RESULTS OF PROVENANCE TESTING OF *ACACIA DEALBATA*, *A. MEARNSII*, AND OTHER ACACIAS AT AGES 7 AND 5 YEARS IN NEW ZEALAND

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ABSTRACT

Provenance and species trials of *Acacia dealbata* Link. (31 seedlots) and *A. mearnsii* de Wildeman (23 seedlots), together with one or a few seedlots each of *A. decurrens* (Wendl.) Willd., *A. falciformis* D.C., *A. filicifolia* Cheel. & Welch ex Welch, *A. melanoxylon* R.Br., and *A. silvestris* Tind. were planted at five sites in 1989 and at two sites in 1991. All trials were assessed in 1996 at ages 7 years and 5 years (for 1991-planted trials) for diameter at breast height (dbh), bole straightness (score 1–9), and malformation (score 1–5). A small subsample of trees from seven seedlots each of *A. mearnsii* (from two sites) and of *A. dealbata* (from three sites) were assessed for height, dbh, and wood density (5-mm pith-to-bark cores) at age 7 years.

Acacia dealbata and *A. mearnsii* greatly outgrew the other species, and were of much better form than all except *A. silvestris*. Both *A. dealbata* and *A. mearnsii* showed large and significant differences between seedlots (mostly provenances) in diameter growth and bole straightness, and *A. dealbata* did in malformation. For *A. dealbata* trials aged 7 years, overall mean dbh varied from 206 mm at Kinleith to 145 mm at Tuki Tuki (Havelock North); for *A. mearnsii* (not assessed at Kinleith), site mean dbh ranged from 151 mm at Tuki Tuki to 135 mm at Pohangina (Palmerston North). Averaged across three sites, dbh of the best three seedlots of *A. dealbata* was 175 mm compared with over 162 mm for the best three seedlots of *A. mearnsii*.

The seedlots of *A. dealbata* with better growth and form were reasonably free of malformation and their bole straightness was acceptable for sawlogs. All seedlots of *A. mearnsii* were much more sinuous in stem form than *A. dealbata*, such that very few trees would be straight enough for sawlogs. Height of *A. dealbata* averaged 12 m at Tuki

Tuki and up to 15 m at Kinleith. Height of *A. mearnsii* averaged 12 m at Tuki Tuki and Emerald Hills.

Basic wood density of *A. dealbata* averaged 369 kg/m^3 at Kinleith, 371 kg/m^3 at Emerald Hills, and 412 kg/m^3 at Tuki Tuki. By contrast, wood density of *A. mearnsii* averaged 553 kg/m^3 at Tuki Tuki and 556 kg/m^3 at Emerald Hills. There was substantial variation between seedlots in both species, with a range of 348 to 437 kg/m^3 for *A. dealbata* (averaged over three sites) and of 521 to 573 kg/m for *A. mearnsii* (over two sites).

The better provenances of *A. dealbata* show promise for sawlog and pulpwood production, based on rapid growth rate, acceptable bole straightness and wood density, and (from other work) good sawing, seasoning, and appearance characteristics. The rapid growth rates and high wood density of *A. mearnsii* in New Zealand, as well as existing market acceptance of South African material for pulp, indicate a real potential for this species for pulpwood.

Keywords: provenance; growth; form; wood density; *Acacia dealbata; A. mearnsii.*

INTRODUCTION

The New Zealand forest industry relies heavily on one softwood species, *Pinus radiata* D. Don, which constitutes more than 90% of the present plantation forest estate. There is a need to diversify in New Zealand by growing other species to provide a wider range of products as well as greater genetic diversity, as insurance against changing markets as well as changing climatic and biotic factors. In particular, hardwood species with rapid growth, adaptability to a wide range of soils and climates, decorative timber with good sawing, seasoning, and strength properties, and/or with good pulping properties would be valuable additions to New Zealand forestry.

Acacia dealbata (silver wattle), is widely distributed in south-eastern Australia and Tasmania (Boland *et al.* 1984) (Fig. 1). It ranges in latitude from 30°S in northern New South Wales (NSW) to 43°S in Tasmania, and is found at elevations from 350 to 1000 m in the Australian Alps from Victoria to northern NSW and from 50 to 500 m in Tasmania. *Acacia dealbata* is a large shrub or tree which reaches heights of 25–28 m in its best development in Tasmania and Victoria where it is adapted to heavy frosts and snow. It is found in association, largely as an understorey, with such species as *Eucalyptus regnans* F. Mueller, *E. delegatensis* R.T.Baker, *E. fastigata* Deane et Maiden, and *E. viminalis* Labill. (all well-adapted species in most parts of New Zealand).

Acacia mearnsii (black wattle) has a similar latitudinal distribution to *A. dealbata* (Fig. 1), ranging from 34°S to 43°S (in Tasmania) at elevations up to 1070 m (Boland *et al.* 1984; Brown & Ho 1997). It is found on coastal lowlands and adjacent lower slopes of tablelands and ranges, sites which are generally warmer and drier than those occupied by *A. dealbata*, and is associated with many eucalypt species, including, *E. cypellocarpa* L. Johnson, *E. radiata* Sieb. ex DC. ssp. *robertsonii*, *E. muelleriana* Howitt, and *E. viminalis*.

Acacia species have established roles for soil conservation and shelter, especially in drought-prone areas, and soil conservation work with this genus preceded most plantation-forestry research in New Zealand (Sheppard 1987). Systematic evaluation of a range of *Acacia* species was begun by the National Plant Materials Centre (NPMC), Aokautere, Palmerston North, in 1973 and field trials were established between 1978 and 1988 on 16 sites in the North Island (B.T.Bulloch unpubl. data) and on 14 sites in the South Island

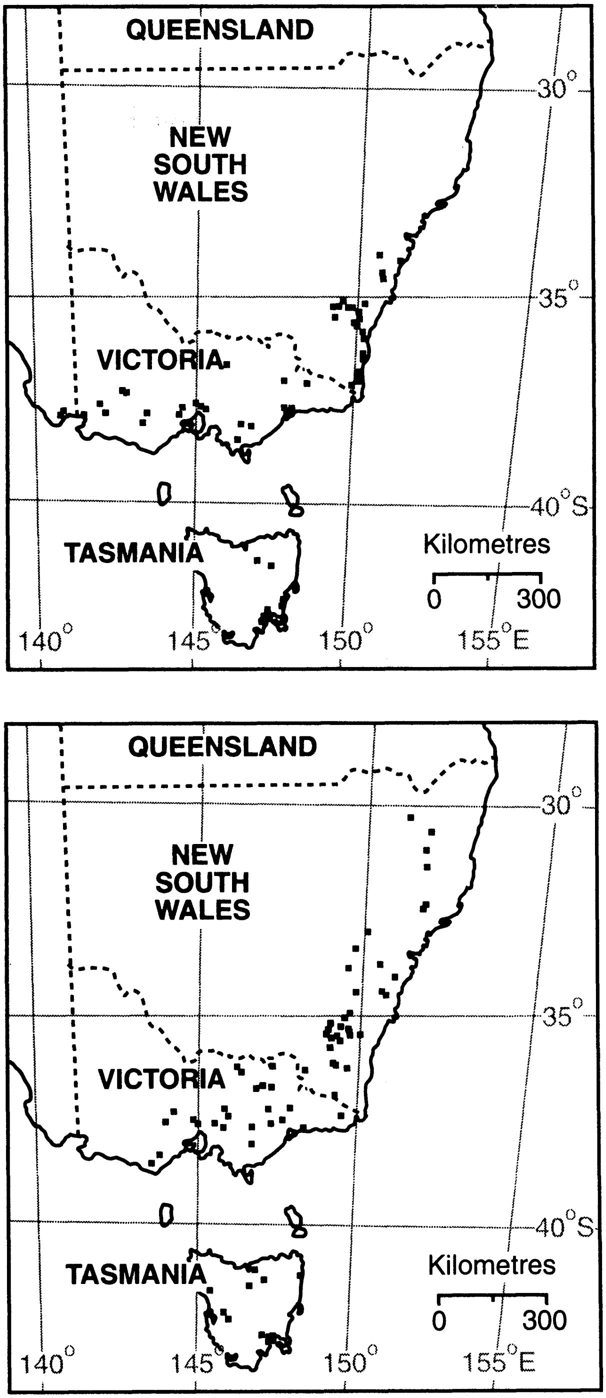

FIG. 1–Natural distribution of *Acacia mearnsii* (top) and *A. dealbata* (bottom). Source: Boland *et al.* (1984)

(J.S.Sheppard unpubl data). Results of assessments of survival, height, diameter, and form were combined into performance categories of "upper" (with one least significant difference (LSD) below the best) and "lower" (with one LSD above the worst), the rest being assigned to a "middle" category (Bulloch unpubl. data). The resulting groupings by species and site in the North Island showed that *A. melanoxylon*, *A. dealbata*, *A. mearnsii*, and *A. silvestris* had the highest frequency of "upper" performance rankings among the 56 species tested, and *A. dealbata* seedlots were in general the best performers of these four species. There were 10 seedlots of *A. dealbata* and six of *A. mearnsii* included altogether and there were strong indications of large seedlot differences within both species. The same group of species performed well in the South Island, including also *A. decurrens*.

There has been little interest by the New Zealand forest industry in the genus *Acacia* (syn. *Racosperma*), except for *A. melanoxylon* (Tasmanian blackwood), of which there has been very limited use by industry and some enthusiastic farm-forestry planting. A research programme at the New Zealand Forest Research Institute on pruning and thinning regimes and growth modelling of *A. melanoxylon* has been maintained since 1980 (New Zealand Forest Research Institute 1978). However, this species is plagued by repeated forking, caused by insect attack (psyllids — Appleton & Walsh 1997). A single stem can be maintained only by form pruning or by cultivation under the canopy of another species. Provenance trials of this species established in 1984 (Stehbens 1992) included a single seedlot of *A. dealbata*, and its superior growth rate sparked some interest in further provenance testing of this species and the closely-related *A. mearnsii*.

Acacia dealbata shows promise for cultivation for sawlogs on short rotations for production of appearance-grade lumber and veneers and has been shown to pulp well by the chemi-mechanical process. Its basic density when young is not high enough to make it attractive for kraft pulping. There is little international experience in growing *A. dealbata* in plantations.

Acacia mearnsii has been widely cultivated for its bark tannins in many countries, notably South Africa. Although its wood has been regarded as a by-product in South Africa, it has been used extensively as mining timber, poles, firewood, and, more recently, for kraft pulping. When grown on 7- to 10-year rotations, its basic density is high, its kraft pulp yields good, and its pulp and paper properties acceptable. In South Africa the large amounts of wood produced are increasingly marketed as export chips for kraft pulping in Japan. One Northland (New Zealand) grower has recently started planting about 800 ha per year with the same objective.

A literature review on *A. mearnsii* has been published by Brown & Ho (1997) and a review that includes *A. dealbata*, with a New Zealand focus on all aspects of these two species has recently been completed (Shelbourne, in prep.).

A few other *Acacia* species were chosen for testing based on unpublished observations by Bulloch and Sheppard, and on their Australian distribution; these were *A. decurrens*, *A. falciformis*, *A. filicifolia*, *A. melanoxylon*, and *A. silvestris*.

ACACIA SPECIES AND PROVENANCE TRIALS IN NEW ZEALAND

In 1987, J.T. Miller of the New Zealand Forest Research Institute gathered together several provenance seedlots of *A. dealbata* and *A. mearnsii* and the other acacia species from

Australia, New Zealand, and elsewhere. Seedlings were raised at Rotorua in 1988/89 from 24 *A. dealbata* seedlots (including 18 Australian provenances), 16 *A. mearnsii* seedlots (eight Australian provenances), and 11 seedlots of other species including *A. decurrens, A. saligna* (Labill.) H.L.Wendl., *A. elata* Cunn. ex Benth. in Hook., *A. falciformis, A. filicifolia, A. longifolia* (Andrews) Willd., *A. melanoxylon, A. parramatensis* Tind., *A. rubida* Cunn. in Field, and *A. silvestris*. These seedlots were planted as three separate trials on three sites in the North Island and two in the South Island, but all except the Kinleith trial subsequently failed for a variety of reasons. These included unsuitable bare-rooted nursery stock, poor land preparation and establishment, spraying with weedicides (two sites), and damage by goats and other animals. In the Kinleith trial, weedicide spraying badly affected both survival and form, and only the *A. dealbata* section of the experiment survived and grew sufficiently well to warrant assessment.

In the same year (1989) surplus seed of the same seedlots of *A. dealbata, A. mearnsii*, and the other *Acacia* species was provided by the New Zealand Forest Research Institute to the National Plant Materials Centre (NPMC) at Aokautere, Palmerston North (now part of the HortResearch Crown Research Institute) and, with additional seedlots, this group planted trials at four North Island sites of up to 26 seedlots of *A. dealbata* and 17 of *A. mearnsii*, as well as seedlots of *A. decurrens, A. falciformis, A. filicifolia, A. melanoxylon*, and *A. silvestris*. The trials were first assessed for survival, height, diameter, vigour, and stem form at age 2.5 years in 1992 (Bulloch unpubl. data).

Trials were also planted by the New Zealand Forest Research Institute in 1991 at Carter Holt Harvey's Mangakahia Forest near Dargaville, and at Rotorua with a much-reduced set of seedlots.

Seven trials were assessed by Forest Research staff in 1996, five at age 7 years, and two at age 5 years, and the results are reported here. The trials also form a limited, source-identified, genetic resource of *A. dealbata* and *A. mearnsii* from which some individuals have been selected for future breeding and deployment.

Seedlots

Of the 31 seedlots of *A. dealbata* (Table 1), eight were collected in New Zealand, and three were from other exotic stands outside the Australian natural distribution. Four seedlots are known to each come from a single seed parent and only five seedlots (Australian Tree Seed Centre, CSIRO Forestry and Forest Products, Canberra) have information on number of seed parents involved and latitude and longitude information from which it might be possible to identify stands for re-collection of seed.

For *A. mearnsii*, six out of 23 seedlots were collected in New Zealand (two known to come from single trees) and two seedlots were from South Africa. Of the other 15 Australian seedlots, seven were collected by the Australian Tree Seed Centre which provided information on location and number of parent trees.

The sampling of seed parents from the natural distribution of *A. dealbata* and *A. mearnsii* was generally inadequate both regionally and altitudinally. For *A. dealbata*, the majority of provenances were from Tasmania at varying altitudes; there were only two provenances from Victoria, both from high altitude, and three provenances from the ACT and NSW. For *A. mearnsii* the coverage of regions and altitudes was somewhat better.

TABLE 1–Seedlots in Forest Research Institute and National Plant Materials Centre trials

FRI field code	Seedlot No.	NPMC No.	Origin/source	Latitude (°S)	Longitude (°E)	Altitude (m)	No. of seed parents
Acacia dealbata							
210	9/0/86/004	3261	Cpt 107, 108, Te Wera Forest, N.Z.				
211	9/0/86/007	2993	Ti Kouka Stream, Dannevirke, NZ				
212	9/0/86/008	1148	Roadside trees on SH. 57A, Aokautere, NZ				
201	9/0/86/009	1588	Huon Valley, Kingston, TAS				
213	9/0/86/010	3264	Okane Rd, Little River, Canterbury NZ				
215	9/0/86/014	2737	Wharerata, SH2., south of Gisborne, NZ				
	9/0/86/96	3588	Mirboo North, VIC	38°	146°	500	
202	9/0/86/97		Forestry Comm., TAS				
203	9/0/86/98	3589	Upper Serpentine River, Lake Pedder Rd, West of Maydena, TAS	43°	146°	550	1
204	9/0/86/99	3590	The Sideling, 10 km west of Scottsdale on Launceston Rd, TAS	42°	147°	380	1
	9/0/86/100		Maydena side of Needles, Mt. Tim Shea Saddle, TAS	43°	146°	640	1
216	9/0/86/101	3595	Lime Road. Stockton, WA ex CALM Seedlot D2, (exotic)				
217	9/0/86/118		Tony Plummer, Dannevirke, NZ				
205	9/0/86/157	3591	Retreat, north-east TAS				
206	9/0/86/158	3592	Dendrecasteau Channel area, south TAS				
218	9/0/86/162	3596	Umgeni, Port Natal, South Africa (Commercial Lot)				
	9/0/87/20		Acacia Rd., Lake Okareka R.D. 43, NZ				
208	9/0/87/26	C15538 3593	East of Melbourne, VIC (Mt Baw Baw)	37° 48'	146° 16'	900	8
207	8/0/86/23	3553	Nickolls Riverlet, TAS				
209	8/0/86/04	3594	Lower Foothills, Himalayas, INDIA				
220	9/0/88/859	C17123 3598	Paddy's R. Rd, Pierces Cr, ACT	35° 22'	148° 57'	600	13
222	9/0/88/861	C15857 3599	2–15 km south-west Bendoc, VIC	37° 12'	148° 48'	900	9
223	9/0/88/862	C16269 3600	26 km south of Cooma, NSW				
		3620	26 km south of Cooma, NSW	36° 28'	149° 07'	910	5
221	9/0/88/860	C14724	East of Bungendore, NSW	35° 15'	149° 31'	740	30
		3619	Errinundra plateau, VIC			960	
		3621	6–15 km south-south-east Snug, TAS			140	
		3650	Upper Esk, Manthinna, TAS			500	
		3651	Tunnack, TAS			400	

TABLE 1–*cont.*

FRI field code	Seedlot No.	NPMC No.	Origin/source	Latitude (°S)	Longitude (°E)	Altitude (m)	No. of seed parents
Acacia dealbata							
		1303	Aokautere (ex Blackburn, Melbourne, VIC), NZ				
		1649	Lake George, NSW				
		3292					
		3233					
Acacia mearnsii							
313	9/0/86/12	1146	Trees at Aokautere, SH 57a, NZ				1
314	9/0/86/13	3292	Aokautere, NZ ex Seedlot 11669 ex Cheviot, Cant.				1
307	9/0/86/70		Bodalla SF 606, Narooma, NSW				
	9/0/86/94		Sherbrooke Forest Park, Belgrave, VIC	38°	145°30’		
301	9/0/86/95	3601	Forestry Comm, TAS				
	9/0/86/117		Inspiration Lookout, Mt Talbinga, NSW	35°	148°	969	
309	9/0/86/159	3608	ICFR-Pietermaritzburg, S. Africa. Commercial seedlot				
310	9/0/86/160	3609	ICFR Pietermaritzburg, S. Africa. Seed Orchard S0.5				
308	9/0/87/32	C14396 3607	10 km from Braidwood, NSW	35° 29’	149°	640	5
302	9/0/87/33	C14416 3602	Dargo, VIC	37° 28’	147°	200	3
303	9/0/87/34	C14925 3603	Blackhill Reserve, VIC	37° 12’	144°	500	6
304	9/0/87/35	C14926 3604	Omeo Hwy, VIC	37° 26’	147° 45’	300	9
305	9/0/87/36	C14927 3605	S.Gippsland , VIC	38° 0’	147° 0’	100	7
306	9/0/87/37	C14928 3606	Cann R. & Orbost, VIC	37° 40’	149° 0’	100	5
	9/0/87/38	C14923	SW of Bungendore, NSW	35° 19’	149° 25’	730	19
311	9/0/85/325		Blk 59, Aokautere, NZ				
312	9/0/86/001	3610	Motukarara, Nelson, NZ				
		1669	Aokautere ex Cheviot, NZ				
		3026	Tai tapu, Cant., NZ				
		3548	Purau, Cant. (ex ICFR Pietermaritzburg, S. Africa) NZ				
		3622	Bombala, NSW			860	
		3623	8 km N of Orbost, VIC			120	
		2624	24–39 km wouth-east of Launceston, TAS			360	

TABLE 1–*cont.*

FRI field code	Seedlot No.	NPMC No.	Origin/source	Latitude (°S)	Longitude (°E)	Altitude (m)	No. of seed parents
A. silvestris		1686	Bodalla, NSW				
		3625	30 km west. Narooma, NSW			570	
		3626	11 km west-north-west Narooma, NSW			130	
		3627	Dewa R., Dawa N. Park, NSW			350	
A. filicifolia	9/0/87/039	3615	Armidale, NSW				
A. decurrens		1133	Aokautere (ex Cheviot, Canterbury NZ)				
		1578	Aokautere (ex Canberra, ACT)				
	9/0/87/27	3611	South-west of Goulburn, NSW				
	2/0/85/07	3612	Rotorua, NZ				
	9/0/86/161	3613	South Africa				
A. falciformis		3021	South-east Australia				
	9/0/87/31	3614	North-east of Ravenshoe, Q.				
A. melanoxylon		1152	Mawbanna S.F., TAS				

For the other *Acacia* species, there were four seedlots of *A. silvestris*, five of *A. decurrens,* and one or two each for the remainder. There was therefore no attempt made to properly sample provenance variation in these species.

Planting stock for all NPMC trials was raised, successfully, as follows (Bulloch unpubl. data). Seed was treated with hot water and sown in trays in January–February, and emerged seedlings were pricked out into a freely-draining peat-sand mix in plastic bags, 50 mm diameter by 300 mm long, and planted about 7 months later (in July) when the seedlings were about 300 mm tall. Similarly-containerised root-trainer stock were planted in the Forest Research Institute trial at Mangakahia in 1991. Open-rooted stock was used in the Forest Research Institute trials planted in 1989, of which only the *A. dealbata* at Kinleith survived.

Trial Sites and Experiment Design

The sites involved in the NPMC trials (Table 2) were typically steep and/or eroding because the objective was to test different species for their soil conservation capabilities. The three sites of the Forest Research Institute trials are more typical forest sites (two of them volcanic ash soils and one on Northland clay) where growth was better and the sites less heterogeneous than the NPMC sites.

The NPMC trials, planted in 1989, were located at four sites (Table 2) and were planted in three or four replications of five-tree-row plots in randomised complete block designs which were unbalanced with respect to seedlots within replications, with several "missing plots". Plots of all seedlots of all species involved were planted randomly mixed in these trials. Spacing was 3 × 2 m at Pohangina, Tuki Tuki, and Kai-Iwi, and 4 × 2 m at Emerald Hills.

At Kinleith in the trials planted in 1989, weedicide spray damage (Velpar) at about age 9 months from planting caused extensive deaths such that the *A. mearnsii* trial and the trial of other *Acacia* species had to be abandoned. *Acacia dealbata* was also killed but sufficient survived to make a viable trial. After the failure of the first Mangakahia trial planted in 1989, in which bare-rooted stock was used and which was ruined by weedicide spraying, the second trial in 1991 was planted with root-trainer stock, and survival and early growth were uniform and good. A randomised complete block design with 24 replications and a spacing of 4 × 2.5 m was used at Kinleith.

In the Forest Research Institute trials planted in 1991 at Rotorua and in Mangakahia Forest at Dargaville, *A. dealbata* and *A. mearnsii* seedlots were planted in separate but adjoining experiments, with other *Acacia* species planted in mixture in a third experiment. The Forest Research Institute trials utilised single-tree plots and randomised complete-block designs with eight replications at the Rotorua site and 24 at Mangakahia. Spacing was 4 × 3 m at Mangakahia and 2.5 × 2.5 m at Rotorua.

Traits Assessed

The Mangakahia trial was assessed in July 1996 and the other trials, later that year.

The traits assessed for all trees in all trials were:

diameter at breast height:	in millimetres (largest stem of basally forked trees)
stem straightness rating:	1 = very sinuous to 9 = straight

TABLE 2–Sites

Name, location, organisation	Altitude (m)	Slope (°)	Aspect	Soil	Spacing (m)
Pohangina, 20 km north of Palmerston North (NPMC)	240	30–35	SE	Shallow silt loam over parent unconsolidated sandstone	3 × 2
Tuki Tuki, 4 km east of Havelock North (NPMC)	150	10–40	NE	Silt loam hillsoil over jointed siltstone and mudstone	3 × 2
Kai-iwi, 13 km north-west of Wanganui (NPMC)	90	20–40	N	Sandy loam soil over consolidated sandstone	3 × 2
Emerald Hills, 25 km south-west of Gisborne (NPMC)	200	25–35	NW	Silt loam soil over parent mudstone	4 × 2
Kinleith Forest, Cpt A 6234 5 km from Tokoroa (FRI)	380	Undulating	NW	Volcanic ash, Rhyolitic pumice	4 × 2.5
Long Mile, Forest Research Institute, Rotorua* (FRI)	300	Flat		Volcanic ash, Rhyolitic pumice	2.5 × 2.5
Mangakahia Forest 5 km north-east of Dargaville* (FRI)	30	10–30	NE	Clay	4 × 3

* Trial planted 1991. All others planted 1989.

malformation: 1 = multiple forks;
2 and 3 = major forking;
4 = ramicorn branching;
5 = no forks, ramicorns, or loss of leader

At Mangakahia, and for *A. dealbata* only, a single form score incorporating straightness and malformation was used.

Pith-to-bark increment cores of 5 mm diameter were collected for basic wood density measurement, from two to four well-grown trees per seedlot per site of a group of seven well-grown provenances of *A. dealbata* and seven of *A. mearnsii*, at Kinleith, Tuki Tuki, and Emerald Hills for *A. dealbata*, and at Tuki Tuki and Emerald Hills only for *A. mearnsii*. Height and dbh were measured of the unmalformed dominants or codominants that had been sampled for wood density, and volume per tree was calculated.

Statistical Analysis Models and Methods

All the NPMC trials utilised a randomised complete block design with three to six replicates of five-tree row plots. Forest Research Institute trials at Kinleith and Mangakahia were planted with 24 replicates of single-tree plots, and at Rotorua with eight replications, all as randomised complete blocks. *Acacia dealbata* and *A. mearnsii* seedlots were each analysed separately.

Each site was analysed separately; the analysis looked for replicate, provenance, and provenance × replicate interaction effects.

The equation for the model of a randomised complete-block design is as follows:

$$Y_{ij} = \mu + \tau_i + \beta_i + \beta\tau_{ij} + \varepsilon_{ij}$$

where: Y_{ij} = the response of seedlot (or treatment) i in replication (or block) j
μ = the overall mean
τ_i = seedlot effect of the ith seedlot
β_i = replication effect of the jth replication
$\beta\tau_{ij}$ = a replication × seedlot interaction effect or plot error
ε_{ij} = experimental error

The data for Pohangina, Tuki Tuki, Emerald Hills, Kai-Iwi, and Kinleith (for *A. dealbata*) and Pohangina, Tuki Tuki, and Emerald Hills for *A. mearnsii* were combined and analysed, looking for site, replicate within site, and provenance differences. The replicates in the single-tree plot layouts were re-assigned to emulate a multiple-tree plot design. The first four replicates were renamed as new replicate 1; the second four replicates were renamed into replicate 2, etc. Some provenances were not planted on all sites, and so only those provenances present on all sites could be used in this analysis.

The equation for the model of a randomised complete block design over several locations is as follows:

$$Y_{ijk} = \mu + \Lambda_i + \tau_j + \beta_k + \Lambda\tau_{ij} + \beta\tau_{j_k} + \varepsilon_{ij_k}$$

where: Y_{ijk} = the response of site i and seedlot (or treatment) j in replicate (or block) k
μ = the overall mean
Λ_i = location effect of the ith location

τ_j = seedlot effect of the *j*th seedlot
β_k = replicate effect of the *k*th replicate
$\Lambda\tau_{ij}$= a location × seedlot interaction effect
$\beta\tau_{j_k}$ = a replicate × seedlot interaction effect or plot error
ε_{ij_k} = experimental error

The site effect was considered to be fixed and all other effects were treated as random effects.

An additional across-sites analysis was carried out for *A. dealbata* and *A. mearnsii*, separately, using GENSTAT (Payne *et al.* 1987). Within-site seedlot means for each species of all seedlots that had some representation at the same sites as in the previous across-sites analysis were arranged in a two-way table and missing cell values were calculated. Least squares seedlot means were then calculated through GENSTAT.

RESULTS

The data for *A. dealbata* and *A. mearnsii* from each of the seven sites were subjected to analysis of variance, and F ratios and their significance are shown in Table 3.

TABLE 3–F ratios for seedlots from within-site analyses of variance

Site	Dbh		Straightness		Malformation	
	A. dealbata	*A. mearnsii*	*A. dealbata*	*A. mearnsii*	*A. dealbata*	*A. mearnsii*
Pohangina	6.05***	1.40	6.48***	2.08**	4.06***	2.17**
Tuki Tuki	8.30***	3.21***	5.18***	2.53***	2.93***	1.72*
Emerald Hills	5.00***	3.06**	5.68***	3.22***	3.73***	0.93
Kai-Iwi	4.67***		8.94***		2.54***	
Kinleith	8.03***		11.86***		9.49***	
Rotorua	3.98*	4.38***	13.76***	2.60*	15.73***	0.73
Mangakahia	7.75***	4.63***	19.30***	2.46**	-	2.07*

* $p< 0.005$
** $p< 0.01$
*** $p< 0.001$

Across-site analyses of a limited group of *A. dealbata* and *A. mearnsii* seedlots that were common to all trials planted in 1989 were also carried out and variance components were calculated (Table 4), particularly to reveal the importance of seedlot × site interaction variance and thus the possible need for selecting seedlots for particular sites. Site means of dbh, straightness, and malformation for both species are shown in Table 5. Across-site seedlot means for the 12 *A. dealbata* seedlots common to five sites (Pohangina, Tuki Tuki, Emerald Hills, Kai-Iwi, and Kinleith) are shown in Table 6. Across-sites seedlot means for 16 *A. mearnsii* seedlots common to Pohangina, Tuki Tuki, and Emerald Hills are also shown in Table 6.

Analyses of variance for 25 *A. dealbata* and 17 *A. mearnsii* seedlots across all seven sites were also carried out using GENSTAT least squares (Payne *et al.* 1987) and adjusted across-sites seedlot means for both species were calculated (Tables 7 and 8).

Seedlot means for *Acacia* species other than *A. dealbata* and *A. mearnsii* are shown in Table 9.

Table 4—Variance components from analysis of variance across sites

Source	D.F.	Dbh Estimated variance components	Straightness Estimated variance components	Malformation Estimated variance components
A. dealbata				
Sites	4	642***	–0.016**	0.1182***
Rep (sites)	16	105***	0.126***	–0.0208
Seedlots	11	533***	1.831***	0.4454***
Site × seedlot	44	105***	0.217***	0.1043***
Rep × seedlot (site)	127	175**	0.291**	0.0166
Error	473	1448	2.396	0.9125
A. mearnsii				
Sites	2	48***	0.267***	0.318***
Rep (sites)	7	57***	0.126**	0.024***
Seedlots	15	128***	0.223***	0.010
Site × seedlot	30	–28	0.050**	0.021*
Rep × seedlot (site)	83	155***	0.321***	0.138*
Error	337	791	1.537	1.132

TABLE 5—Site means from analysis across sites

	Dbh	Straightness	Malformation
A. dealbata			
Pohangina	162	4.91	3.62
Tuki Tuki	145	4.87	4.34
Emerald Hills	149	5.37	4.16
Kai-iwi	173	4.71	3.84
Kinleith	206	4.65	3.53
A. mearnsii			
Pohangina	135	2.56	2.88
Tuki Tuki	151	3.30	3.89
Emerald Hills	137	3.68	3.95

Two to four trees per seedlot per site, of seven seedlots each of *A. dealbata* and *A. mearnsii,* were assessed for height, dbh, volume per tree, and basic wood density, and results of analysis of variance, seedlot means, and site means are shown in Tables 10 and 11.

Average percentage survival at each site of dominants and codominants (i.e., trees that were assessed) was: Pohangina (*A. dealbata*) 69, (*A. mearnsii*) 64; Tuki Tuki (*A. dealbata*) 54, (*A. mearnsii*) 70; Emerald Hills (*A. dealbata*) 59, (*A. mearnsii*) 67; Kai- Iwi (*A. dealbata*) 36; Kinleith (*A. dealbata*) 54; Mangakahia (*A. dealbata*) 86, (*A. mearnsii*) 85.

DISCUSSION

Acacia dealbata

Differences between seedlots within sites were large and mostly very highly significant ($p<0.001$) for diameter at breast height (dbh), bole straightness, and malformation at Pohangina, Tuki Tuki, Emerald Hills, Kai-iwi, Kinleith, Rotorua, and Mangakahia (Table 3).

TABLE 6–Across-site seedlot means (*A. dealbata* means in parentheses for Emerald Hills, Tuki Tuki, and Pohangina only)

Seedlot No.	Origin/source	Number of trees	Dbh	Straightness score	Malformation score
A. dealbata	Sites: (Emerald Hills), Kai-Iwi, Kinleith, (Tuki Tuki) (Pohangina)				
3591	Retreat, TAS	48	209 (176)	5.65 (5.74)	4.08 (4.39)
3593	Mt. Baw Baw, VIC	70	193 (169)	6.20 (6.54)	4.29 (4.43)
3553	Nickolls R., TAS	75	192 (179)	5.49 (5.35)	4.25 (4.28)
3592	Dendrecasteaux Channel, TAS	67	178 (165)	4.60 (4.74)	4.18 (4.21)
1588	Huon Valley, TAS	63	177 (166)	6.30 (6.71)	4.37 (4.59)
1148	Aokautere, NZ	62	172 (153)	2.81 (3.54)	2.84 (3.43)
3261	Te Wera, NZ	53	171 (150)	4.49 (4.16)	3.64 (3.63)
3599	Bendoc, VIC	52	167 (149)	5.88 (5.88)	4.21 (4.15)
3589	Maydena, TAS	59	147 (132)	5.76 (5.71)	4.61 (4.60)
3596	South Africa	46	141 (115)	2.56 (3.15)	2.37 (2.74)
3598	Pierces Ck, ACT	33	124 (127)	2.58 (2.87)	3.18 (3.61)
3600	Cooma, NSW	48	122 (118)	4.45 (4.71)	3.77 (4.07)
A. mearnsii	Sites: Emerald Hills, Tuki Tuki, Pohangina				
3605	S. Gippsland, VIC	32	165	3.16	3.53
1669	Aokautere, NZ	29	164	3.11	3.61
3601	Tasmania	30	156	2.72	3.48
3623	Cann R. and Orbost, VIC	38	150	3.19	3.79
3603	Blackhill Res., VIC	32	142	3.84	3.81
3622	Bombala, NSW	29	142	3.62	3.86
3607	Braidwood, NSW	30	142	3.90	3.77
2624	Launceston, TAS	30	139	3.47	3.33
3608	South Africa (commercial)	29	138	2.72	3.52
3606	Orbost, VIC	37	137	2.89	3.03
3602	Dargo, VIC	32	137	3.28	3.91
3604	Omeo Hwy, VIC	29	136	3.97	3.72
3610	Nelson, NZ	16	133	2.69	3.06
3548	Purau, Canterbury, NZ	29	132	2.69	3.41
3609	South Africa (Seed Orchard)	34	128	3.09	3.68
3026	Taitapu, Canterbury, NZ	19	107	2.11	3.42

Seedlot differences were also highly significant ($p<0.001$) in the across-sites analyses, as was the site × seedlot interaction variance (Table 4). However, this variance was small relative to the seedlot variance (20% for dbh, 12% for straightness, and 23% for malformation) and it should not be large enough to result in marked changes in seedlot ranking and thus appreciable reduction in gains through selecting across sites for stability of seedlot performance.

The large range of seedlot means both within each site, and across sites (Tables 6 and 7) indicate that there is considerable scope for selection of seedlots of *A. dealbata* for growth, bole straightness, and freedom from malformation. Seedlots vary from being extremely malformed to having a large proportion of stems free from forking, and from slow- to very fast-grown.

For instance, at Pohangina near Palmerston North, seedlot mean dbh on this heterogeneous, eroded site varied from 100 to over 200 mm and straightness scores from just over 2 to

TABLE 7–Least-squares across-sites seedlot and site means—*A. dealbata*

Seedlot number	Origin/source	Dbh	Straightness	Malformation
3590	Scottsdale, TAS	205	5.49	4.06
3591	Retreat, TAS	199	5.68	4.17
3553	Nickolls R., TAS	190	5.52	4.27
3621	Snug, TAS	189	5.33	4.17
3593	Mt Baw Baw, VIC	188	6.28	4.32
2993	Dannevirke, NZ	187	4.01	3.76
3651	Tunnack, TAS	184	3.62	2.92
1588	Huon Valley, TAS	179	6.36	4.43
3592	Dendrecasteau Channel, TAS	176	4.47	4.11
1148	Aokautere, NZ	175	2.86	2.98
3261	Te Wera, NZ	162	4.59	3.63
1303	Aokautere, NZ	158	4.17	3.71
3599	Bendoc, VIC	154	6.08	4.24
3619	Errinundra Plateau, VIC	151	5.34	4.09
1649	Lake George, NSW	149	3.61	3.24
3589	Maydena, TAS	148	5.78	4.61
3292	*A. mearnsii*, Aokautere, NZ	145	2.82	3.41
3650	Manthinna, TAS	145	4.45	3.82
3594	Himalayas, India	142	2.90	3.16
3596	Poort Natal, S. Africa	140	2.59	2.43
3620	Cooma, NSW	128	3.64	3.75
3264	Little River, Cant., NZ	124	3.39	3.49
3600	Cooma, NSW	120	4.64	3.48
3598	Pierce's Ck, ACT	117	2.27	3.26
3595	Stockton, WA	97	–	–
Site means				
	Pohangina (Palmerston Nth)	154	4.55	3.47
	Tuki Tuki (Havelock Nth)	147	4.45	4.23
	Emerald Hills (Gisborne)	134	5.02	3.98
	Kai-Iwi (Wanganui)	162	4.05	3.71
	Kinleith (Tokoroa)	193	3.99	3.25

nearly 7. Seedlot mean dbh varied similarly at Tuki Tuki (107–174 mm), Emerald Hills (103–201 mm), Kinleith (122–256 mm), and Kai-iwi (99–211 mm) (unpubl. data).

These sites (except for Kinleith) were very steep, often showing patches of gully erosion and generally variable growth, yet the experiments with three or four replications of five-tree-row plots were able to detect statistically significant seedlot differences. The better seedlots appeared capable of producing straight sawlogs. Some pruning was done at Tuki Tuki and Kai-iwi, but branch development was generally quite modest in unmalformed trees in well-stocked parts of the trials.

The only discernible pattern to seedlot variation (Tables 6 and 7) was that of poor performance in growth and also poor straightness and frequent malformation of the New South Wales and ACT seedlots. In the across-sites analysis of five sites, seedlots from Cooma, NSW, and Pierce's Creek, ACT, (as well as the exotic seedlot from South Africa) grew very poorly and showed a lot of forking.

TABLE 8–Least-squares across-sites seedlot and site means—*A. mearnsii*

Seedlot number	Origin/source	Dbh	Straightness	Malformation
3605	S. Gippsland, VIC	164	3.04	3.48
1669	Aokautere, ex Cheviot, NZ	162	2.95	3.51
3601	Tasmania	157	2.68	3.46
3623	Orbost, VIC	152	3.13	3.67
3607	Branchwood, NSW	142	3.90	3.77
3292	Aokautere, ex Cheviot, NZ	140	3.20	3.62
3603	Blackhill Reserve, VIC	140	4.09	3.82
3608	S. Africa (commercial)	138	2.45	3.36
3602	Dargo, VIC	137	3.30	3.91
3606	Cann R. and Orbost, VIC	137	2.99	3.26
3622	Bombala, NSW	137	3.83	3.87
3604	Omeo Hwy, VIC	136	3.90	3.66
3548	Purau, Cant., NZ ex S. Africa	133	2.62	3.34
3610	Motukarara, Nelson, NZ	132	2.95	3.03
2624	Launceston, TAS	130	3.63	3.81
3609	S. Africa (seed orchard)	128	3.06	3.66
3026	Tai Tapu, Cant., NZ	107	1.79	3.11
Site means				
	Pohangina	134	2.36	2.85
	Tuki Tuki	145	3.27	3.88
	Emerald Hills	135	3.81	3.91

TABLE 9–Species means of other acacias at Tuki Tuki, Pohangina, and Emerald Hills

Species	Tuki Tuki	Pohangina	Emerald Hills
Dbh			
A. decurrens	117	93	80
A. falciformis	112	97	
A. filicifolia	112	107	87
A. melanoxylon	61		67
A. silvestris	130	116	101
A. schinoides		115	
A. dealbata	145	162	149
A. mearnsii	151	135	137
Straightness			
A. decurrens	2.8	1.4	2.2
A. falciformis	3.3	3.5	
A. filicifolia	3.9	3.7	3.7
A. melanoxylon	3.8		4.0
A. silvestris	4.7	4.9	5.7
A. schinoides		3.5	
A. dealbata	4.9	4.9	5.4
A. mearnsii	3.3	2.6	3.7
Malformation			
A. decurrens	4.1	3.2	2.1
A. falciformis	2.4	2.9	
A. filicifolia	4.1	2.3	3.8
A. melanoxylon	3.0		3.4
A. silvestris	4.7	3.7	4.5
A. schinoides		1.7	
A. dealbata	4.3	3.6	4.2
A. mearnsii	3.9	2.9	4.0

TABLE 10–*Acacia dealbata*: Seedlot means and site means for a basic wood density, height, and volume sub-sample

Across-site seedlot means (Tuki Tuki, Emerald Hills, and Kinleith)

Seedlot No.	Origin/Source	Number of trees	Basic density (kg/m³)	Height (m)	Dbh (mm)	Volume (m³/tree)
3599	Bendoc, VIC	11	437	12.2	184	0.146
3593	Mt Baw Baw, VIC	13	390	14.3	210	0.220
3553	Nickolls R., TAS	13	384	13.8	200	0.190
3591	Retreat, TAS	12	376	14.6	230	0.248
3590	Scottsdale, TAS	8	370	14.5	231	0.252
3589	Maydena, TAS	11	367	13.7	189	0.166
3592	Dendrecasteaux Channel, TAS	14	348	13.6	196	0.175
	Seedlot differences $F_{6, 73}$		5.05	2.94	3.36	3.35
	p		**	*	**	**

Site means

Site	Number of trees	Basic density (kg/m³)	Height (m)	Dbh (mm)	Volume (m³/tree)
Tuki Tuki	22	412	12.3	194	0.155
Emerald Hills	23	371	13.4	189	0.178
Kinleith	37	369	14.8	221	0.233
Site differences $F_{2, 73}$		7.09	17.89	7.98	8.62
p		**	***	***	**

The best seedlots overall for growth and form (Tables 6 and 7) were from Retreat, Nickolls Riverlet, Snug, and Huon Valley in Tasmania and from Mt Baw Baw in Victoria, altitude 900 m. Seedlots from Bendoc and the Errinundra plateau in eastern Victoria, also altitude 900 m, were well-formed but rather slower-grown. Most seedlots of New Zealand source performed poorly, but there were some exceptions. Interpreting individual seedlot performance at different sites was hindered by the variable nature of the sites, the sometimes-large plot error, the variable and small numbers of trees per seedlot at each site, and lack of representation of some seedlots at some sites. Also, the unknown numbers of seed parents or very few seed parents (often one) of many seedlots added to the difficulties of interpreting provenance variation, because of effects of genetic sampling.

The trials are a valuable interim source of selections from the best seedlots, which we are attempting to propagate by grafting to establish a clonal seed orchard but these clones will be too few and of too-small a genetic base to suffice as a long-term breeding population. More importantly, these trials have given an indication of what this species can do (in growth rate and stem form) on widely differing sites. *Acacia dealbata* appears to be a hardy and adaptable species on well-watered sites, ranging from Mangakahia in Northland to Kinleith on the pumice plateau, as well as on a site of 850 mm rainfall at Tuki Tuki (Havelock North). With the favourable reports on sawing and seasoning of timber and on wood properties, and the good bole straightness of some seedlots, *A. dealbata* shows promise for sawlog production on rotations as low as 20 years.

TABLE 11–*Acacia mearnsii*: Seedlot means and site means for basic wood density, height, and volume sub-sample

Across-site seedlot means (Tuki Tuki and Emerald Hills)

Seedlot No.	Origin/Source	Number of trees	Basic density (kg/m^3)	Height (m)	Dbh (mm)	Volume (m^3/tree)
3608	South Africa, (commercial)	1	582	11.0	157	0.087
3602	Dargo, VIC	7	575	12.0	152	0.087
3603	Blackhill Res., VIC	6	567	11.6	165	0.101
3605	S. Gippsland, VIC	6	557	12.5	195	0.153
3604	Omeo Hwy, VIC	5	554	12.1	169	0.110
3606	Cann R. and Orbost, VIC	6	541	12.7	150	0.091
3607	Braidwood, NSW	5	521	12.0	163	0.106
	Seedlot differences $F_{6,28}$		142	0.57	2.85	2.08
	p				*	

Site means

Site	Number of trees	Basic density (kg/m^3)	Height (m)	Dbh (mm)	Volume (m^3/tree)
Tuki Tuki	17	553	12.0	172	0.1118
Emerald Hills	19	556	12.1	158	0.103
Site differences $F_{1,28}$		0.05	0.10	4.36*	1.62
p				*	

Acacia mearnsii

Acacia mearnsii at age 7 years has shown a similar picture of large and significant differences between seedlots at each site and across sites (Tables 3 and 4) in diameter growth and bole straightness, although differences in malformation were mostly small and not significant. Bole straightness scores were much lower (more sinuous) than for *A. dealbata* (e.g., 3.2 for *A. mearnsii* at Pohangina, Emerald Hills, and Tuki Tuki *vs* 5.1 for *A. dealbata* at the same sites) (Tables 5, 7, and 8), but dbh of the better seedlots of *A. mearnsii* was on average only 15 mm less than that of better seedlots of *A. dealbata*. At Pohangina, Tuki Tuki, and Emerald Hills, plots of all species were randomised together and so direct comparisons between seedlots of each species are valid, although statistical analyses were confined within species. Competition effects will tend to accentuate differences between well- and poorly-grown seedlots/species.

Differences between seedlot means in dbh were very large, ranging from 107 to 165 mm in the across-site analysis at three sites (Tables 6 and 8). Differences amongst the 16 seedlots common to the three sites in bole straightness scores were modest (2.1 to 4.0) though significant ($p<0.001$). Nearly all trees in this species were too sinuous for sawlogs. Stem straightness was generally better at Emerald Hills than the other two sites. Differences between seedlots within sites were generally significant ($p<0.05$) for dbh and straightness but not significant for dbh at Pohangina, reflecting site variability (Table 3). However, differentiation of seedlots within sites was nowhere precise. Rankings of seedlots for diameter and straightness generally agreed quite well between sites, but interpreting individual seedlot performances at different sites was hindered by large plot error effects and small numbers of trees surviving per seedlot at each site.

It was difficult to distinguish any pattern in provenance performance (Tables 6 and 8). A single Tasmanian seedlot ranked highly amongst the best, predominantly Victorian seedlots for dbh, alongside a NSW seedlot. The number of parents involved was known in only nine of 23 seedlots of A. mearnsii, and those numbers were generally low (1–9). Thus genetic sampling error probably affected any comparisons of seedlots.

As with *A. dealbata*, although not showing a clear provenance pattern, the seedlots in these trials have provided an indication of the potential genetic variability amongst provenances and exotic land races and of the potential value of the species. The trees in each seedlot have also formed a valuable population from which to make selections for seed orchards but are inadequate as the basis of a long-term breeding population, because of their small genetic base. This species' potential for sawlog production is severely hampered by its generally sinuous stems, at least at this stage of its genetic improvement. However, *A. mearnsii* is marketed internationally for kraft pulping because of its high wood density and good fibre properties when young.

Other *Acacia* Species

Of the other *Acacia* species tested at Pohangina, Tuki Tuki, and Emerald Hills, only *A. silvestris* showed any promise (Table 9). The better seedlots of this species had dbh exceeding 130 mm at the best-grown site, Tuki Tuki, and bole straightness and malformation scores approached those of the better *A. dealbata* seedlots. *Acacia decurrens* grew more slowly than *A. silvestris* and showed very poor bole straightness and a lot of repeated forking. *Acacia melanoxylon* grew so slowly it was suppressed wherever it was planted in these trials, and showed repeated forking. None of these species could rate as serious competitors with *A. dealbata* and *A. mearnsii* in growth rate.

Basic Wood Density and Height Subsample

A small subsample of trees were assessed for basic wood density, height, and dbh at age 7 years, in a set of seven well-grown provenances each of *A. dealbata* and *A. mearnsii* (Tables 10 and 11). Two to four trees per provenance per site of both species were assessed at Tuki Tuki and Emerald Hills, but only *A. dealbata* could be sampled at Kinleith. Differences between seedlots in these traits were not detectable within sites because of the small number of trees assessed. Across-site seedlot differences, however, were significant for basic density, height, dbh, and volume per tree in *A. dealbata* but were significant only for dbh in *A. mearnsii.*

Acacia dealbata on average showed highest wood density at Tuki Tuki (412 kg/m^3), with site means at Emerald Hills and Kinleith being somewhat lower (371 and 369 kg/m^3). Trees were tallest at Kinleith (14.8 m) and shorter at Tuki Tuki and Emerald Hills (12.3 and 13.4 m respectively). Wood density of *A. dealbata* showed considerable variation between seedlots with the slower-grown provenance from Bendoc, Victoria (altitude 900 m), averaging 437 kg/m^3 (rings 1 to 6). The other Victorian provenance from Mt Baw Baw (also from altitude 900 m) which was almost as fast-grown as the best Tasmanian provenances, had a density of 390 kg/m^3. Densities of other Tasmanian provenances, from either one or an unknown number of parents and from altitudes ranging from 380 to 550 m, ranged from 348 to 384 kg/m^3. Mean height over sites for provenances varied from 12.2 m for Bendoc, Victoria, to 14.6 m for Retreat, Tasmania.

Wood density of *A. mearnsii* did not differ significantly among seedlots (range 521–575 kg/m^3) or between sites, but was much higher than for *A. dealbata*. At Tuki Tuki, mean density of *A. dealbata* and *A. mearnsii* was 412 *vs* 553 kg/m^3 and at Emerald Hills 371 *vs* 556 kg/m^3. Across-sites mean height of *A. mearnsii* seedlots varied from 11.0 to 12.5 m and dbh from 150 to 195 mm. Height was over 1 m shorter than *A. dealbata* at Emerald Hills but about the same at Tuki Tuki.

In general, the small number of trees sampled per seedlot for *A. mearnsii* meant that provenance differences in all traits except dbh were undetectable (average about six trees per provenance) whereas for *A. dealbata*, with a total about 12 trees per provenance sampled by including the additional Kinleith site, more precise estimates of provenances means were possible. The most important contrast between *A. dealbata* and *A. mearnsii* was the very high density of *A. mearnsii* when aged only 7 years.

CONCLUSIONS

Although these trials were still young at the time of the assessment (7 years and 5 years) the generally-rapid growth rates on a wide range of sites for both *A. mearnsii* and *A. dealbata,* combined with their wood properties which are favourable for contrasting end-uses, make these species worthy of serious consideration.

The better seedlots of *A. dealbata* at this age have shown good stem straightness and freedom from malformation, with dbh of the better seedlots on the best site, Kinleith, of over 240 mm and individual tree heights up to 18 m at age 7 years. Wood density of the first six annual rings averaged 370 kg/m^3 and, judging from some earlier sawing, seasoning, and wood property studies, this species has potential for sawn-timber production on short rotations of possibly less than 20 years. Early heartwood development gives the species an attractive colour. It also has a good reputation for chemi-mechanical pulping.

The dbh of *A. mearnsii* at this age was generally only a little less than that of *A. dealbata* (at the driest site, Tuki Tuki, it was a little higher), but its bole straightness was much inferior and it was more malformed than the better *A. dealbata* seedlots. These disadvantages, which may prohibit its use for sawlogs, are offset by its substantially higher wood density and good kraft pulping properties. *Acacia mearnsii* is grown primarily for production of tannin from its bark in South Africa, Brazil, and China, an end-use that has not yet been investigated in New Zealand.

These trials utilised seedlots which were available at the time they were established but which were far from ideal in terms of population sampling. Several seedlots were based on seed collected from one tree and numbers of parents of other seedlots were generally low (from three to nine); the coverage of Victorian provenances of *A. dealbata,* with only two, was quite inadequate. It is difficult to discern clear patterns of provenance variation in growth rate or other traits in both species, though it appears for *A. dealbata* that central Victorian and Tasmanian provenances are of better growth rate and form than New South Wales and ACT provenances.

An important outcome of the trials has been the selection of superior individual trees from the better seedlots of both species; these are now being propagated in seed orchards by grafting and by seed.

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