10 Year Results of River Gum (Eucalyptus Camaldulensis) Provenance Trials at 6 Localities in Agricultural Areas of W.A.

by

A.J. Hart

FORESTS DEPARTMENT
PRODUCTION
PROTECTION
RECREATION
CONSERVATION
WESTERN AUSTRALIA

January 1982

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JANUARY, 1982

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EUCALYPTUS CAMALDULENSIS (RIVER GUM) PROVENANCE TRIAL - RESULTS AFTER 10 YEARS

A.J. Hart (Forests Department)

INTRODUCTION

River gum stock in Inland Arboreta species suitability trials undertaken by the Forests Department in the 1960-68 period was obtained almost exclusively from the Murchison and Wiluna areas.

After a period of about 5 years, and with the advent of severe droughts in 1967-69 in some of the northern and eastern wheatbelt areas, performance of this species gave concern due to increased insect attack and obvious stress under drought conditions.

It was therefore decided to undertake a trial with eleven (11) different provenances drawn from all parts of Australia, all planted at various arboreta in the northern, eastern and central wheatbelt areas. The aim was to find better provenances, perhaps more suited to inland areas. This was done in May-August, 1970.

Location of Trials and Climatic Conditions

As per Plan 1 of Western Australia and enlargements. These were:

1. North Eneabba Arboretum - upland situation.
2. West Morawa - light soil arboretum.
3. Southern Cross.
4. Merredin South - heavy soil, lower slope, arboretum.
5. South Shackleton - gully flat.
6. East Pingelly - upper slopes of creek side.

Climatic conditions are summarised as per Table 1.

Preparation of Planting Sites and Planting Procedure

Planting sites were either:

1. Sprayed with "Vorox" AA prior to planting; or
2. Mechanically cultivated with discs or hand cultivated by spade at each planting site to remove grass competition.

All sites had been previously cleared for some years and were vacant areas within an existing arboretum.

Plantings were made so that competition from other species was not an immediate factor, if at all.

Planting Procedure

Initial spacing: with the exception of the South Merredin and South Shackleton trials planted at 11 x 8m, spacings were made at 11m x 11m (33' x 33').

Watering

Immediate post-planting watering was made of approximately 2 litres/plant at all sites except South Shackleton and East Pingelly. Planting details are summarised in Table 2.

Provenance Details

Details of the origin of planting stock used are shown in Table 3, and also on Plan 2.

RESULTS

Survival, height and diameter growth for provenances at each arboretum are set out in Table 4. Statistical test results are shown in Graph 1. Incidence of insect attack is also noted in Tables 4 and 5, as far as could be ascertained.

Tables 5-(1) to 5-(4) summarise height growth for four (4) localities. Table 5-(5) summarises surival for four (4) localities. Graph 1 indicates the comparison of growth for these localities.

Of interest is the better height growth at the South Merredin plot which receives less rainfall than South Shackleton. Four (4) provenances, S/Nos 4112, 4114, 4116 and 4119, at South Merredin are almost twice as tall as those at South Shackleton. The latter site is salt affected which also adds to the unavailability of usable moisture whilst the Merredin site is a moisture gaining one.

CONCLUSIONS

1. Three (3) provenances, S/Nos 4118, 4113 and 4116, have demonstrated greater drought resistance than the other 8 under trial.
2. Drought conditions and possible rain shadowing effects of existing trees contributed to the failure of plantings in West Morawa and East Pingelly.
3. There is a need to preserve pure stands of river gum in low rainfall areas to preserve a drought resistant factor.

4. Observations have indicated little insect attack on the 2 provenances S/Nos 4118 and 4113, which have shown greatest survival. The main attacks have been leaf cutters, probably wild bees. S/No 4116 has been attacked by leaf tiers at South Merredin and South Shackleton, presumable when under stress conditions.
5. Observations generally indicate that establishment and development is best on moisture gaining sites.
6. The value of hybrid stock of Eucalyptus camaldulensis is regarded as low, as indicated by Euc 'C' ex Zanzibar, Africa, included in these trials as S/No 3919, which has been a dismal failure in arid areas.
7. It is considered of particular significance that all of the provenances which have exhibited greatest survival rates over all sites have originated from PURE stands in low rainfall sites, e.g. 162.5 to 346 mm. This suggests that in some way the factor of drought resistance is being diminished by hybridisation (however slight) with associated species.

   The need is considered to exist therefore for preservation of pristine stands of river gum to preserve this factor of resistance, exhibited in these trials through the occurrence of extremely dry and drought conditions of 1972 and 1979/80.

RECOMMENDATIONS

1. It is recommended that E. camaldulensis plants supplied to wheatbelt areas below 550 mm per year be obtained from the provenances S/Nos 4118 or 4113.
2. Relevant bodies controlling areas with pure stands of river gum be advised of the apparent drought resistant value of such stands and recommend preservation of those areas. (This may in time be of benefit because of salt tolerance as well in the same areas).

ACKNOWLEDGEMENTS

The assistance of Mr D Ward in carrying out statistical analyses of results is greatly appreciated, various officers from Kalgoorlie who have measured the Southern Cross trial at different times, and Mr O Loneragan. Also C S I R O, Canberra, for supplying seed of the various provenances.

BIBLIOGRAPHY

Arboreta in Arid and Semi Arid Parts of Western Australia, June 1980. A.J. Hart, p.8.

TABLE 1

CLIMATIC CONDITIONS OF TRIAL SITES

METEOROLOGICAL STATION	ARBORETUM LOCALITY	RAINFALL (mm)	MEAN MAX. TEMP. OF HOTTEST MONTH (^{o}C)	MEAN MIN. TEMP. OF COLDEST MONTH (^{o}C)
1. Southern Cross	Southern Cross	275	34.7 (Jan.)	4.2 (Jly)
2. Merredin	South Merredin	330	33.6 (Jan.)	4.7 (Jly)
3. Morawa	West Morawa	338	36.6 (Jan.)	5.6 (Jly)
4. Kellerberrin	South Shackleton	350	33.9 (Jan.)	5.6 (Aug.)
5. Brookton	East Pingelly	375	32.9 (Jan.)	4.0 (Aug.)
6. Eneabba	North Eneabba	525	35.4 (Dec. Feb.)	8.8 (Aug.)

TABLE 2

ARBORETUM LOCALITY	DATE OF ESTABLISHMENT	SITE PREPARATION	WATERING (POST PLANT)	SPACING
. North Eneabba	27-28 May 1970	Hand spot cultivation	Approximately 2 litres post plant (= 8.5 mm rain equivalent)	11 x 11m
. West Morawa	27 May 1970	No Vorox + hand cultivated	As above	11 x 11m
. South Merredin	5 August 1970	As above	Watered as above	11 x 8m
. East Pingelly	3 August 1970	No Vorox + hand cultivated	Nil watering (?)	11 x 11m
. South Shackleton	4 August 1970	Mech. disc cultivation + no Vorox	Nil watering	11 x 8m
. Southern Cross	6 August 1970	Vorox AA + hand cultivated	Watered in as for 1 above	11 x 11m

TABLE 3

"THE ORIGIN OF PROVENANCES TESTED"

ERIAL NO.	LOCALITY OF COLLECTION	LATITUDE	LONGITUDE	ALTITUDE	SOIL	ASSOCIATED SPECIES	HT. OF PARENT TREE(S)	LOWEST RECORDED TEMP.	RAINFALL/ ANNUM (mm)
4110	Upper Waterhole - 5 miles from P/ Station for Wyndham Water Supply	15°41'S	128°5'E	300'	Brown alluvial soil, loam texture	Melaleuca sp. as fringing forest near water	40-45'	50°F	682.5
4111	Newcastle Waters Creek N.T.	17°30'S	133°3o'E	700'	Clay to sandy clay loam	Pure stand - some Euc. cyanoclada at distance	30'-45'	28.5°F	476.5
4112	Walpola Island S.F. 35 miles W of Mildura N.S.W.	34°10'S	142°6¼'E	185'	Heavy grey clay pH7	Pure with Euc. largiflorens on drier ground away from creek	50'-120'	23°F	242.75
4113	Silverton - 13 miles W of Broken Hill	31°57'S	141°28'E	700'	Deep coarse red sand pH7	Pure stand in creek beds	35'-50'	27°F	230.4
4114	Little Swamp 5 miles W of Port Lincoln S.A.	24°40'S	135°50'E	100'	Rendzina with lime-stone outcrops - shallow water table pH8	Some Euc. diversifolia and Euc. landsdownea present	25'	32°F	456
4115	Charters Towers	20°0'S	146°17'E	1019'	Sandy loam shales	?	?	35.5°F	633.75
4116	10 miles W of Mt Isa on Mary Catherine Road	20°43'S	139°35'E	1200'	& (sand and loam) of creek bed	Pure stand on creek	15'-35'	27°F	162.5
4117	Gilbert R. 40 miles W of Georgetown	18°10'S	142°50'E	800'	River loam and alluvial over granite	Melaleuca spp. plus occas-ional Casuarina spp.	25'-35'	29°F	711
4118	Goodarra Creek ½ mile from junc. with Tennant Creek N.T.	19°34'S	134°19½'E	1100'	Sandy loam	Pure stand	25'-45'	36.4°F	346.25
119	20 miles N of Three Springs W.A.	29°20'S	115°35'E	1000'	Silty grey loam	Euc. loxophleba associated aff. with Euc. rudis	?	32.0°F	394.75
919	Zanzibar	6°30'S	39°20'E	?	?	Suspected hybrid from Zanzibar	?	?	?

TABLE 4

EUCALYPTUS CAMALDULENSIS PROVENANCE TRIAL RESULTS

TO SPRING 1980 (AGE 10 YEARS)

LOCATION OF ARBORETUM	SOIL TYPE	C.S.I.R.O. SOIL DIV^{n} EQUIVALENTS (APPROX.)	GROWTH FACTOR	SERIAL NO. of PROVENANCE (see Table 3)											OVERALL % SURVIVAL
				4110	4111	4112	4113	4114	4115	4116	4117	4118	4119	3919	
1. Southern Cross	Brown red sandy loam	MY 41-50 AB 3-8 AC 9,10,11	1. Survival % 2. Mean height at 10 years 3. Thrift	25 3.10 (3) All	64 3.91 (7) trees	35 5.17 (7) in good thrift - some coppicing back after rains	50 3.52 (6)	40 3.60 (4)	57 3.90 (4)	75 4.51 (9)	47 3.67 (7)	80 2.83 (8)	33 3.33 (4)	20 2.1 (1)	48.8
2. West Morawa	Yellow grey sandy clay -clay gravel below	JY, JZ 1-2 Lb 10-11	1. Survival %	)		Failed except for 3 of S/No 4119							50		4.5
3. Merredin	Medium textured red/brown loam	MS 7-12	1. Survival % 2. Mean height at 10 years 3. Thrift	50 2.80 Most of	50 0.65	100 6.00 very good thrift - leaf	100 4.08	100 6.75	- -	100 6.13 suckers on S/No 4116	100 3.75	50 3.25	100 7.00	- -	68
4. South Shackleton	Light grey brown sandy silt	SV, SV4	1. Survival % 2. Mean height at 10 years 3. Thrift	ALL FAIL-ED	100 3.18 Leaf suck-ers, tiers and bor-ers. Good	33.3 2.80 Fair	33.3 3.00 Fair to good	33.3 3.90 Good	66.6 1.50 Leaf suck-ers	66.6 3.22 Leaf tiers not very act-ive. Fair	33.3 3.50 Good	66.6 2.90 Fair to good	66.6 3.45 Stem bor-ers & leaf suck ers.	ALL FAIL-ED	45

TABLE 4 (cont'd)

EUCALYPTUS CAMALDULENSIS PROVENANCE TRIAL RESULTS

TO SPRING 1980 (AGE 10 YEARS)

LOCATION OF ARBORETUM	SOIL TYPE	C.S.I.R.O. SOILS DIVn EQUIVALENTS (APPROX.)	GROWTH FACTOR	SERIAL NO. of PROVENANCE (see Table 3)											OVERALL % SURVIVAL
				4110	4111	4112	4113	4114	4115	4116	4117	4118	4119	3919	
6. East Pingelly	Pale yellow/ grey sandy laterite over mottled gravelly clay	SV, SV4	1. Survival %	100					50						13.6
7. North Eneabba	Grey sand over mottled gravelly clay	Xd, YA JK11 Wd 9.7 Sl 30	1. Survival % 2. Mean height at 10 years 3. Mean DBH 4. Thrift	60 8.0 (6) 17.9 (5) Good	20 7.0 19.9 (1) Fair to Good	50 7.2 14.4 (3) Fair to Good	90 6.5 (9) 10.9 (9) Good to Very Good	40 6.8 (4) 14.5 (4) Good	60 6.5 14.2 (4) Fair	40 7.0 (4) 16.9 (4) Very Good	40 6.7 (10) 14.3 (4) Good	100 7.4 (1) 12.6 (12) Good	10 6.0 (1) 26.0	20 5.6 (2) .2	48

NOTE: (1) Insect activity at North Eneabba mostly leaf cutting by bees and seem to have outgrown maior insect attacks.

(2) Numbers in brackets refer to number of trees measured for that growth factor.

(3) Height shown in metres and diameters in centimetres.

GROWTH DATA SUMMARIES OF RIVER GUM PROVENANCES

APPENDIX 1 - (TABLE 5-1)

AT 1) NORTH ENEABBA - Estd May 1970

Serial No.	No. trees	Mean height (m) 11/72	7/77	4/80	M.A.I. (m/ann)	Mean D.B.H.O.B. (cm) 11/72	7/77	4/80	M.A.I. cm/ann. April 1980	Survival % at 4/80	Comments - bark, foliage insect attack, etc.
4110	4	1.9	8.8	8.04	0.81	NO OBSERVATIONS	13.18	17.87	1.90	60	Gregarious gall weevils 6m up the bole otherwise free of insect attack.
est ht (m)		2.7	10.3	10.50							
4111	2	1.9	5.72	7.00	0.71		15.2 (one stem only)	19.9	1.99*	20	
est ht (m)		2.8	7.44	10.00							
4112	5	1.32	6.95	7.20	0.73		12.13	14.38	1.55	50	Some trees heavily attack by leaf tiers (1977) up t 4m above ground.
est ht (m)		1.65	9.60								
4113	9	1.68	6.8	7.34	0.74		14.08	18.65	1.97	90	No prominent insects - vigorous growth but some- what irregular.
est ht (m)		1.65	7.8	8.50							
4114	4	1.63	6.53	7.08	0.71		12.38	14.30	1.49	40	Leaf tiers and leaf galls.
est ht (m)		2.2	6.90	8.50							
4115	4	1.78	7.68	7.00	0.71		13.40	17.19	1.72	40	Little evidence of insect attack.
est ht (m)		2.30	8.50	8.25							
4116	5	2.10	7.50	6.75	0.68		10.98	14.20	1.42	60	Slight insect attack.
est ht (m)		2.4	10.80	8.75							
4117	4	1.49	6.60	6.69	0.67		10.48	14.26	1.43	40	Some gregarious gall weevils collected.
est ht (m)		1.90	7.90	8.00							
4118	4	1.68	6.60	7.40	0.75		9.22	11.65	1.16	100	Heavy defoliation of 50% of trees.
est ht (m)		1.80	6.90	9.00							
4119	1	1.5	6.3	6.0	0.61		18.3	25.95	2.60*	10	Galls, lerps and coccids present.
est ht (m)		1.5	6.3	6.0							
3919	2	2.03	5.35	5.63	0.57		11.25	15.15	1.52	20	Leaf eaters and tiers to 3m up tree crown.
est ht (m)		2.15	7.2	7.25							

(* = based on 1 or 2 trees only)

APPENDIX 1 - (TABLE 5-2)

AT 2) SOUTHERN CROSS - Estd 6/8/70. NOTE: Diameter growth data not available

Serial No	No. trees (1980)	Mean height (m) 11/72	11/76	4/80	M.A.I. (m/ann)	Survival % at 4/80	Comments - bark, foliage, insect attack, etc.
4110	3	0.89	2.50	3.10	0.32	25	Leaf eaters observed 11/76. Gregarious gall weevils noted 8/66.
Best height				4.3			
4111	7	1.68	3.64	3.91	0.41	70	Case moths on fresh leaves (1977) (Hyalarcta sp. of Psychidae)
Best height				5.1			
4112	7	1.68	5.94	5.07	0.53	41.2	Stem borers in 1 tree plus leaf eaters - (1977) Pyrallidae spp.
Best height				6.5			
4113	6	0.95	2.71	3.52	0.37	50	Leaf eaters observed 11/76.
Best height				4.4			
4114	4	1.18	3.05	3.60	0.38	40	Leaf eaters on edges of leaves. Leaf suckers on 1 unthrifty tree 1977
Best height				6.2			
4115	4	1.08	3.38	3.90	0.41		Psychidae - Clania sp. observed 12/77.
Best height				4.4			
4116	9	1.43	4.33	3.64	0.69	75	Some gregarious gall weevil only 1977 and low attack of leaf eaters.
Best height				6.20			
4117	10	1.20	3.20	3.67	0.38	58.8	Leaf tiers (1977) Pyrallidae - Polyphrados sp. and Curculionid weevils.
Best height				5.60			
4118	8	0.90	2.39	2.83	0.29	80	Borers in 1 stem and case moths 12/77.
Best height				5.20			
4119	4	0.92	2.63	3.33	0.35	33.3	Leaf eaters observed 11/76. Twig galls of Apiomorpha sp of Coccidae observed 8/77 with small scarab larvae.
Best height				5.0			
3919	1	0.70	2.0	2.1	0.22	20	
Best height				-			

(M.A.I. calculated on 9.6 years)

APPENDIX 1 - (TABLE 5-3)

AT: 3) SOUTH SHACKLETON - Estd 4/8/70 NOTE: Diameter growth data not available.

Serial No	No. trees (1980)	Mean height (m) 11/72	11/77	6/80	M.A.I. cm/ann.	Survival % at 4/80	Comments - bark, foliage insect attack, etc.
4110 best ht (m)	-	NO OBSERVATIONS	2.10	All failed	-	-	
4111 best ht (m)	3		2.10	3.18 3.90	0.32	100	
4112	1		N/Av.	2.80	0.28	33.3	
4113	1		1.52	3.00	0.30	33.3	Leaf suckers - Gonipterus sp. vigorourly attacking foliage.
4114	1		3.11	3.90	0.39	33.3	
4115	2		1.02	1.5	0.15	66.7	Poor thrift on heavy clay loam site.
4116	2		2.10	3.23	0.32	66.7	Possible saline influences
4117	1		2.10	3.50	0.35	33.3	Jassids and ants prevalent feeding on "bloom" of twigs, etc., glaucous foliage.
4118	2		1.52	2.90	0.29	66.7	
4119	2		2.61	3.45	0.35	66.7	Possible saline influences.
3919	-	All failed -		-	-	-	

APPENDIX 1 - (TABLE 5-4.)

AT: 4) SOUTH MERREDIN - Estd 5/8/70. NOTE: Diameter growth data not available.

Serial No	No. trees 1980	Mean height (m) 11/72	11/77	6/80	M.A.I. cm/ann.	Survival % 1980	Comments - bark, foliage insect attack etc.
4110	1	NO OBSERVATIONS	1.02	2.80	0.28	50	Galls on twiglet
4111	-		Failed	-	-	-	
4112	2		3.12	6.0	0.6	100	Very heavy fruiting
4113	1		2.61	3.55	0.36	50	Leaf tip cutters observed 6/80
4114	2		4.13	6.75	0.68	100	Bluish glaucous foliage - rough bark at base
4115	1		1.02	0.65	0.06	50	Galls and leaf tiers collected 1977 - suckering.
4116	2		5.13	6.13	0.61	100	Thin pendulous crown, rough bark at base; leaf suckers 6/80. Best result of all serial numbers.
4117	2		2.10	3.75	0.38	100	Leaf tiers present. Broad ovate leaves blue green colour. Cockatoo attack on branchlets.
4118	1		1.52	3.25	0.33	50	-
4119	2		4.64	7.00	0.70	100	Mid-green leaves - heavy fruit crop - excellent form, pendulous foliage.
3919	-		Failed		-	-	
	Plot covered with 1.2m of water in flash flood approx. February 1980						

APPENDIX 1 (TABLE 5-5)

SURVIVAL

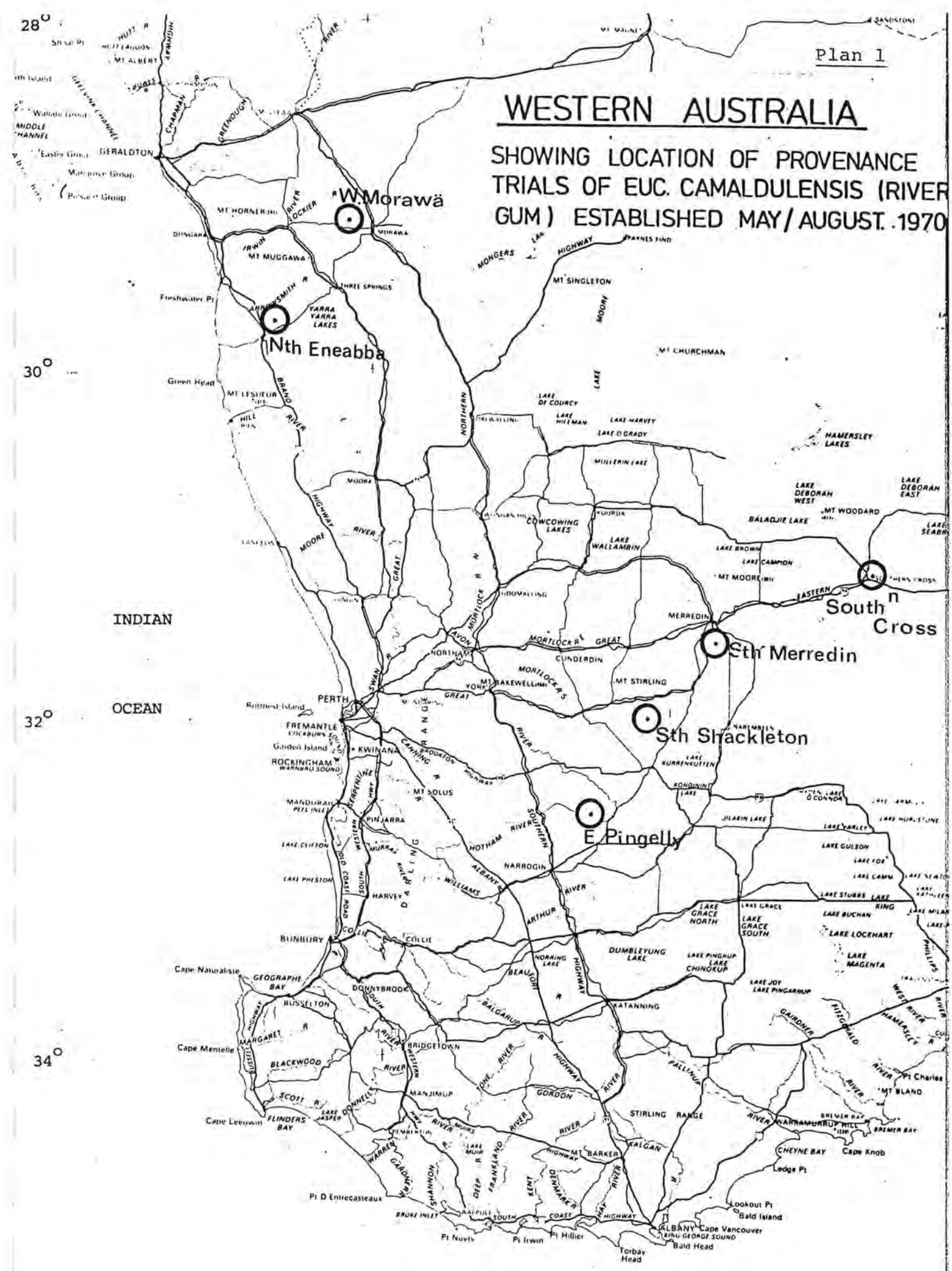
(Excluding W. Morawa & E. Pingelly)

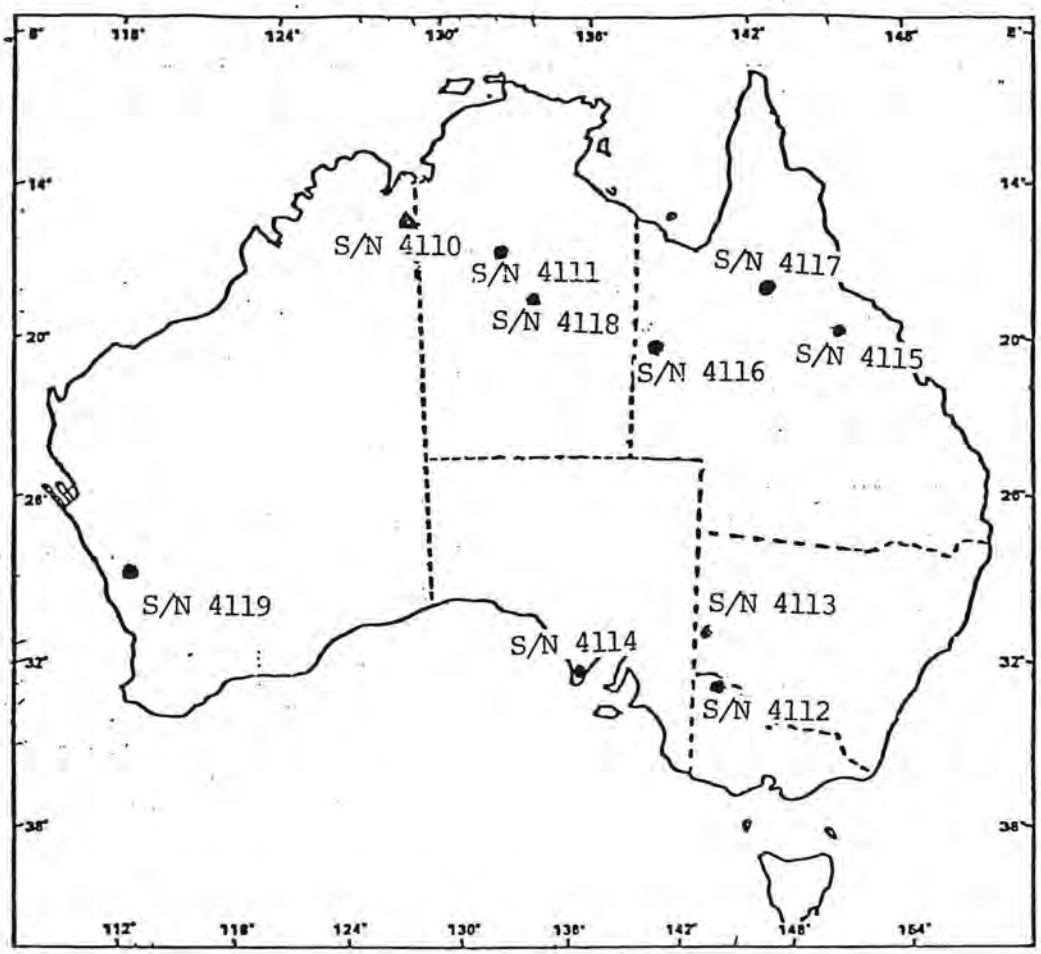
ARBORETUM LOCALITY	PLANTING DETAILS ETC	NO. PLANTS PER PROVENANCE											TOTALS
		4110	4111	4112	4113	4114	4115	4116	4117	4118	4119	3919	
North Eneabba	No Planted	10	10	10	10	10	10	10	10	10	10	10	110
	Survivals	6	2	5	9	4	6	4	4	10	1	2	
South Merredin	No Planted	2	2	2	2	2	2	2	2	2	2	2	22
	Survivals	1	1	2	2	2	-	2	2	1	2	-	15
South Shackleton	No Planted	3	3	3	3	3	3	3	3	3	3	3	33
	Survivals	-	3	1	1	1	2	2	1	2	2	1	15
Southern Cross	No Planted	12	11	17	12	10	7	12	17	19	12	5	125
	Survivals	3	7	7	6	4	4	9	8	8	4	1	61
	Total Planted	27	26	32	27	25	22	27	32	34	27	20	
	Total Survival	10	13	15	18	11	12	17	15	21	9	4	
	% Survival	37	50	47	67.7	44	54.5	63	47	62	33.3	30	
	Rank	8	5	6	1	7	4	2	6	3	9	10	

Plan 1

WESTERN AUSTRALIA

SHOWING LOCATION OF PROVENANCE TRIALS OF EUC. CAMALDULENSIS (RIVER GUM) ESTABLISHED MAY/AUGUST. 1970





PLAN 2

AUSTRALIA

Showing sites of seed collection of river gum provenances used in these trials.

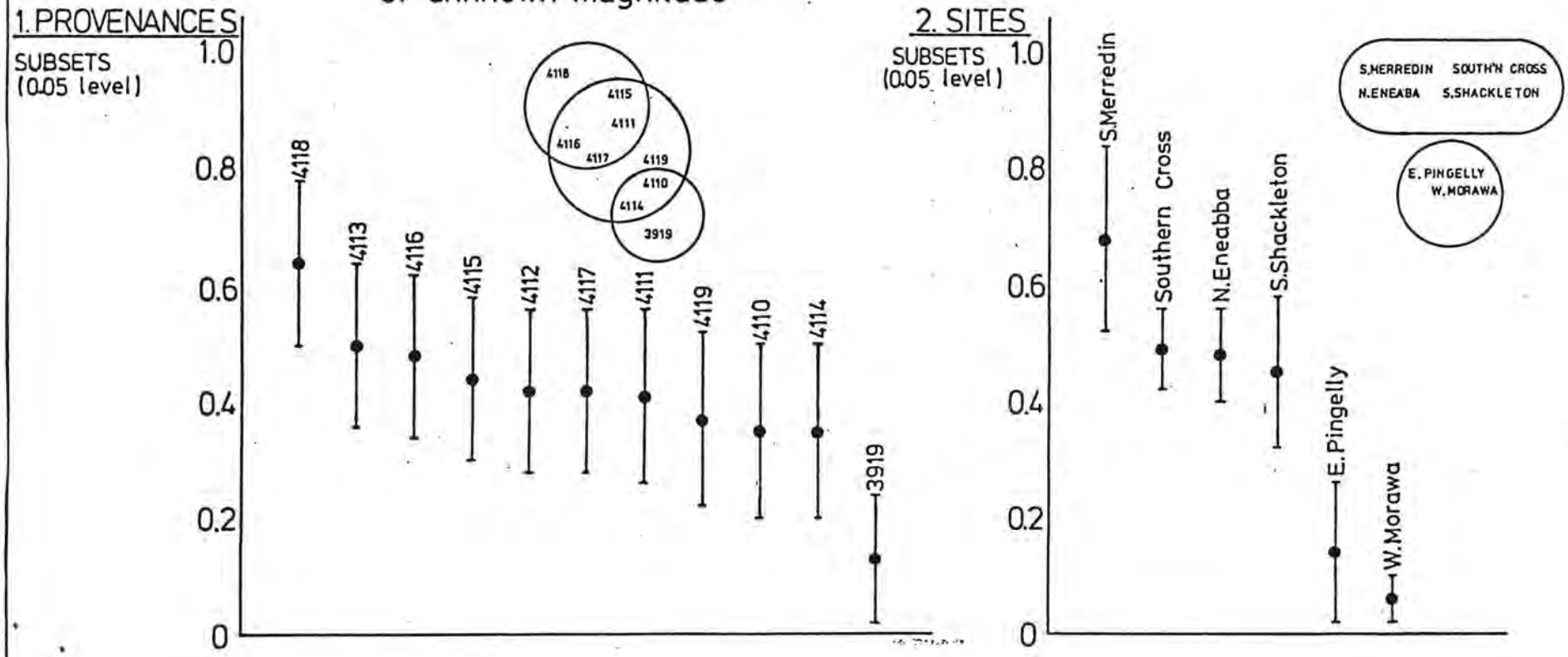
(S/No 3919 ex Zanzibar, East Africa).

APPENDIX 2 - GRAPH 1

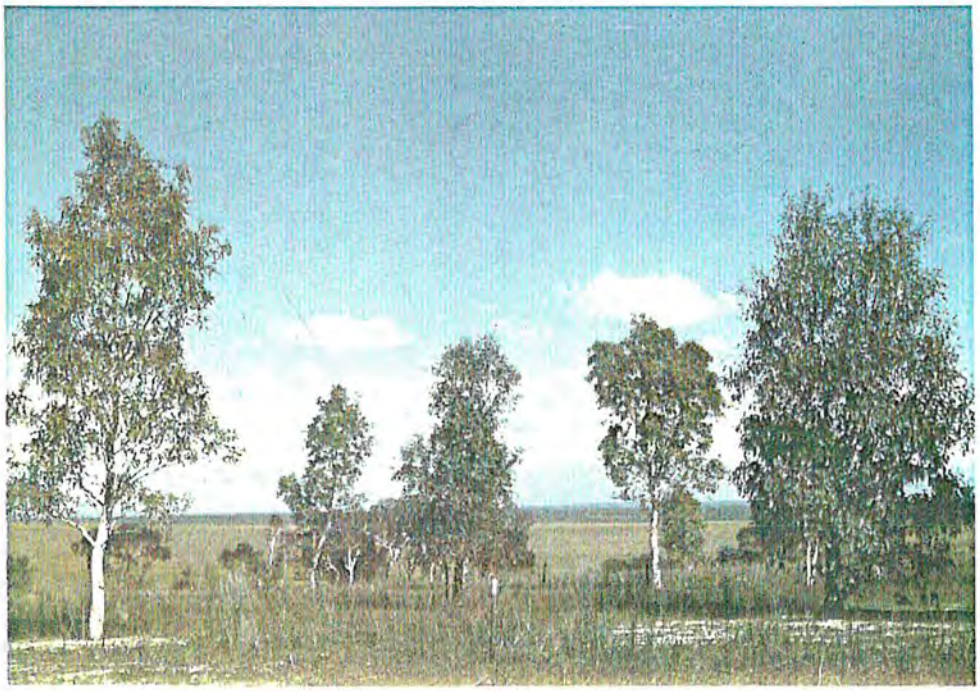
EUC. CAMALDULENSIS (RIVER GUM) PROVENANCE TRIAL (1970-1980)

90% CONFIDENCE INTERVALS for SURVIVAL PROPORTION

NOTE: 1. Insufficient data for interactions analysis
2. Unbalanced design of trial may have incurred error due to skewness of unknown magnitude



Features of Some Provenances of River Gum at .....



1. North Eneabba.

L. to R. S/Nos. 4111 and 4110 showing light green foliage and smooth bark.

S/No. 4114 with deep glaucous green foliage

Date 29/7/77.

2. Southern Cross.

L. to R. S/No. 4113 (2 trees), S/No. 4116 (9 trees)

S/No. 4118 Rest of trees in the row.