KENYA FORESTRY RESEARCH INSTITUTE

TECHNICAL NOTE NO: 3

Kenya Forestry Research Institute,
P.O. Box 20412,
Nairobi, Kenya

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Provenance Trial of *Eucalyptus grandis* in Kenya

P.K.A. Konuche

Introduction

Eucalyptus grandis Hill (Maiden) and ***E. saligna*** Sm. were introduced to Kenya around 1905 (Pudden, 1957). The two species have been widely planted in the highlands for production of woodfuel, building poles, fencing posts, transmission poles and pulp. For a long time, their identities have remained confused in Kenya. The locally grown "***E. saligna***" is considered to be either ***E. grandis*** or a hybrid of ***E. grandis*** and true ***E. saligna*** (Howland and Freeman, 1970). Because of this confusion, Australian seeds of ***E. grandis*** and ***E. saligna*** were imported in 1953 to compare their fuelwood yields against that of the Kenya "***E. saligna***". ***E. grandis*** seed came from Queensland while that of ***E. saligna*** came from New South Wales (NSW). During the first three rotations, ***E. grandis*** produced higher volume than the local ***E. saligna*** (Dyson, 1974). However, the local "***E. saligna***" produced higher volume than ***E. grandis*** during the fourth rotation (Kaumi, 1983). The NSW provenance of ***E. saligna*** produced intermediate yields during the four rotations.

The good performance of ***E. grandis*** after the third rotation generated renewed interest on Australian provenances of this species. In 1980, Kenya co-operated in the International Union of Forestry Research Organization (IUFRO) co-ordinated International Provenance Trials of ***Eucalyptus grandis***. Kenya's objectives in participating in this project were to widen the local gene pool of this species, to identify Australian possible sources of commercial seed and to compare performance of the Australian provenances against the local provenances. This report presents the results of this provenance trial at ages 5 and 8 years.

Methods and Materials

The experiment (E.P 138/R.E. 391) was sited north of Ndoswa Village, compartment 3 (H), Elburgon Forest Reserve. The area lies at 0° 21' South, latitude; 35° 52' East, longitude and at 2380 m a.s.l. Annual rainfall is 1300 mm falling mainly between March and November. The soils are sandy loams having poor structure. The site was previously under old ***E. saligna*** which was cut down a year before the experiment was planted.

The provenances tested are indicated in table 1. Their seed sources were: Australia (16), South Africa (1) and Kenya (3). Of the 16 Australian provenances, 7 originated from northern Queensland, 4 from Southern Queensland and the remaining 5 were from Northern New South Wales (NSW).

The origin of South African provenance is Sabie Seed Orchard. The sources of the two Kenyan provenances of *E. grandis* were Muguga Arboretum (Plot 74) and Muguga Estate plantation (compartment 2G). The remaining local provenance was the Kenya "*E. saligna*" from an old shelterbelt at Lugari Forest, Kakamega District.

The experiment was planted in June 1980. The design was complete randomised blocks of 5 replicates and 36 trees per plot in a spacing of 2.5 m x 2.5 m. Beating up was done a year after planting.

The experiment was tended by growing agricultural crops ("shamba" system) of maize and pyrethrum during the first two years. Some damage to trees were observed in plots inter planted with pyrethrum.

Table 1: Locality and Origin of Provenances

Seed Batch Number	Locality	Latitude	Longitude East	Altitude (m)
12380	East of Mareeba Northern Queensland	17° 03'S	145° 36'	740
12426	SFR 700, Gillies Highway Queensland	17° 13'S	145° 42'	730
12383	Herberton Area Queensland	17° 20'S	145° 24'	1000
12381	Wondecla Area "	17° 25'S	145° 27'	1010
12409	Ravenshoe Area "	17° 42'S	145° 28'	940
12382	Tully Falls Area "	17° 49'S	145° 31'	800
12462	West of Paluma "	19° 00'S	14° 6 00'	900
10693	Northeast of Gympie Southern Queensland	26° 07'S	152° 42'	76
10694	Southeast of Gympie Southern Queensland	26° 18'S	152° 46'	75
19695	Kenilworth Southern Queensland	26° 40'S	152° 33'	530
10696	Bellthorpe S. Queensland	26° 52'S	152° 42'	460
11243	South of Tyalgum Northern NSW	28° 27'S	153° 12'	100
11244	South of Murwillumbah NSW	28° 33'S	153° 23'	300
11681	North of Woolgoolga NSW	29° 32S	153° 12'	30
7823	North of Coffs Harbour NSW	32° 10'S	153° 08'	18
7810	North of Bulahdelah NSW	32° 20'S	152° 13'	120
12894	Sabie Seed Orchard South Africa	-	-	420
MA 74	Muguga Arboretum Plot No. 74	01° 13'S	36° 38'	2070
MP	Muguga Plantation, CPT. 2G	" "	" "	"
SL	Lugari Stand *(E. saligna)*	00° 08'N	35° 52'	1800

NSW = New South Wales
SFR = State Forest Reserve

Survival count and height measurements were made soon after planting, and then annually for the first two years. From the third year, survival, height and diameter at breast height (D.B.H.) were assessed annually upto the eighth year. Stem straightness and branch persistence were assessed at the age of 5 years. All the assessments were based on the inner 16 trees per plot leaving outer two rows.

From one to eight years, measurements on height and diameter were made to nearest tenth of a metre and centimetre respectively. Scores for stem straightness and branch persistence were as follows:

Stem straightness	Branch persistence
5 - perfectly straight stem	5 - tree with long clean bole with branches cast naturally
4 - minor deviation from perfectly straight	3 - tree of average branch persistence
3- average straightness	1 - tree with very persistence branches

2 - stem with more than average defects

1 - crooked stem

Analysis of variance was carried out on height, diameter, stem form, branch persistence and transformed (arc sine) percentage survival data.

Table 2: Mean values for height, diameter, stem straightness, branch persistence and survival for ***E. grandis*** provenances at 5 and 8 years

Seed Batch No.	Provenances Origin	means at 5 years				Means at 8 years		
		Height m	D.b.h. cm	Stem straight-ness	Branch persist-ence	Height m	D.b.h. cm	% survival
12380	East of Mareeba, Northern Queensland	14.9	14.2	3.4	4.0	21.8	15.4	54.7
12426	SFR 700 Gillies Highway "	15.1	12.3	3.1	4.0	21.3	15.4	57.8
12383	Herberton Area Northern "	14.4	13.1	4.0	4.0	22.7	14.8	92.2
12381	Wondecla " " "	15.2	13.2	4.1	4.4	21.8	16.4	82.8
12409	Rovenshoe " " "	14.9	13.3	3.7	4.5	22.4	15.8	70.3
12282	Tully Falls " " "	15.3	13.5	3.4	4.1	22.0	17.9	68.8
12462	West of Paluma " "	14.6	13.5	3.8	4.0	21.3	15.9	87.5
10693	NE of Gympie, Southern Queensland	15.9	13.8	3.9	4.5	22.7	15.6	95.3
10694	SE " " " "	15.2	12.3	4.2	4.5	21.1	14.8	95.3
10695	Kenilworth " "	15.2	13.0	3.2	4.2	21.4	15.9	75.0
10696	Bellthorpe " "	15.4	13.1	4.0	4.6	22.6	15.8	82.8
11243	South of Tyalgum, Northern NSW	14.9	13.2	4.1	4.5	22.3	15.1	87.5
11244	" " Murwillumbah " "	15.8	13.2	3.7	4.2	23.3	15.5	92.2
11681	North of Woolgoolga " "	14.5	12.6	3.4	4.2	22.5	15.1	71.9
7823	" " Coffs Harbour " "	15.7	14.5	3.5	4.6	23.2	17.5	67.2
7810	" " Bulahdelah " "	15.5	13.4	3.9	4.6	23.4	15.9	81.3
12894	Sabie Seed Orchard, South Africa	15.2	13.4	4.0	4.7	22.2	15.7	84.4
MA 74	Muguga Arboretum Plot 74	15.3	13.6	4.1	4.1	22.2	15.4	68.8
MP	Muguga Estate Plantation Compt 2G	14.7	13.2	4.0	4.5	21.0	16.1	87.5
SL	Lugari "E. saligna"	13.8	13.2	4.1	4.1	20.1	15.8	78.2
	L.S.D. at P = 0.05	n.s	1.11	0.60	n.s	n.s	n.s	n.s

Results and Discussion

A summary of mean heights, d.b.h., percentage survival and mean scores for stem straightness and branch persistence is given in table 2.

Survival

There was no significant difference between provenances in percentage survival in the 8th year. Survival for most provenances was very good with 15 of them recording over 70 per cent. This high survival was achieved because of good tending through the "shamba" system. However, damage to trees in plots planted to pyrethrum contributed to moderate survival of some provenances.

Diameter Growth

There was significant difference in diameter growth at 5 per cent level between provenances at 5 years. The provenances with the largest d.b.h. were those with moderate percentage survival. By the 8th year, however, there was no significant difference between the provenances in diameter growth. At 8 years, the Tully Falls (Queensland) and Coffs Harbour (NSW) had the best diameters but with percentage survival of 68.8 and 67.2 respectively. While mean diameters generally varied inversely with percentage survival, two Queensland provenances (Mareeba and Gillies Highway) with the lowest survival, did not produce trees with largest diameters as expected. This was because some trees of these provenances were damaged by pyrethrum cultivators and the plots had to be beaten up a year later.

Height Growth

At 5 years, there was significant difference between provenances in mean heights. However, this was not significant in the 8th year. The best provenance at 5 years was from Northeast of Gympie (Queensland). This was followed by three provenances from NSW (Murwillumbah, Coffs Harbour and Bulahdelah). The provenance with the lowest mean height was the ***E. saligna*** (Lugari).

At 8 years, the best three provenances were from NSW (Bulahdelah, Murwillumbah and Coffs Harbour). The Muguga Arboretum and the Sabie (South African) provenances had the same mean height and were about a metre shorter than the best provenances. Trees in the Muguga Estate plantation provenance were about 2 metres shorter than the best provenances. ***E. saligna*** (Lugari) maintained the lowest mean height.

Provenances of ***E. grandis*** from NSW grew faster in height than the other provenances although this was not well marked in 5th year. By the 8th year their superior performance was quite apparent. Compared to the Queensland provenances, the NSW provenances were growing 5 per cent faster. In a similar trial at Zimbabwe, Matheson and Mullin (1987) did not find any geographic region of Australia as providing the best provenances. However, they reported that three of the four best provenances came from NSW and that the Bulahdelah and the Coffs Harbour were among the best provenances.

The NSW provenances were also better in height by 3.9 and 14 per cent compared to Muguga Arboretum, Muguga Plantation and ***E. saligna*** (Lugari) provenances respectively. It is interesting to note that the Muguga Arboretum provenance was better than its sister Muguga Plantation provenance. The original source of seed of the Arboretum provenance was Pine Creek (NSW) but that of the plantation provenance was unknown. The poor growth of ***E. saligna*** (Lugari) seem to suggest that this particular Kenya "***E. saligna***" is unlikely to be ***E. grandis*** nor its hybrid.

It is worth noting that the fuelwood experiment reported by Howland and Freeman (1970), Dyson (1974) and Kaumi (1983) used *E. grandis* seed from Queensland. Since NSW provenances appear better than the Queensland provenances, this suggests that better results could have been obtained had NSW provenances been represented and that Kaumi (1983) could have arrived at a different result favouring ***E. grandis*** during the fourth rotation.

Stem straightness and Branch Persistence

The mean scores for stem straightness differed significantly between provenances at 5 per cent level. The provenance from Southeast of Gympie produced the most straight trees while the Gillies Highway provenance had trees with just above average straightness. The local provenances ranked high in stem straightness.

There was no significant difference between provenances in branch persistence. All provenances had above average mean scores. The best provenance was the Sabie Seed Orchard (S. Africa). It should be noted that the Muguga Estate Plantation (2G) provenance had better score than the other two local provenances.

The results from this experiment indicate that most provenances had good stem form and that local provenances compared favourably with the improved S. African provenance.

Conclusion

The New South Wales provenances of ***E. grandis*** appear superior to the Kenya, Queensland and improved Sabie (S. Africa) provenances. The local provenances had straight stems and good branching habits. The Muguga Estate plantation (2G) does not appear a good source of seed for commercial plantations. The trial contains valuable genepool of ***E. grandis*** and should be used as a source of seed for commercial plantation and tree improvement work. The experiment should continue upto 10 years when detailed measurements will be made, inferior provenances removed and coppices of superior provenances managed for seed production.

Acknowledgements

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