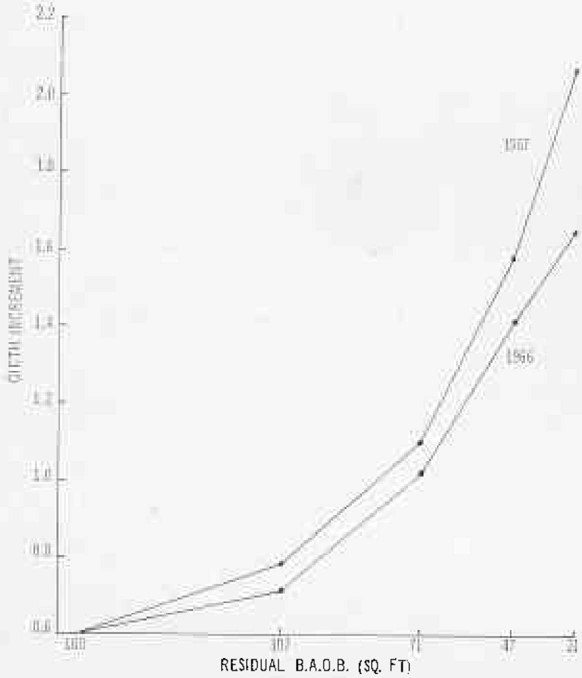


FIGURE 2: *Variation of increment of a final crop tree with progressive time since release.*

It is anticipated that the superiority of the heavily thinned stands over the lighter thinning will increase as the trees increase crown and root volume to fully utilize the growing space. For the second summer of record, increments for the density classes were 0.02, 0.04, 0.09, 0.15 inches respectively, trebling the previous advantage of the 31 sq. ft. density over the 107 sq. ft. density. Although this large increase must be mainly attributed to greater differences in water availability in the exceptional 1967 summer drought, it probably also reflects increased crown and root development of the 31 sq. ft. stand during the two year period (Fig. 2). Experience with the species has shown *Pinus pinaster* to have a remarkable facility to rebuild crown, with release, from practically any detrimental stand condition.

The reliability of increment during the spring and the fact that this season is the major period of growth has been demonstrated in previous studies for both height and cambial growth. Within the Mediterranean type climate of Western Australia and with the particular growth habits of the species, it is further evident that a potential for increment during the dry season can be obtained by adjusting water availability. The cumulative increase of the average final crop tree with seasons is summarized for density classes and site groups in Figure 1.

Results indicating that thinning responses on poor sites were at least of the same order as those for the same densities on good sites, were not entirely expected. The finding suggests that thinning prescriptions to a fixed basal area residual can be satisfactorily standardized for plantation compartments irrespective of the site quality distribution. Further, the result indicates that treatment of poor sites can salvage a final crop of reasonable size class, if this policy is warranted.

Site classes sampled within this study represent the highest (Site I) and the poorest (Site III) present within the study area. Site II was the second most productive homogeneity group formed in the plot stratification.

Results obtained separating the major period of cambial activity, relating thinning response and water availability and demonstrating the need for thinning, substantiate previous work carried out in unreplicated plots. The advantages gained in the present study are verification of the previous work over a wide range of thinning densities and the tie-in of data with general plantation conditions. Increment responses for standard density levels over the entire range of site conditions have not been previously obtained.

CONCLUSIONS

The study has shown that response to thinning in *Pinus pinaster* is rapid and of considerable extent under all site conditions. Increment responses to thinning immediately following release are directly related to increased water availability.