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THE EFFECTS OF LOW PRUNING ON INCREMENT IN RADIATA PINE PLANTATIONS

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THE EFFECTS OF LOW PRUNING ON INCREMENT IN RADIATA PINE PLANTATIONS

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SUMMARY

Low pruning with shears at age six to ten years is standard practice in the Radiata pine plantations administered by the New South Wales Forestry Commission. In order to point the way from a purely cultural angle the studies reported here were commenced in the winter of 1954. Study plots were pruned at age six to nine years during the winter and an analysis of growth increments was made for diameter basal area and height, in 1959.

Results have shown that pruning of more than thirty-five per cent. of the live crown, using predominant height as a basis for calculation, results in depression of increment in each of the parameters studied.

A general prescription for live pruning in Radiata plantations is given.

INTRODUCTION

Low pruning with shears at age six to ten years is standard practice in the Radiata pine (*Pinus radiata* D. Don) plantations administered by the New South Wales Forestry Commission. This pruning is carried out to the maximum height to which the operator can reach with shears, in in the case of the present study to eleven feet. Almost all limbs are alive at the time of pruning.

There are two main reasons for carrying out this low pruning operation. These are:—

(i) Fire Protection. The elimination of the lower crown minimises the risk of a crown fire developing in the event of a forest fire. The lower crown dies quickly in an unthinned stand after age eight to nine years. In an unpruned stand dead needles are held on all the small twigs and in the forks by these dead limbs thus providing continuity of very inflammable fuel between ground litter and the live crown.

(ii) The knotty core of the butt-log is kept to a minimum. Although no differential stumpage operates for pruned or unpruned logs at present, pruning does not help to upgrade logs into the higher or No. 1 log grade. Mill studies have shown that pruned stems produce a higher percentage of better grade lumber than unpruned stems.

In addition to these main reasons there are other, less important advantages in pruning such as easier access for inspection or assessment purposes and ease of working at the time of first thinning.

The costs of this operation vary somewhat from one plantation to another, depending on the terrain, the amount of scrub present (wattle or Eucalypt coppice) and limb size. However, an average cost would be in the vicinity of £9 per acre or 3d. per tree (8 ft. x 8 ft. planting; basic wage approximately £13 15s. 0d. per week).

The age at which low pruning is carried out varies from district to district. The policy depends on local conditions of growth and experience in pruning coupled with economic considerations. The age group pruned in any one year will depend on—

(*a*) the finance available;

(*b*) the acreage planted in each age class. This may be an important consideration where the acreage in each class varies considerably.

In order to point the way from a purely cultural angle the studies reported here were commenced during the winter of 1954. The aim was to study the effects of low pruning at various ages on growth in Radiata plantations of the Tumut district. No attempt was made to study the economics of pruning.

REVIEW OF LITERATURE

There has not been a great deal of work published which is pertinent to the subject under discussion. Jacobs (1938) discussed some of the effects of pruning P. radiata, particularly effects on branch size.

Two most interesting papers are those of Lückhoff (1949 and 1956). In the first of these papers he states that live pruning had a much greater effect on diameter than on height increment. He also showed that the total loss in diameter caused by severe live pruning was, for the species discussed, approximately proportional to the age at which pruning takes place and is less in older stands. He recommended a removal of not more than 40 per cent. of the living crown, the prescription for initial low pruning given being to 8 feet when the *mean* height of the stand was 20 feet.

In his paper in 1956 Lückhoff states that " Predominant height has been reverted to in view of the fact that when pruning on the basis of mean height the pruning of a considerable number of the best predominant trees in the stand is delayed for at least a year or more. In order to prevent over-pruning a proportion of the height to which pruning is to take place, rather than a fixed height, has been defined." This modification of policy took place in 1953.

Brown and Pawsey (1959) discussed three types of pruning tools used in Radiata plantations in the Australian Capital Territory and in South Australia. Part of this paper is referred to in later discussion.

GREEN HILLS PRUNING TRIALS

METHODS

These trials were established during the winter of 1954 in Compartment 73, 1948 planting. Spacing 8 ft. x 8 ft. Elevation 2,700 ft. a.s.l. Location is approximately sixteen miles south-west of Tumut. This region is in a winter rainfall area with a mean annual rainfall of 52 inches. December to February are the driest months but the mean monthly rainfall is still approximately 2·75 inches, although somewhat unreliable.

The experiment was designed as a randomised block of four treatments and an untreated control with five replications. For details of plot layout see Appendix I. Each measured sub-plot was equal to one-twentieth of an acre.

Table I shows the treatments and stand details at the time of pruning.

Table I.

1 Treatment Number	2 Year of Pruning	3 Age Years	4 Mean Dia. in.	5 Mean Hgt. ft. 100 tallest trees per ac.	6 Mean Hgt. to 1st Green limb ft.	7 $\frac{6}{5}$%
Control—	—	—	—	—	—	—
1	1954	6	3·02	21·5	11·1	51·6
2	1955	7	3·81	28·5	11·4	40·0
3	1956	8	4·63	36·4	11·1	30·5
4	1957	9	5·15	43·2	11·1	25·7

Measurements of diameter and height were recorded for all trees each winter (with the exception of height in 1955 when only predominant heights were measured).

The basal area per acre was calculated from the sum of the individual basal areas of all trees on the plot.

Calculations

The results of measurements taken in these plots during the period 1954-59 have been analysed as follows:—

(i) Increment during the five year period 1954-59 has been derived for the following parameters.

- (*a*) Mean diameter of all trees.
- (*b*) Basal area per acre.
- (*c*) Mean height of all trees.

(ii) An analysis of variance was carried out on each of these three sets of increment data. Tests of significance and calculations of critical differences were made. Details are given in Appendix II (*a*), (*b*) and (*c*).

(iii) An analysis of diameter and basal area increments by treatments was made for each year of growth from 1954-55 to 1959-60.

Except where obvious differences existed an analysis of variance was carried out, tests of significance and calculations of critical differences were made.

Details are given in Appendix V (*a*) and (*b*).

These results are also shown graphically in Figures I and II.

RESULTS

(a) *Mean diameter of all trees*

From Appendix II, the increments obtained for the five year period 1954-59 were as follows:—

Control	Unpruned	3·16 inches.
1	6th year pruning	2·38 inches.
2	7th year pruning	2·75 inches.
3	8th year pruning	3·20 inches.
4	9th year pruning	3·20 inches.

Critical difference for $p = 0{\cdot}05$ is 0·33 inches.
$p = 0{\cdot}01$ is 0·45 inches.

Thus the following comparison shows—

	Difference	Significance
Control compared to Treatment 1	0·78 inches	**
Control compared to Treatment 2	0·41 inches	*
Control compared to Treatment 3	0·04 inches	n.s.
Control compared to Treatment 4	0·04 inches	n.s.
Treatment 3 compared to Treatment 1	0·82 inches	**
Treatment 3 compared to Treatment 2	0·45 inches	**

From Appendix V it can readily be seen that for the 6th year pruned stand a considerable depression of annual increment has occurred in the first and second growth period following pruning. Analysis has shown that a significant difference in annual increment existed (95 per cent. level) between the control and this treatment for the third growing season after treatment but that there was no significant difference thereafter.

A similar situation existed for the 7th year pruning. A depressed annual increment was shown by analysis for the three growing seasons after pruning but thereafter there was no significant difference between this treatment and the control.

No significant depression of annual increment occurred for the 8th and 9th year pruning at any stage when compared to the unpruned control.

(b) *Basal area per acre*

From Appendix II, the increments obtained for the five year period 1954-59 were as follows:—

	Treatment	Increment (sq.ft. acre)
Control	Unpruned	.. 116·2
1	6th year pruning	.. 78·5
2	7th year pruning	.. 90·2
3	8th year pruning	.. 106·7
4	9th year pruning	.. 105·4

Critical difference for $p = 0{\cdot}05$ is 16·8 sq. ft.
$p = 0{\cdot}01$ is 23·1 sq. ft.

** significant at 0·01 level. * significant at 0·05 level. n.s. not significant.

Thus the following comparison shows—

	Difference	Significance
Control compared to Treatment 1	37·7	**
Control compared to Treatment 2	26·0	**
Control compared to Treatment 3	9·5	n.s.
Control compared to Treatment 4	10·8	n.s.
Treatment 3 compared to Treatment 1	28·2	**
Treatment 3 compared to Treatment 2	16·5	n.s.

From Appendix V it can be seen that a similar situation exists for current annual increment as has been presented above for diameter. However, in the case of 6th year pruning, depression of annual increment has been carried through to the fourth growing season after pruning. For the 1958-59 growing season there was no significant difference between the current annual increment for each of the five treatments.

This depression of current annual increment for several years following live pruning in young stands confirms the opinion of Jacobs (1938) but is contrary to Lückhoff (1949) working with other species.

(c) *Height of all trees*

From Appendix II, the increments obtained for the five year period 1954-59 were as follows:—

Control	Unpruned	30·4 feet.
1	6th year pruning	26·2 feet.
2	7th year pruning	28·3 feet.
3	8th year pruning	29·9 feet.
4	9th year pruning	29·8 feet.

Critical difference for $p = 0{\cdot}05$ is 1·18 feet.
$p = 0{\cdot}01$ is 1·63 feet.

Thus the following comparison shows:—

	Difference	Significance
Control compared to Treatment 1	4·2 feet	**
Control compared to Treatment 2	2·1 feet	**
Control compared to Treatment 3	0·5 feet	n.s.
Control compared to Treatment 4	0·6 feet	n.s.
Treatment 3 compared to Treatment 1	3·7 feet	**
Treatment 3 compared to Treatment 2	1·5 feet	*

RED HILL PRUNING TRIALS

Methods

This trial was established during the winter of 1954 in Compartment 42, 1948 planting. Spacing 9 ft. x 7 ft. Elevation approximately 2,200 ft. a.s.l. Location is approximately fourteen miles north-east of Tumut. The climate is also a predominantly winter rainfall area but rainfall is much lower than at Green Hills, being 44 inches annually, together with a more severe dry period from December to February.

** significant at 0.01 level. * significant at 0.05 level. n.s. not significant.

The experiment consisted of five circular plots, each with a measured area of one eighth of an acre and a forty link buffer strip all round. There were no replications.

For details of layout see Appendix III.

Table 2 shows the treatments and stand details at the time of pruning.

Table 2.

1 Plot Number	2 Year of Pruning	3 Age Years	4 Mean Diameter in.	5 Mean Hgt. ft. of 80 tallest trees ac.	6 Height to 1st Green Limb ft.	7 $\frac{6}{5}$ %
Control						
1	1954	6	3·16	23·8	10·4	43·7
2	1955	7	4·48	33·4	10·9	32·6
3	1956	8	5·11	38·0	11·5	30·3
4	1957	9	5·23	39·3	10·5	26·7

Measurements of diameter were taken each winter. Heights of all trees were taken in 1954 and 1959 with only predominant heights taken for 1955 to 1958.

The basal area per acre was calculated from the sum of the individual basal areas of all trees on the plots.

Calculations and Results

The increment during the five year period 1954 to 1959 has been derived for the following parameters.

(*a*) Mean diameter of all trees.

(*b*) Basal area per acre.

(*c*) Mean height of all trees.

Details are given in Appendix IV.

There were no statistical analysis possible for these plots. With no replications, the results must be considered with some caution even though the plots were carefully selected with a minimum of obvious site differences between each.

Clear cut differences were not obtained. In the light of results at Green Hills these results do give a good indication that pruning prior to the 7th year will result in loss of increment.

The Red Hill results are not included in the general discussion and conclusions below.

Discussion

Although all the results for pruning treatments in the Green Hills trials have been considered in relation to the unpruned control, this discussion will not do this. Discussion will centre around the second comparison given, i.e. for treatments 1 and 2 in comparison with treatment 3. This treatment, as well as treatment 4, showed no significant difference from the unpruned control. Departmental policy is to carry out low pruning. Therefore if it is wished to analyse the effects of early pruning, say at six or seven years of age at Green Hills, then these effects must be compared to pruning at age eight or nine where no adverse effects are known to occur.

(a) *Mean Diameter Increment*

When comparisons are made with the pruning treatment 3, age eight years, it can be seen that significant losses in diameter increment have occurred for six and seven year old pruned stands.

However, the losses are not large, 0·82 inches in the case of treatment 1 and 0·45 inches in the case of Treatment 2. In some respects this loss may be accomplished by beneficial effects such as a much smaller knotty core. It is of interest to consider these results together with those of Brown & Pawsey (1959). Their paper deals with the relationship of stub length and occlusion depth with branch diameter. This type of data is presented for various pruning implements used in Radiata pruning. Given the d.b.h. at the time of pruning, the average branch size and the pruning implement, it is possible to calculate the knotty core diameter.

For pruning shears the following values have been derived from this paper.

Branch diameter in inches	Diameter Growth necessary after pruning prior to production of clear wood—inches
0·5	2·3
1·0	3·5
1·5	4·6
2·0	5·8

An average branch diameter of 1·0 inch has been assumed for Green Hills for the purpose of argument. Compared to the average diameter of branches reported by Brown & Pawsey for Mt. Stromlo, this appears quite fair. Thus Table 3 has been derived to indicate the position with regard to production of clear wood for various ages at Green Hills.

Table 3

1 Treatment	2 Age of Pruning	3 Mean Dia. in. at time of Pruning	4 Mean Dia. in. age 11 years years	5 "Occlusion Wood" formed by age 11 years
1	6 years ..	3·02	5.40	2.38
2	7 years ..	3·81	5.54	1.73
3	8 years ..	4.63	5.94	1.31

Thus the trees pruned at 6 years, although smaller, have a definite advantage in the race to produce clear timber. This does not take into consideration the probability of smaller branches on the trees at age six years.

(b) *Basal Area per Acre*

There has been a significant loss of basal area increment (at the 1 per cent. level) when pruning has been carried out at age six years when compared to pruning at age eight years. Seven year pruning has shown no significant loss of basal area increment when compared to 8 year pruning, although the difference was very close to significance at the five per cent. level.

Compared to the 8th and 9th year pruning the 6th year pruning has shown a loss of 28 square feet of basal area and the 7th year pruning 16 square feet. Experience with thinning, especially in Radiata pine plantations, has shown that this loss of basal area will most probably be permanent.

At the time of first thinning this lower basal area per acre could mean a lower volume per acre of up to 500 cubic feet. This estimate has been based on the basal area per acre and volume per acre of local 8 ft. x 8 ft. stands of Radiata (at age fifteen years) which have been pruned at eight or nine years. Where a firm market for first thinnings is available, this could mean quite a finanical loss.

(c) *Height Increment*

Height has also been affected by early pruning. At age six years pruning has resulted in a significant loss in height increment (at the 1 per cent. level) when compared to pruning at age eight years. Similarly at seven years a loss in height increment (significant at the 5 per cent. level) has resulted when compared to eighth year pruning. In the case of the sixth year pruning the difference in height of 3·7 ft. is quite sufficient to contribute to a lower volume per acre at the time of first thinning as discussed above under (*b*).

For a more general picture it is preferable to consider these results from the point of view of stand height rather than age. Thus we can derive Table 4 below.

Table 4

Treatment age years	Mean Hgt. of all trees ft.	Per cent of crown removed	Mean height of 100 tallest trees trees/ac.	Per cent. of crown removed
6	17·7	65·3	21·5	51·6
7	23·6 (i)	48·3	28·5	40·0
8	29·4	37·7	36·4	30·5
9	35·2	24·0	43·2	19·1

Thus we can see that the maximum 40 per cent. removal of live crown as recommended by Lückhoff (1949) is fairly much in agreement with the results given here when mean height of all trees is used as the basis for pruning prescriptions.

(i) Note.—This height of 23·6 feet was not obtained by direct measurement but by extrapolation of height data for both Green Hills and Red Hills trials.

CONCLUSIONS

It was stated earlier that the economics of pruning were not studied in the trials reported. However, some general theories in the light of the results given may help to indicate future lines of research.

The cost of pruning is certainly less at age six than at age eight years. Pruning dates may be governed purely by costs. However, the royalty situation of the plantation should possibly also be considered. In high royalty plantations, it may be the best policy to prune late so as to ensure maximum volume productions with the hope of good royalty returns from 1st thinning yields. In remote plantations, where royalty is relatively low, the best policy may be to prune early at a low cost to minimise capital investment in the plantations.

Thus some sacrifice of early 1st thinning yield may be made deliberately for the reason that the market is uncertain and unremunerative for 1st thinnings.

From the results presented here the following general prescription for low pruning in Radiata plantations is proposed.

Where the pruning height is to be 10 to 11 feet, low pruning should be carried out when the predominant height of the stand is 30 to 35 feet. For trees less than 30 feet high in such a stand the proportion of the live crown removed should not exceed one third of the their height if increment losses are to be avoided.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the assistance given by Messrs. J. L. Henry and R. A. Free and to the various foresters who laid out and maintained the pruning trials during the early stages.

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Brown, A.G. & Pawsey, C.K. (1959). A study of Stub Length and Occlusion Depth Following Pruning in *Pinus radiata.* Australian Forestry, Vol. XXIII, No. 1.

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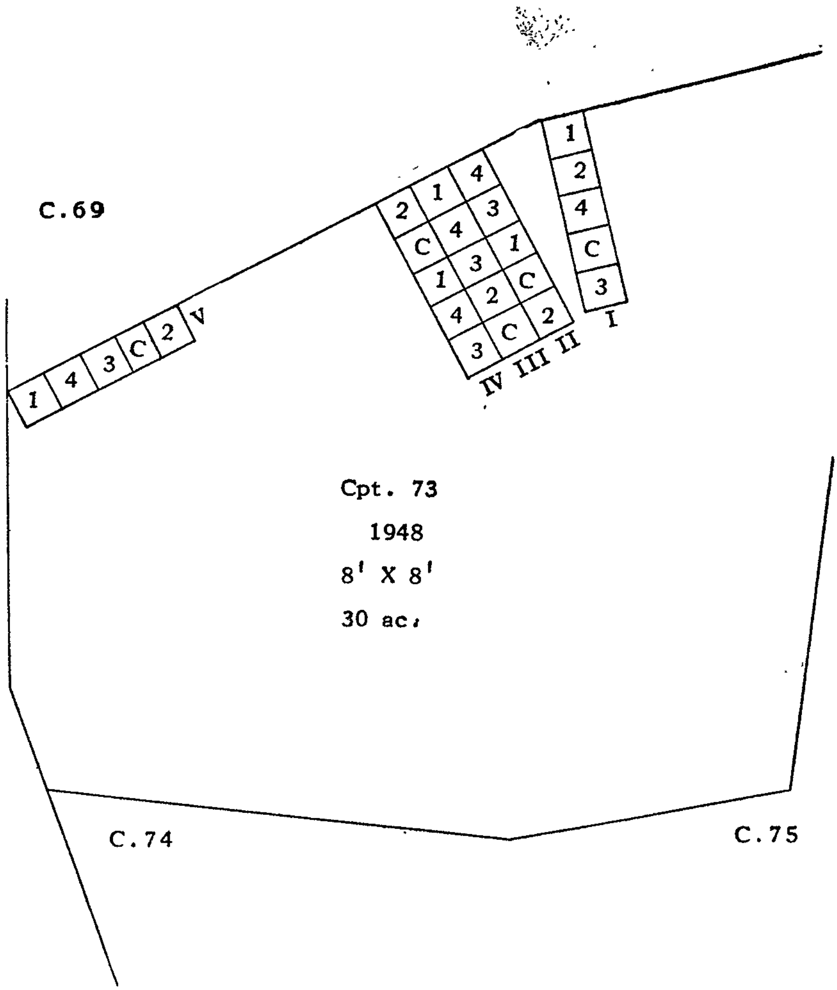
Lückhoff, H.A. (1949). The Effect of Live Pruning on the Growth of *Pinus patula*, *P. cambaea* and *P. taeda.* Jour. of the Sth. African For. Assoc. No. 18.

——(1956). High Pruning in *Pinus patula*, its Feasibility. Effect on Growth and Economics. Jour. of the Sth. African Forestry Assoc. No. 27.

Plan of plot Layout, Experimental pruning Plots, Compartment 73, Green Hills S.F. 657.

Scale:- 5 chs to 1 inch.



Details of treatments.

C. Control, no pruning.
1. Pruned at six years in 1954.
2. Pruned at seven years in 1955.
3. Pruned at eight years in 1956.
4. Pruned at nine years in 1957.

(a) *Mean Diameter of all Trees*—inches.

Treatment	1954	1959	Increment
Control ..	3·07	6·23	3·16
1	3·02	5·40	2·38
2	2·78	5·54	2·76
3	2·74	5·94	3·20
4	2·81	6·01	3·20

Analysis of Variance Table

Source	Degrees of Freedom	Sum of Squares	Mean Square of Variance	F ratio
Blocks	4	1·0370	0·2593	
Treatments	4	2·6398	0·6599	10·871**
Error	16	0·9719	0·0607	
Total	24	4·6487		

For $n_1 = 4$; $n_2 = 16$. F. table values at 5% = 3·01.
at 1% = 4·77.

(b) *Basal area per Acre*—square feet.

Treatment	1954	1959	Increment
Control ..	38·3	154·5	116·2
1	33·6	112·1	78·5
2	31·4	121·6	90·2
3	30·1	136·8	106·7
4	30·1	135·5	105·4

Analysis of Variance Table

Source	Degrees of Freedom	Sum of Squares	Mean Square of variance	F ratio
Blocks	4	857·85	214·46	
Treatments	4	4,466·15	1,116·54	7·12**
Error	16	2,507·42	156·71	
Total	24	7,831·42		

For $n_1 = 4$; $n_2 = 16$. F table values at 5% = 3·01.
at 1% = 4·77.

(c) *Mean Height of all Trees*—feet

Treatment	1954	1959	Increment
Control	17·7	48·1	30·4
1	17·0	43·2	26·2
2	16·1	44·4	28·3
3	15·6	45·5	29.9
4	16·3	46·1	29·8

Analysis of Variance Table

Source	Degrees of Freedom	Sum of Squares	Mean Square of Variance	F ratio
Blocks	4	5·04	1·26	
Treatments	4	59·26	14·82	19·00**
Error	16	12·54	0·78	
Total	24	76·84		

$n_1 = 4$; $n_2 = 16$. F table values at 0·05 = 3·01.
0·01 = 4·77.

** significant at 0·01 level. * significant at 0.05 level. n.s. not significant.

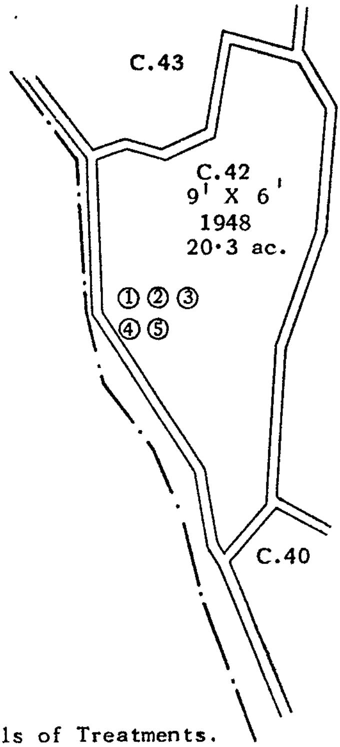
Appendix III

RED HILL S.F. No. 591 COMPARTMENT 42.

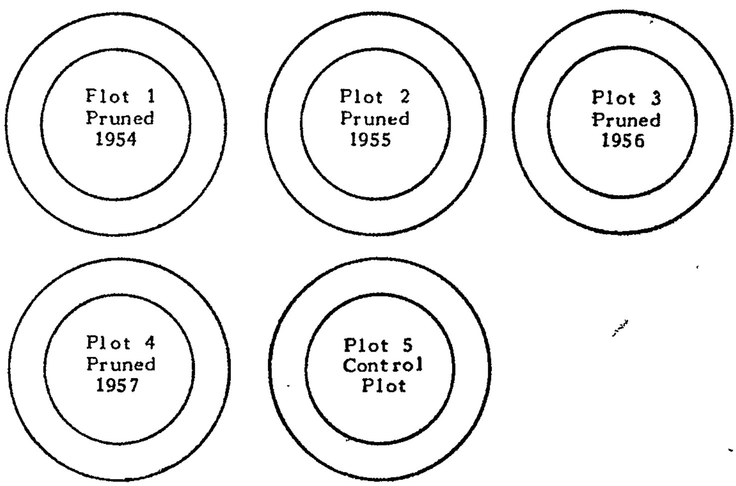
EXPERIMENTAL PRUNING PLOT.

PLAN OF LAYOUT

Scale:- 10 chs to 1 incn.



Details of Treatments.



RED HILL S.F. 591—PRUNING TRIALS

Compartment 42, 1948 area.

Established March, 1954, last measured September, 1959.

Area of plots ⅛ acre.

Diameter—inches.

Treatment	Year	1954	1959	Increment
Control		3·11	6·34	3·23
6 years	1954	3·16	5·96	2·80
7 years	1955	3·62	6·42	2·80
8 years	1956	3·46	6·36	2·90
9 years	1957	3·17	6·25	3·08

Basal Area—sq. ft. per acre.

Treatment	Year	1954	1959	Increment
Control		34·84	142·07	107·23
6 years	1954	34·31	120·96	86·65
7 years	1955	43·42	138·26	94·84
8 years	1956	41·48	140·22	98·76
9 years	1957	34·44	135·40	100·96

Height—ft.

Treatment	Year	1954	1959	Increment
Control		17·9	44·2	26·3
6 years	1954	18·8	43·5	24·7
7 years	1955	21·1	47·8	26·7
8 years	1956	19·7	45·6	25·9
9 years	1957	18·1	43·2	25·1

MEAN ANNUAL INCREMENTS 1954-55 to 1959-1960

(a) *Mean Diameter*—inches.

Increment Period.

	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60
Treatments.						
Control	0·97	0·80	0·51	0·45	0·43	0·31
(1) 6 years ..	0·49	0·55	0·44	0·44	0·46	0·34
(2) 7 years ..	1·03	0·55	0·39	0·37	0·42	0·28
(3) 8 years ..	1·05	0·83	0·47	0·43	0·42	0·28
(4) 9 years ..	1·00	0·83	0·51	0·45	0·41	0·27

Increment 1956-57.

Analysis of Variance Table.

Source	Degrees of Freedom	Sum of Squares	Mean Square of Variance	F ratio
Blocks	4	·0303	·0076	
Treatments	4	·0520	·0130	5·2**
Error	16	·0397	·0025	
Total	24	·1220		

$n_1 = 4$; $n_2 = 16$. F table values at 5% = 3·01.
1% = 4·77.

Critical differences between means are 5% — ·57 inches.
1% — ·09 inches.

Thus when the following means are compared:—

Control compared to Treatment 1 .. .. Difference = ·07 *
Control compared to Treatment 2 .. .. Difference = ·12 **
Control compared to Treatment 3 .. .. Difference = ·04 n.s.
Control compared to Treatment 4 .. .. Difference = ·00 n.s.
Treatment 3 compared to Treatment 1 .. Difference = ·03 n.s.
Treatment 3 compared to Treatment 2 .. Difference = ·08 *

** significant at 0·01 level. * significant at 0·05 level. n.s. not significant.

Increment 1957-58.

Analysis of Variance Table.

Source	Degrees of Freedom	Sum of Squares	Mean Square of Variance	F ratio
Blocks	4	·0246	·0062	
Treatments	4	·0225	·0056	3·29*
Error	16	·0275	·0017	
Total	24	·0746		

$n_1 = 4$; $n_2 = 16$. F table values at 5% = 3·01.
1% = 4·77.

Critical differences between means are 5% — ·06.
1% — ·08.

Thus when the following means are compared :—

Control compared to Treatment 1 ..	.. Difference =	·01	n.s.
Control compared to Treatment 2 ..	.. Difference =	·08	**
Control compared to Treatment 3 ..	.. Difference =	·02	n.s.
Control compared to Treatment 4 ..	.. Difference =	·00	n.s.
Treatment 3 compared to Treatment 1	.. Difference =	·01	n.s.
Treatment 3 compared to Treatment 2	.. Difference =	·06	*

Increment 1958-59—An analysis of variance revealed no significant difference between treatment means.

(b) *Basal area increment*—square feet per acre.

Treatments.	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60
Control ..	26·9	28·0	20·9	20·2	20·2	16·5
(1) 6 years ..	13·5	16·0	14·5	16·4	18·9	14·6
(2) 7 years ..	26·6	17·0	14·5	14·6	17·5	13·5
(3) 8 years ..	25·8	26·5	17·7	17·9	18·7	13·3
(4) 9 years ..	24·6	25·6	18·8	18·5	17·7	13·3

Increment 1957–58.

Analysis of Variance Table.

Source	Degrees of Freedom	Sum of Squares	Mean Square of Variance	F ratio
Blocks	4	42·0424	10·5106	
Treatments	4	125·6411	31·4103	5·72**
Error	16	87·8229	5·4889	
Total	24	255·5064		

$n_1 = 4$; $n_2 = 16$. F table values at 5% = 3·01.
1% = 4·77.

Critical difference for p = 0·05 is 3·14 sq. ft.
= 0·01 is 4·33 sq. ft.

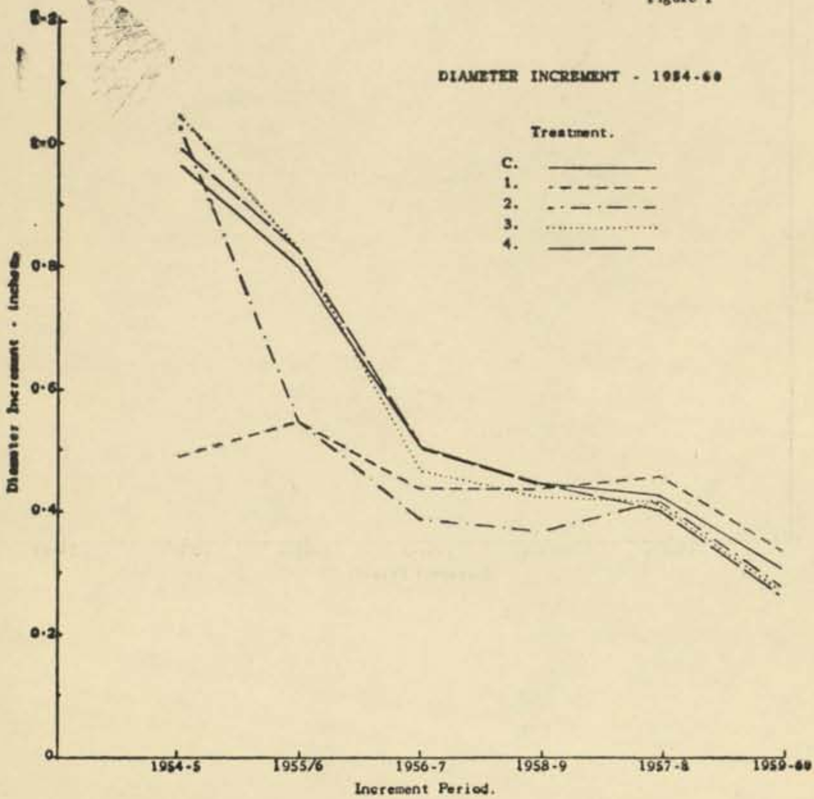
** significant at 0·01 level. * significant at 0·05 level. n.s. not significant.

Control compared to Treatment 1 ..	.. Difference = 3·84	*
Control compared to Treatment 2 ..	.. Difference = 5·58	**
Control compared to Treatment 3 ..	.. Difference = 2·34	n.s.
Control compared to Treatment 4 ..	.. Difference = 1·63	n.s.
Treatment 3 compared to Treatment 1	.. Difference = 1·50	n.s.
Treatment 3 compared to Treatment 2	.. Difference = 3·24	*

Increment 1958–59—An analysis of variance revealed no significant difference between treatment means.

Figure I. Shows the current annual diameter increment for each treatment for the growing periods 1954–55 to 1959–60. The severe depression of increment due to pruning at age six and seven years is evident. This depression is shown by this graph, to be effective for three growing seasons after pruning.

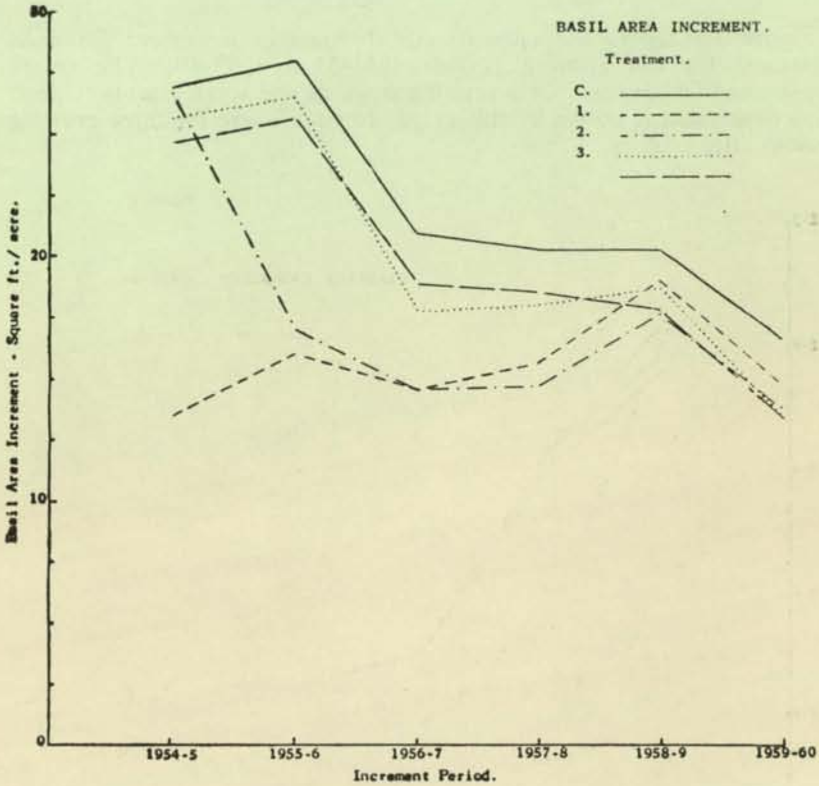
Figure I



** significant at 0·01 level. * significant at 0·05 level. n.s. not significant.

Figure II. Shows the current annual basal area increment for each treatment for the growing periods 1954–55 to 1959–60. The depression of increment due to early live pruning is shown to be effective for four growing seasons and three growing seasons after pruning for 6-year-old and 7-year-old pruning respectively.

Figure II



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