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SPECIAL-PURPOSE BREED TRIALS
FORM ASSESSMENTS

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EXECUTIVE SUMMARY

In 1999, there was agreement between Stand Growth Modelling Cooperative and the Radiata Pine Breeding Cooperative (now Radiata Pine Breeding Company) to jointly support a series of trials to compare the performance of special-purpose breeds across regions. Two series were designed in 1991, one was planted in 1992 and the other in 1994 (FR Workplan 3211).

The Stand Growth Modelling Cooperative (SGMC) and the Radiata Pine Breeding Company (RPBC) jointly support this work which will extend knowledge gained from the genetic gain and silviculture/breed trials (Hayes, 2001). Data collected from these and other trials in the series will give a better understanding of the growth and performance of the improved breeds so that growth models can be developed or modified to reflect growth increase due to genetic improvement.

Plot establishment and silvicultural treatment has been completed according to plan in most cases. PSPs will be measured annually starting from the first winter after plot establishment. Each trial, once established, is measured during the same winter month each year for 4 years following plot establishment, then every two years following. A full establishment report, including growth data from these trials at the first measurement is presented in Stand Growth Modelling Cooperative Reports Nos. 101 and 106.

Forest Research GTI staff carried out form assessments at the time of PSP plot establishment for all trials in the 1992 and 1994 series. The data from these assessments is documented in this report. The following traits were assessed:

- Straightness
- Branching
- Malformation
- Acceptability

The results have been analysed for significant differences between seedlots.

SPECIAL-PURPOSE BREED TRIALS
FORM ASSESSMENTS

INTRODUCTION

In 1999, there was agreement between Stand Growth Modelling Cooperative and the Radiata Pine Breeding Cooperative (now Radiata Pine Breeding Company) to jointly support a series of trials to compare the performance of special-purpose breeds across regions. Two series were designed in 1991, one was planted in 1992 and the other in 1994 (FR Workplan 3211).

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Plot establishment and silvicultural treatment has been completed according to plan in most cases. PSPs will be measured annually starting from the first winter after plot establishment. Each trial, once established, is measured during the same winter month each year for 4 years following plot establishment, then every two years following. A full establishment report, including growth data from these trials at the first measurement is presented in Stand Growth Modelling Cooperative Reports Nos. 101 and 106.

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TRIAL LOCATIONS

Six sites were planted in the 1992 series, but one site at Riverhead Forest was abandoned before plot establishment. Three sites were planted in the 1994 series. Overall, five different growth regions are represented by these trials. Table 1 shows details of the all the Special-purpose Breed trials that are now part of a large series of genetically improved trials under the umbrella of the Stand Growth Modelling Cooperative.

TABLE 1. Trial sites established as part of the Special-Purpose Breed trial series.

Trial No.	Plant year	Forest Name	Forest Owner	Growth Region	Site Category
FR 172/1	1992	Woodhill	Carter Holt Harvey Forests	Auckland Sands	Low SI
FR 172/3	1992	Kaingaroa	Fletcher Challenge Forests	Central N. Island	Medium SI
FR 172/4	1992	Kinleith	Carter Holt Harvey Forest	Central N. Island	High SI
FR 172/5	1992	Takitoa	City Forests	Southland	High BA
FR 172/6	1992	Otago Coast	Wenita Forest Products	Southland	Medium SI
FR 215/1	1994	Kaingaroa	Fletcher Challenge Forests	Central N. Island	High SI
FR 215/2	1994	Rakautao	Carter Holt Harvey Forests	Auckland Clays	High BA
FR 215/3	1994	Tokoiti	City Forests	Southland	High BA

PLOT ESTABLISHMENT

PSP plot establishment (see Table 2) took place at various times between November 1999 and February 2001 as the funding schedule of the Stand Growth Modelling Cooperative allowed. GTI staff carried out visual form assessments at the time of PSP plot establishment for all trials (although not all plots were assessed at all sites).

TABLE 2. PSP plot establishment in the Special-Purpose Breed trial series.

Trial	Forest	PSPs Established	Age at Establish	Range of seedlots (GF)	No. plots
FR 172/1	Woodhill	Feb 2001	8.8	7, 13(LI), 14, 18, 27, 28	28
FR 172/3	Kaingaroa	Nov 1999	7.6	7, 13(LI), 14, 18, 27, 28	27
FR 172/4	Kinleith	Dec 1999	7.6	7, 13(LI), 14, 18, 27, 28	27
FR 172/5	Takitoa	Feb 2000	7.8	7, 13(LI), 14, 18, 27, 28	35
FR 172/6	Otago Coast	Feb 2000	7.8	7, 13(LI), 14, 18, 27, 28	25
FR 215/1	Kaingaroa	Nov 1999	5.6	7, 14, 15(LI), 18, 25, 30	36
FR 215/2	Rakautao	Sept 2000	6.2	7, 14, 15(LI), 18, 25, 30	36
FR 215/3	Tokoiti	Nov 2000	6.6	7, 14, 15(LI), 18, 25, 30	36

PLANTING STOCK

The planting stock used in these trials was selected to cover a range of special-purpose breeds such as high and low density, uninodal and highly multinodal, as well as some control seedlots of GF7 and GF14. Table 3 shows the range of seedlots used.

TABLE 3. Seedlots used in the special-purpose breed trials.

Stock	Seedlot Number	Breed	Description
GF7	88/102	Climbing select	Kaingaroa & Rotoehu climbing select
GF14	88/105	'850' orchard	OP mix of '850' series
GF14	3/3/87	'850' orchard	OP mix of Gwavas '850' series
GF13(LI25)	89/15	Uninodal	OP Tikokino mix of 7 clones
GF15(LI27)	'870' mix	Uninodal	CP mix of 3 clones
GF17	Tissue culture	Multinodal	TeTeko
GF18	'875' x '268' mix	High density	CP mix of 6 clones
GF18*	91/523	High density	OP Kaingaroa seed orchard
GF25	'875' x '268' mix	Highly multinodal	CP mix of 5 clones
GF27*	91/296, 91/297 mix	Highly multinodal	CP Proseed mix
GF28*	91/294	Low density	CP mix top 16 '268' clones x 850.55
GF30*	'850' x '268' mix	Low density	CP mix of one '268' clone x 850.55

FORM ASSESSMENT CODING

GTI staff carried out visual form assessments at the time of PSP plot establishment for all trials in the 1992 and 1994 series. The trials were also measured for growth (height and diameter) at the same time as part of normal PSP establishment procedures. The following assessments are summarised by trial (site) and seedlot, and the seedlot means are provided:

- Straightness
- Branching
- Malformation
- Acceptability

Straightness is graded on the stem from crooked to straight where:

1 = very crooked

9 = very straight

Branching is assessed on the number of whorls per year where 1 = one whorl per year, 2 = two whorls per year etc. and it follows that:

<5 = uninodal

>5 = multinodal

Malformation is assessed by point deductions. 1 point is deducted for each fault or malformation (eg. ramicorn, top out, forked etc) where:

9 = no malformation

1 = a real mess

Acceptability as a final crop tree is a combination of malformation, straightness and size. No dead trees were assessed for acceptability and not all plots were assessed so this rating may be biased. Assessments are coded 'in' or 'out' where :

1 = acceptable

0 = not acceptable

The mean score is a percentage of trees coded as acceptable (1)

FORM ASSESSMENT and GROWTH MEASUREMENT RESULTS

The 'Tukey' test was used (because the sample size was not equal for all treatments means) to test for significant differences between seedlots for the traits DBH (cm), height (m), straightness, branching and malformation. All trials, except the sites at Kaingaroa and Tokoiti Forests planted in 1994 (FR215/1 and FR215/3), had less than three plots planted in the GF7 seedlot. Consequently, the GF7 seedlot had significantly fewer trees in these trials, so this seedlot was not included in the analysis for significant differences (except at FR215/1 and FR215/3). Also the acceptability assessment was not tested because not all plots were assessed.

Seedlot mean values with the same letter are not statistically different.

Note: Assessments were not carried out at the same age. The ages ranged from 5.6 to 8.8 years (Table 4).

TABLE 4. Age of assessment for each trial.

Trial	Forest	Age at Assessment
FR 172/1	Woodhill	8.8
FR 172/3	Kaingaroa	7.6
FR 172/4	Kinleith	7.6
FR 172/5	Takitoa	7.8
FR 172/6	Otago Coast	7.8
FR 215/1	Kaingaroa	5.6
FR 215/2	Rakautao	6.2
FR 215/3	Tokoiti	6.6

1. FR 172/1, Woodhill Forest, February 2001 assessment results

Age 8.8 years

GF	Seedlot	N(DBH)	diameter	height	straight	branch	malform	accept
7 *	Climbing Select	18	20.5	12.2	7.7	6.8	7.5	0.78
13	Long internode	206	15.7 b	11.5 b	7.2 c	5.2 b	7.7 a	0.68
14	Gwavas SO	86	18.2 a	13.1 a	7.7 ab	6.5 a	7.7 a	0.70
18	High Wood Density	208	15.9 b	11.6 b	7.5 bc	6.7 a	8.1 a	0.71
27	Highly Multinodal	217	17.1 ab	11.9 b	8.0 a	7.1 a	8.1 a	0.77
28	Low Wood Density	199	17.3 a	11.8 b	7.4 bc	6.9 a	8.0 a	0.75

* The GF7 seedlot was not included in the significant difference test because sample size was too small.

Diameter

The GF7 seedlot has the largest mean diameter. The GF14 seedlot is also doing well, as for height. There are very little significant differences between the other seedlots.

Height

The GF14 seedlot is the tallest, on average and is significantly different to the other seedlots (note - there are only two plots).

Straightness

The GF13 and GF27 seedlots are significantly different, but they are all relatively straight trees.

Branching

The long internode seedlot, GF13, is significantly different from the others, but this site shows the least uninodal tendency overall. The GF27 seedlot is the most multinodal as expected.

Malformation

There are no significant differences between seedlots. Overall malformation is low at this site.

Acceptability

Overall acceptability is high at this site, with very little difference between seedlots.

2. FR 172/3, Kaingaroa Forest, November 1999 assessment results

Age 7.6 years

GF	Seedlot	N(DBH)	diameter	height	straight	branch	malform	accept
7*	Climbing Select	21	15.4	9.9	na	na	na	na
13	Long internode	221	14.5 b	10.2 a	4.9 c	2.7 c	6.1 b	0.21
14	Gwavas SO	81	14.5 b	10.4 a	6.0 b	5.8 b	6.9 ab	0.32
18	High Wood Density	226	15.2 b	10.4 a	6.2 b	6.3 b	7.2 a	0.48
27	Highly multinodal	225	17.1 a	10.3 a	7.1 a	7.3 a	7.6 A	0.58
28	Low Wood Density	199	15.1 b	10.4 a	6.0 b	6.1 bc	7.11 A	0.39

* The GF7 seedlot was not included in the significant difference test because sample size was too small. No form assessments were carried out for this seedlot.

Diameter

The GF27 seedlot is significantly larger for diameter growth. There are no significant differences between the other seedlots.

Height

There are no significant differences between seedlots.

Straightness

The GF27 seedlot is significantly different and these trees are much straighter than other seedlots.

Branching

The long internode seedlot, GF13, is significantly different and highly uninodal, as expected. The GF27 seedlot is highly multinodal as expected, and has the highest rating of all sites.

Malformation

There is very little difference between seedlots. Overall malformation is low at this site.

Acceptability

All seedlots except GF27 have a less than 50% acceptance as a final crop tree. The GF13 seedlot is very low with only 21% acceptance.

3. FR 172/4, Kinleith Forest, December 1999 assessment results

Age 7.6 years

GF	Seedlot	N(DBH)	diameter	height	straight	branch	malform	accept
7*	Climbing Select	22	16.3	9.8	4.4	3.8	6.8	0.41
13	Long internode	203	13.2 ab	9.8 ab	4.9 c	2.5 c	7.4 a	0.36
14	Gwavas SO	82	12.4 b	10.0 ab	5.8 ab	4.1 b	7.0 a	0.42
18	High Wood Density	214	14.4 a	10.3 a	5.4 bc	4.5 b	7.5 a	0.48
27	Highly multinodal	203	14.2 a	9.6 b	6.3 a	5.2 a	7.7 a	0.59
28	Low Wood Density	195	14.4 a	10.3 a	5.1 c	4.1 b	7.1 a	0.43

* The GF7 seedlot was not included in the significant difference test because sample size was too small.

Diameter

The GF7 seedlot has the largest mean diameter. There is very little difference between the other seedlots.

Height

GF18 and GF28 are the tallest seedlots, on average, but there is little significant difference between the seedlots.

Straightness

The seedlots are variable for straightness, with the GF7 seedlot the worst. The GF27 seedlot has a higher than average rating and is significantly different from the other seedlots except GF14.

Branching

The long internode seedlot, GF13, is significantly different and strongly uninodal, as expected. At this site all seedlots do have a uninodal tendency though, except the highly multinodal GF27 seedlot.

Malformation

There are no significant differences between seedlots. Overall malformation is low at this site.

Acceptability

All seedlots except GF27 have a less than 50% acceptance of live trees for the final crop. The GF13 seedlot has the lowest acceptance of 36%.

4. FR 172/5, Takitoa Forest, February 2000 assessment results

Age 7.8 years

GF	Seedlot	N(DBH)	diameter	height	straight	branch	malform	accept
7*	Climbing Select	25	19.5	8.8	4.7	3.2	6.5	0.15
13	Long Internode	243	18.6 bc	9.6 A	4.9 b	2.6 c	5.6 c	0.20
14	Gwavas SO	119	19.7 a	9.7 A	6.3 a	6.4 a	7.4 a	0.26
17*	Local clone	265	19.3 ab	9.9 A	5.8	4.1	5.7	na
18	High Wood Density	241	18.7 bc	9.7 A	5.3 b	5.1 b	6.5 abc	0.30
27	Highly Multinodal	232	19.2 ab	9.6 A	6.5 a	6.5 a	6.9 ab	0.45
28	Low Wood Density	245	18.3 c	9.7 A	5.3 b	4.8 b	6.3 bc	0.32

* The GF7 seedlot was not included in the significant difference test because sample size was too small. The GF17 seedlot was not included in the significant difference test for the straightness, branching and malformation assessments because the sample size was too small.

Diameter

The GF14 seedlot has the largest diameter and the GF28 the smallest, on average and these are significantly difference.

Height

The GF7 seedlot has the smallest mean height and the GF17 (local clone) has the tallest mean height.. There are no significant differences between the seedlots.

Straightness

Generally there is a low rating for straightness at this site, with the GF27 and GF14 seedlots performing best for straightness.

Branching

The GF14 and GF27 are shown to be very multinodal. At this site all other seedlots have a uninodal tendency though. The long internode seedlot, GF13, as expected, has the lowest number of whorls per year and the GF7 seedlot is also highly uninodal in this trial.

Malformation

There are no serious malformation problems indicated at this site. The GF14 and GF13 are the only seedlots that are significantly different.

Acceptability

The GF17 seedlot was not assessed at this trial. Overall acceptability is low at this site. Trees of GF7 and GF13 seedlots, in particular, have a very low acceptability rate (≤ 20%).

5. FR 172/6, Otago Coast Forest, February 2000 assessment results

Age 7.8 years

GF	Seedlot	N(DBH)	diameter	height	straight	branch	malform	accept
7*	Climbing Select	0	na	na	na	na	na	na
13	Long Internode	194	16.4 bc	9.0 ab	3.9 b	2.0 c	5.1 a	0.17
14	Gwavas SO	81	17.4 ab	9.2 ab	5.7 a	4.6 ab	6.1 a	0.34
18	High Wood Density	217	15.7 c	8.8 b	5.3 a	3.7 b	5.6 a	0.31
27	Highly Multinodal	209	17.7 a	9.3 ab	5.8 a	4.8 a	5.5 a	0.39
28	Low Wood Density	218	16.6 bc	9.4 a	4.9 ab	4.0 ab	6.8 a	0.36

* there are no plots in the GF7 seedlot at this site

There are <50 observations for each seedlot for the straightness, branching and malformation assessments at this site. This may bias the results.

Diameter

There are significant differences between two seedlots only, the GF14 and GF18, which have the largest and smallest diameters, on average, respectively.

Height

There are significant differences between two seedlots only, the GF18 and GF28 which have the shortest and tallest trees, on average, respectively.

Straightness

This site has the lowest straightness values overall (ie. trees tend to be rather crooked). There is very little significant difference between seedlots.

Branching

The GF13 seedlot, as expected, is significantly more uninodal than other seedlots. At this site, though all seedlots show a uninodal tendency, with no branching values >5 (even the highly multinodal seedlot).

Malformation

There are no significant differences between the seedlots but this site has the lowest (worst) malformation values overall. This site shows a tendency for greater malformation but the values are still above average.

Acceptability

Acceptability is particularly low for the GF13 seedlot (only 17% of live trees are acceptable as final crop trees). This seedlot also has noticeably low values for straightness and malformation. All seedlots have < 40% acceptance of trees for the final crop, which means this is a poor site for form.

6. FR 215/1, Kaingaroa Forest, November 1999 assessment results

Age 5.6 years

GF	Seedlot	N(DBH)	diameter	height	straight	branch	malform	accept
7*	Climbing Select	202	12.6 b	7.6 cd	5.6 c	4.2 c	6.2 b	0.33
14	Gwavas SO	183	12.9 ab	7.5 cd	5.9 bc	4.5 c	6.6 ab	0.38
15	Long Internode	210	12.7 b	7.8 bc	5.9 bc	2.0 d	6.6 ab	0.41
18	High Wood Density	194	13.1 ab	8.1 ab	6.6 a	6.1 a	7.4 a	0.61
25	Highly Multinodal	153	13.1 ab	7.4 d	6.4 ab	6.2 a	6.3 b	0.48
30	Low Wood Density	202	13.7 a	8.3 a	6.5 a	5.4 b	6.8 ab	0.54

* The GF7 seedlot was included in the significant difference test because the sample size was similar to all other seedlots.

Diameter

The GF30 seedlot also has the largest diameter on average, although there are only small differences between the means.

Height

The are significant differences between the seedlots for height. The GF30 seedlot is tallest, on average, and the GF25 the smallest.

Straightness

The straightness values are all above average. There is a significant difference between the GF30 and GF18 seedlots (highest values) and the GF7 seedlot (lowest value).

Branching

The long internode seedlot, GF15, is significantly different from the others, as expected. It only has 2 whorls per year on average. The three highest GF seedlots all have multinodal values (>5), with the GF25 highly multinodal seedlot having the highest value, as expected.

Malformation

There is very little malformation at this site (mean values >6). Most seedlots are not significantly different.

Acceptability

There is a wide range of differences in acceptability, ranging from 33% to 61% of live trees acceptable for final crop.

7. FR 215/2, Rakautao Forest, September 2000 assessment results

Age 6.2 years

GF	Seedlot	N(DBH)	diameter	height	straight	branch	malform	accept
7*	Climbing Select	67	19.7	11.5	5.3	5.9	5.5	0.19
14	Gwavas SO	215	19.1 b	12.1 ab	5.3 c	5.4 c	5.6 a	0.24
15	Long Internode	231	19.7 b	11.6 b	5.3 c	2.2 d	4.1 b	0.19
18	High Wood Density	235	20.0 b	12.2 a	6.7 a	6.8 ab	6.0 a	0.49
25	Highly Multinodal	235	20.0 b	11.8 ab	6.1 b	6.9 a	6.0 a	0.35
30	Low Wood Density	232	21.3 a	12.2 ab	6.9 a	6.4 b	6.0 a	0.51

* The GF7 seedlot was not included in the significant difference test because sample size was too small.

Diameter

The GF30 seedlot has the largest diameter, on average, and is significantly different from all other seedlots. There is very good diameter growth over all seedlots at this site though.

Height

The height growth, on average, is excellent, with very little difference between the seedlots.

Straightness

All seedlots are moderately straight, but the GF18 and GF 30 seedlots are significantly higher.

Branching

All seedlots are significantly different. The GF18, GF25 and GF30 are highly multinodal (>6), and the long internode, GF15, is highly uninodal, as expected.

Malformation

The GF15 long internode seedlot is significantly different from all other seedlots and is below average ie. fairly badly malformed on average.

Acceptability

There is a wide range of differences in acceptability, ranging from 19% to 51% of live trees acceptable for final crop. The GF7 and GF15 seedlots are very low (<20%).

8. FR 215/3, Tokoiti Forest, November 2000 assessment results

Age 6.6 years

GF	Seedlot	N(DBH)	diameter	height	straight	branch	malform	accept
7*	Climbing Select	119	15.2 c	7.8 bc	5.6 bc	5.0 d	6.9 ab	0.29
14	Gwavas SO	227	16.1 b	7.5 c	6.0 ab	5.6 c	6.1 bc	0.26
15	Long Internode	223	15.9 bc	7.8 bc	5.5 c	2.9 e	5.9 c	0.21
18	High Wood Density	218	16.3 b	8.0 b	6.2 a	6.6 ab	7.2 a	0.44
25	Highly Multinodal	217	16.2 b	7.8 bc	6.3 a	7.0 a	6.7 ab	0.38
30	Low Wood Density	234	17.3 a	8.7 a	6.4 a	6.3 b	6.6 abc	0.44

* The GF7 seedlot was included in the significant difference test because the sample size was similar to all other seedlots.

Diameter

The GF30 seedlot has the largest diameter on average, and is significantly different from the other seedlots. GF7 is the smallest seedlot on average.

Height

The GF30 seedlot is the tallest, on average. Height growth over all seedlots is slow at this site.

Straightness

All seedlots are above average straightness, with the GF30 the highest. The GF15 seedlot is significantly lower than other seedlots.

Branching

All seedlots are significantly different, although they are all multinodal (>5), except for the long internode, GF15, which is highly uninodal, as expected. The GF25 seedlot is extremely multinodal with almost 7 whorls per year on average.

Malformation

Malformation is relatively low at this site, with the GF18 seedlot having significantly less malformation than the GF15 seedlot.

Acceptability

All seedlots have < 45% acceptance of live trees for the final crop, which means this is a fairly poor site for form. The GF15 seedlot is the lowest at only 21% acceptance.