FOREST RESEARCH INSTITUTE

RESULTS OF A SEEDLING TRIAL IN WHAKAWERAWERA FOREST
- NURSERY FERTILISER
- HANDLING PRACTISE
- FIELD FERTILISER

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RESULTS OF A SEEDLING TRIAL AT AGE 2.

WHAKAREWAREWA FOREST, ROTORUA.

A Report Prepared for the National Fertiliser Co-operative

Report 2

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MANAGEMENT SUMMARY

Seedlings were grown in the nursery with two fertiliser regimes, high and low. At lifting the well nourished seedlings were 50 % heavier. There were two lifting, handling and planting regimes, a very careful one using all the Trewin techniques and a "bad" one which was actually fairly close to average management handling and planting. Then in the field some seedlings were slit fertilised. The main implications of the study for managers are as follows:-

1. Bare-root transplanting is a shock from which all seedlings take time to recover but well nourished, well handled and fertilised seedlings recover sooner and make more growth in the first year.

2. Nursery nutrition regime had no effect on growth after transplanting but low nutrition, badly handled seedlings had a poor initial survival.

3. Fertilising in the field overcame poor survival problems and produced much improved growth. This finding is very important for FOREST managers who do not control the condition of their nursery stock. They may be able to recover from poor transplant condition by fertilising after planting.

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RO2016 SEEDLING TRIAL - WHAKAREWAREWA FOREST, ROTORUA, N.Z.

INTRODUCTION

There has over the years, been much increased attention paid to the treatment of radiata pine seedlings from the time they are lifted to the time the are safely in the ground. Detailed studies have been undertaken by several scientists. Chavasse undertook studies to review handling practices in New Zealand in 1969, and then carried on to look at deterioration of seedlings in plastic bags in 1973. Since then major changes in the outplanting systems for bare-rooted seedlings have evolved.

The objective of the trial described below is to show the effects of fertilising in the nursery, handling of the seedlings (including planting) and fertilising in the field on the subsequent growth of the seedlings.

This report covers the preparation of the seedlings, the treatment schedule, and the results of both a glasshouse root regeneration study and a field trial in Whakarewarewa Forest.

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METHODS

1. SEEDLING BED PREPARATION

In January 1984 two adjacent bed of 1/0 seedlings were selected in the nursery. These seedlings came from seed lot number seed orchard 3383002/2. The two beds were compared to ensure that they were equal in growth to that point. One bed then received no further fertiliser, while the other received double doses of fertiliser. Regular samples of seedlings were taken and analysed for N, P, K, Ca, and Mg. The fertiliser applications were adjusted according to these results.

The objective was to produce seedlings in the fertilised bed with 2% N, 0.2% P, 2% K, 0.2% Ca and 0.2% Mg.
Foliar spray application of Epsom Salts ($MgSO_4,7H_2O$) and D.A.P. (Diammonium Phosphate, N-P-K. 12-20-0) were used.
At harvest time a sample of seedlings were determined for dry weight.

2. HANDLING PRACTICES

At lifting, randomly selected seedlings from each bed were subjected to good and bad handling treatment.

The Good Treatment consisted of:-

Pull up gently,
Shake gently to remove loose soil only.
Trim lightly in handfuls of 10 seedlings.
Pack carefully and loosely into cardboard boxes.
Cover roots with damp cloth to prevent drying out.
Store overnight in a cool place out of direct light.

The **Bad** Treatment consisted of:-

Pull up vigorously,
Shake, tap against side of boot to remove all soil.
Trim in bundles of approximately 30-40 seedlings.
Pack in plastic bags.
Leave bag exposed in direct light for 3 hours.

Lifting was carried out on 1 August 1984.

In the field, the seedlings were planted in plots of 6 m x 6 m at 1 m spacing i.e. 36 trees/plot. The well handled seedlings were carefully planted using the modified pit planting technique with pull up. The badly handled seedlings were planted using the one cut slit planting method. (Trewin and Cullen 1985).

Planting took place 2 August 1984.

The field fertilising treatment of 150 gm/tree of Ammophos (N-P-K, 12-10-10) was applied in a spade slit, 15 cm from the tree, one month after planting. It is normal forestry practice to apply fertiliser in this way.

The field trial consisted of four replications of a 2^3 factorial design. i.e. 32 plots in total.

Treatments are as follows:-

Treatment	Nursery Fert.	Handling	Field Fert.
1	No	Good	No
2	No	Good	Yes
3	No	Bad	No
4	No	Bad	Yes
5	Yes	Good	No
6	Yes	Good	Yes
7	Yes	Bad	No
8	Yes	Bad	Yes

The field trial was measured monthly until completion in December 1985. This was done in order to monitor any slight changes in growth patterns. At age 2 there was a height measurement performed before thinning half the trees out.

Root collar diameter and height were measured on the central 4 m x 4 m (16 trees) of each plot. This allowed a buffer of two rows between each measurement plot.

Mean air temperature, mean grass minimum temperature and rainfall data were recorded from the nearest meterological station during the course of the experiment.

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THE ROOT REGENERATION STUDY

At lifting sixty seedlings of each level of nursery fertiliser and handling, were potted individually in a coarse pumice sand into plastic 15 cm free-drainage pots. The field difference in planting methods could not be simulated in the glasshouse.

Half of each batch of sixty seedlings received only water while the other half received a nutrient solution containing all nutrients required for adequate plant growth.

Thus in the glasshouse there was the combination of the eight treatments, mirroring the field trial.

Each pot was watered weekly to drain.

At harvest, four weeks after planting, the seedlings were carefully extracted from the pots and the coarse sand gently swirled away with water.

The root regeneration was then scored according to the following scale:-

0.0	No new roots
0.5	Very few
1.0	Some (less than 33%) of the old roots showing new white root activity.
1.5	Approximately 50% shooting
2.0	A moderate number (up to 66%) of the old roots shooting
2.5	A high number,(up to 75%) of old roots shooting
3.0	Nearly all old roots showing vigorous and copius activity.

RESULTS

1. NURSERY NUTRITION OF THE SEEDLINGS.

TABLE 1. Nutrient Concentrations of the Seedling Tops at Three Dates.

	Element				
	N	P	K	Ca	Mg
High Nutrition					
April 84	2.14	0.22	1.14	0.22	0.12
June 84	1.31	0.08	1.14	0.21	0.17
August 84	1.82	0.11	1.07	0.22	0.14
Low Nutrition					
April 84	1.28	0.14	0.89	0.14	0.08
June 84	1.22	0.10	0.93	0.17	0.11
August 84	1.26	0.16	1.00	0.19	0.14

Even with the back up of a laboratory, it proved very difficult to achieve exactly what was required in the way of nursery nutritional concentrations. The elements that most required adjusting in the high nutrition (N, P, and Mg) fluctuated considerably, despite attempts to adjust them with foliar sprays.

2. ROOT REGENERATION STUDY

A. NUTRITION

At harvest roots were collected and analysed for nutrients as shown in Table 2. The nutrition of the seedling tops is, as presented for August 1984 in Table 1.

TABLE 2. Nutrient Concentrations of the Seedling Roots at Time of Harvest.

	Element				
	N	P	K	Ca	Mg
High Nutrition	1.29	0.12	0.56	0.10	0.06
Low Nutrition	0.87	0.17	0.59	0.29	0.08

The dry weights of the two components at harvest are shown in Table 3.

TABLE 3. Dry Weights (grams) of Roots and Tops at Harvest

	Tops	Roots
High Nutrition	6.69	2.01
Low Nutrition	4.32	1.51

Thus the high nutrition treatment has produced seedlings with a foliage weight increase of 50 %.
They were, however, all fairly light in weight by comparison with Peter Knight's survey seedlings (N.Z.J. For. Sci. 8(1): 54-69) which had a mean of 8.3 grams for tops a range of 5.1 to 12.2 grams.

B. ROOT REGENARATION SCORES.

After analysis of variance, the main effects of nursery fertiliser, handling and pot fertiliser were all significant. The interaction of the two fertilisers was significant. The handling and pot fertiliser interaction was significant at between 5 % and 10 %.

Seedlings that were not fertilised in the nursery were more improved by the pot fertiliser than those that were fertilised in the nursery. Badly handled seedlings did not respond as well to the nutrient solution as the well handled ones.

Root scores were averaged for each treatment. The means are shown in Table 4.

TABLE 4. Mean Root Scores for each Treatment.

Treatment	Nursery fert.	Handling	Nutrient sol.	Regeneration Score
1	No	Good	No	1.75
2	No	Good	Yes	2.23
3	No	Bad	No	0.43
4	No	Bad	Yes	0.65
5	Yes	Good	No	2.38
6	Yes	Good	Yes	2.57
7	Yes	Bad	No	1.22
8	Yes	Bad	Yes	1.10

In terms of the original scoring system these data suggests that badly handled unfertilised seedlings had "very few" new roots and the fertilised well handled ones had a "high number". There was very little difference between individual seedlings of the same treatment.

3. THE FIELD TRIAL

A. The seedlings made no height increment in August and September 1984. However young trees in an adjacent compartment were well into their spring flush by then.

B. Even after two years the treatments are still very different in growth and show a strong effect of handling and field fertilising. The well handled seedlings have made consistently better growth than the badly handled ones. Figure 1.

The graph legend is explained as follows:-

NNF = Nursery No Fert.	NFT = Nursery Fert.
GOOD = Good Handling	BAD = Bad Handling
FNF = Field No Fert.	FFT = Field Fert.

The best two treatments are good handling and field fertilisation, regardless of nursery nutrition, and the two worst being bad handling and no fertiliser in the field (also regardless of nursery nutrition).
This was also true of the root regeneration study.

Figure 2 shows the difference between mean initial height and diameter to the mean final height and diameter for each treatment, at eighteen months.

C. The nursery fertilisation has made no apparent difference to the height and diameter increment, the only difference, being in the survival rate. The fertilised trees had a better rate of survival than the unfertilised.

D. In the first year the peak in height increment was in December 1984, while the peak in diameter increment was not until three months later, in March 1985. This shows that seedling produce height increment before diameter.

E. The second season of growth started in May/June of 1985. This shows the seedlings had started putting on height increment during the winter months. The previous year the seedlings "sat around" until October/November before growth started. See Figure 3.

The "time lag" in the first growing season could be a function of either soil moisture or soil temperature restricting root initiation, or ,just simply lost opportunity through planting out bare rooted stock. A study of rainfall and temperature records was made. The results are graphed in Figures 4 and 5.

When the rainfall data for first three months after planting was studied, it was found that October 1984 had abnormally low rainfall, which brought down the average for those three months. (Rainfall = 232.9 mm, compared with 339.0 mm for the same period in the following year). However this rainfall was probably more than adequate for growth. There was very little difference in temperature figures for the comparable periods.

There does not appear to be sufficient difference between the two years to justify ascribing the lag in growth to climate. It must therefore be a feature of bare-root planting.

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CONCLUSIONS

A. Producing heavier, well nourished seedlings in the nursery had no effect on subsequent growth in the field but it did increase the seedlings "reserves" - and this had beneficial effects on survival.

B. Careful handling is very important, not only for survival but also for sustained growth. Field fertilising proved to be a way of overcoming some of the detrimental effects of small seedling size and bad handling.

C. Nursery Managers need to ensure that they produce well nourished seedlings and handle them carefully.
Forest Managers should ensure continued care in handling and planting, but can recover from untoward events by fertilising.

ECONOMIC CONCLUSIONS

This trial enables us to calculate the amount of money it is worthwhile spending to achieve the growth benefits demonstrated.

The gain, so far to handling is 30 cm in height. Assuming that this is the full gain, and there is reason to doubt this since the growth rates are still diverging, then by the end of the rotation this gain can be expected to increase the clearfell volume by about 8 m3/ha.

Discounting that gain to the present day, you could afford to pay about $40/ha more at planting - the greater the survival rate, the better the return in the end. Since many of the costs incurred are simply management and supervision in ensuring tight distribution systems and careful handling of seedlings achieving the better result should be economically feasible.

The gain to fertilising is approx 50 cm at age 2. This shows that if the forest manager can fertilise at a cost of less than $70/ha it would be worthwhile.
(in our study the materials alone cost approx $40/ha.)

The total gain from careful handling and fertilising is about 80 - 100 cm in height. This equates to half to two-thirds of a years growth. Discounted to the present day this is worth about $100 per hectare.

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Chavasse,C.G.R. (1973). Packaging, Storage and Transportation of Radiata Pine Seedlings. New Zealand Forest Service, Forest Research Institute Forest Establishment Report No. 41.

Trewin,A.R.D. and Cullen,A.W.J. (1985). Fully Intergrated System for Planting Bare-rooted Seedlings of Radiata Pine in New Zealand. IUFRO Symposium. Management Practices for the Southern Pine. August 1985 Montgomory, Alabama, U.S.A.

Trewin, A.R.D. and Hunter, J.A.C. (1986). A Containerised Handling System for Bare-rooted Seedlings. New Zealand Forest Service Reprint No. 1927.

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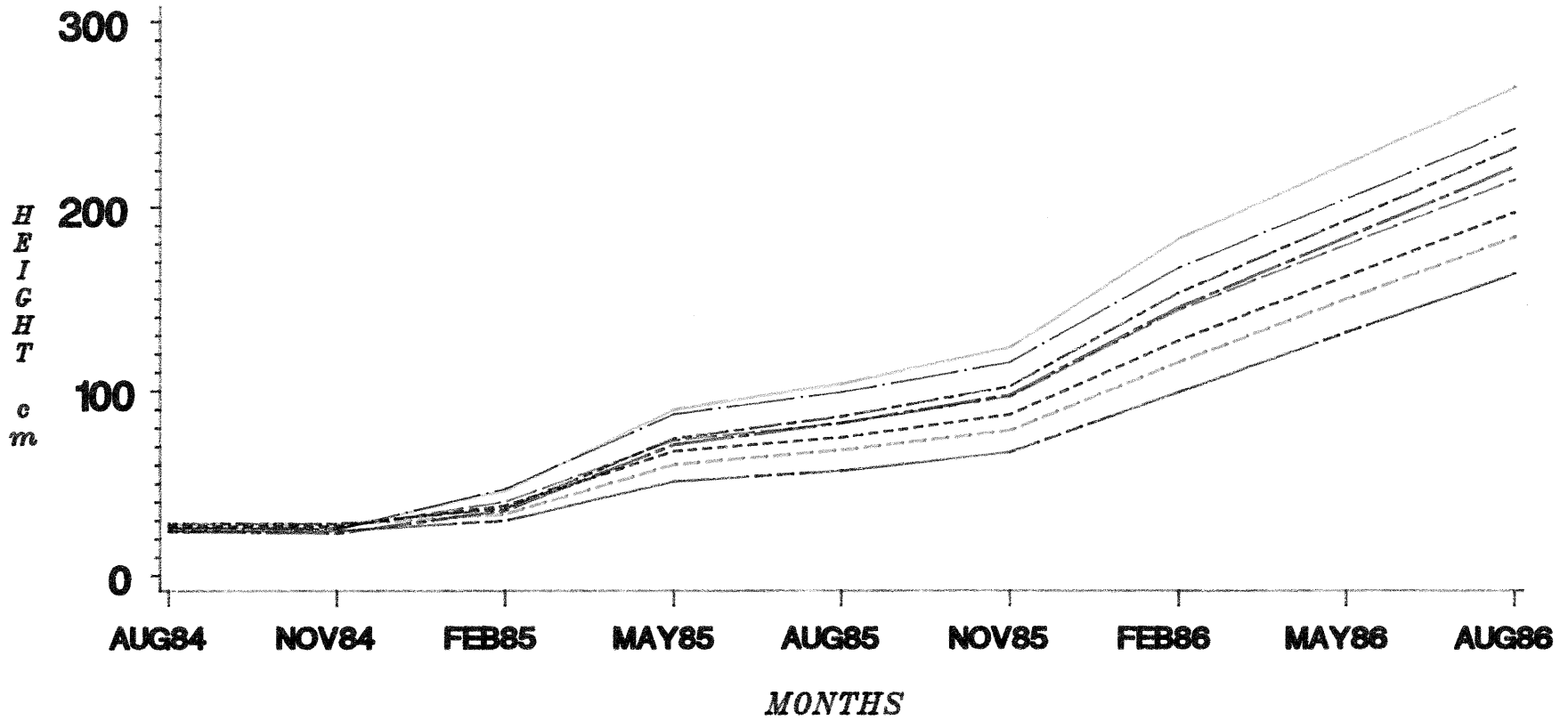
Figure 1.

R02016 SEEDLING TRIAL – WHAKA FOREST

Height By Treatment. August 84 – August 86

Radiata Pine Planted 2 August 1984



LEGEND: *NNF/GOOD/FFT* ___ *NNF/GOOD/FNF* Δ ___ *NNF/BAD/FFT* _ ___ _ *NNF/BAD/FNF* Δ _ _ ____

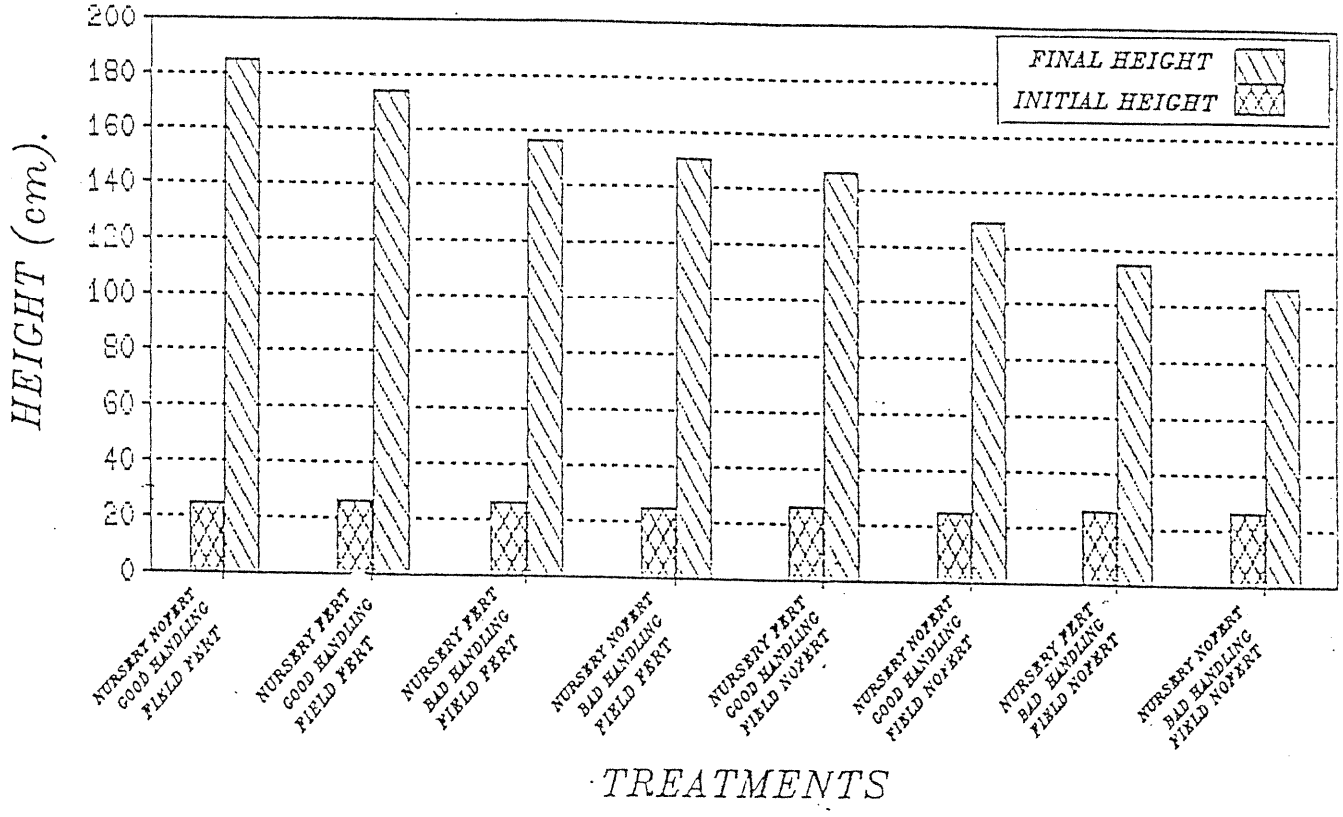
NFT/GOOD/FFT ___ *NFT/GOOD/FNF* Δ ___ *NFT/BAD/FFT* _ ___ _ *NFT/BAD/FNF* Δ _ _ ____

FIGURE 2.

R02016 WHAKA FOREST SEEDLING TRIAL

MEAN HEIGHT MEASUREMENTS (cm).

(AT 18 MONTHS)



MEAN DIAMETER MEASUREMENTS (mm).

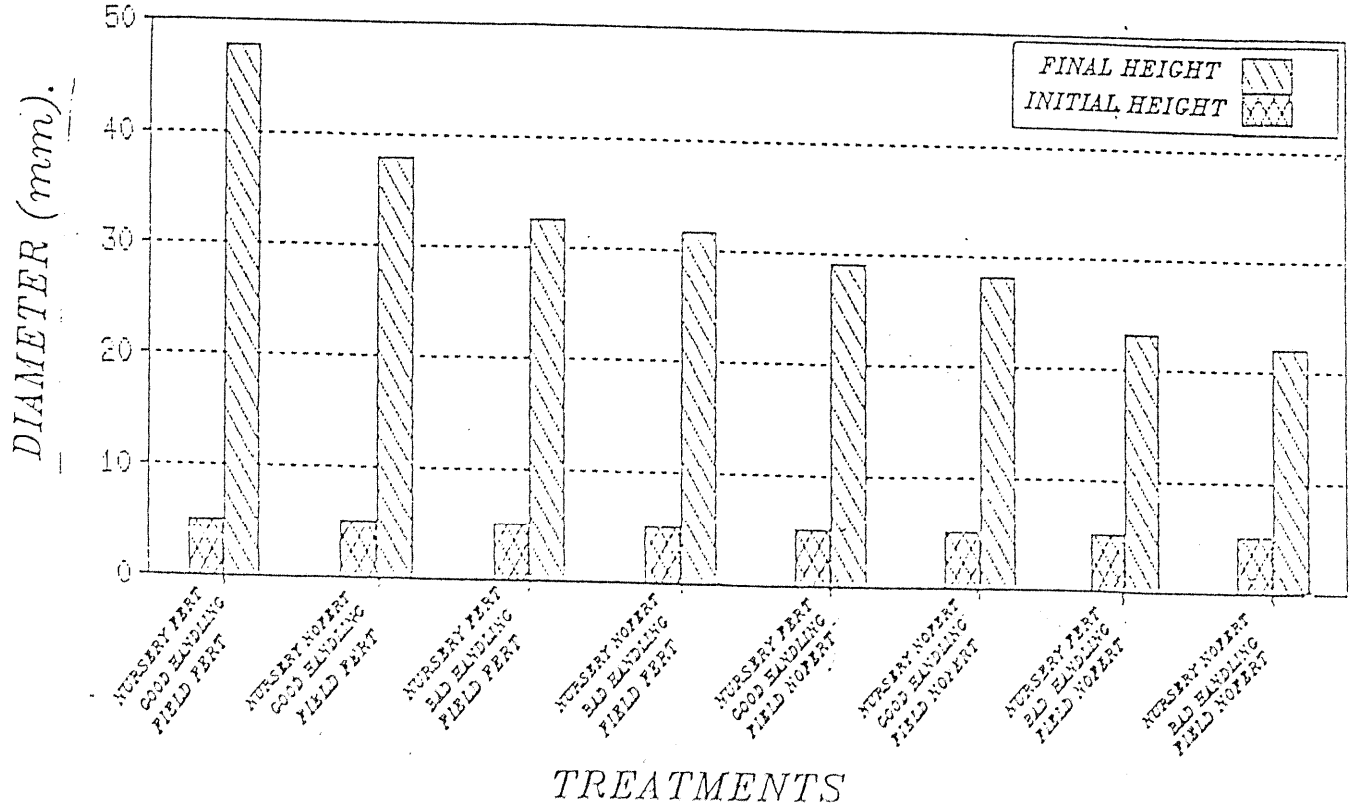
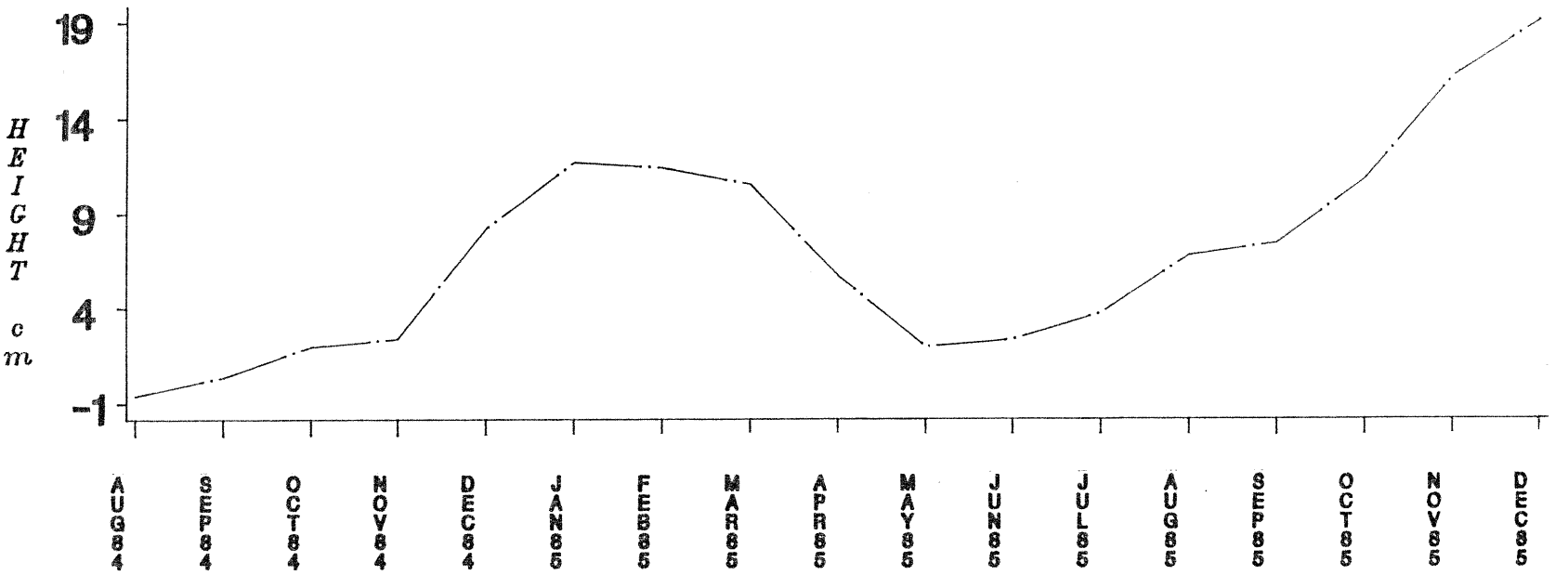


FIGURE 3

R02016 SEEDLING TRIAL – WHAKA FOREST

Mean Monthly Height Incr. August 84 – December 85

Radiata Pine Planted 2 August 1984



WINTER *SPRING* *SUMMER* *AUTUMN* *WINTER* *SPRING* *SUMMER*

LEGEND:HEIGHT INCR.____

FIGURE 4.

RAINFALL ROTORUA N.Z.

August 84 – December 85 Monthly Rainfall Records

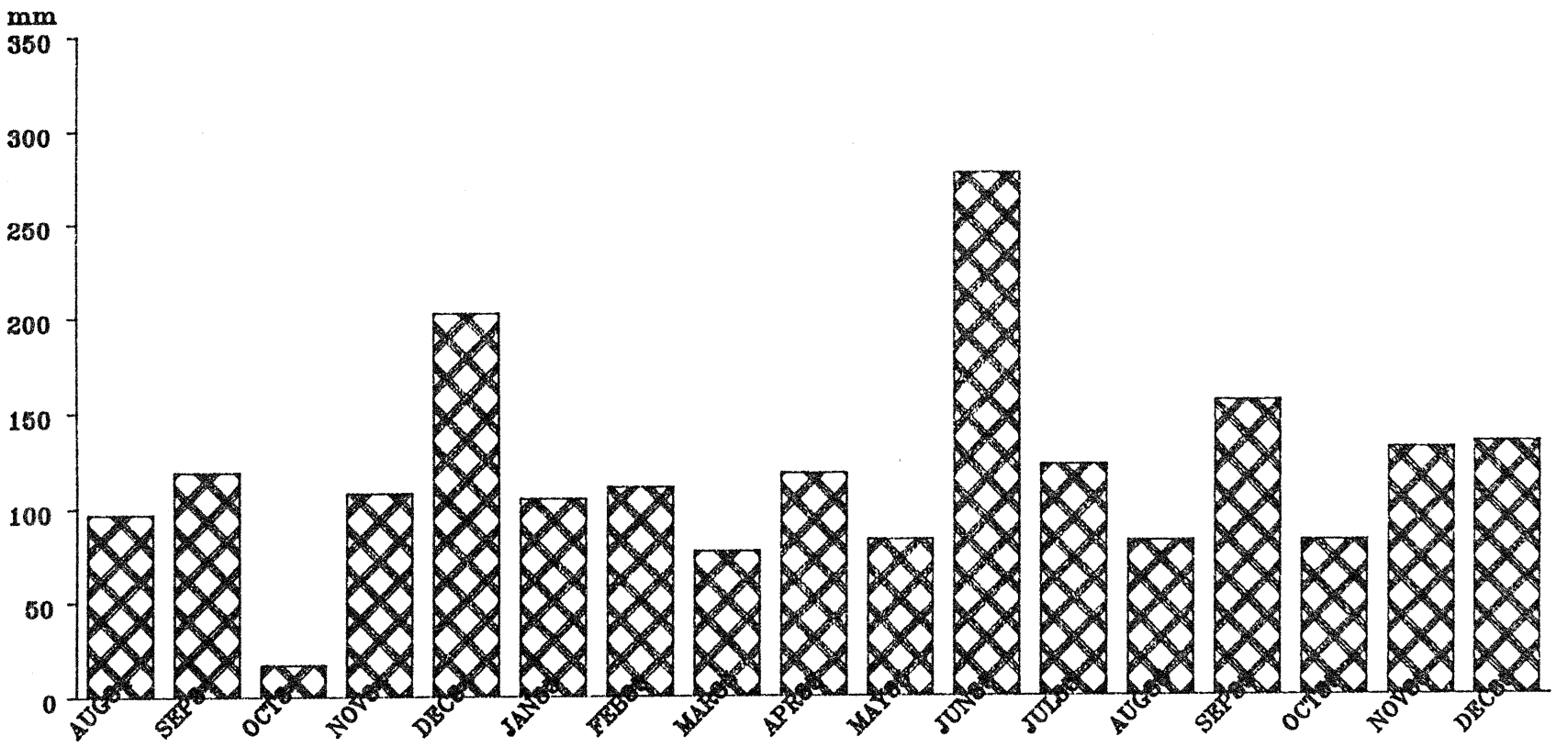
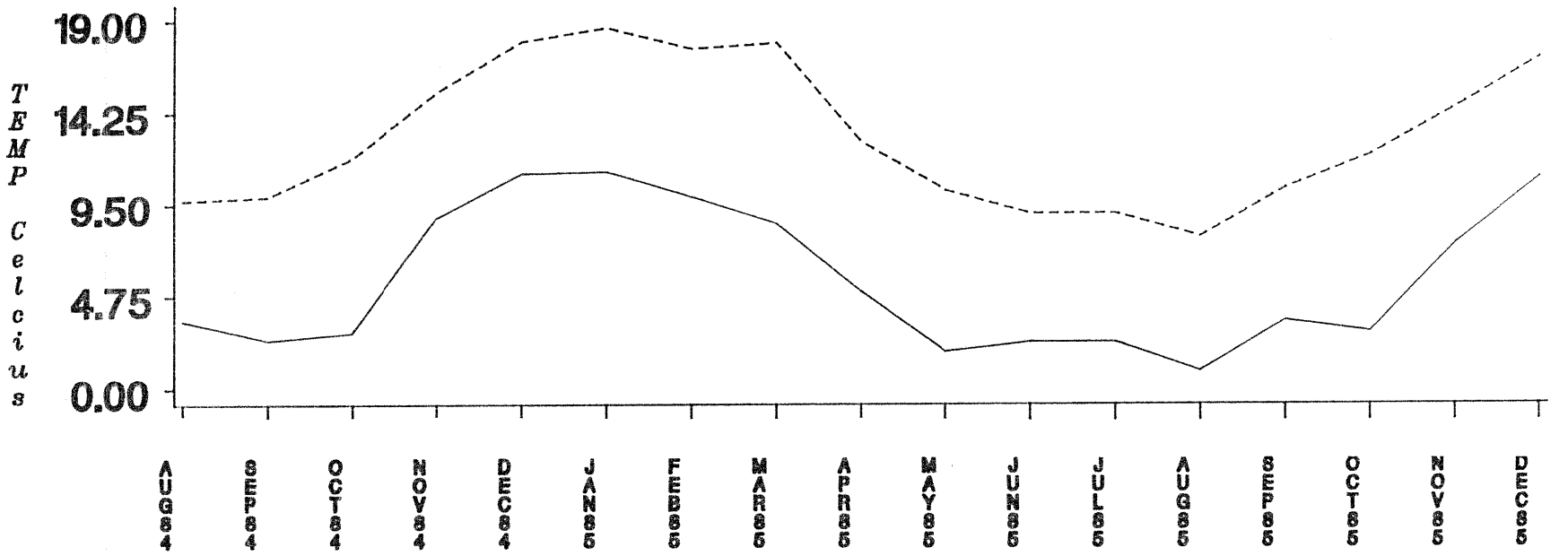


FIGURE 5

R02016 SEEDLING TRIAL – WHAKA FOREST

August 84 – December 85 Monthly Temp. Records



WINTER *SPRING* *SUMMER* *AUTUMN* *WINTER* *SPRING* *SUMMER*

LEGEND:MEAN GRASS MIN.____ MEAN AIR TEMP.Δ _ _