Heather McKenzie

FRI/INDUSTRY RESEARCH COOPERATIVES

MANAGEMENT OF EUCALYPTS COOPERATIVE

FOREST RESEARCH INSTITUTE
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E. REGNANS REGIME TRIAL

SUMMARY OF GROWTH FROM AGE 4-12

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Executive Summary

Growth rates of 11 treatments of a 12 year-old *E. regnans* regime trial are summarised. Height, basal area and volume growth are compared for each treatment graphically. Statistical tests are used to show which treatments are significantly different for basal area and volume growth as well as the growth of the largest 100 stems per hectare. Mortality in 2500 and 1111 s/ha unthinned treatments is shown. Volume growth is strongly related to the stocking retained for the treatments thinned to less than 1000 s/ha. The growth of the MTD trees appears to be affected by initial stocking rather than treatment at age 11. Current annual increment (CAI) and mean annual increment (MAI) have not yet peaked. The best mean annual increments in the high stocking plots is about 20 m^3/ha/year. Growth rates are better in an adjoining stand and better site preparation is suggested to be the reason.

1 INTRODUCTION

The *Eucalyptus regnans* regime trial which was established in 1978 has been described by Kampfraath (1987). The original regimes devised for each treatment covered sawlog, pulpwood and combined objectives. There was an underlying assumption that 100 s/ha was the best option as a final stocking for sawlog production in the design of the regimes (Revell 1981). The regimes were modified subsequently to give a wider range of final crop stockings. The seed origin is Franklin Tasmania. There was weed control but apart from cultivation by spade at each planting spot the site was not cultivated. The trial suffered form *Mycosphaerella* attack in the initial stages which appeared severe enough to affect growth rates.

2 TRIAL DESIGN

2.1 Trial Layout

There are three replicates of the trial. Within each replicate trees were planted in three 1 hectare blocks at the following spacings: 2 × 2 m (2500 s/ha), 3× 3 (1111 s/ha), and 4× 4 (625 s/ha). Each of the blocks was divided into quarters and had a different silvicultural regime applied. However the treatment that was to be thinned to 50 s/ha final crop had half a hectare allocated to give sufficient trees for measurement after that thinning. Measurement plots of 0.09 ha with a 10 m surround were established in each treatment (0.24 ha for the plot to be 50 s/ha). Table 1 shows the age and height of the plots when they were thinned.

2.2 Measurement

Each winter the diameter of every tree in the plots was measured. At age 4 years all heights were measured but a sample of 30 trees in the higher stockings were measured next year. The sample was reduced to 20 trees at age 9 and 12 trees at age 12. This has been necessary to reduce the measurement time when the trees are more than 20 metres tall. The height of the green crown was measured on height trees for possible use in growth modelling. Measurements required for the assessment of diameter over stubs were taken at the time of pruning which have been used to produce predictive equations (Deadman and Calderon 1988). Sectional measurements have also been taken at the time of thinning for use in volume functions.

Table 1: Schedule of Treatments in the E. Regnans Regime Trial

TREATMENT	INITIAL	STEMS PER HECTARE					
		AGE 4 PRUNE (MTH=9.3)	AGE 5 PRUNE (MTH=11.7)	AGE 5 THIN	AGE 8 PRUNE (MTH=17).	AGE 8 THIN	AGE 12 THIN (MTH=24.5)
1	2500						
2	2500			1500			700
3	2500			1200			400
4	1111						
5	2500	800	800	800	670	400	
6	1111	650	650	650	370	325	
7	1111	500	500	500	260	250	
8	1111	400	300	400	AS REQD	100	
9	625	270	270	275	AS REQD	200	
10	625	122	122	125	AS REQD		
11	625	200	200	200	AS REQD	100	50

Note: The shaded plots were pruned to 4 and 6 metres at ages 4 and 5 respectively. Some trees received less than a 6 metre lift because of their size so they were also pruned at age 8 to achieve a 6 m lift.

3 GROWTH DATA SUMMARY

The data for each of the treatments are summarised in Appendix 1. The relationship between the various variables is examined in more detail by showing the data graphically and by statistical analysis. Age 11 was selected for analysis as the trees had been growing undisturbed for 3 years. An analysis after the most recent thinning should be included in a future report.

3.1 Height

At age 7 years there was a significant difference between the three replicates for MTH ($p>0.0011$). The mean for each of the replicates was 16.5m, 15.2 and 15m. However at age 12 years there was much less difference ($P>0.0382$). The mean for each of the replicates was 25.3 m 24.7 m and 23.8 m. The greatest height difference between replicates remained the same (1.5 m between replicate 1 and 3). Thus because the trees are taller the difference is of less consequence. The height growth for the 11 treatments is shown in Figure 1. The analysis of variance showed that mean top height $_{100}$ (MTH) is not significantly different between treatments at the age tested (age 11 years).

3.2 Basal Area

Basal area growth for the eleven treatments is shown in Figure 2. Basal area growth was greatest in treatment 1 (unthinned 2500 s/ha planted). The difference between treatments at age 11 before the most recent thinning was examined. The Duncans multiple range test rankings are shown in Table 2.

Table 2: Basal Area at Age 11 for each Treatment

Duncan Grouping	Treatment	Mean Basal Area m^2/ha	Stocking s/ha
A	1	30.4	1970
B	3	25.4	1156
B	4	25.3	922
B	2	23.7	1448
C	6	14.1	314
C	5	13.5	411
C	9	12.0	203
C	7	11.9	256
D	11	8.1	100
D	10	7.3	114
D	8	5.9	100

Means with the same letter are not significantly different.

3.3 Volume

Volume growth for the eleven treatments is shown in Figure 3. The levelling in volume growth from age 11 to 11.8 years for treatments 2 and 3 is a result of the assessment at the time of thinning. Because the trees were thinned in February the diameters but not the heights were measured. The height curve derived for the following winters measurement was used to calculate volume at the time of the thinning. The differences between plots at age 11 is shown in Table 3.

Table 3: Volume at age 11 for each Treatment

Duncans Grouping		Treatment	Mean Volume m^3/ha	Stocking s/ha
	A	1	214.4	1970
	A	4	200.3	922
	A	3	197.3	1156
	B	2	168.5	1448
	C	6	115.6	314
	C	5	102.2	411
D	C	7	98.0	256
D	C	9	97.0	203
D	E	11	69.3	100
	E	10	60.2	114
	E	8	50.8	100

Means with the same letter are not significantly different.

There is one notable feature of volumes for each treatment. The unthinned treatments 1 and 4 are not significantly different from each other. This means that treatment 4 with half the stocking has the same volume. Treatment 3 which was thinned at age 5 to 1500 s/ha is not significantly different form these treatments. However treatment 2 thinned to 1500 s/ha at age 5 is significantly different from this group. There is no apparent reason for this.

The mean annual and current annual increments are shown in Figures 4 and 5. There is a fall off in CAI after a thinning operation except for treatment 11 thinned at age 11 presumably because the stocking was low (100s/ha). There are also fluctuations in CAI each year shown by the unthinned treatments. Presumably this is because some seasons are more favourable for growth than others. For example, in 1986 for example at age 8 treatments 1, 2, 3, 4 and 10 were not thinned but there was a general fall in CAI for all plots except plot 10.

CAI was still greater than MAI at age 12 for all treatments except for the thinned plots which have fallen as a consequence of the recent thinning. CAI for the unthinned treatments 1 and 4 at age 12 are 43 m^3/ha and 27 m^3/ha. The previous year the CAI was 29 and 32 respectively. Further years measurement will be required to determine when CAI falls.

3.4 Growth of top 100 stems per hectare

There has been an assumption that in order to grow sawlogs to 75 cm dbh 100 s/ha is the optimum stocking (Revell 1981). This is based on a dbh to crown diameter ratio of 1:15. Eucalypts are crown shy so that if the crowns are touching they are fully occupying the site. Hence 100 trees of 75 cm dbh with a crown radius of 11.2 m would fully occupy the site. In New Zealand mean top diameter (MTD) is routinely calculated for the calculation of mean top height (MTH). MTD is the mean diameter of the 100 largest diameter trees per hectare. Hence MTD can be used as an indicator of the performance of the final sawlog crop in the trial treatments. In Figure 6 the MTD is shown in relation to volume per hectare and in Figure 7 in relation to s/ha. The mean top diameter does not appear to be related to the stocking or volume in the plots. Closer examination of the figures shows that groups of means are not significantly different.

Table 4: Mean Top Diameter at age 12 for each Treatment

Duncan Grouping				Treatment	Mean MTD
		B		9	33.6
C		B		10	32.1
C		B	D	4	31.7
C		B	D	6	31.5
C	E	B	D	7	30.7
C	E		D	8	30.0
C	E	F	D	1	28.7
	E	F	D	3	28.3
	E	F		5	28.2
		F		2	26.1

Means with the same letter are not significantly different.

Treatment 11 is not included in the above table because it is now standing at 50 s/ha so that MTD is not relevant. However at age 11 Treatment 11 was not significantly different to Treatments 9, 4, 10 and 6.

The apparent lack of relationship between MTD and the treatments was further analysed. The two unthinned treatments were compared with the treatments that had been thinned. Unthinned treatment 1 was compared with thinned treatments 2, 3 and 5 (all initially 2500 s/ha). Similarly unthinned treatment 4 was compared with thinned treatments 6, 7 and 8 (all initially 1111 s/ha). The results are summarised in Table 5.

The treatments were also grouped by initial stocking for comparison of MTD. Treatments initially at 2500 s/ha were compared with those initially at 1111 s/ha and treatments initially at 1111 s/ha were compared with the those initially at 625 s/ha. Age 11 years was used so that the effect of the recent thinning was excluded. The results are also summarised in Table 5.

Table 5: Mean Top Diameter compared within same initial stocking and between initial stockings at age 11 years.

Treatment contrast	F value	Pr > F
1 vs 2	3.22	0.0877
1 vs 3	0.0	1.0000
1 vs 5	0.29	0.5944
4 vs 6	0.2	0.6627
4 vs 7	0.87	0.3611
4 vs 8	3.14	0.0918
2500 vs 1100 s/ha	14.63	0.0011
1100 vs 625 s/ha	8.85	0.0075

It is apparent that thinning the 2500 and 1111 s/ha treatments has had no effect on MTD. None of the contrasts is statistically significant. However MTD is affected by the initial stocking with the contrasts being significant at the 5% level.

3.5 Mortality

The mortality in the unthinned plots is shown in Figure 8.

3.6 Diameter distribution

The diameter distribution at age 11 years (before the latest thinning) is shown in Figures 9, 10, and 11. Those trees that contribute to the mean top diameter are shown. They have been identified on a plot basis so they are not the biggest trees in the combined diameter distribution. The frequency is on a plot basis, ie., trees in three 0.09 ha plots (three 0.24ha plots for treatment 11). The equivalent s/ha have been indicated.

4 GROWTH OF AN ADJACENT PLOT OF THE SAME AGE.

In the same compartment there is a stand of *E.regnans* that was planted at the same time as the regime trial. It was an FRI trial of planting equipment using FRI nursery stock. Three plots were established in 1986 when the stand was thinned from 1800 s/ha. The object was to test an option not included in the trial but which appeared to be a useful option for forest managers. This was to thin to 400 s/ha at age 8 and high prune in one lift and then to thin to 100 s/ha at age 12 years. The plots are not included in the above analysis because they are not part of the replicated trial and the establishment practice was different. The growth is summarised in table 6.

Table 6: Summary of growth in an adjacent stand (3 PSPs)

	Age (years)				
	8	9	10	11	12
Stocking (s/ha)	396	396	396	393	96
Stocking thinned (s/ha)	1407			296	
Basal Area (m^2/ha)	8.2	10.9	14.1	17.2	8.1
Volume (m^3/ha)	51	70	103	135	75
Volume thinned (m^3/ha)	82			99	
MTD (cm)	21.2	24.2	27.6	30.9	32.6
MTH (m)	17.1	18.4	20.7	22.2	24.4
MAI (m^3/ha)	16.7	17.0	18.5	19.9	21.5
CAI (m^3/ha)		19.2	43.2	33.7	33.5

The MAI is currently similar to the highest achieved in the trial; 20.9 compared with 21.4 in treatment 1. The actual treatment received until the latest thinning is in fact most similar to Treatment 5. The good growth in this thinned treatment may be attributable to a different seed source or it could be because the area was cultivated by v-blading.

5 EFFECT OF PRUNING ON GROWTH

The trial was designed to test regimes. An analysis included in Deadman and Calderon (1988) of stem volumes in the plots that were at the same stocking but had received different pruning treatments. For the plots planted at 1111 s/ha there were in effect 4 treatments; no pruning (treatment 4), 3 lift pruning of 650 (treatment 6) and 500 s/ha (treatment 7) and 2 lift pruning of 400 s/ha (treatment 8). One year after the first pruning lift the plots were thinned to the pruned stocking so that only the rate of growth between the first and second lifts can be compared. Total volumes were calculated for all pruned tree, and in the unpruned plots, for all trees that had heights recorded (30 per plot). An analysis of covariance with the covariate being volume at time of pruning, showed that the combined effect of the four treatments was not significant ($p > 0.0590$). A test of the 4 m treatment compared with the other treatments was however highly significant ($p > 0.0001$). The mean volume of the unpruned and 2.5m pruned trees one year later was 0.047 m^3/tree compared with 0.044 m^3/tree. This represents a 6% reduction in volume.

6 DISCUSSION

This report, covering the growth of the plots up to age 11, records the growth response of trees growing in the different treatments through the tending phase. Further measurements are required to determine when CAI and MAI peak for each treatment. Annual measurements are recommended to allow this to be accurately recorded.

Further analysis of the growth of components of each treatment would be of interest. If the mean top $diameter_{100}$ is not strongly related to treatment at this stage will it become so after a few more years growth? Is the mean top $diameter_{200}$ similarly unrelated to treatment at this time? If this is a feature of stands of *E. regnans* at present will it continue in genetically more uniform stands?

The volume production in the stand is less than that achieved on many other North Island sites. However the growth rates of the other *E. regnans* planting undertaken at the same time in the same compartment give an indication of the growth potential in the area. The cultivation was much better in the other area and given the acknowledged importance of cultivation it appears likely this is the reason for the poorer growth in the trial. The trial site had not been burnt so the amount of slash on the site prevented cultivated.

The trial data show that if a forest manager wishes to maximise volume a high stocking should be retained. There are limits to the volume gain with the maximum volume at age 11 being about 200 m^3/ha which can be achieved with 1000 or almost 2000 s/ha. There appears to be the possibility of production thinning to utilise some of the production on the site without much effect on growth rate of the larger trees in the stand.

Earlier thinning to sawlog-type stockings does not seem to increase the volume markedly at age 11. For example treatment 10 was thinned to 125 s/ha at age 5 whilst treatments 8 and 11 were thinned to 100 s/ha from 400 and 200 s/ha respectively at age 8. At age 11 the volume in these three plots was not significantly different. This suggests that a low cost option is to delay thinning which may lead to better quality sawlogs with smaller branches. Production thinning could be an option to improve yield. However production thinning has not in the past been a practical option for growers of sawlogs.

At this stage it is not possible to predict the growth rates following on from the latest thinning and any changes that will occur over the next decade in the rankings of volume production from the different treatments. Measurements over future years are required to determine the best option for sawlog production.

7 REFERENCES

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KAMPFRAATH B. M. P. 1987: Data from the Eucalyptus regnans regimes trial, Murupara 1982-1986. Management of Eucalypts Cooperative Report No. 2. Unpublished

REVELL, D.H. 1981: Silviculture of eucalytpts; New Zealand experience. Pp 116-22 *in* Proceedings of workshop "Wood: Future Growth and Conversion", 5-8 May 1981, Canberra, Australia

FIGURE 1: REGNANS REGIME TRIAL

HEIGHT GROWTH

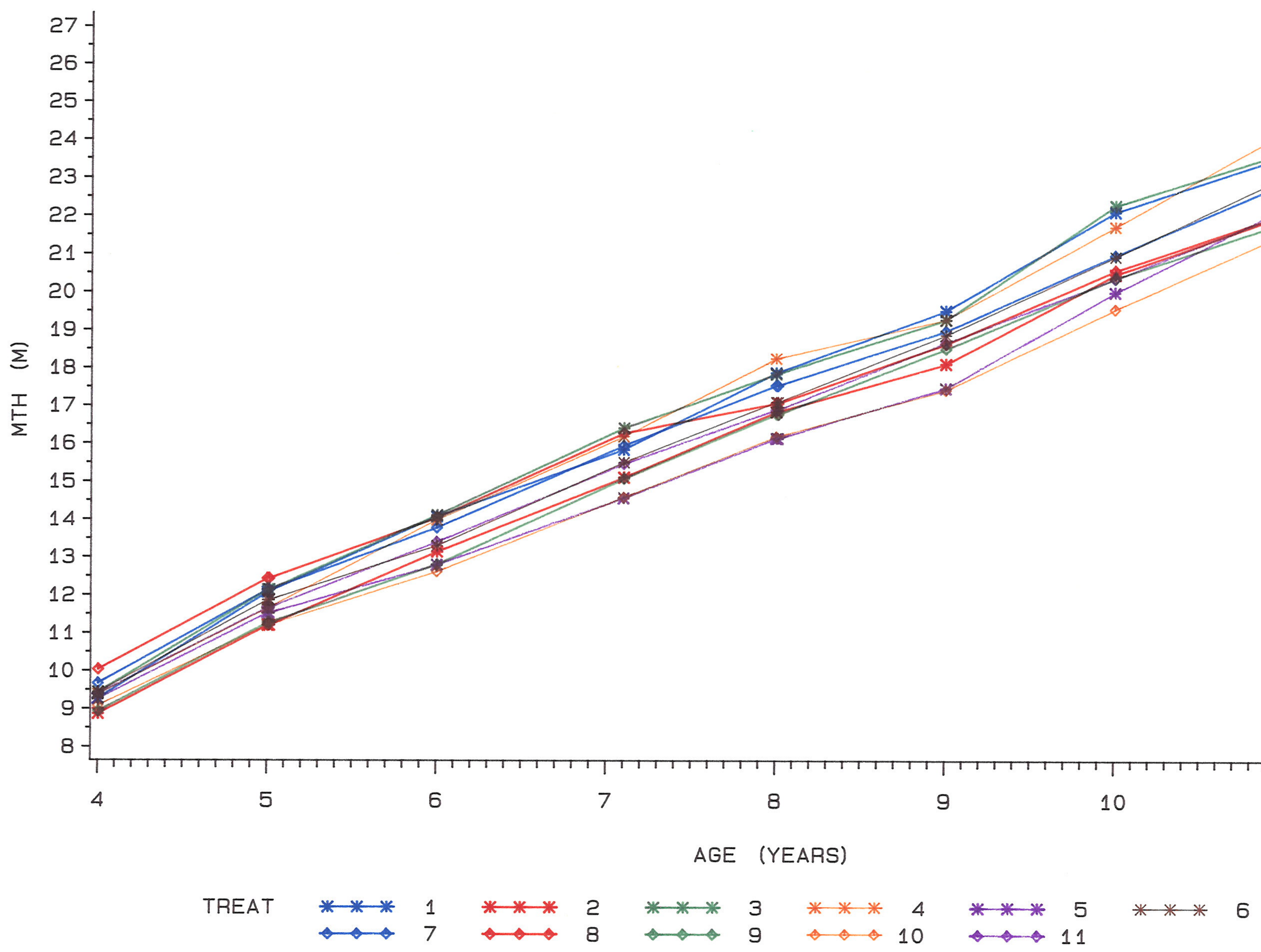


FIGURE 2: REGNANS REGIME TRIAL

BASAL AREA GROWTH

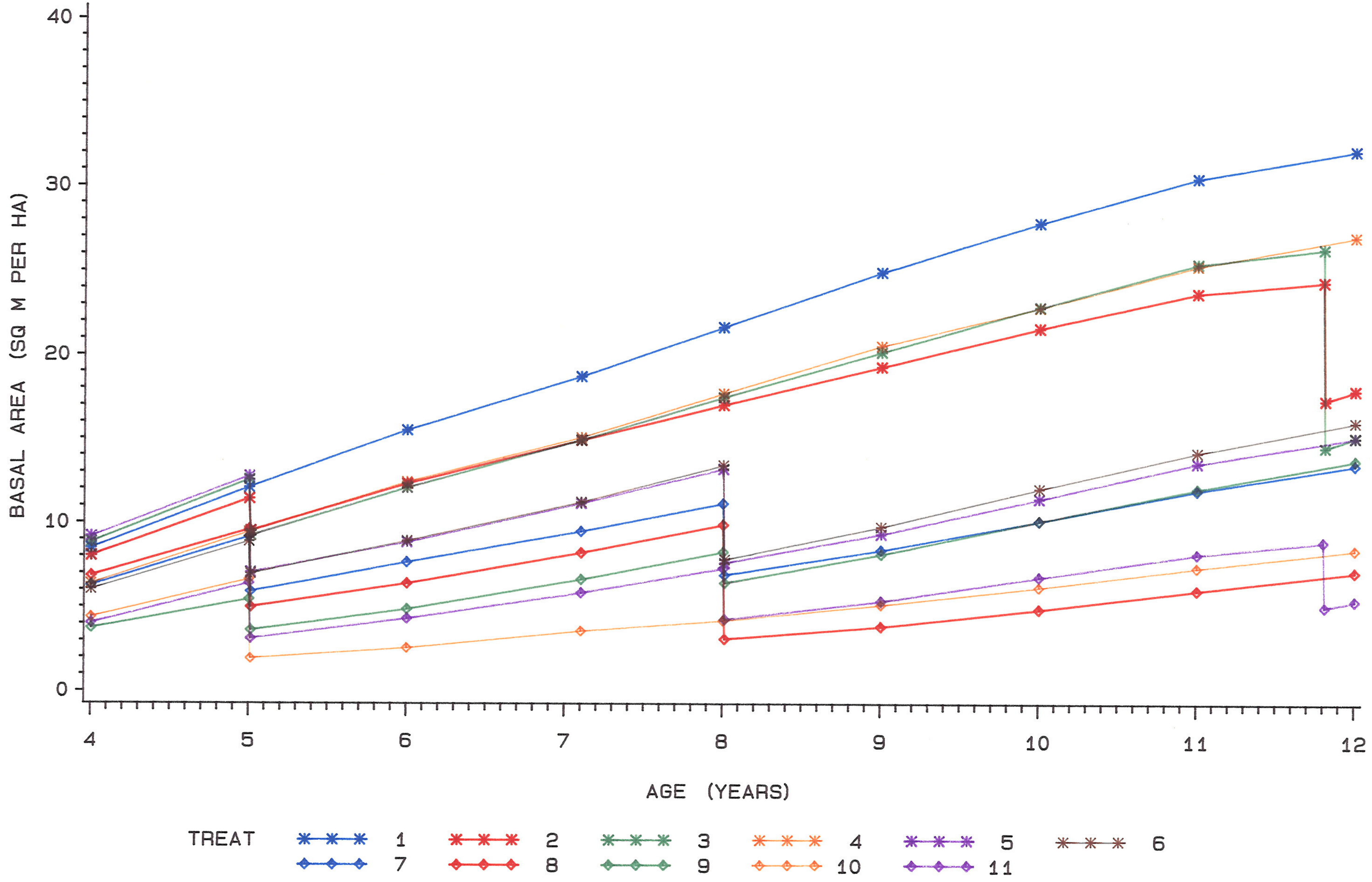


FIGURE 3: REGNANS REGIME TRIAL

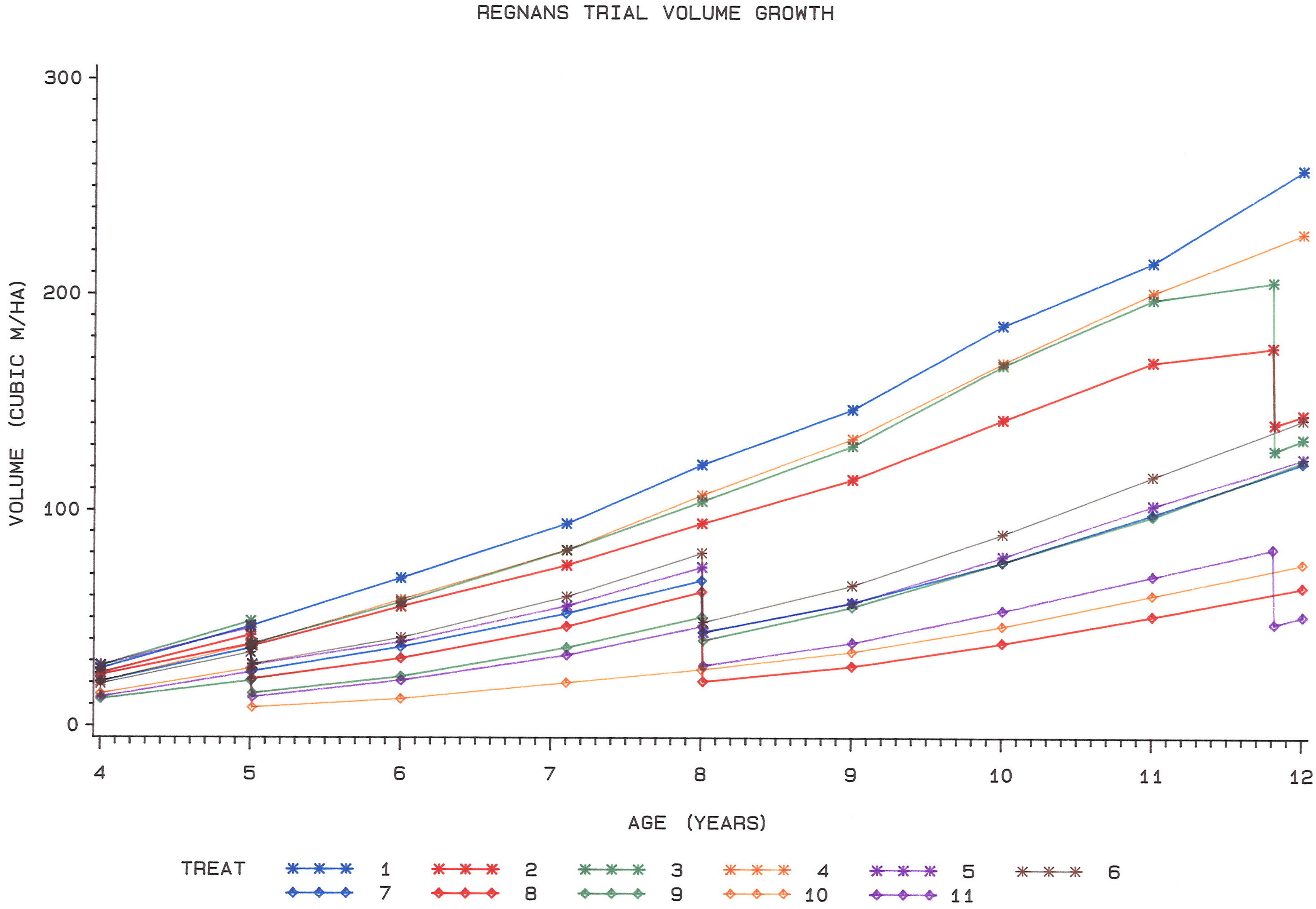


FIGURE 4: REGNANS REGIME TRIAL

MEAN ANNUAL VOLUME INCREMENT

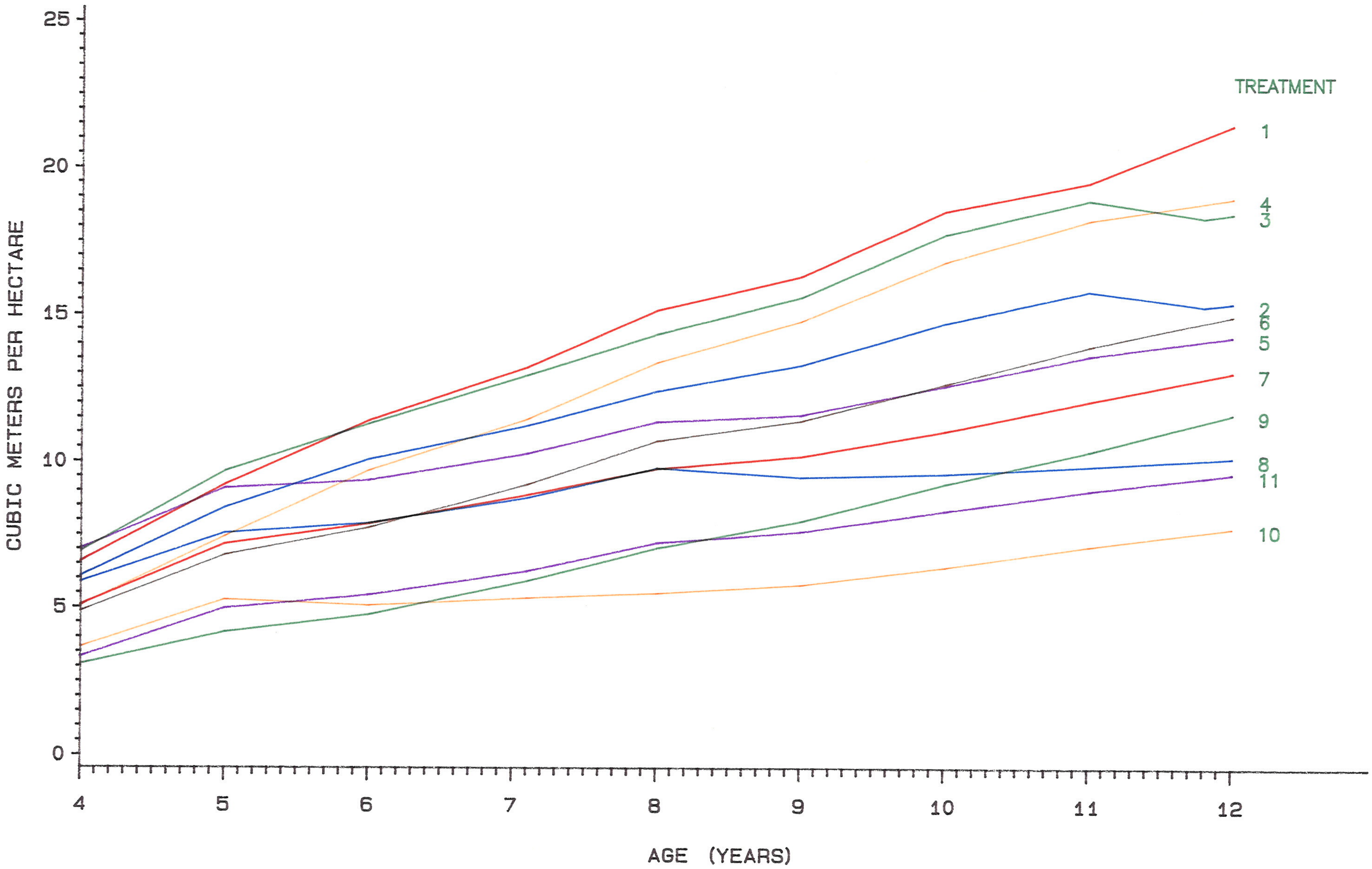


FIGURE 5: REGNANS REGIME TRIAL

CURRENT ANNUAL VOLUME INCREMENT

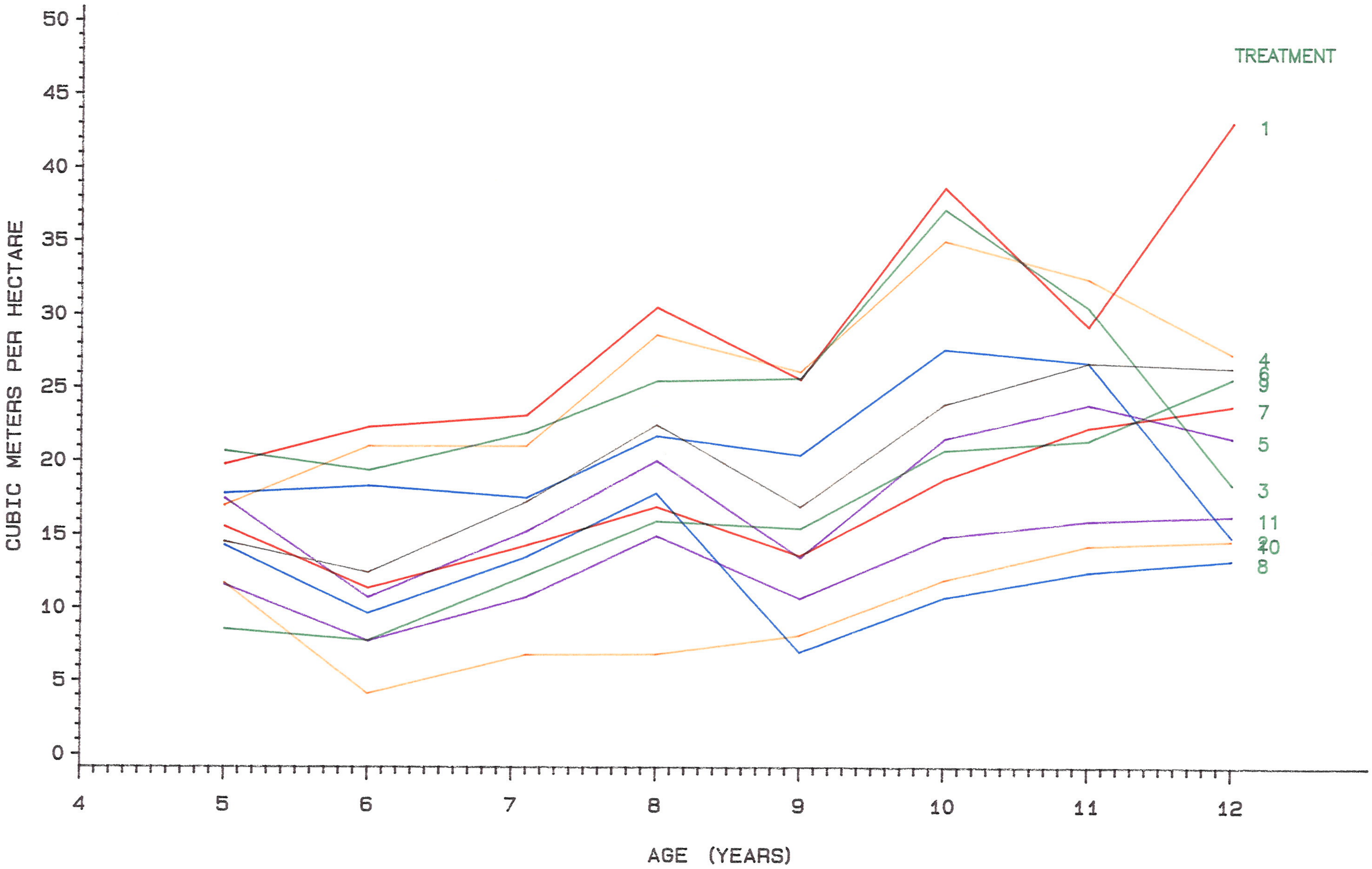


FIGURE 6: REGNANS REGIME TRIAL

MTD COMPARED WITH VOLUME

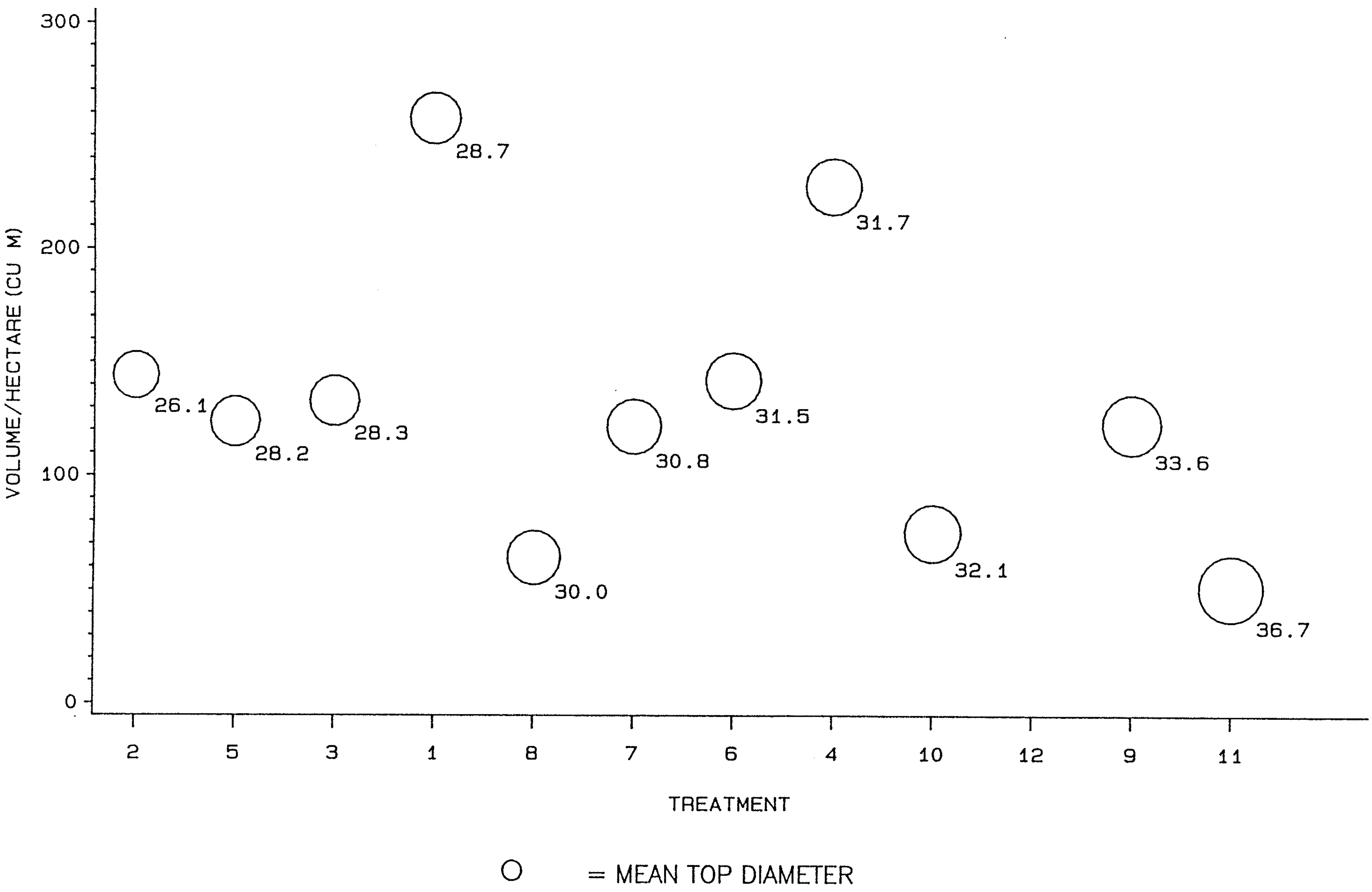
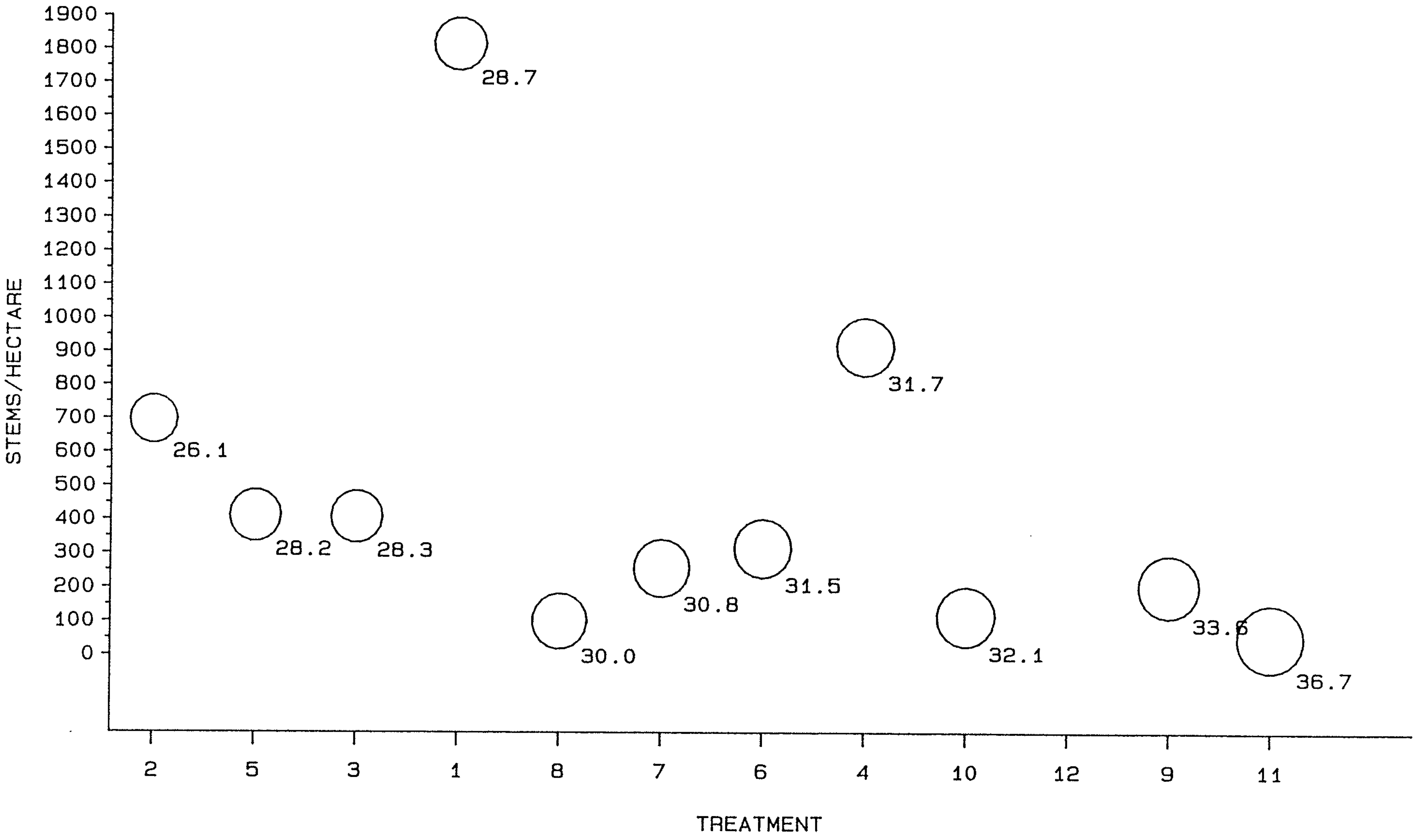


FIGURE 7: REGNANS REGIME TRIAL

MTD COMPARED WITH S/HA



○ = MEAN TOP DIAMETER

FIGURE 8: REGNANS REGIME TRIAL

MORTALITY (UNTHINNED PLOTS)

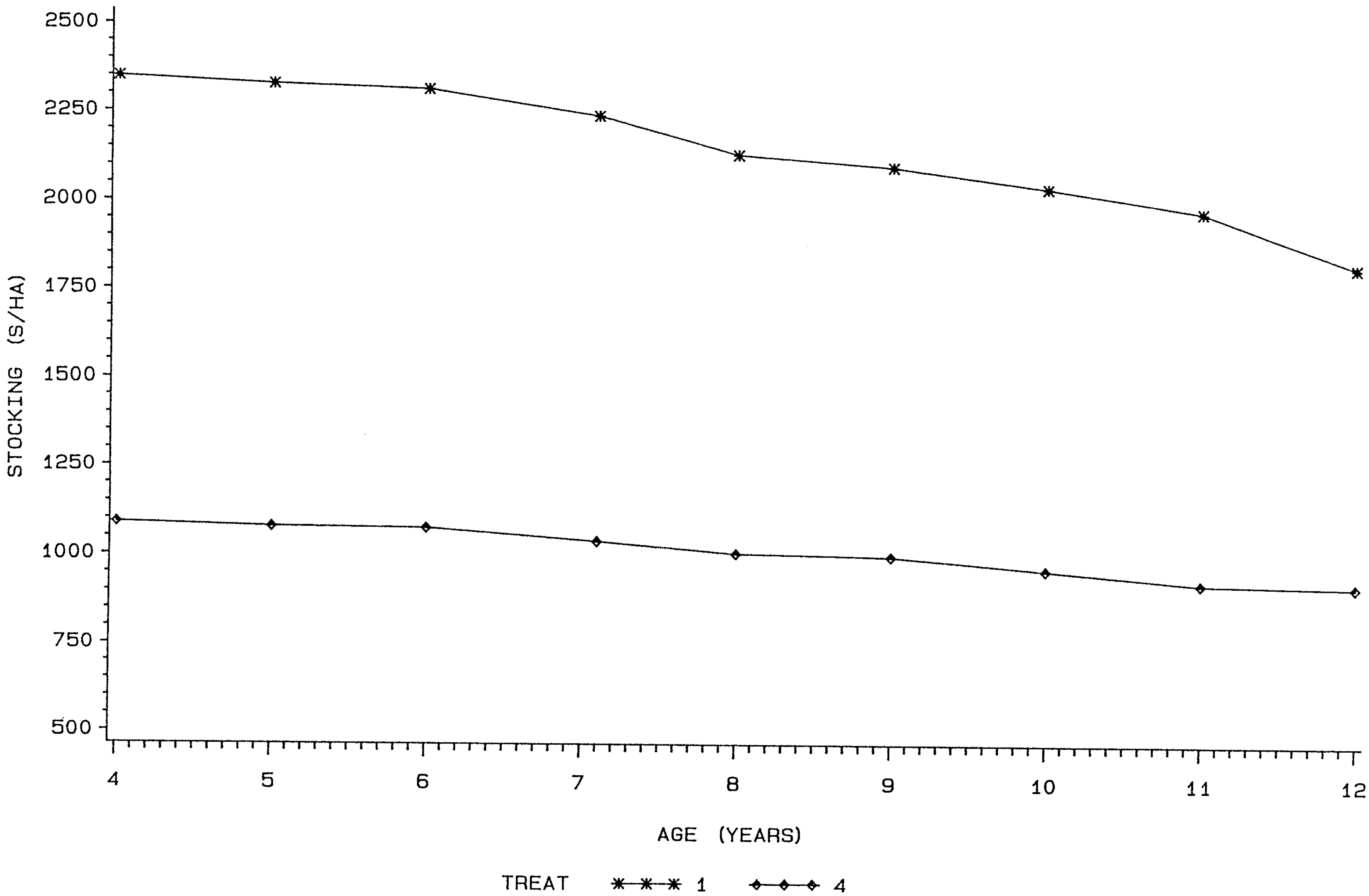
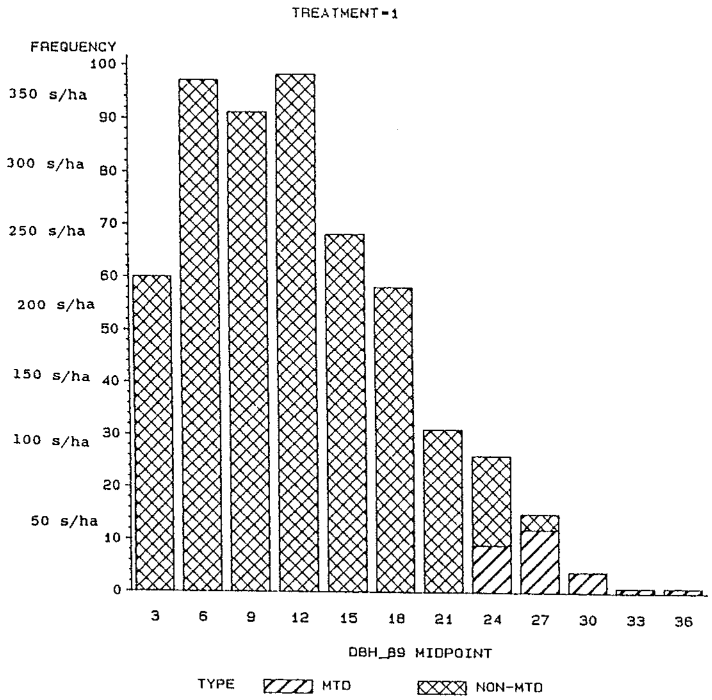
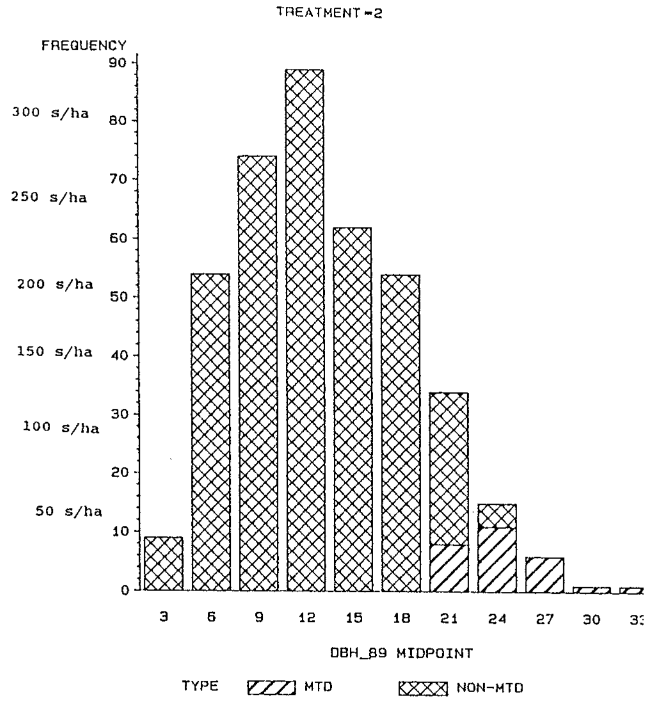
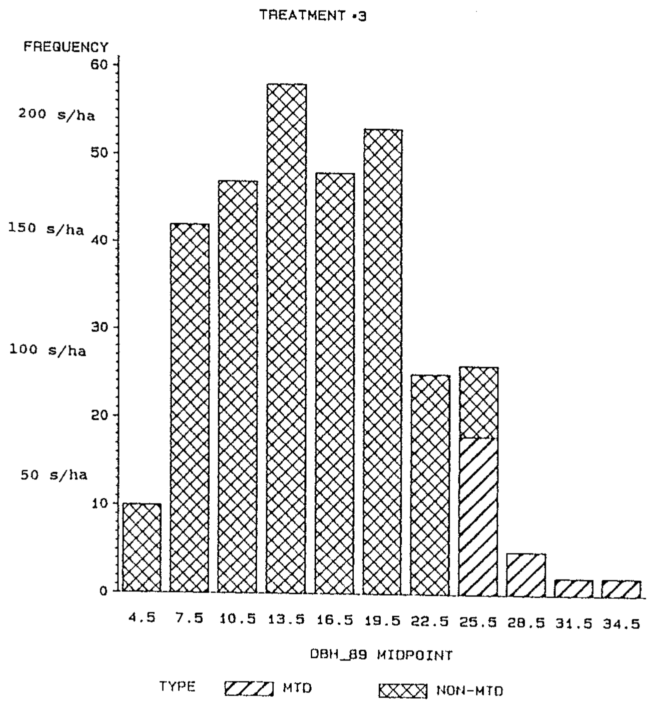


FIGURE 9: REGNANS REGIME TRIAL

DIAMETER DISTRIBUTION OF TREATMENTS PLANTED AT 2500 S/HA







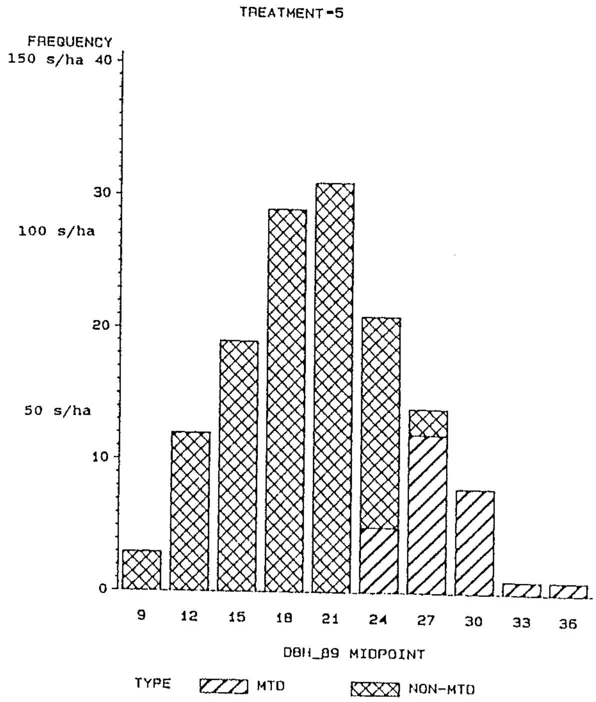
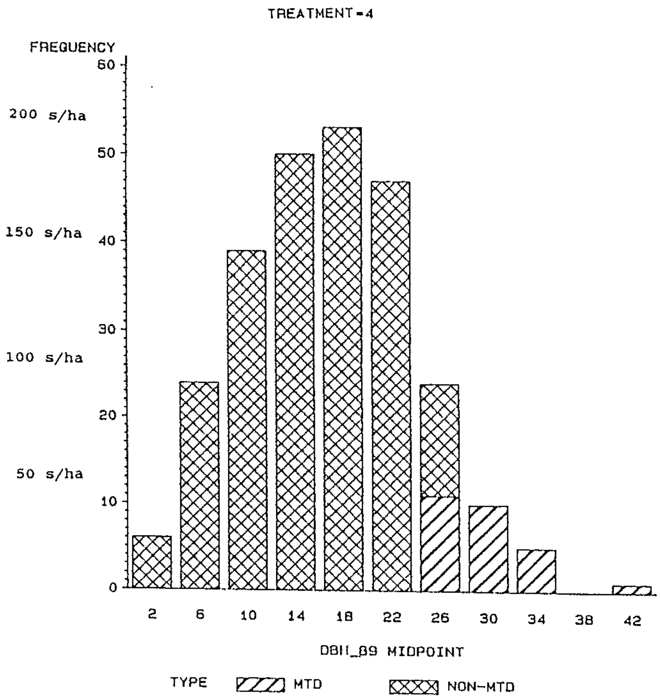
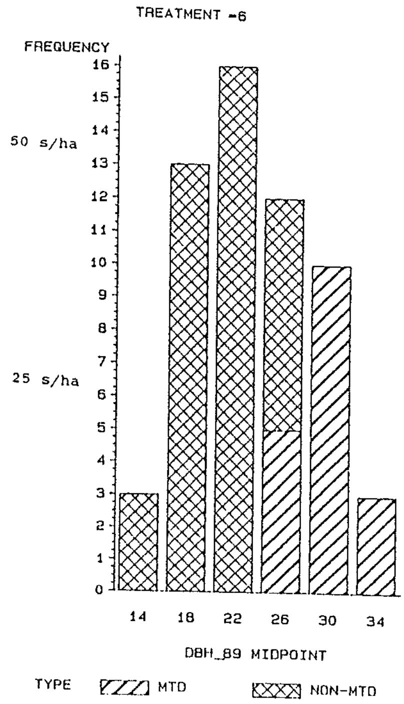
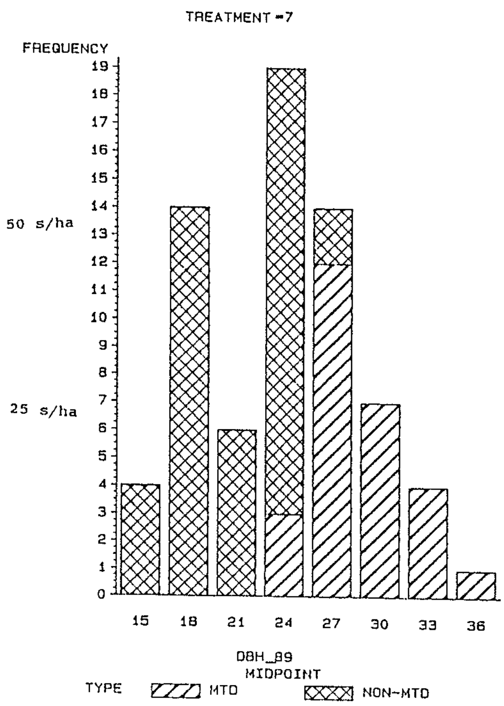


FIGURE 10: REGNANS REGIME TRIAL

DIAMETER DISTRIBUTION OF TREATMENTS PLANTED AT 1111 S/HA







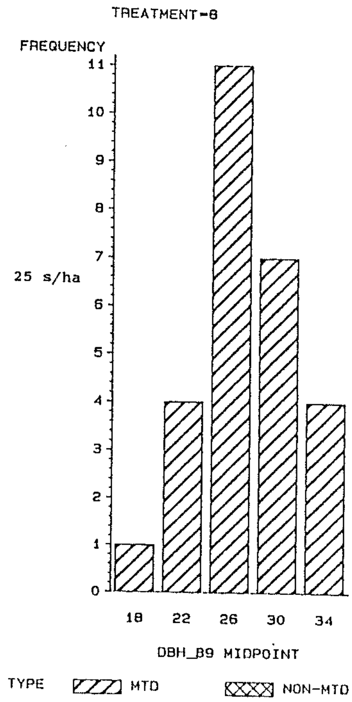
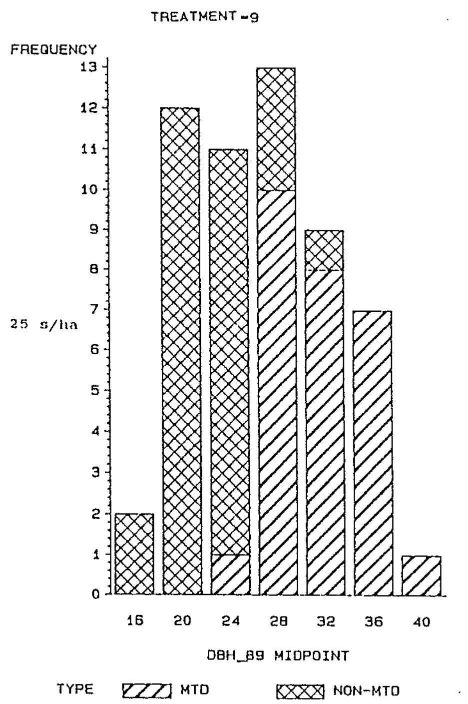
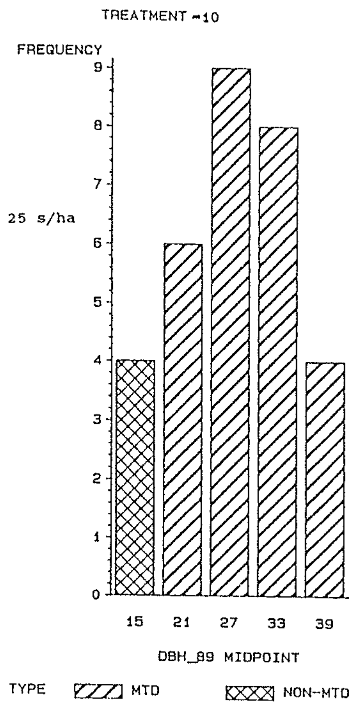
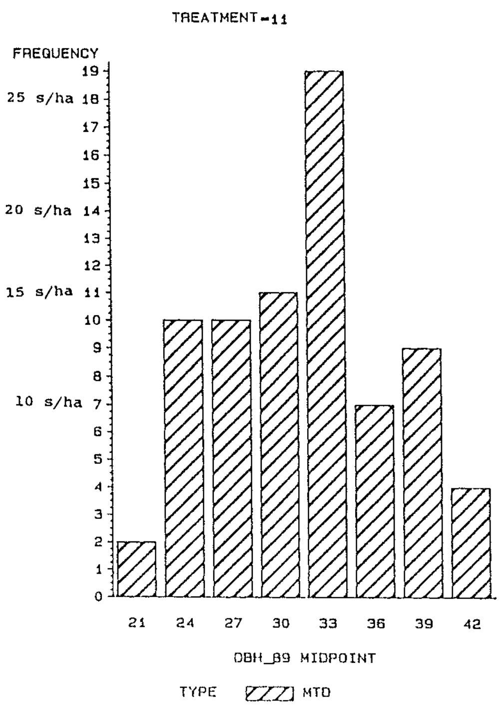


FIGURE 11: REGNANS REGIME TRIAL

DIAMETER DISTRIBUTION OF TREATMENTS PLANTED AT 625 S/HA







APPENDIX 1

TREATMENT	AGE (YEARS)	STOCKING (S/HA)	HEIGHT (MTH) (M)	BASAL AREA (M^2/HA)	VOLUME (M^3/HA)	MEAN TOP DIAMETER (M)	MEAN HEIGHT (M)	MEAN DIAMETER (CM)	DEAD (S/HA)	THINNED (S/HA)	THINNED BASAL AREA (M^2/HA)	THINNED VOLUME (M^3/HA)	MEAN ANNUAL INCREMENT (M^3/HA)	CURRENT ANNUAL INCREMENT (M^3/HA)
1	4	2348	9.3	8.5	26.3	12.9	7.1	6.6	0	0			6.6	.
1	5	2326	12.1	12.1	46.0	15.2	9.2	8.0	22	0			9.2	19.7
1	6	2311	14.1	15.5	68.3	17.3	10.8	9.2	15	0			11.4	22.3
1	7	2237	15.8	18.7	93.7	19.2	12.4	10.3	74	0			13.2	23.1
1	8	2130	17.9	21.6	121.1	21.0	13.8	11.4	108	0			15.1	30.5
1	9	2096	19.5	24.9	146.6	23.3	15.1	12.3	33	0			16.3	25.5
1	10	2037	22.1	27.8	185.3	25.3	16.7	13.2	59	0			18.5	38.6
1	11	1970	23.6	30.4	214.4	27.1	17.9	14.1	67	0			19.5	29.2
1	12	1815	25.7	32.1	257.5	28.7	19.8	15.1	156	0			21.5	43.1
2	4	2411	8.9	8.0	24.3	11.9	7.0	6.3	0	0			6.1	.
2	5	1530	11.2	9.5	36.9	14.0	9.5	8.8	11	870	1.9	5.2	8.4	17.8
2	6	1530	13.1	12.3	55.1	15.9	11.1	10.0	0	0			10.1	18.3
2	7	1515	15.1	14.9	74.3	17.7	12.5	11.1	15	0			11.2	17.5
2	8	1497	16.8	17.0	93.8	19.4	13.8	12.0	19	0			12.4	21.7
2	9	1497	18.1	19.3	114.2	21.1	14.8	12.8	0	0			13.3	20.4
2	10	1478	20.5	21.6	141.8	22.9	16.3	13.6	18	0			14.7	27.6
2	11	1448	22.0	23.7	168.5	24.7	17.5	14.4	30	0			15.8	26.7
2	11.8	696	23.8	17.3	139.7	25.4	20.6	17.8	30	722	7.1	32.3	15.3	.
2	12	696	23.9	17.9	144.0	26.1	20.5	18.1	0	0			15.4	14.8
3	4	2256	9.4	8.8	27.7	13.5	7.4	7.0	0	0			6.9	.
3	5	1204	12.1	9.2	37.8	15.7	10.3	9.8	11	1041	3.3	10.5	9.7	20.6
3	6	1204	14.1	12.0	57.1	17.8	11.9	11.3	0	0			11.3	19.3
3	7	1196	16.4	14.9	81.2	19.8	13.6	12.6	7	0			12.9	21.9
3	8	1196	17.8	17.4	104.1	21.6	14.9	13.6	0	0			14.3	25.4
3	9	1193	19.3	20.1	129.7	23.4	16.0	14.6	4	0			15.6	25.6
3	10	1178	22.3	22.8	166.9	25.3	18.1	15.7	15	0			17.7	37.2
3	11	1156	23.7	25.4	197.3	27.1	19.2	16.7	22	0			18.9	30.4
3	11.8	407	25.0	14.5	127.5	27.7	22.7	21.3	15	733	11.8	77.8	18.3	.
3	12	407	24.9	15.1	132.9	28.3	22.7	21.7	0	0			18.4	18.4

TREATMENT	AGE (YEARS)	STOCKING (S/HA)	HEIGHT (MTH) (M)	BASAL AREA (M^2/HA)	VOLUME (M^3/HA)	MEAN TOP DIAMETER (M)	MEAN HEIGHT (M)	MEAN DIAMETER (CM)	DEAD (S/HA)	THINNED (S/HA)	THINNED BASAL AREA (M^2/HA)	THINNED VOLUME (M^3/HA)	MEAN ANNUAL INCREMENT (M^3/HA)	CURRENT ANNUAL INCREMENT (M^3/HA)
4	4	1089	9.4	6.3	20.2	13.4	7.9	8.6	0	0			5.1	.
4	5	1078	11.6	9.4	37.2	16.0	9.9	10.5	11	0			7.4	17.0
4	6	1074	14.0	12.4	58.1	18.5	11.8	12.1	4	0			9.7	21.0
4	7	1037	16.2	15.0	81.2	20.8	13.6	13.6	37	0			11.4	21.0
4	8	1004	18.2	17.7	106.9	23.3	15.3	14.9	33	0			13.4	28.6
4	9	996	19.3	20.5	133.0	25.6	16.3	16.1	7	0			14.8	26.1
4	10	959	21.7	22.8	168.0	27.8	18.3	17.4	37	0			16.8	35.0
4	11	922	24.2	25.3	200.3	30.0	19.8	18.7	37	0			18.2	32.4
4	12	915	26.3	27.0	227.6	31.7	21.3	19.3	7	0			19.0	27.3
5	4	2374	9.3	9.1	28.0	13.1	7.5	7.0	0	0			7.0	.
5	5	804	11.5	7.0	28.1	14.7	10.3	10.5	0	1570	5.7	17.3	9.1	17.4
5	6	804	12.8	8.8	38.8	16.2	11.3	11.8	0	0			9.3	10.7
5	7	793	14.6	11.1	55.5	18.0	12.8	13.3	11	0			10.2	15.2
5	8	411	16.1	7.6	43.4	19.0	14.6	15.3	4	378	5.6	30.1	11.3	20.0
5	9	411	17.5	9.3	56.8	21.3	15.6	17.0	0	0			11.6	13.4
5	10	411	20.0	11.4	78.3	23.9	17.5	18.8	0	0			12.6	21.5
5	11	411	22.2	13.5	102.1	26.4	19.2	20.4	0	0			13.6	23.8
5	12	411	23.7	15.0	123.6	28.2	20.9	21.6	0	0			14.2	21.5
6	4	1059	9.4	6.0	19.4	13.6	7.9	8.5	0	0			4.9	.
6	5	640	11.9	7.0	28.4	16.0	10.3	11.7	4	415	1.9	5.5	6.8	14.5
6	6	640	13.3	8.9	40.8	17.9	11.5	13.3	0	0			7.7	12.4
6	7	640	15.5	11.2	59.8	19.9	13.4	14.9	0	0			9.2	17.2
6	8	315	17.1	7.8	48.1	21.2	15.7	17.8	7	318	5.6	31.9	10.7	22.5
6	9	315	18.9	9.8	65.0	23.9	17.1	19.9	0	0			11.4	16.9
6	10	315	20.9	12.0	88.9	26.8	19.1	22.0	0	0			12.6	23.9
6	11	315	23.0	14.2	115.6	29.4	21.0	23.9	0	0			13.9	26.7
6	12	315	24.9	16.0	141.9	31.5	22.8	25.4	0	0			14.9	26.3

TREATMENT	AGE (YEARS)	STOCKING (S/HA)	HEIGHT (MTH) (M)	BASAL AREA (M^2/HA)	VOLUME (M^3/HA)	MEAN TOP DIAMETER (M)	MEAN HEIGHT (M)	MEAN DIAMETER (CM)	DEAD (S/HA)	THINNED (S/HA)	THINNED BASAL AREA (M^2/HA)	THINNED VOLUME (M^3/HA)	MEAN ANNUAL INCREMENT (M^3/HA)	CURRENT ANNUAL INCREMENT (M^3/HA)
7	4	1059	9.7	6.3	20.3	13.6	8.0	8.6	0	0			5.1	.
7	5	493	12.1	5.9	25.0	16.0	10.9	12.3	0	567	3.2	10.8	7.2	15.5
7	6	493	13.8	7.6	36.4	18.2	12.2	14.0	0	0			7.9	11.3
7	7	489	15.9	9.5	52.0	20.4	14.0	15.7	4	0			8.9	14.2
7	8	256	17.5	6.9	43.4	21.8	16.1	18.5	0	233	4.2	23.8	9.8	16.9
7	9	256	19.0	8.4	57.0	23.9	17.5	20.4	0	0			10.2	13.6
7	10	256	21.0	10.1	75.7	26.3	19.3	22.4	0	0			11.0	18.8
7	11	256	22.9	11.9	98.0	28.7	21.2	24.3	0	0			12.1	22.3
7	12	256	25.2	13.4	121.7	30.8	23.3	25.8	0	0			13.0	23.7
8	4	1044	1	6.8	23.5	14.8	8.4	9.1	0	0			5.9	.
8	5	400	12.4	5.0	21.6	15.9	11.0	12.5	0	644	4.6	16.1	7.5	14.2
8	6	400	14.0	6.4	31.2	17.9	12.4	14.2	0	0			7.9	9.6
8	7	396	16.3	8.2	46.0	20.3	14.2	16.2	4	0			8.7	13.4
8	8	100	17.1	3.1	20.7	19.9	17.1	19.9	0	296	6.8	41.4	9.8	17.8
8	9	100	18.6	3.8	27.6	22.1	18.6	22.1	0	0			9.5	7.0
8	10	100	20.6	4.9	38.3	24.8	20.6	24.8	0	0			9.6	10.7
8	11	100	22.1	6.0	50.8	27.6	22.1	27.6	0	0			9.8	12.5
8	12	100	23.6	7.1	64.0	30.0	23.6	30.0	0	0			10.1	13.3
9	4	619	8.9	3.7	12.3	13.6	7.4	8.6	0	0			3.1	.
9	5	278	11.3	3.6	15.0	15.7	10.2	12.6	0	341	1.8	5.8	4.2	8.5
9	6	278	12.8	4.8	22.7	18.1	11.6	14.7	0	0			4.8	7.7
9	7	278	15.1	6.6	36.1	21.2	13.7	17.3	0	0			5.9	12.2
9	8	204	16.8	6.4	39.5	23.0	15.7	20.0	0	74	1.8	10.9	7.0	15.9
9	9	204	18.5	8.1	54.9	25.8	17.3	22.5	0	0			8.0	15.4
9	10	204	20.4	10.1	75.6	28.8	19.3	25.1	0	0			9.2	20.7
9	11	204	21.8	12.0	97.0	31.4	20.9	27.4	0	0			10.3	21.4
9	12	204	24.2	13.7	122.6	33.6	23.2	29.2	0	0			11.6	25.6

TREATMENT	AGE (YEARS)	STOCKING (S/HA)	HEIGHT (MTH) (M)	BASAL AREA (M^2/HA)	VOLUME (M^3/HA)	MEAN TOP DIAMETER (M)	MEAN HEIGHT (M)	MEAN DIAMETER (CM)	DEAD (S/HA)	THINNED (S/HA)	THINNED BASAL AREA (M^2/HA)	THINNED VOLUME (M^3/HA)	MEAN ANNUAL INCREMENT (M^3/HA)	CURRENT ANNUAL INCREMENT (M^3/HA)
10	4	618	9.1	4.4	14.6	13.7	7.8	9.1	0	0			3.7	.
10	5	122	11.2	1.9	8.3	14.6	10.9	13.9	7	489	4.7	18.0	5.3	11.7
10	6	118	12.6	2.5	12.4	17.1	12.2	16.4	4	0			5.1	4.1
10	7	118	14.6	3.5	19.8	20.3	14.1	19.4	0	0			5.3	6.8
10	8	115	16.2	4.2	26.0	22.3	15.7	21.5	4	0			5.5	6.8
10	9	115	17.4	5.1	34.1	24.8	16.9	23.8	0	0			5.8	8.1
10	10	115	19.5	6.1	46.0	27.4	19.1	26.1	0	0			6.4	11.9
10	11	115	21.5	7.3	60.2	29.9	21.0	28.5	0	0			7.1	14.2
10	12	115	23.4	8.4	74.8	32.1	22.9	30.5	0	0			7.7	14.6
11	4	607	9.4	4.0	13.3	13.8	7.9	9.0	0	0			3.3	.
11	5	201	11.7	3.1	13.3	16.0	11.0	13.8	0	406	3.3	11.5	5.0	11.5
11	6	201	13.4	4.3	21.0	18.7	12.5	16.3	0	0			5.4	7.7
11	7	201	15.5	5.8	32.8	21.8	14.4	19.1	0	0			6.2	10.7
11	8	100	16.9	4.2	27.9	23.1	16.9	23.1	0	101	3.0	34.5	7.2	14.9
11	9	100	18.7	5.3	38.6	25.9	18.7	25.9	0	0			7.6	10.6
11	10	100	20.4	6.8	53.4	29.3	20.4	29.2	0	0			8.3	14.8
11	11	100	22.1	8.1	69.3	32.0	22.1	32.0	0				9.0	15.9
11	11.8	50	24.7	5.0	47.4	35.5	24.7	35.5	0	50	3.9	34.5	9.5	
11	12	50	24.7	5.3	50.7	36.7	24.7	36.7	0	0			9.6	16.3

APPENDIX 1

TREATMENT	AGE (YEARS)	STOCKING (S/HA)	HEIGHT (MTH) (M)	BASAL AREA (M^2/HA)	VOLUME (M^3/HA)	MEAN TOP DIAMETER (M)	MEAN HEIGHT (M)	MEAN DIAMETER (CM)	DEAD (S/HA)	THINNED (S/HA)	THINNED BASAL AREA (M^2/HA)	THINNED VOLUME (M^3/HA)	MEAN ANNUAL INCREMENT (M^3/HA)	CURRENT ANNUAL INCREMENT (M^3/HA)
1	4	2348	9.3	8.5	26.3	12.9	7.1	6.6	0	0			6.6	.
1	5	2326	12.1	12.1	46.0	15.2	9.2	8.0	22	0			9.2	19.7
1	6	2311	14.1	15.5	68.3	17.3	10.8	9.2	15	0			11.4	22.3
1	7	2237	15.8	18.7	93.7	19.2	12.4	10.3	74	0			13.2	23.1
1	8	2130	17.9	21.6	121.1	21.0	13.8	11.4	108	0			15.1	30.5
1	9	2096	19.5	24.9	146.6	23.3	15.1	12.3	33	0			16.3	25.5
1	10	2037	22.1	27.8	185.3	25.3	16.7	13.2	59	0			18.5	38.6
1	11	1970	23.6	30.4	214.4	27.1	17.9	14.1	67	0			19.5	29.2
1	12	1815	25.7	32.1	257.5	28.7	19.8	15.1	156	0			21.5	43.1
2	4	2411	8.9	8.0	24.3	11.9	7.0	6.3	0	0			6.1	.
2	5	1530	11.2	9.5	36.9	14.0	9.5	8.8	11	870	1.9	5.2	8.4	17.8
2	6	1530	13.1	12.3	55.1	15.9	11.1	10.0	0	0			10.1	18.3
2	7	1515	15.1	14.9	74.3	17.7	12.5	11.1	15	0			11.2	17.5
2	8	1497	16.8	17.0	93.8	19.4	13.8	12.0	19	0			12.4	21.7
2	9	1497	18.1	19.3	114.2	21.1	14.8	12.8	0	0			13.3	20.4
2	10	1478	20.5	21.6	141.8	22.9	16.3	13.6	18	0			14.7	27.6
2	11	1448	22.0	23.7	168.5	24.7	17.5	14.4	30	0			15.8	26.7
2	11.8	696	23.8	17.3	139.7	25.4	20.6	17.8	30	722	7.1	32.3	15.3	.
2	12	696	23.9	17.9	144.0	26.1	20.5	18.1	0	0			15.4	14.8
3	4	2256	9.4	8.8	27.7	13.5	7.4	7.0	0	0			6.9	.
3	5	1204	12.1	9.2	37.8	15.7	10.3	9.8	11	1041	3.3	10.5	9.7	20.6
3	6	1204	14.1	12.0	57.1	17.8	11.9	11.3	0	0			11.3	19.3
3	7	1196	16.4	14.9	81.2	19.8	13.6	12.6	7	0			12.9	21.9
3	8	1196	17.8	17.4	104.1	21.6	14.9	13.6	0	0			14.3	25.4
3	9	1193	19.3	20.1	129.7	23.4	16.0	14.6	4	0			15.6	25.6
3	10	1178	22.3	22.8	166.9	25.3	18.1	15.7	15	0			17.7	37.2
3	11	1156	23.7	25.4	197.3	27.1	19.2	16.7	22	0			18.9	30.4
3	11.8	407	25.0	14.5	127.5	27.7	22.7	21.3	15	733	11.8	77.8	18.3	.
3	12	407	24.9	15.1	132.9	28.3	22.7	21.7	0	0			18.4	18.4

TREATMENT	AGE (YEARS)	STOCKING (S/HA)	HEIGHT (MTH) (M)	BASAL AREA (M^2/HA)	VOLUME (M^3/HA)	MEAN TOP DIAMETER (M)	MEAN HEIGHT (M)	MEAN DIAMETER (CM)	DEAD (S/HA)	THINNED (S/HA)	THINNED BASAL AREA (M^2/HA)	THINNED VOLUME (M^3/HA)	MEAN ANNUAL INCREMENT (M^3/HA)	CURRENT ANNUAL INCREMENT (M^3/HA)
4	4	1089	9.4	6.3	20.2	13.4	7.9	8.6	0	0			5.1	.
4	5	1078	11.6	9.4	37.2	16.0	9.9	10.5	11	0			7.4	17.0
4	6	1074	14.0	12.4	58.1	18.5	11.8	12.1	4	0			9.7	21.0
4	7	1037	16.2	15.0	81.2	20.8	13.6	13.6	37	0			11.4	21.0
4	8	1004	18.2	17.7	106.9	23.3	15.3	14.9	33	0			13.4	28.6
4	9	996	19.3	20.5	133.0	25.6	16.3	16.1	7	0			14.8	26.1
4	10	959	21.7	22.8	168.0	27.8	18.3	17.4	37	0			16.8	35.0
4	11	922	24.2	25.3	200.3	30.0	19.8	18.7	37	0			18.2	32.4
4	12	915	26.3	27.0	227.6	31.7	21.3	19.3	7	0			19.0	27.3
5	4	2374	9.3	9.1	28.0	13.1	7.5	7.0	0	0			7.0	.
5	5	804	11.5	7.0	28.1	14.7	10.3	10.5	0	1570	5.7	17.3	9.1	17.4
5	6	804	12.8	8.8	38.8	16.2	11.3	11.8	0	0			9.3	10.7
5	7	793	14.6	11.1	55.5	18.0	12.8	13.3	11	0			10.2	15.2
5	8	411	16.1	7.6	43.4	19.0	14.6	15.3	4	378	5.6	30.1	11.3	20.0
5	9	411	17.5	9.3	56.8	21.3	15.6	17.0	0	0			11.6	13.4
5	10	411	20.0	11.4	78.3	23.9	17.5	18.8	0	0			12.6	21.5
5	11	411	22.2	13.5	102.1	26.4	19.2	20.4	0	0			13.6	23.8
5	12	411	23.7	15.0	123.6	28.2	20.9	21.6	0	0			14.2	21.5
6	4	1059	9.4	6.0	19.4	13.6	7.9	8.5	0	0			4.9	.
6	5	640	11.9	7.0	28.4	16.0	10.3	11.7	4	415	1.9	5.5	6.8	14.5
6	6	640	13.3	8.9	40.8	17.9	11.5	13.3	0	0			7.7	12.4
6	7	640	15.5	11.2	59.8	19.9	13.4	14.9	0	0			9.2	17.2
6	8	315	17.1	7.8	48.1	21.2	15.7	17.8	7	318	5.6	31.9	10.7	22.5
6	9	315	18.9	9.8	65.0	23.9	17.1	19.9	0	0			11.4	16.9
6	10	315	20.9	12.0	88.9	26.8	19.1	22.0	0	0			12.6	23.9
6	11	315	23.0	14.2	115.6	29.4	21.0	23.9	0	0			13.9	26.7
6	12	315	24.9	16.0	141.9	31.5	22.8	25.4	0	0			14.9	26.3

TREATMENT	AGE (YEARS)	STOCKING (S/HA)	HEIGHT (MTH) (M)	BASAL AREA (M^2/HA)	VOLUME (M^3/HA)	MEAN TOP DIAMETER (M)	MEAN HEIGHT (M)	MEAN DIAMETER (CM)	DEAD (S/HA)	THINNED (S/HA)	THINNED BASAL AREA (M^2/HA)	THINNED VOLUME (M^3/HA)	MEAN ANNUAL INCREMENT (M^3/HA)	CURRENT ANNUAL INCREMENT (M^3/HA)
7	4	1059	9.7	6.3	20.3	13.6	8.0	8.6	0	0			5.1	.
7	5	493	12.1	5.9	25.0	16.0	10.9	12.3	0	567	3.2	10.8	7.2	15.5
7	6	493	13.8	7.6	36.4	18.2	12.2	14.0	0	0			7.9	11.3
7	7	489	15.9	9.5	52.0	20.4	14.0	15.7	4	0			8.9	14.2
7	8	256	17.5	6.9	43.4	21.8	16.1	18.5	0	233	4.2	23.8	9.8	16.9
7	9	256	19.0	8.4	57.0	23.9	17.5	20.4	0	0			10.2	13.6
7	10	256	21.0	10.1	75.7	26.3	19.3	22.4	0	0			11.0	18.8
7	11	256	22.9	11.9	98.0	28.7	21.2	24.3	0	0			12.1	22.3
7	12	256	25.2	13.4	121.7	30.8	23.3	25.8	0	0			13.0	23.7
8	4	1044	1	6.8	23.5	14.8	8.4	9.1	0	0			5.9	.
8	5	400	12.4	5.0	21.6	15.9	11.0	12.5	0	644	4.6	16.1	7.5	14.2
8	6	400	14.0	6.4	31.2	17.9	12.4	14.2	0	0			7.9	9.6
8	7	396	16.3	8.2	46.0	20.3	14.2	16.2	4	0			8.7	13.4
8	8	100	17.1	3.1	20.7	19.9	17.1	19.9	0	296	6.8	41.4	9.8	17.8
8	9	100	18.6	3.8	27.6	22.1	18.6	22.1	0	0			9.5	7.0
8	10	100	20.6	4.9	38.3	24.8	20.6	24.8	0	0			9.6	10.7
8	11	100	22.1	6.0	50.8	27.6	22.1	27.6	0	0			9.8	12.5
8	12	100	23.6	7.1	64.0	30.0	23.6	30.0	0	0			10.1	13.3
9	4	619	8.9	3.7	12.3	13.6	7.4	8.6	0	0			3.1	.
9	5	278	11.3	3.6	15.0	15.7	10.2	12.6	0	341	1.8	5.8	4.2	8.5
9	6	278	12.8	4.8	22.7	18.1	11.6	14.7	0	0			4.8	7.7
9	7	278	15.1	6.6	36.1	21.2	13.7	17.3	0	0			5.9	12.2
9	8	204	16.8	6.4	39.5	23.0	15.7	20.0	0	74	1.8	10.9	7.0	15.9
9	9	204	18.5	8.1	54.9	25.8	17.3	22.5	0	0			8.0	15.4
9	10	204	20.4	10.1	75.6	28.8	19.3	25.1	0	0			9.2	20.7
9	11	204	21.8	12.0	97.0	31.4	20.9	27.4	0	0			10.3	21.4
9	12	204	24.2	13.7	122.6	33.6	23.2	29.2	0	0			11.6	25.6

TREATMENT	AGE (YEARS)	STOCKING (S/HA)	HEIGHT (MTH) (M)	BASAL AREA (M^2/HA)	VOLUME (M^3/HA)	MEAN TOP DIAMETER (M)	MEAN HEIGHT (M)	MEAN DIAMETER (CM)	DEAD (S/HA)	THINNED (S/HA)	THINNED BASAL AREA (M^2/HA)	THINNED VOLUME (M^3/HA)	MEAN ANNUAL INCREMENT (M^3/HA)	CURRENT ANNUAL INCREMENT (M^3/HA)
10	4	618	9.1	4.4	14.6	13.7	7.8	9.1	0	0			3.7	.
10	5	122	11.2	1.9	8.3	14.6	10.9	13.9	7	489	4.7	18.0	5.3	11.7
10	6	118	12.6	2.5	12.4	17.1	12.2	16.4	4	0			5.1	4.1
10	7	118	14.6	3.5	19.8	20.3	14.1	19.4	0	0			5.3	6.8
10	8	115	16.2	4.2	26.0	22.3	15.7	21.5	4	0			5.5	6.8
10	9	115	17.4	5.1	34.1	24.8	16.9	23.8	0	0			5.8	8.1
10	10	115	19.5	6.1	46.0	27.4	19.1	26.1	0	0			6.4	11.9
10	11	115	21.5	7.3	60.2	29.9	21.0	28.5	0	0			7.1	14.2
10	12	115	23.4	8.4	74.8	32.1	22.9	30.5	0	0			7.7	14.6
11	4	607	9.4	4.0	13.3	13.8	7.9	9.0	0	0			3.3	.
11	5	201	11.7	3.1	13.3	16.0	11.0	13.8	0	406	3.3	11.5	5.0	11.5
11	6	201	13.4	4.3	21.0	18.7	12.5	16.3	0	0			5.4	7.7
11	7	201	15.5	5.8	32.8	21.8	14.4	19.1	0	0			6.2	10.7
11	8	100	16.9	4.2	27.9	23.1	16.9	23.1	0	101	3.0	34.5	7.2	14.9
11	9	100	18.7	5.3	38.6	25.9	18.7	25.9	0	0			7.6	10.6
11	10	100	20.4	6.8	53.4	29.3	20.4	29.2	0	0			8.3	14.8
11	11	100	22.1	8.1	69.3	32.0	22.1	32.0	0				9.0	15.9
11	11.8	50	24.7	5.0	47.4	35.5	24.7	35.5	0	50	3.9	34.5	9.5	
11	12	50	24.7	5.3	50.7	36.7	24.7	36.7	0	0			9.6	16.3