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THE COMPARISON OF IMPROVED AND UNIMPROVED SEEDLOTS OF *EUCALYPTUS NITENS* IN TWO TRIALS IN SOUTHLAND

R.McConnochie and C. Low

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R. McConnochie and C. Low, 2001

SUMMARY

Two *Eucalyptus nitens* trials in Southland were assessed in July 2001. One trial was the 1996 seed source trial at Overton, the other was a 1994 provenance trial at Blackmount.

At Overton the improved seedlots showed good gains for volume per hectare and form over a non-select seedlot from a McAlister provenance. There was an unusually high incidence of forking in all seedlots except for a seedlot comprising the best two families in PROSEED's Waikuku seed orchard. The Glentunnel seedlot performed similarly to the McAlister control seedlot.

The Blackmount provenance trial showed smaller differences between seedlots than the seed source trial. Findings of interest were a good performance from the Waiouru seedlot, an improvement in ranking from two early age assessments at one and two years to the seven year old assessment for a southern New South Wales seedlot and a poor performance from an *E. fastigata* seedlot.

INTRODUCTION

In the late 1980's the rate of *Eucalyptus nitens* planting increased significantly as several companies started to develop plantations for the production of short fibre pulp on a 10 –15 year rotation. This forestry development was predominantly in the Bay of Plenty and Southland and *E. nitens* was chosen as the species most suited to these regions because of its frost tolerance and fast early growth rate. Sufficient *E. nitens* seed for the annual establishment programme was not available from seed orchards and most of the seed was obtained from native provenance collections, from plantation stands of known origin and from genetic trials that had been converted into seed collection areas.

A large plot design is needed to estimate the volume production per hectare differences between seedlots over the length of the rotation. Restricted numbers of replications and large plot size can mean that microsite effects are more pronounced and error variance is larger for this design. On the other hand, row plots and single-tree-plots give precise early results and microsite variation and resulting plot error is controlled by a greater number of replications. However, these designs are unsuited for estimating volume production per hectare and inter-row and inter-tree competition effects between seedlots reduce the useful life of the trial.

A native provenance trial was planted in 1994 and seed source trial of commercial seed orchard seedlots was planted in 1996 at two Southland sites. The assessments at age 5 and 7 years is the subject of this report.

PART 1: 1996 SEED SOURCE TRIAL, OVERTON FOREST, SOUTHLAND

A seed source trial was established in 1996 to evaluate and compare the growth, form and wood properties of various commercially available seedlots that were being planted or that would be available for plantation establishment in the future.

MATERIALS AND METHOD

Genetic Material

Eight open-pollinated bulked seedlots were tested. The genetic quality of the seedlots varied from progeny tested, family identified clonal orchard seed to native population collections. There was no control-pollinated seedlot available for testing so two open-pollinated, progeny tested families from the Waikuku clonal seed orchard were selected to represent an elite seedlot. These families were selected based on breeding values from age 5-year assessment data of two North Island progeny tests. The seedlot origins are summarised in Table 1, more detail is given in Appendix 1.

Table 1. Seedlot Origins

Set	Seedlot Origin – central Victoria	No. of parents
A*	Proseed NZ, Waikuku Clonal Seed Orchard	2
B*	Waikuku Clonal Seed Orchard	28
C	96/070 Waiouru, Toorongo Provenance collection	-
D	Glentunnel, 1973 planted stand	-
E*	VRD 26 AMCOR Seed Orchard	29
F*	VRD 36 AMCOR Seed Orchard	17
G	94/09 McAlister State Forest, native population collection	178
H	A.E O'Connor PTY Ltd Seed Orchard	7

* Progeny tested

Trial Design and Establishment

The trial site is located in Overton Forest, on the Otapiri – Mandeville Rd north of Invercargill. The latitude is 46° 02'S, longitude 168° 35'E and altitude 320m. The site was previously pasture with a north-west aspect and the slope is less than 5°. Prior to establishment the area was ripped and mounded, the seedlings were fertilised with 80gms of DAP at the time of planting and the weeds were chemically controlled for the first two years. The understory growth is managed by grazing.

The seedlings were raised in the ***Forest Research*** nursery. The seed was sown into trays in July 1996, then pricked out into 170ml root trainers immediately after germination. In October 1996 the seedlings were air-freighted to Invercargill the day before planting.

The trial was planted as randomised complete blocks with 6 replications of 64-tree plots, each plot was 0.061ha. The establishment stocking was 1050sph at a 3.4m x 2.8m spacing. There have been no silvicultural treatments applied to the trial.

Assessment Traits

An inner subplot of 6 rows by 6 trees was measured to allow a two-tree buffer between seedlots. All data was recorded according to the tree position in the plot and entered into a CMT field data logger.

Stem diameter-over-bark (dbh) was measured in the inter-whorl nearest breast height (1.4m). Where there were two stems at the measurement point, only the largest stem was measured. A combined assessment of stem form, including stem straightness, malformation and branching was subjectively scored using a 1-9 scale, where 1= multiple forks, sinuous, heavy branching to 9 = single, straight stem with fine branching. Dead or missing trees were recorded and trees with a DBH less than 60mm were recorded as "too small". For purposes of basal area per hectare calculation these small trees were each assigned a diameter of 50 mm.

Basal forking occurring below 0.5m was ignored; as this is generally a response to environmental factors (frosting, mechanical or animal damage) and is not a genetic characteristic.

A sample of 20 – 26 trees per seedlot was measured for height using a Vertex® within one replication of each seedlot. The measurements were recorded against the tree position.

A single bark-to-bark 12mm increment core was collected at breast height from a sample of 15 trees per seedlot previously measured for dbh, height and assessed for stem form.

DATA ANALYSIS

The trial layout is a randomised complete block design. The equation for the model of an analysis of variance for a randomised complete block design is as follows:

$$Y_{ij_k} = \mu + R_i + P_j + R_i x P_j + E_{ij_k}$$

Where :

Y_{ij_k} = the observation on the k^{th} tree in the i^{th} replicate of the j^{th} provenance (or seedlot)

μ = the overall mean

R_i = the random effect of the i^{th} replicate

P_j = the fixed effect of the j^{th} seedlot

$R_i x P_j$ = the interaction between the i^{th} replicate and the j^{th} seedlot

E_{ij_k} = the random error associated with the k^{th} tree in the i^{th} replicate of the j^{th} seedlot

A feasibility check was run on the data using Proc Univariate of the SAS® software package (SAS Institute, 1990). The form scores showed an unusual distribution, so the number of trees from each seedlot for each score was listed using Proc Freq.

The analysis of variance was done using Proc GLM of the SAS® software package (SAS Institute, 1989). Replicates were considered to be random effects and seedlots were considered as fixed effects. The Tukey multiple range test option was used to test the significance of seedlot mean differences. Tree height was measured on a sample of trees per seedlot, height for the remaining trees was estimated using the relationship between height and diameter as determined by PROC REG. Volume per hectare was estimated using diameter and actual height on trees that had been measured for height, or predicted height where heights were not measured.

RESULTS AND DISCUSSION

The F-tests from the analysis of variance are shown in Table 2. There was a significant replicate effect for diameter, revealing microsite variation and there was also a significant replicate by seedlot interaction. These effects are understandable as the large plot size makes it difficult to fit an entire replicate onto a homogeneous site. The large significant rep x seedlot interaction reduces the precision of seedlot means reflected in the Tukey's multiple range test.

Table 2. Overton analysis of variance

Source	Degrees of Freedom	Diameter	Form
Rep	5	4.36**	1.53
Seedlot	7	3.28**	6.95***
Rep*Seedlot	35	2.69***	1.54*
Error	1508		

The range of seedlot means (Table 3) for diameter was 119 to 135mm from the best seedlot (VRD_36) to the worst seedlot (Glentunnel). The VRD36, two-family Waikuku, and O'Connor Seed Orchard seedlots were significantly better than Glentunnel for diameter. The Glentunnel seedlot has performed the poorest for all traits. This seedlot was collected from a small private stand located in inland Canterbury. This stand is itself second-generation from a small number of parents in the original stand leading to inbreeding in this seedlot. The poor growth and form of the Glentunnel seedlot is evident in the stands established by South Wood Export Ltd in Southland in the early 1990's (G. Manley pers. comm).

There is a much larger spread of seedlot means for form and hence larger potential genetic gains for this trait. The two-family Waikuku seedlot is significantly better for form than the Waiouru, O'Connor, McAlister and Glentunnel seedlots. As shown in Figure 1., there is a high incidence of '2' scores for seedlots B,C,D,E,F,G,H. A score of '2' reflects forking within the height of the first log.

Table 3. Overton *E. nitens* seed source trial, age 5 assessment, July 2001

Seedlot	No. Trees	Diameter mm	Form	Height dm	No. Heights	Basal Area/ ha.	Volume m^3/ ha.	Density Kg/m^3
VRD_36	197	135 a	6.41 ab	93	24	14.0	50.2	441
O'Connor	201	131 a	5.84 bc	93	20	13.7	48.7	428
Waikuku 2	199	131 a	6.98 a	95	26	13.3	47.1	446
Waikuku 28	192	129 ab	6.56 ab	88	24	12.7	44.8	438
Waiouru	193	129 ab	5.79 bc	94	23	12.5	44.1	428
VRD_26	188	128 ab	6.04 abc	86	22	12.2	43.1	453
McAlister	188	127 ab	5.28 c	84	24	11.9	41.5	426
Glentunnel	198	119 b	5.74 bc	83	21	11.2	38.0	434

The GLM Procedure

Tukey's Studentized Range (HSD) Test for DEC05

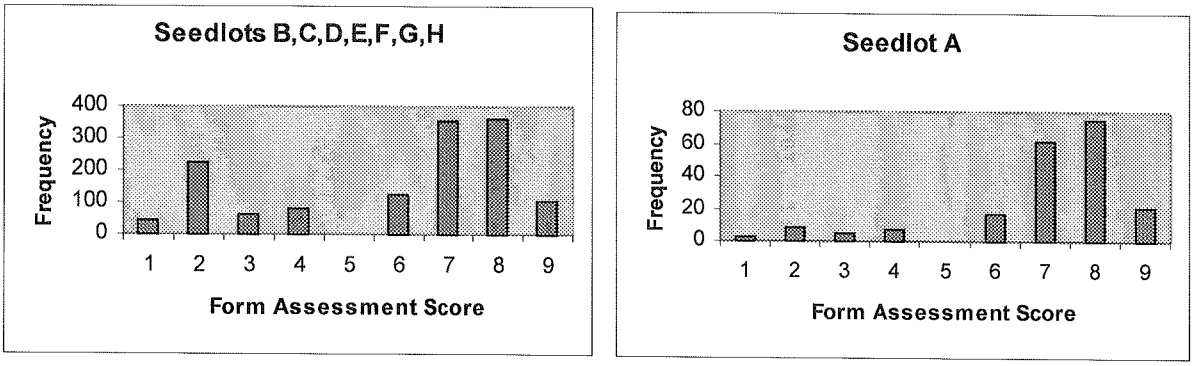
NOTE: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than REGWQ.

Alpha	0.05
Error Degrees of Freedom	152
Error Mean Square	650.6663
Critical Value of Studentized Range	4.34676
Minimum Significant Difference	24.793

Means with the same letter are not significantly different.

Tukey Grouping	Mean	N	SDLT
A	445.425	20	VRD_26
A			
A	444.075	20	Waikuk_2
A			
A	442.475	20	Waikuk30
A			
A	437.550	20	VRD_36
A			
A	430.700	20	Glentunne
A			
A	428.775	20	Waiouru
A			
A	427.775	20	McAlister
A			
A	426.675	20	Sumner

Figure 1. Frequency distributions of the form assessment score



Progeny-tested seedlot VRD 36 is a subset of 17 families from the 29 families in VRD26 (see Appendix1). VRD36 scored better than VRD26 for growth, form and height, but the differences were not significant.

The survival across all seedlots was 89 – 93%. The VRD36 seedlot has the largest volume per hectare, 50.2m^3, followed by O'Connor, 48.7 m^3 and Waikuku 2, 47.1m^3.

Basic Wood Density

The 5mm bark-to-bark increment core samples were collected from 15 trees in each seedlot and the average density value calculated for the whole core. Seedlot mean densities ranged from 426 kg/m^3, McAlister to 453 kg/m^3, VRD_26, however the differences between seedlots were not significant.

Table 4. Basic Wood Density of Seedlots

Seedlot	Basic Wood Density kg/m^3		
	Min	Max	Mean
VRD_26	408	526	453
Waikuku 2	409	466	446
VRD_36	403	489	441
Waikuku 28	410	482	438
Glentunnel	401	473	434
Waiouru	404	454	428
O'Connor	380	467	428
McAlister	390	491	426

Differences between each seedlot mean and the native population from McAlister for each trait in Table 4.
Realised gains in seedlot performance of the seedlot groups are given in Table 5.

Table 5. Percentage gain of seedlots at Overton over the McAlister seedlot

Seedlot	No. trees	Diameter	Form	Height	Basal area	Volume	Density
Waikuku 2	199	3.1	32.2	13.1	11.8	13.5	4.7
Waikuku 30	192	1.6	24.2	4.8	6.7	8.0	2.8
Waiouru	193	1.6	9.7	11.9	5.0	6.3	0.5
VRD_36	197	6.3	21.4	10.7	17.6	21.0	1.9
VRD_26	188	0.8	14.4	2.4	2.5	3.9	6.3
O'Connor	201	3.1	10.6	10.7	15.1	17.3	3.5
Glentunnel	198	-6.3	8.7	-1.2	-5.9	-8.4	0.5
McAlister	**188**	**127mm**	**5.28**	**84dm**	**11.9 m^2/ha**	**41.5 m^3/ha**	**426 kg/m^3**

CONCLUSIONS

The trees in this trial were approaching age 5 years and some of the improved seedlots are significantly better for growth and form. In particular the two family collection from Waikuku seed orchard and the selected families from the VRD seed orchard show gains of 13-21% for volume, 21-32% for form and 4.7 to 6.3% for density. The general crown health of all the seedlots in the trial was good though health was not scored. The trial design will allow the performance of these seedlots to be monitored through to rotation age.
Reselection of orchard seed parents at the Waikuku and Amcor orchard, based on progeny test results has resulted in substantial improvement over the orchard wide seed collection. Volume per hectare differences between seedlots will increase as the small differences in survival become less important as the site becomes fully occupied. Inbreeding could be playing a large role in the poor growth performance of the Glentunnel seedlot. However there is a positive genetic gain for density. This trait appears to be less affected by inbreeding in *E.nitens*, as was reported by Hardner and Tibbits, 1996.

PART 2: 1994 PROVENANCE TRIAL SIMMS BLOCK, BLACKMOUNT

In 1994 a *Eucalyptus nitens* provenance trial was established at Simms Block, Blackmount in Southland. This trial was the initiative of Takayuki Asada, a visiting scientist from Japan with the New Oji Paper Co. Ltd.

MATERIALS AND METHOD

Genetic Material

The seedlots are mainly central Victorian provenance collections purchased from the Australian Tree Seed Centre in Canberra. Five additional seedlots were included, three commercial seedlots that were being planted by South Wood Export Ltd or could be used in the future, a seedlot from southern New South Wales and a seedlot of *Eucalyptus fastigata*. The seedlots were selected and obtained by T.Asada.

Table 6. Seedlots planted in the 1994 Provenance Trial, Simms Block, Southland

CSIRO No.	*Provenance / Seed origin		Latitude	Longitude	Altitude (m)
16750	M	Mt Skene	37°27'S	146°24'E	1200
16751	M	Mt Useful	37°40'S	146°30'E	1240
16868	R	7 kms NNW Rubicon	37°18'S	146°49'E	1000
16869	T	Toorongo Plateau	37°54'S	146°00'E	1000
16906	T	Erica	37°50'S	146°20'E	800
16915	T	Erica Township	37°50'S	146°23'E	1000
16952	M	Matlock	37°35'S	146°11'E	1100
17758	M	MacAlister	37°30'S	146°26'E	1200
18073	T	Mt Horseful	37°47'S	146°02'E	1100
18075	R	Blue Range	37°24'S	145°48'E	1000
18145	T	Thomson SF, Erica	37°44'S	146°17'E	1005
18164	SNSW	Tallaganda	35°59'S	149°30'E	1100
18310	Mix	APPM			
89/725	T	Glentunnel			
93/60	T	Waiouru			
88/172		*E.fastigata*, Rossi			

* R = Rubicon
T = Toorongo
M = McAlister
SNSW = Southern New South Wales

Trial Design and Establishment

The trial site is located on the Clifton-Blackmount Rd west of Invercargill. The latitude is 45°52'S, longitude 167°42'E, and altitude 220m. The site was previously pasture and prepared by ripping and rotary hoeing. The trial was pegged, planted and mapped under the supervision of personnel from the Genetics and Tree Improvement group at ***Forest Research***. The seedlings were raised in large root trainers at Edendale nursery except for *E. fastigata* and *E.nitens* SNSW that were supplied by the Tasman Forestry nursery at Te Teko.

The 16 seedlots were planted in two different trial designs;

1. A randomised complete block design with single-tree-plot design and 16 replications.
2. Small square plots of 16 trees (4 trees x 4 trees) with 2 to 6 replications per seedlot in a complete random block design.

ASSESSMENT AND DATA ANALYSIS

These trials were assessed in July 2001 at age 7 years. All seedlots and replications of the single-tree-plot trial were measured for diameter at breast height, and assessed for tree form scored as for the Overton trial. Six of the 16 seedlots planted in the block design were measured in four replications. A sample of heights was measured in the 16 tree plots and there were no increment cores collected from either the STP or block plantings.

The main analysis was analysis of variance, using Proc. GLM of the SAS® software package (SAS Institute, 1989). Replicates were considered to be random effects and seedlots were considered as fixed effects.

Table 7. Blackmount *E. nitens* provenance trial, 16-tree plots, analysis of variance. *E. nitens* seedlots only

Source	Degrees of Freedom	Diameter	Form
Rep	3	3.33	1.62
Seedlot	4	2.11	2.09
Rep*Seedlot	12	2.44**	1.61
Error	287		

RESULTS AND DISCUSSION

Table 8. Blackmount *E. nitens* trial, age 7 provenance means, July 2001

Seedlot	No. Trees	Diameter mm	Form	Height dm	No. Heights	Basal Area m^2/ ha.	Volume m^3/ ha.
Waiouru	63	173	7.59	128	24	25.0	122.0
Toorongo	62	163	7.27	121	25	21.6	100.5
SNSW	55	173	7.05	123	21	21.7	102.9
APPM SO	64	159	6.75	123	24	21.4	98.4
Glentunnel	63	165	6.35	119	22	22.6	104.6
E. fastigata	39	110	5.51	91	12	8.6	32.6

There were no statistical differences in DBH or form score amongst the six seedlots measured in the 16-tree plot trial. However it was evident that *Eucalyptus fastigata* has performed poorly at this site; survival, growth and form was well below that of all the *E.nitens* seedlots. *E. fastigata* was represented by only one seedlot from Rossi and this collection has shown to be poor for form and growth at other sites. In this trial the plots of *E.fastigata* were disadvantaged by early competition from the neighbouring *E.nitens* plots. This result is not a fair representation of *E.fastigata* performance in Southland. The southern NSW seedlot had good growth and form, although survival was less than the central Victorian seedlots. *Eucalyptus nitens* from

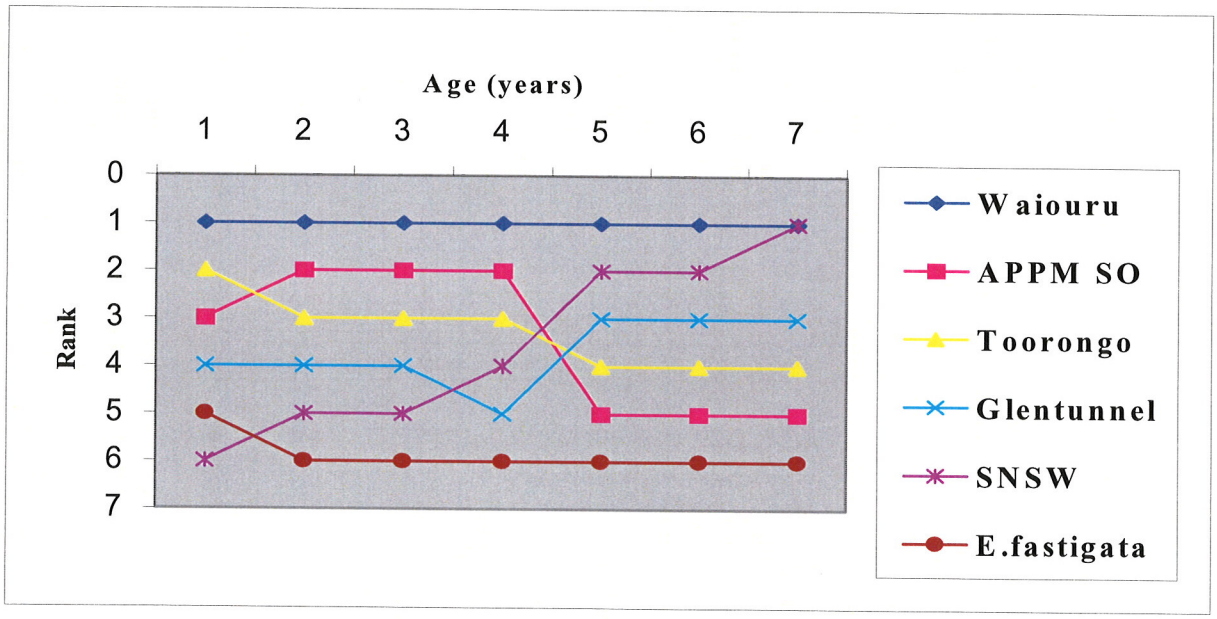
New South Wales has been reported to be slower growing when young but to have better crown health than the central Victorian origins. The seedlot represented in the Blackmount trial is from 70 parent trees in Tallaganda S.F., which was slower-grown than other SNSW lots assessed in a Northland trial (Shelbourne *et al*, 2000). The seedlings of *E.nitens* from SNSW and *E.fastigata* were considerably smaller at planting and this may have impacted on the survival of the two seedlots.

The seedlot from APPM (now North Forests Products) seed orchard had the lowest volume per hectare. The seed was collected from the 22 lowest ranked families in a family test when it was thinned at age 16 years. The poor performance of the seedlot could therefore be expected. The parents were a mix of Toorongo, McAlister, Rubicon and Errinundra provenances.

The inferior ranking for DBH for Glentunnel and high ranking for Waiouru seedlots is consistent with the result of these same seedlots at the Overton trial.

There were two early height measurements recorded by T.Asada at age 1 and 2 years. The change in rankings for the six seedlots is shown in Figure 2. The rankings at age 1 and 2 years are based on height, while the age 7 year ranking is based on diameter (DBH).

Figure 2. Growth versus age – seedlot ranking



There were two changes in the rankings of the seedlots that are of interest. The seedlot from APPM seed orchard is les well ranked at age 7 years than at the age 1 and 2 year measurement. In contrast the seedlot from Tallaganda NSW has improved from a low ranking at age one and two years to first equal with the central Victorian seedlot. Seedlots from NSW have shown to perform better over time than central Victorian provenances particularly on warmer sites measurement (Low, 2000). Normally this is attributed to poor crown health in the central Victorian provenances, however there did not appear to be any differences in crown health between the seedlots at this trial site.

Table 9. Blackmount, *E. nitens* provenance trial, single tree plot, analysis of variance

Source	Degrees of Freedom	Diameter	Form
Rep	15	1.56	2.34**
Seedlot	14	1.82*	2.32**
Error	181		

Table 10. Provenance means, Blackmount *E. nitens* single tree plot trial

Code	Provenance	No. Trees	Diameter	Form
401	R Rubicon	15	182 a	5.67 b
402	R Blue Range	15	174 ab	7.07 ab
408	T Mt Horsfall	14	173 ab	8.36 a
406	M Mt Useful	12	173 ab	6.25 ab
453	T Waiouru	15	169 ab	7.00 ab
410	T Erica Town	16	169 ab	6.81 ab
409	T Erica	14	167 ab	6.71 ab
405	M Matlock	14	166 ab	5.50 b
451	Mix APPM SO	16	165 ab	6.56 ab
407	T Thomson, Erica	13	162 ab	7.92 ab
488	SNSW Tallaganda,	10	162 ab	6.30 ab
404	M McAlister	13	161 ab	5.38 b
452	T Glentunnel	15	160 ab	5.87 ab
999	T Toorongo	15	155 ab	6.53 ab
403	M Mt Skene	14	152 b	7.43 ab
222	*E. fastigata,* Rossi	8	93	6.43

Survival was high for all the Victorian seedlots, but poorer for the stock of southern NSW and *E.fastigata* from Te Teko nursery. Population mean diameter at breast height (DBH) varied from 152mm for Mt Skene to 182mm for Rubicon. These two populations were significantly different, but the remaining Victorian populations and southern NSW population did not differ significantly. Form score ranged from 5.38 for McAlister to 8.36 for Mt Horsfall and this population was significantly better formed than McAlister, Matlock and Rubicon. It was noteworthy that the southern NSW seedlot behaved much the same as the Victorian populations for growth and form on this Southland site. *E.fastigata* grew much slower than *E.nitens* but the seedlot is known to be inferior and planted in small blocks among *E.nitens* it was competing with the fast initial growth *E.nitens*.

At this age the DBH of the second-generation Glentunnel and APPM seed orchard seedlot was about the same and no higher than that of the various native population seedlots. In the adjacent 16-tree plot trial the Waiouru seedlot had grown best-equal with the Tallaganda (SNSW) seedlot. It was notable therefore that at this stage the native population seedlots were not inferior to outcrossed Waiouru and the APPM seed orchard seedlot. This expected inferiority may well develop as inter-tree competition develops in this trial. As reported by King and Wilcox, 1988, and Gea *et al*, 1997 there is no consistent indication as to which is the best provenance overall and that provenance alone can not be used to select the best seedlot.

CONCLUSIONS

Eucalyptus fastigata appears to be unsuited to this Southland site, though early growth of *E.fastigata* can be expected to be less than *E.nitens* even on favourable North Island sites. The inbred Glentunnel seedlot grew slower than other seedlots as might be expected. The southern NSW native population seedlot has grown as well as the best performing second-generation Waiouru seedlot of central Victorian origin. This is an interesting result that needs to be confirmed at later ages.

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REFERENCES

Gea L., McConnochie R., Hong M. and Shelbourne C.J.A. 1997 Variance component differences for first and second generation *E. nitens* progenies. In Proc. IUFRO Conference on 'Silviculture and Improvement of Eucalypts'. Vol 1: Tree Improvement Strategies. Salvador, Brazil.

Gea L., Mc Connochie R. and Borralho N. 1997. Genetic parameters for growth and wood density traits in *Eucalyptus nitens* in New Zealand. New Zealand Journal of Forestry Science 27 (3): 237-244

Hardner, C and Tibbits, W. 1996. Wood density in *Eucalyptus nitens* is under strong additive genetic control but inbreeding is absent. In proceedings, Tree Improvement for Sustainable Tropical Forestry. QFRI-IUFRO Conference, Caloundra, Queensland, Australia.

King, J.N and Wilcox, M.D. 1988. Family tests as a basis for the genetic improvement of *Eucalyptus nitens* in New Zealand. New Zealand Journal of Forestry Science 18(3): 253-66

Low,C. 2000. Performance of 7 year old *Eucalyptus nitens* provenances on a warm site at Rotoehu Forest. Eucalypt Breeding Cooperative Report No. 33;

McConnochie, R,M, Maika, D.C. Establishment report for 1996/97 *Eucalyptus nitens* seed source and *septoria* infection trial. 1998. Unpublished report.

SAS Institute inc. 1989: SAS/STAT® User's Guide, Version 6, Fourth Edition, Cary, North Carolina

SAS Institute inc. 1990: SAS® Procedures Guide, Version 6, Third Edition, Cary, North Carolina

Shelbourne, C.J.A, Low,C.B, Smale, 2000. Eucalypts in Northland: 7- to 11-year results from trials of nine species at four sites. New Zealand Journal of Forestry Science 30(3):366-383

APPENDIX 1. Seedlot information for the Overton Trial.

R = Rubicon
T = Toorongo
M = McAlister

Waikuku Clonal Orchard (Best 2 families)

- Grafted clones
- Established 1989 with best 30 families from age 8-year assessment of 1979 *E.nitens* Provenance/progeny trial.
- Ortets located in provenance/progeny trial at Rotoaira
- Top 2 families selected based on age 5-year assessment of 1990 progeny test (growth, form, pilodyn)

Clone No.	Family		Provenance
874	81	M	Conners plain
893	78	M	Conners plain

Waikuku Clonal Orchard

- As above, however, 28 families in the seedlot.

Clone No.	Family		Provenance
102	29	T	Mt Erica
104	111	T	Mt St Gwinear
106	6	M	Heyfield
107	89	T	Mt Erica
109	113	T	Mt Erica
110	71	R	Blue Range
112	114	T	Mt Erica
113	9	R	Mt Torbreck
811	6	M	Heyfield
824	29	T	Mt Erica
864	20	T	Toorongo Plateau
865	73	R	Blue Range
867	111	T	Mt St Gwinear
870	92	T	Mt St Gwinear
874	81	M	Conners plain
875	84	T	Mt St Gwinear
876	26	T	Mt Horsfall
881	20	T	Toorongo Plateau
882	26	T	Mt Horsfall
887	112	T	Pennys Saddle
888	14	R	Cathedral Range
889	24	T	Mt Horsfall
890	92	T	Mt St Gwinear
893	78	M	Conners Plain
895	114	T	Mt Erica
896	24	T	Mt Horsfall
897	82	T	Mt Erica
898	114	T	Mt Erica

96/070 Waiouru

- Amenity plantings in Waiouru Township and Military Camp
- Toorongo Plateau origin
- Number of parent trees is unknown

Glentunnel

- Stand located inland Canterbury.
- Originally planted in 1960 presumably with seed collected from the Mt Erica locality. Seed collected from the 1960 stand was planted in 1973 and used for commercial seed collection.
- Number of parent trees is unknown

VRD 26

- Progeny trial, established in 1978 by AMCOR

No. Families	Provenance
18	St Gwinear / Toorongo
10	Rubicon / Blue Range
7	Toolangi / Other

Total 35

- Rogued to 29 families based on 9 year assessment (growth, stem, branch angle, branch retention)

VRD 36

- Established in 1978, with 26 of the 35 families planted in VRD26
- Rogued to 17 families based on ranking of family mean index scores from VRD26 and phenotypic selection within families.

94/09 McAlister State Forest, Victoria

- Seed supplied by Kylisa Seeds PTY Ltd
- Native stand collection from Connors Plain and Barky River Road locality
- Latitude 37°33', Longitude 146°29', Altitude 1200 – 1308m ASL
- 178 parent trees

A.E. O'Connor PTY.Ltd

- Seedling Seed orchard located at Sumner Spur, Powellton District.
- Established in 1974
- First generation unrogued seed orchard

Family Code No.		Provenance
11	R	Tweed Spur
13	R	Tweed Spur
14	R	Royston Road
17	R	Snobs Creek
20	R	Mt. Torbreck
44	M	Barkley Road
46	M	Mt. Useful