Eucalyptus species trials on pumiceland

G.R. Johnson and M.D. Wilcox

ABSTRACT

Twenty species and two hybrids of Eucalyptus were tested on three central North Island pumiceland sites at altitudes of 70 m, 380 m, and 920 m. At age nine years Eucalyptus saligna had performed the best on the warmer low altitude site, E. delegatensis and E. dendromorpha had performed well on the high altitude site, and E. regnans was the best on the intermediate altitude site. For overall adaptability on pumice soils E. regnans and E. fastigata were the best, but E. delegatensis and E. fraxinoides also did well on more than one site. Eucalyptus nitens showed excellent potential on all three sites, notwithstanding its susceptibility to Paropsis attack.

Introduction

Eucalyptus have been planted in New Zealand for over 100 years. Currently five *Eucalyptus* species, *E botryoides, E. delegatensis, E. fastigata, E. regnans,* and *E. saligna,* are regarded as suitable for forestry use. In addition, *Eucalyptus nitens* and *E. fraxinoides* are recognised as promising. These species may be able to supply wood for end uses in which radiata pine is not ideal or suitable, such as high-quality furniture, veneer, short-fibred pulp, and firewood.

The list of preferred eucalypts has evolved mainly from general experience with plantations, woodlots, shelterbelts and arboreta as, in the past, few formal species trials were available to compare species side by side. In 1978, to provide more reliable comparative information, *Eucalyptus* species trials were established on three pumiceland sites at Rotoehu, Waiotapu, and Matea, representing a range of climates and elevations. The trials compared 17 species – mostly from the ash group, but also including some hardy gums. This paper reports the results of these trials after nine growing seasons.

Materials and Methods

Provenance seedlots of the 17 species were procured from CSIRO Division of Forest Research in Canberra, from the Forests Commission in Victoria, from commercial seed merchants, and by collection from some exotic stands in New Zealand. A full schedule of seedlots is given in Appendix 1.

The plants were raised at the Forest Research Institute nursery at Rotorua. Seed was sown in a greenhouse in August 1977 and germinants were pricked out at the cotyledon stage and planted into peat pots. Potted plants were kept in the greenhouse for six weeks, grown for a further six to nine weeks outside, and planted in the field in November or December.

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Trial Sites

All three trial sites were flat but otherwise varied as follows:

Rotoehu: Warm site, altitude 70 m. Former pasture on a sandy pumice soil. The site was rotary hoed before being planted in November 1977.

Waiotapu: Intermediate in temperature, altitude 380 m. A former firebreak on a hydrothermal mud soil depleted of topsoil. Planting lines were ripped as a form of soil cultivation before planting in November 1977.

Matea: Cold site, altitude 920 m. Formerly in scrub of *Leptospermum, Dracophyllum, Phyllocladus,* and *Hebe.* Humic topsoil overlies a yellow pumice at this site. Before planting in December of 1977 the area was: crushed (July, 1976), burnt (December, 1976) disced and ripped (May, 1977), and sprayed with atrazine/amitrole and simazine (August, 1977).

All trees were fertilised at time of planting with 20 g of Magamp per tree, except at Rotoehu where only 10 g per tree was applied. Weeds were controlled for the first two years after planting at all sites. Trees at Rotoehu and Waiotapu sites were form-pruned in 1979.

Experimental Design

A split-plot design was employed in all three trials with species as the whole plots and provenances within species as the subplots. At Rotoehu and Waiotapu subplots were non-contiguous single trees. Species blocks were of a constant size (30 trees) and one block of each species was planted, except for *E. obliqua* and *E. viminalis* which occupied two blocks each (60 trees). The number of subplot trees varied with the species and the number of provenances tested. Subplots at Matea were five-tree row plots. Three replicates were planted at Rotoehu and Waiotapu, and two replicates were planted at Matea.

Assessments

Performance at the three sites was assessed in the winter of 1986 after nine growing seasons. Because of different trial designs, site-to-site survival differences, and broom infestation at Waiotapu, performance at each site was assessed differently. At Rotoehu stem diamater at 1.4 m and a subjective form score (1 = worst to 9 = best) was recorded for each tree. The height of four crop trees in each species block was also measured. Crown health (mainly influenced by attack by the *Eucalyptus* tortoise beetle, *Paropsis charybdis*) was noted for each species block (1 = unhealthy to 5 = healthy).

At Waiotapu diameter at 1.4 m was measured from five crop trees in each species block and the total number of surviving trees was recorded. Each species block was scored for form and crown health, as at Rotoehu. Severe broom infestation and the relative poor survival prohibited a thorough assessment of performance since provenance identification for each tree could not always be guaranteed.

At Matea all trees were measured for height. Numbers of malformed and healthy trees, and the degree of attack by

Paropsis (0 = completely chewed to 5 = no chewing) were recorded for each provenance row.

Data Analysis

Arithmetic means were calculated for all measured traits by provenance. Species means were calculated as arithmetic means of provenance means.

Each species was then classified as suitable or unsuitable for planting at a particular site on the basis of overall survival, health, growth, and form.

Each species was represented by 1-8 provenances (see Appendix 1). While some provenance variation was present, formal examination of the variation was not pursued on account of the limited sampling and weak experimental resolution of provenance differences.

Results and Discussion

Rotoehu (warm, low elevation site)

The best performer at this site was *E. saligna* (Tables 1 and 2). It was the tallest, had the best form, and was free of pests. *Eucalyptus regnans* and *E. fastigata* grew vigorously, but the former had patchy survival and the latter had poor form.

Eucalyptus oreades, E. fraxinoides, E. obliqua x *regnans,* and *E. obliqua* were also vigorous, but either had poor form or low survival. While these species may be considered possibilities, at age nine years they were inferior to *E. saligna, E. regnans,* and *E. fastigata.* Overall, *Paropsis* was the primary cause of reduced crown health scores among the less successful species, although earlier attacks by *Mycosphaerella* leaf blotch had been equally severe.

Growth of *E. nitens* on this site was markedly checked by severe attacks of both pests. The trees suffered complete defoliation of juvenile leaves in 1982 by *Mycosphaerella,* followed by severe attack to adult foliage by *Paropsis* up to the time of assessment.

Eucalyptus delegatensis was set back at Rotoehu as a result of *Mycosphaerella* attack. *Eucalyptus triflora* failed altogether in a drought experienced in the first growing season.

The trial experienced frost damage in 1978 and damage was assessed in September 1978. Results are shown in Table 3. All seven species listed in Table 2 as winners or possibilities experienced moderate frost damage at an early age.

In addition to frost damage, insect damage had been a problem on the following species: *E. andrewsii, E. campanulata, E. cypellocarpa, E. dalrympleana, E. dunnii, E. fraxinoides, E. gunnii, E. johnstonii, E. nitens, E. sieberi,* and *E. viminalis.*

Waiotapu (intermediate site)

Eucalyptus regnans was the overall winner, having the best form and health scores, and the second largest diameter, although survival was only moderate (Table 1). *Eucalyptus obliqua* and *E. obliqua* x *regnans* were also vigorous and healthy, but did not have such good form as *E. regnans. Eucalyptus delegatensis, E. fastigata,* and *E. fraxinoides* all had reasonable diameters, form, and health. No other species appeared to have potential on this site either because of poor diameter growth, poor crown health, or both. Once again *Paropsis* was the primary cause of low crown-health scores.

Matea (cold, high elevation site)

This is a very cold exposed site and few species could tolerate the conditions. Frost damaged most species. Results are shown in Table 3. *Eucalyptus dendromorpha* and *E. delegatensis* were the obvious winners for growth, survival, and health. As a species *E. dendromorpha* was generally more vigorous, and healthier than *E. delegatensis*, but the Victorian provenance of *E. delegatensis* was as vigorous and healthy as *E. dendromorpha.* One provenance of *E. fastigata* (Oberon NSW) also appeared suitable. Although one provenance of *E. viminalis*

TABLE 1 – *Eucalyptus* species means at Rotoehu, Waiotapu, and Matea, age 9 years

Species	Rotoehu					Waiotapu				Matea					
	% surv.	Dia (cm)	Ht (m)	Form (1-9)	Health (1-5)	% surv.	Dia (cm)	Form (1-9)	Health (1-5)	% surv.	Dia (cm)	Ht (m)	% non malf.	% healthy	*Paropsis* (0-5)
E. andrewsii	8	23.0	13.7	2.7	5.0	0				0					
E. campanulata	36	14.5	11.5	2.1	3.0	19	9.6	3.0	1.0	0					
E. cypellocarpa	6	11.0	8.6	1.0	1.0	57	14.9	2.7	2.0	0					
E. dalrympleana	10	8.6	12.1	1.8	2.0	39	17.6	2.5	2.0	67		3.0	0	0	1.7
E. delegatensis	66	17.6	10.7	2.5	2.0	63	18.8	6.7	4.3	64	9.7	5.6	41	49	2.0
E. dendromorpha	0					22	16.3	4.0	5.0	70	12.8	8.0	86	100	5.0
E. dunnii	68	14.5	10.7	3.1	4.0	14	9.6	2.0	2.5	0					
E. fastigata	46	32.4	18.0	3.4	5.0	69	18.2	7.3	5.0	44	8.4	5.0	12	37	5.0
E. fraxinoides	26	29.8	17.8	3.5	4.5	51	16.2	6.7	4.7	0					
E. gunnii	0					0				0					
E. johnstonii	0					23	6.5	2.0	1.0	0					
E. nitens	88	19.5	14.1	4.8	1.0	39	17.8	7.3	2.0	85	8.4	5.0	17	0	0.0
E. obliqua	43	19.5	16.6	3.6	3.0	53	21.2	5.5	3.9	0					
E. obliqua x *regnans*	17	26.0	19.0	4.5	5.0	37	20.9	5.3	5.0	0					
E. oreades	40	29.8	18.6	3.3	4.0	39	16.4	5.7	3.7	0					
E. regnans	34	28.0	18.9	5.6	4.0	49	21.0	8.0	5.0	15	8.8	5.6	5	15	4.0
E. reg x fast															
E. saligna	51	24.0	22.0	5.6	5.0	18	12.9	7.0	5.0	0					
E. sieberi	13	17.5	14.2	1.1	4.0	47	13.9	5.0	4.5	0					
E. stenostoma	4	19.1	11.5	1.0	4.0	0				0					
E. triflora	0					55	14.9	4.5	5.0	10	6.8	5.5	0	100	5.0
E. viminalis	38	10.7	10.7	1.5	1.5	33	10.1	3.0	2.5	37	7.3	5.7	8	0	1.0

TABLE 2 – Winners, possibilities, and losers at Rotoehu, Waiotapu and Matea

	Site		
	Rotoehu	Waiotapu	Matea
Winners	*E. saligna* *E. regnans* *E. fastigata*	*E. regnans*	*E. dendromorpha* *E. delegatensis*
Possibilities	*E. fraxinoides* *E. obliqua* x *regnans* *E. oreades* *E. obliqua*	*E. delegatensis* *E. fastigata* *E. fraxinoides* *E. obliqua* *E. obliqua* x *regnans* *E. regnans* x *fastigata*	*E. fastigata*
Losers	*E. andrewsii* *E. campanulata* *E. cypellocarpa* *E. dalrympleana* *E. delegatensis* *E. dendromorpha* *E. dunnii* *E. gunnii* *E. johnstonii* *E. nitens* *E. sieberi* *E. stenostoma* *E. triflora* *E. viminalis*	*E. andrewsii* *E. campanulata* *E. cypellocarpa* *E. dalrympleana* *E. dendromorpha* *E. dunnii* *E. gunnii* *E. johnstonii* *E. nitens* *E. oreades* *E. saligna* *E. sieberi* *E. stenostoma* *E. triflora* *E. viminalis*	*E. andrewsi* *E. campanulata* *E. cypellocarpa* *E. dalrympleana* *E. dunnii* *E. fraxinoides* *E. gunnii* *E. nitens* *E. obliqua* *E. obliqua x regnans* *E. oreades* *E. regnans* *E. saligna* *E. sieberi* *E. stenostoma* *E. triflora* *E. viminalis*

(Maydena) grew quite rapidly, all trees were unhealthy (*Paropsis*) and most were malformed. *Eucalyptus nitens* would have fared well here but for *Paropsis*.

Conclusions

Table 2 lists the winners, possibilities, and losers for each of the three pumiceland locations based on results to nine years. On low altitude warm sites *E. saligna* appears to be the species of choice. On high altitude cold sites *E. delegatensis* or *E. dendromorpha* seem the best prospects. On sites of intermediate altitude *E. regnans* appears to be the first choice, but *E. fastigata, E. delegatensis, E. fraxinoides,* and *E. obliqua* should not be ruled out.

Eucalyptus regnans had excellent growth and form on all but the coldest site where it seemed prone to severe frost damage. *Eucalyptus delegatensis* should be considered on cool sites because it performed moderately well in the cool temperatures at Waiotapu and was a winner at the cold Matea site. *Eucalyptus fastigata* grew rapidly and was healthy at all three sites (although only the Oberon provenance survived at Matea) but had poor form at Matea and Rotoehu. It would probably be suitable for products not requiring good tree form (e.g. pulp and firewood).

Eucalyptus nitens started well on all three sites, but *Paropsis* attacked the mature foliage and reduced vigour throughout. Although there are stands of *E. nitens* exhibiting good vigour and minimal *Paropsis* infestation on some pumiceland sites, one could be taking a risk by planting *E. nitens* for a long-rotation crop. If *Paropsis* could be controlled economically in the future with chemicals or biological agents, then *E. nitens* would become one of the favoured species of *Eucalyptus*.

TABLE 3 – Frost tolerance ratings after one year in the field Rotoehu and Matea

Species	Rotoehu	Matea
E. andrewsii	1*	1
E. campanulata	4	4
E. cypellocarpa	2	1
E. dalrympleana	5	5
E. delegatensis	5	5
E. dendromorpha	4	5
E. dunnii	5	3
E. fastigata	3	4
E. fraxinoides	3	5
E. gunnii	5	5
E. johnstonii	5	-
E. nitens	5	5
E. obliqua	2	1
E. obliqua regnans	3	2
E. oreades	2	3
E. regnans	3	2
E. saligna	3	1
E. sieberi	1	1
E. stenostoma	1	1
E. triflora	–	3
E. viminalis	5	5

* *Code: 5 slight to no frost damage*
4 slight-moderate frost damage
3 moderate frost damage
2 moderate to severe frost damage
1 severe frost damage

The following species did not do well at any of the three locations and are not recommended for planting in the Bay of Plenty: *E. andrewsii, E. campanulata, E. cypellocarpa, E. dalrympleana, E. dunnii, E. gunnii, E. johnstonii, E. sieberi, E. stenostoma, E. triflora,* and *E. viminalis.* Insects were a problem on all but *E. stenostoma* and *E. triflora. Eucalyptus andrewsii, E. cypellocarpa, E. sieberi,* and *E. stenostoma* all had poor frost tolerance. *Eucalyptus triflora,* while healthy, had poor growth and form.

The three species which seem to have reasonably wide tolerances on the North Island pumicelands, *E. regnans, E. delegatensis,* and *E. fraxinoides,* have also done well in Southland (Wilcox *et al.,* 1985). While *E. fastigata* has been deemed unsatisfactory for Southland (Wilcox *et al.,* 1985) it has been successful in the Bay of Plenty. *Eucalyptus regnans, E. fraxinoides,* and *E. fastigata* have also performed well in trials in the Wairarapa district, but *E. delegatensis* did well on only one of two sites (Hathaway and King, 1986). All four species warrant further examination on pumiceland sites.

Literature Cited

Hathaway, R.L. and M. King, 1986: Selection of *Eucalyptus* species for soil conservation planting in seasonally dry hill country. New Zealand Journal of Forestry Science 16: 142-151.

Wilcox, M.D.; J.T. Miller; I.M. Williams and D.W. Guild, 1985: *Eucalyptus* species trials in Longwood Forests, Southland. FRI Bulletin No. 95. Forest Research Institute, New Zealand.

APPENDIX 1

List of *Eucalyptus* species and origins

Species	Origin
E. andrewsii	Glen Innes (Mt Mitchell), NSW
E. campanulata	South New England Tablelands, NSW
E. cypellocarpa	Grampian Mountains, Victoria
E. dalrympleana	Mullion Creek, Orange, NSW, 915 m
E. dalrympleana	Wihareja, Tasmania, 850 m
E. dalrympleana	Brindabella, NSW, 1200 m
E. delegatensis	Bluff Creek, Mansfield, Victoria, 1310 m
E. delegatensis	Bondo S.F., NSW, 1150 m
E. delegatensis	Fingal, Tasmania, 520 m
E. delegatensis	Maydena, Tasmania, 920 m
E. delegatensis	Crookston, Southland
E. dendromorpha	Mount Budawang, NSW
E. dunnii	Coffs Harbour, NSW
E. fastigata	Cpt 122, Kaingaroa Forest
E. fastigata	Burrawang, Yarrawa Highlands, NSW
E. fastigata	Oberon, NSW
E. fastigata	Rossi, NSW
E. fastigata	Bombala, NSW
E. fraxinoides	Badja Mountain, NSW
E. fraxinoides	Robertson/Mossvale, NSW
E. fraxinoides	Big Badja Mt Southern Tablelands, NSW
E. gunnii	Shannon, Tasmania
E. gunnii	Drummond, Southland, NZ
E. johnstonii	Russell Valley, SW Tasmania
E. nitens	Barrington Tops, NSW
E. nitens	Nimmitabel, NSW
E. nitens	Bendoc, NSW
E. nitens	Mount Erica, Victoria
E. nitens	Taggerty, Victoria
E. nitens	Tallaganda S.F., NSW
E. obliqua	Powelltown, Victoria
E. obliqua	Ranelagh, Tasmania
E. obliqua	Millicent, South Australia
E. obliqua	Tuamarina, Blenheim, NZ
E. obliqua	Lavers Hill, Victoria
E. obliqua	Nietta, Tasmania
E. obliqua	Mawbanna, Tasmania
E. obliqua	Powelltown, Victoria
E. obliqua regnans	Otway Ranges, Victoria
E. oreades	Bellangry S.F., NSW, 1130 m
E. oreades	Lithgow, NSW, 1070 m
E. regnans	Uxbridge, Tasmania, 500 m
E. regnans	Narbethong, Victoria, 600-800 m
E. regnans	Nugent, Tasmania, 340-400 m
E. regnans	Cpt 399, NZFP Forests Ltd, Tokoroa (orig. Tasmania)
E. regnans	Ruapuna, Canterbury, NZ
E. saligna	Athenree Forest, NZ
E. saligna	Windsor, NSW, 300 m
E. saligna	Kangaroo Valley, NSW, 610 m
E. saligna	Kauaeranga seed orchard, NZ
E. saligna	South Africa seed orchard
E. sieberi	Fingal, Tasmania, 450 m
E. sieberi	Newnes, NSW, 1070 m
E. sieberi	Penrose, NSW, 610 m
E. sieberi	Nerrigundah, NSW, 305 m
E. sieberi	Currarong, NSW, 30 m
E. sieberi	Powelltown, Victoria
E. stenostoma	Belimbla, Dampier S.F., NSW, 700 m
E. triflora	Sassafras, NSW, 530 m
E. viminalis	Rotorua, NZ
E. viminalis	Canberra, ACT
E. viminalis	Kingston, Tasmania
E. viminalis	Maydena, Tasmania
E. viminalis	Fingal, Tasmania
E. viminalis	Bruthen, Victoria
E. viminalis	Orbost, Victoria
E. viminalis	Billapaloola, Tumut, NSW