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RO2004/1,2,3,4,5; WN287/1,2TITLE: GROWTH AND SURVIVAL OF RADIATA PINE CUTTINGS, PLANTLETS
AND SEEDLINGS ON TEN NORTH ISLAND SITESAUTHOR(S): B.K. KLOMP, D.G. HOLDEN, S.O. HONG, DATE: JUNE 1992
M.I. MENZIESKEYWORDS: RADIATA PINE, CUTTINGS, SEEDLINGS, PLANTLETS, GENETIC
QUALITY, IMPROVED STOCK**ABSTRACT***

Survival and growth data of 11 planting stock types of radiata pine are compared on 5 forest and 5 farm sites in the North Island. The planting stock included seedlings, cuttings from 1-, 2-, 3- and 4-year-old donor trees and tissue-cultured plantlets.

Seven years after planting, data on survival, height and diameter (dbh) growth of planting stock types of identical or similar genetic origin and GF rating were statistically analysed. Generally, results showed that tissue-cultured plantlets and all types of cuttings survived as well as or better than their seedling counterparts on all sites. The cuttings from 3-year-old donor trees had a significantly higher percentage survival than seedlings on most farm sites.

All types of cuttings grew as tall as but generally taller than seedlings on all sites. The plantlets showed a similar pattern in height growth, although they showed a significantly inferior height on two sites.

Diameter growth for juvenile cuttings (1- and 2-year-old donor trees) was generally as good as or better than that of the seedlings, whilst aged cuttings (from 3-year-old donor trees) were generally similar to seedlings, although a loss in diameter growth was evident on 3 sites.

Diameter (dbh) growth was generally less for cuttings from 4-year-old donor trees compared with seedlings. Diameter growth was reduced further on at least 6 sites, when cuttings (from 4-year-old donor trees) collected from a warm site were compared with those collected from a colder site. Plantlets showed a loss in diameter growth compared to seedlings on 4 sites, but had a similar dbh on the remaining sites.

Collectively, trees grew taller and survived better on the forest sites but had a significantly smaller diameter (dbh) than those growing on the farm sites.

Note: This material is unpublished and must not be cited as a literature reference.

INTRODUCTION

The information in this report refers to the series of field trials comparing the performance of radiata pine seedlings, cuttings and plantlets, established on ten North Island sites in 1984. This report summarises height, diameter growth and survival at age seven years after planting for all ten sites. It is an update of Management of Improved Breeds Cooperative Report No. 10 (February 1989), which covered the establishment phase and growth data up to age four years.

Survival and growth data of 11 planting stock types are compared on five farms and five forest sites.

Comparisons of log form and quality are not included and will be done at a later stage when all trials have been final-lift pruned.

MATERIALS AND METHODS

LOCATION AND SITE DESCRIPTIONS

The field trials were established on five pasture sites and five conventional forest sites, on a variety of soil types in the North Island. The ten trial localities and site descriptions are listed in Table 1.

TABLE 1 - Trial sites : 1984 series

Locality	Soil type	Topography	Aspect
Forest sites			
1. Otangaroa	Mangonui hill soils - clay	undulating - steep	N & S
2. Pouto	stabilised sand dune	flat - easy rolling	N
3. Rerewhakaaitu	Tarawera lapilli/Taupo ash	easy rolling	SW
4. Tahorakuri	Kaingaroa gravelly sand-pumice	flat - undulating	SW
5. Taupo	Kaingaroa gravelly sand-pumice	flat- undulating	N & S
Farm sites			
6. Whangarei	Maumu silt loam - clay	flat-easy rolling	W
7. Tikitere	Rotoiti hill soils-pumice	undulating	SE
8. Reporoa	Kaingaroa gravelly sand-pumice	flat-easy rolling	SE
9. Kanui Station (Hawkes Bay)	Okara fine, sandy loam	flat-easy rolling	S
10. Oroua Downs (Foxton)	Himatangi sand	flat	-

A map showing the ten trial localities is presented as Appendix I.

TRIAL DESIGN

The trials are laid out as a randomised complete block design with 11 stock types replicated in 12 blocks, except the Tikitere site which has 10 blocks and the Reporoa trial which has 11 blocks. Stock types are represented by a single row of eight trees per block.

Initial plant espacement was 5 x 5 m (400 stems/ha) and each block measures 40 x 55 m (0.22 ha), giving a trial site of 2.6 ha.

PLANTING STOCK

The 11 stock types in the trials include four seedling types, cuttings from 1-, 2-, 3- and 4-year-old donor trees, and tissue-cultured plantlets. The genetic origin, seedlot and associated GF ratings are shown in Table 2.

TABLE 2 - Stock types used in the trials

Tri No.	Seed source	Seedlot No.	Material age	Collection site	GF rating	Code
1	Bulked "880" op seedlings	9/0/83/080	1/0	-	12	S12
2	Bulked "875" cross seedlings	9/0/83/081	1/0	-	17	S17
3	"268" special seedlings	9/0/83/082	1/0	-	15	S15
4	Gwavas seed orchard seedlings	3/3/82/002/3	1/0	-	14	S14
5	Tissue-cultured plantlets Gwavas seed orchard "850"	3/3/82/002/3	0/1	Lined out 1983	14	P14
6	"880" op progeny test ex 1-year ortets	-	0/1	FRI nursery	12	1C12
7	"850" seed orchard ex 2-year ortets	-	0/1	FRI nursery	14	2C14
8	"880" op progeny test ex 3-year ortets	-	0/1	Lake Taupo Forest	12	3C12
9	"875" x "268" ESSO ex 3-year ortets	-	0/1	Cpt 1132 Kaingaroa	16	3C16
10	"875" progeny test ex 4-year ortets	-	0/1	Cpt 327 Kaingaroa	17	4C17K
11	"875" progeny test ex 4-year ortets	-	0/1	Onepu, Tasman	17	4C17O

Two types of cuttings from 3-year-old donor trees (treatments 3C12 and 3C16) were included to enable comparisons to be made with seedlings of similar genetic origin and with comparable GF ratings (treatments S12 and S17).

To test the effect of physiological aging comparing a cold site with a warmer collection site, two treatments consisting of cuttings from 4-year-old donor trees with identical genetic origin were included, treatments 4C17K and 4C17O. The first treatment contains cuttings collected from Kaingaroa Forest in the Central North Island plateau whilst the second treatment contains cuttings collected at Onepu, a relatively warm, coastal Bay of Plenty site.

SILVICULTURAL MANAGEMENT

All ten trials were grown on a direct sawlog regime involving regular pruning lifts to variable tree heights, aimed at leaving 3-3.5 m of green crown. Cull thinnings of toppled or unprunable trees were done on all trial sites at the first and second pruning lifts.

DATA ANALYSES

The statistical software GENSTAT and SAS were used to analyse the data. Analysis of variance (ANOVA) was done and if treatment effect was significant, then the least significant difference (LSD) test was carried out to compare treatment means.

Linear contrasts between seedlings and cuttings with an equivalent GF rating were done to compare particular levels of treatments.

RESULTS

Data of height, dbh and survival percentages of 11 stock types on 10 sites measured in 1991 were combined and analyses of variance (ANOVA) were carried out.

The ANOVA showed highly significant differences for sites, treatments and site-treatment interaction, suggesting that the treatments behaved differently on different sites. It is therefore not appropriate to generalise about treatment effect over all sites, and rather treatment effects should be compared for each site separately.

The treatment means on each site are shown in detail in Appendices II, III and IV.

CUTTINGS VERSUS SEEDLINGS

To compare the overall performance of cuttings and seedlings, treatments 1C12, 2C14, 3C16 and 4C17K were chosen from the cuttings as these were comparable to seedling treatments S12, S17, S15 and S14 in terms of their GF ratings. A linear contrast between the two groups was done in the analysis of variance of mean height, mean dbh and survival percentages at age 7 years, on each site.

The results are summarised in Table 3.

TABLE 3 - Growth and survival comparisons at age 7 years
Cuttings versus seedlings

	Mean height	Mean DBH	Survival
Forest sites			
1. Otangaroa	ns	ns	ns
2. Pouto	C>S**	ns	ns
3. Rerewhakaaitu	C>S**	ns	C>S**
4. Tahorakuri	C>S*	S>C**	ns
5. Taupo	C>S**	ns	ns
Farm sites			
6. Whangarei	C>S**	ns	C>S*
7. Tikitere	C>S**	ns	C>S**
8. Reporoa	C>S**	ns	ns
9. Kanui Station	C<S**	ns	C>S**
10. Oroua Downs	ns	ns	ns

C = Cuttings, treatments 1C12, 2C14, 3C16 and 4C17K combined

S = Seedlings, treatments S12, S17, S15 and S14 combined

Note : * significant at the 5% level
 ** significant at the 1% level
 ns not significant at P>5% level

The cuttings grew significantly taller than the seedlings on 8 of the 10 sites. There was no significant difference in dbh on 9 sites out of 10. However seedlings had a significantly larger dbh at Tahorakuri, the only forest cutover site sampled. There was little difference in survival on the forest sites, except for Rerewhakaaitu where cuttings survived better. Cuttings also had a significantly better survival rate than seedlings on 3 of the 5 farm sites.

JUVENILE (NURSERY) CUTTINGS VERSUS SEEDLINGS

Juvenile cuttings from 1- and 2-year-old donor trees (treatments 1C12 and 2C14) were compared to seedlings (treatments S12 and S14) with an equivalent GF rating. The results of a linear contrast analysis of variance is shown in Table 4.

TABLE 4 - Growth and survival comparisons at age 7 years
Juvenile cuttings versus seedlings

	Mean height	Mean DBH	Survival
Forest sites			
1. Otangaroa	ns	ns	ns
2. Pouto	C>S**	C>S**	ns
3. Rerewhakaaitu	C>S**	C>S**	ns
4. Tahorakuri	ns	ns	ns
5. Taupo	C>S*	ns	ns
Farm sites			
6. Whangarei	ns	ns	ns
7. Tikitere	C>S**	ns	ns
8. Reporoa	C>S**	C>S**	ns
9. Kanui Station	C>S**	C>S**	C>S*
10. Oroua Downs	ns	ns	ns

C = Cuttings, treatments 1C12, 2C14 combined
S = Seedlings, treatments S12 and S14 combined

Note : * significant at the 5% level
** significant at the 1% level
ns not significant at P>5% level

The juvenile cuttings grew as tall (on 4 sites) or taller (on 6 sites) than the seedlings. There was no loss of dbh growth on any of the sites, and in fact at Pouto, Rerewhakaaitu, Reporoa and Kanui Station, cuttings had a significantly larger dbh than the seedlings.

The cuttings survived better at Kanui Station but there was no significant difference in survival rate between the two stock types on the other 9 sites.

AGED (FIELD-COLLECTED) CUTTINGS VERSUS SEEDLINGS

Firstly, field-collected cuttings from 3-year-old donor trees (treatments 3C12 and 3C16) were compared to seedlings (treatments S12, S17 and S15) with a comparable GF rating. A summary of a linear contrast analysis of variance is shown in Table 5.

TABLE 5 - Growth and survival comparisons at age 7 years
Aged (3 years) cuttings versus seedling

	Mean height	Mean DBH	Survival
Forest sites			
1. Otangaroa	C>S*	ns	ns
2. Pouto	ns	S>C**	ns
3. Rerewhakaaitu	ns	S>C*	C>S**
4. Tahorakuri	C>S*	ns	ns
5. Taupo	C>S**	ns	ns
Farm sites			
6. Whangarei	ns	ns	C>S*
7. Tikitere	ns	S>C**	C>S**
8. Reporoa	ns	ns	C>S*
9. Kanui Station	C>S**	ns	C>S**
10. Oroua Downs	ns	ns	ns

C = Cuttings, treatments 3C12 and 3C16 combined

S = Seedlings, treatments S12, S17 and S15 combined

Note : * significant at the 5% level
 ** significant at the 1% level
 ns not significant at P>5% level

The cuttings from 3-year-old donor trees grew taller than the seedlings on 3 forest and 1 farm site. There was no significant difference in height growth between the two groups on the other 6 sites.

The cuttings showed a significant loss in dbh growth at Pouto, Rerewhakaaitu and Tikitere but there was no significant difference in dbh between the two stock types on the other 7 sites.

Generally, cuttings survived significantly better on the farm sites but there was little difference in survival on the forest sites, except for Rerewhakaaitu where the cuttings also outperformed the seedlings.

Secondly, field -collected cuttings from 4-year-old donor trees (treatments 4C17K and 4C17O) were compared to seedlings (treatment S17). Results of a linear contrast comparison are shown in Table 6.

TABLE 6- Growth and survival comparisons at age 7 years
Aged (4 years) cuttings versus seedling

	Mean height	Mean DBH	Survival
Forest sites			
1. Otangaroa	ns	S>C*	S>C*
2. Pouto	ns	ns	ns
3. Rerewhakaaitu	ns	S>C**	ns
4. Tahorakuri	C>S**	S>C**	ns
5. Taupo	C>S*	S>C*	S>C*
Farm sites			
6. Whangarei	C>S*	ns	ns
7. Tikitere	C>S**	S>C**	C>S*
8. Reporoa	C>S**	S>C**	ns
9. Kanui Station	C>S**	S>C*	C>S**
10. Oroua Downs	ns	S>C*	ns

C = Cuttings, treatments 4C17K and 4C17O combined

S = Seedlings, treatment S17

Note : * significant at the 5% level
 ** significant at the 1% level
 ns not significant at P>5% level

The field-collected cuttings from 4-year-old donor trees grew as tall as seedlings on 4 sites and taller than the seedlings on the other 6 sites.

There was a significant loss of dbh growth of these cuttings compared to seedlings, on 8 of the 10 sites. However, no significant loss of dbh growth occurred at Pouto (forest) and Whangarei (farm), both warmer sites. The seedlings survived significantly better on two forest sites (Otangaroa and Taupo) but the cuttings survived significantly better on two of the farm sites (Tikitere and Kanui Station). There was no significant differences in survival between the two groups on the other 6 sites.

THE EFFECT OF COLLECTION SITE

The effect of collection site of cuttings comparing a warm and a cold site was tested by inclusion of two types of cuttings from 4-year-old donor trees. Treatment 4C17K contains cuttings collected from a relatively cold site in southern Kaingaroa Forest, whilst treatment 4C17O contains cuttings of identical genetic origin, but collected from a warmer site at Onepu, in coastal Bay of Plenty. The two treatments were compared by linear contrast analysis and the results are given in Table 7.

TABLE 7 - Growth and survival comparisons at age 7 years
Warm versus Cold collection site

	MEAN HEIGHT	MEAN DBH	SURVIVAL
Forest sites			
1. Otangaroa	ns	cold > warm	ns
2. Pouto	ns	ns	ns
3. Rerewhakaaitu	ns	cold > warm	ns
4. Tahorakuri	ns	ns	ns
5. Taupo	ns	ns	ns
Farm sites			
6. Whangarei	ns	ns	ns
7. Tikitere	ns	ns	ns
8. Reporoa	ns	cold > warm	ns
9. Kanui Station	ns	ns	ns
10. Oroua Downs	ns	cold > warm	ns

warm = cuttings collected from 4-year-old donor trees at Onepu

cold = cuttings collected from 4-year-old donor trees at Kaingaroa Forest

Note: * significant at the 5% level

ns not significant at P>5% level

There were no significant differences in either height or survival between the two stock types on any of the 10 sites. The cuttings collected from the warmer site at Onepu did show a significant loss of diameter growth on 4 of the 10 sites, indicating the effect of an increase in physiological aging.

FOREST SITES VERSUS FARM SITES

The overall effects of the two types of site on height, dbh and survival were statistically analysed for the eleven stock types. Treatment effects were highly significant for height, dbh and survival. However, the interaction effects between site and stock type were not found, indicating that the stock types behaved similarly on both sites.

The performance of all stock types combined, comparing forest with farm sites is shown in Table 8.

TABLE 8 - Growth and survival comparisons at age 7 years
Forest sites versus Farm sites

	Mean height (m)	Mean DBH (cm)	Survival (%)
Forest sites (5)	9.3*	17.8	70.5**
Farm sites (5)	9.1	20.2**	64.5

* significantly higher at the 5% level

** significantly higher at the 1% level

The results indicate that the trees grew significantly taller on the forest sites than on the farm sites. However, diameter (dbh) growth was significantly bigger on the farm sites. Percentage survival, however, was higher on the forest sites.

PLANTLETS VERSUS SEEDLINGS

Tissue-cultured plantlets (treatment P14) were compared with seedlings of identical genetic origin and GF rating (S14). A summary of these results is given in Table 9.

TABLE 9 - Growth and survival comparisons at age 7 years
Plantlets versus Seedlings

	Mean height (m)	Mean DBH (cm)	Survival (%)
Forest sites			
1. Otangaroa	ns	ns	ns
2. Pouto	S>P*	S>P*	ns
3. Rerewhakaaitu	P>S*	ns	ns
4. Tahorakuri	ns	S>P*	ns
5. Taupo	ns	S>P*	ns
Farm sites			
6. Whangarei	S>P*	ns	ns
7. Tikitere	P>S	ns	ns*
8. Reporoa	P>S*	ns	ns
9. Kanui Station	ns	S>P*	P>S*
10. Oroua Downs	ns	ns	ns

The comparison of height growth is rather inconclusive as the plantlets showed a superior height at Rerewhakaaitu, Tikitere and Reporoa but seedlings grew taller at Pouto and Whangarei. The remaining 5 sites did not show a significant height difference. On 4 of the 10 sites, seedlings had a significantly bigger dbh, whilst there was no significant difference on the remaining 6 sites. There was generally no significant difference in the percentage survival between the two types.

DISCUSSION

In general, cuttings from 1-, 2-, 3- and 4-year-old donor trees as a group grew taller but had a similar diameter (dbh) compared to seedlings with a comparable genetic background and GF rating, on eight of the ten sites sampled. Similar results were reported on the 1983 series of seedling/cutting trials (D.G. Holden 1988). Although there was little difference in survival percentage between the two types on forest sites, the cuttings tended to survive better on the farm sites.

The cuttings from 1- and 2-year-old donor trees were also compared with their seedling counterparts. These juvenile cuttings can be likened to much of the current planting stock

produced from nursery stoolbed systems, in terms of physiological age. They grew as tall or taller than seedlings and had a similar diameter growth or significantly larger dbh (on 4 sites). Their survival rate was similar to seedlings on both forest and farm sites.

The field-collected cuttings from 3-year-old donor trees were equal or better than seedlings in terms of height growth and had similar diameter growth than their seedling counterparts on most sites. At Pouto, Rerewhakaaitu and Tikitere, however, seedlings had a significantly larger dbh. These cuttings also survived better than seedlings on the farm sites but survival was not significantly different on the forest sites.

The field-collected cuttings from 4-year-old donor trees were also equal or better than seedlings in terms of height growth. However, there was a significant loss of dbh growth of these cuttings on 8 of the 10 sites. It is not certain if this leads directly to a volume loss as Penman (1988) found, in a comparison between seedlings and cuttings from 7-year-old donor trees, that cuttings had an 8% volume gain, comparing trees with the same dbh, because of a reduction in log taper.

In a more recent trial comparing seedlings with cuttings from 3-year-old donor trees, on farmland at Rotorua, cuttings also showed a loss in diameter (dbh) growth but had significantly less taper (23 mm/m compared to 29 mm/m) in the 5 m butt log (Holden *et al.* 1992).

It is recognised that physiological aging of radiata pine occurs more rapidly on warmer sites compared to sites with a colder climate. Hence, cuttings collected from parent material growing on a warmer site are likely to show a physiological age which is more advanced than their chronological age suggests.

The comparison carried out with the two types of cuttings from parent material of the same chronological age and identical genetic quality, verified this point. The Onepu (warm site) cuttings proved to be significantly smaller in diameter (dbh) than their counterparts from Kaingaroa on 4 of the 10 sites tested, indicating the effect of increased physiological aging.

Collectively, these trees grew taller on the forest than on the farm sites but diameter (dbh) growth was significantly more on the farm sites. The trees grown on the forest sites survived better than those on the farm sites.

The tissue-cultured plantlets performed well in terms of height growth, compared with seedlings, although height was inferior at Pouto and Whangarei. Their survival was generally as good as that for seedlings but a significant loss in diameter (dbh) growth was evident, especially on the forest sites. Field observations suggest that the latter is most likely due to increased physiological aging of this stock type.

CONCLUSIONS

In summary, it can be concluded that the plantlets and juvenile cuttings (from 1- and 2-year-old donor trees) survived as well as the seedlings on all sites tested.

The aged or field-collected cuttings (from 3- and 4-year-old donor trees) had a better survival rate than seedlings on the farm sites, but had a similar survival rate on the forest sites.

All types of cuttings tested had grown as tall as or taller than seedlings, seven years after planting, on all 10 sites tested. The height growth of plantlets was similar, except a loss of height compared to seedlings occurred on two (warmer) sites at Whangarei and Pouto,

Diameter (dbh) growth of the juvenile cuttings (from 1- and 2-year-old donor trees) was equal to (on 6 sites) or better than (on 4 sites) that of the seedlings. Diameter growth of the cuttings from 3-year-old donor trees was equal to that of seedlings, except at Pouto, Rerewhakaaitu and Tikitere, where a deficit compared with seedlings was evident.

A loss in diameter growth of the cuttings from 4-year-old donor trees was found on most sites, except at Pouto and Whangarei, both warmer sites.

Plantlets generally showed a loss in diameter growth compared to seedlings on the forest sites but not on the farm sites.

Generally, in terms of survival and growth, radiata pine cuttings should perform as well as seedlings on forest sites and better than seedlings on farm sites. A loss in diameter growth of cuttings from 4-year-old or older donor trees can be expected to occur on most sites.

RECOMMENDATION

Comparisons of log form, quality and associated values be carried out, especially between the cuttings and seedlings as soon as the butt log pruning has been completed.

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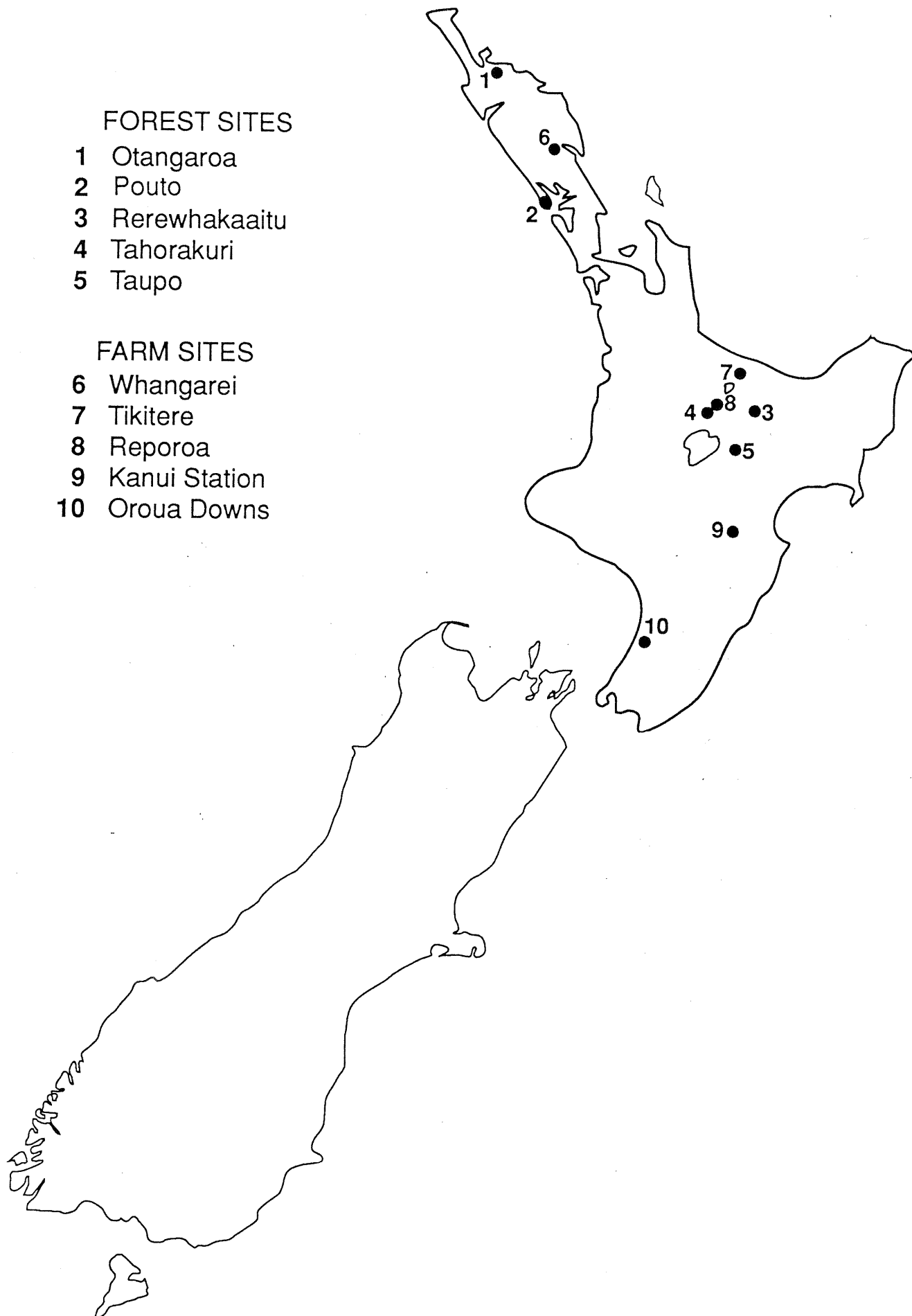
APPENDIX I MAP SHOWING TRIAL LOCATIONS

FOREST SITES

- 1 Otangaroa
- 2 Pouto
- 3 Rerewhakaaitu
- 4 Tahorakuri
- 5 Taupo

FARM SITES

- 6 Whangarei
- 7 Tikitere
- 8 Reporoa
- 9 Kanui Station
- 10 Oroua Downs



APPENDIX II - Height (m) at age 7 years

FOREST SITES						FARM SITES					
Trt	Otagaroa	Pouto	Rerewhakaaitu	Tahorakuri	Taupo	Whangarei	Tikiteree	Reporoa	Kanui Station	Oroua Downs	
S12	7.8	9.4	c d	8.3	c d	9.6	b c	9.8	a b	c	
S17	8.7	9.5	c d	8.5	b c	9.6	b c	9.4	b c	d	
S15	8.8	9.5	c d	8.0	c	9.6	c	9.6	a b	c d	
S14	8.7	9.6	b c d	8.4	c d	9.5	c	9.5	c	d	
P14	9.5	8.4	e	8.9	a b	9.5	c	9.5	a b	d	
1C12	8.5	10.0	a	9.0	a	9.8	a b c	10.1	a	b c	
2C14	8.6	9.9	a b	8.6	a b c	9.6	b c	10.4	a b	b	
3C12	9.3	9.5	c d	8.4	c d	9.9	a b	10.1	a	b	
3C16	9.0	9.4	d	8.3	c d	9.7	b c	10.7	a b	b	
4C17K	9.0	9.8	a b c	8.7	a b c	9.8	a b c	11.2	a	b	
4C17O	9.2	9.7	a b c d	8.6	b c	10.1	a	10.9	a b	a	
Sig. (F-test)	ns	**	**	**	**	**	**	**	**	ns	

For each site, means followed by the same alphabetical letter are not significantly different (LSD test, P = 0.05)

APPENDIX III - Dbh (cm) at age 7 years

FOREST SITES						
Trt	Otagaroa	Pouto	Rerewhakaaitu	Tahorakuri	Taupo	
S12	14.2	18.9 a b	17.3 c d e	19.8 a b c	20.9 a	
S17	15.1 b c	17.8 c d	17.3 d e	19.2 c d	19.8 a b	
S15	15.1 c	17.8 c d	17.0 d e f	19.7 a b c d	20.6 a	
S14	16.4 a	18.4 b c	17.7 b c d	20.2 a	21.0 a	
P14	16.0 a b	16.4 f	18.6 a b	16.0 f	18.5 c	
1C12	14.9	19.6 a	18.6 a	20.2 a b	21.0 a	
2C14	15.1 b c	19.2 a	18.2 a b c	19.3 b c d	20.5 a	
3C12	15.0 b c	17.6 d	e f	18.9 d	20.3 a b	
3C16	14.3 c d	16.8 e f	16.3 f	19.2 c d	20.3 a b	
4C17K	14.7 c	17.4 d e	16.9 d e f	18.0 e	19.1 b c	
4C17O	13.6 d	17.1 d e f	15.4 g	17.7 e	18.1 c	
Sig. (F-test)	ns	**	**	**	**	**

FARM SITES				
Trt	Whangarei	Tikitere	Reporoa	Kanui Station
S12	17.8	24.6 a	21.0 b c d	21.0 b c d e
S17	18.2	24.2 a b	20.8 c d	20.7 d e
S15	17.9	23.2 b c	21.0 b c d	21.8 a b
S14	19.1	24.1 a b	21.4 b c	21.2 b c d
P14	17.7	24.8 a	20.7 c d	19.3 g
1C12	18.6	25.1 a	22.8 a	21.7 a b
2C14	18.8	24.7 a	21.8 a b	22.4 a
3C12	18.5	22.6 c	20.6 c d	20.8 c d e
3C16	18.0	22.4 c	20.6 c d	21.5 b c
4C17K	18.4	22.7 c	20.2 d	20.2 e f
4C17O	18.3	22.5 c	18.8 e	19.6 f g
Sig. (F-test)	ns	**	**	**

For each site, means followed by the same alphabetical letter are not significantly different (LSD test, P = 0.05)

APPENDIX IV - Survival (%) at age 7 years

Trt	FOREST SITES					FARM SITES				
	Otagaroa	Pouto	Rerewhakaaitu	Tahorakuri	Taupo	Whangarei	Tikitere	Reporoa	Kanui Station	Oroua Downs
S12	49	b c d	87	66	b c d	62	39	c d	46	e
S17	62	a	90	77	a b c	76	46	b c d	49	d e
S15	41	d	90	60	a b c	75	20	e	52	c d e
S14	65	a	94	67	c d	74	40	c d	44	e
P14	57	a b c d	88	76	a b c d	79	55	a b c	76	a
1C12	60	a b c	87	77	a b c d	76	36	d e	52	c d e
2C14	66	a b	92	81	a b c	59	59	a b	62	b c d
3C12	59	a b c	93	78	a b	75	59	a b	69	a b
3C16	55	a b c d	88	81	a b	71	62	a b	65	a b
4C17K	45	c d	90	83	a	67	64	a	73	a b
4C17O	51	b c d	94	84	a	72	62	a b	65	b c
Sig. (F-test)	*	ns	ns	**	ns	ns	**	ns	**	**

For each site, means followed by the same alphabetical letter are not significantly different (LSD test, P = 0.05)