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Cover photo:

One year old *Eucalyptus urophylla* in Malindi
Picture by Paul Tuwei, KEFRI

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Summary

Seven provenances of *Eucalyptus urophylla* from Indonesia and East Timor were established in a trial at Gede along the Kenya Coast. After ten years of growth, the Mt. Wuko Fores and Mt. Boleng provenances from Indonesia proved to be superior to the others. The provenance from Mt. Wuko Fores, Indonesia showed the fastest growth at 25 m in height and 17.2 cm in diameter at breast height (DBH), although general performance of the provenance was variable. Mt. Boleng, Mt. Lewotobi and Mt. Langkoeroe provenances also showed relatively good growth of 24.7 m, 24.3 m and 24.2 m in height and 15.3 cm, 14.7 cm, 17.1 cm in DBH respectively. The over bark volume for Mt. Wuko Fores, Mt. Boleng, Mt. Lewotobi and Mt. Langkoeroe provenances were 550m^3, 425m^3, 400m^3 and 525m^3 respectively and survival percent was 76%, 88%, 85% and 73% respectively. The Mt. Wuko Fores provenance is recommended for growing in Gede along the Kenya coast.

Introduction

Eucalyptus urophylla S.T. Blake, Timor Mountain gum, occurs in Timor, Indonesia, the surrounding Islands and Papua New Guinea (FAO 1979). The north most point for growing of species is latitude 10°41'S (Boland *et al.* 1987). The altitudinal range of the species is 0 – 3000 m with a mean maximum temperature of 29°C and a mean minimum of 10°C. The annual rainfall required ranges from 1000 – 1500 mm and the latitudinal range is 8° – 10°S. Due to the wide altitudinal range in Timor and its occurrence on several islands, *E. urophylla* exhibits considerable variation (Pyror 1975).

According to Gunn and McDonald (1991), *E. urophylla* is among the priority species identified by the FAO Panel of Experts on Forest Genetic Resource, for research on taxonomy, germplasm conservation, provenance performance and breeding. In reviewing the acceptance of this species worldwide, Martin (1977), reported that the species was widely grown in Congo and some of the trees from Lomblem provenance grew up to eight metres in the first year. Martin (1977), also reported that Timor provenances with rough bark were adapted to the humid tropical climate with annual rainfall of 2500 mm and an altitude of up to 2900 m. However, provenances from the northern islands with smooth bark were adapted to drier areas with 750 – 1200 mm of rainfall and low altitudes between 300 – 1100 m.

Based on the potential of *E. urophylla*, a provenance trial was established at Gede along the Kenya Coast. The objective of the trial was to identify better provenances or individuals for use in afforestation programmes along the Kenya Coast. This paper highlights the results of the trial.

Materials and Methods

The experiment was established at Gede in Kenya at latitude 3° 20'S, longitude 45°E and 15 m altitude. The soils are deep white sands and the topography flat. The annual temperature ranges from 26° – 30°C and the annual rainfall is between 800 – 1200 mm. The planting site was formerly under a natural forest and thereafter cultivated for four years before the experiment was established.

Table 1 gives the list of provenances represented in the trial and their origin. Seeds were sown in a seedbed using normal nursery practices and germinated within five days. The seedlings were pricked out after two weeks and transplanted into white polyethylene tubes of 10 cm diameter and 13 cm in length. The assessment for survival in the nursery was carried out before transplanting to the field when seedlings were 5 months old. Field planting was carried out during the rainy season in April, 1992.

Table 1: Seed origin of *Eucalyptus urophylla* provenances used in the trial at Gede in Kenya

Provenance	Seedlot No.	Latitude (S)	Longitude (E)	Altitude. (m)
Mt. Wuko Fores (Indonesia)	12897	8°32'	122°35'	830
Mt. Lewotobi (Indonesia)	12896	8°32'	122°48'	475
Mt. Langkoeroe (Indonesia)	11876	-	-	-
Mt. Boleng (Indonesia)	12898	8°21'	123°15'	890
Bessilaou (East Timor)	12362	8°37'	125°38'	1100
Mt. Egon (Indonesia)	12899	8°40'	122°27'	500
Mt. Mandiri (Indonesia)	12895	8°15'	122°58'	415

The experimental design was randomized complete block of four replicates and one guard row of *Casuarina equisetifolia*. Each plot had 20 trees spaced at 2.0 m x 2.0 m. Weeding was done twice a year for the first two years, and thereafter slashing was done once yearly.

Data was collected at years 1, 2, 3, 4, 8 and 10 on survival, total height and DBH. Analysis of variance (ANOVA) was carried out on parameters measured and Duncan's Multiple Range test was used to separate the means.

At 10 years, whole tree over bark volume (o.b) was computed using the following volume equation (Easley and Lambeth 1989).

$V=0.000031D^2H$ where

V= Tree Volume over bark (m^3)
D=Diameter (DBH) (cm)
H=Height (m)

Volume per hectare was calculated by multiplying the sum of the volume per tree in each plot by the plot area fraction represented in hectares.

The stem form was assessed subjectively using a scale of 1 to 3 as follows:

1 – good (with no bend at all)
2 – satisfactory (with one slight bend)
3 – poor (with more than one bend).

Arcsine transformation for survival was done before analysis (Freese 1983).

Results and Discussion

Table 2 summarizes results of germination and survival percentages in the nursery at 5 months. The germination for all the provenances was excellent with the least at 90% and the survival in the nursery before transplanting was between 55 and 97% for Mt. Mandiri and Mt. Egon provenances respectively. The high mortality was probably caused by unreliable water supply and high evaporation rate in the nursery.

Table 2: Germination and survival percent of various provenances in the nursery at age 5 months

Provenance	Germination (%)	Survival (%)
Mt. Wuko Fores	98	61
Mt. Lewotobi	96	60
Langkoeroe	90	73
Mt. Boleng	96	71
Bessilaou	94	59
Mt. Egon	95	97
Mt. Mandiri	92	55

Table 3 shows the growth results of various parameters at ten years. The height ranged from 20.5 m for Mt. Mandiri to 25.0 m for Mt. Wuko Fores provenances, giving a difference of about 5 m between the poorest and the best provenance. ANOVA showed significant differences among provenances at $P \leq 0.05$. The mean annual increment for the best provenance was 2.5 m at 10 years, which is relatively higher than the growth of *Eucalyptus camaldulensis* with annual increment of 1 – 1.5 m at the same age (Kiriinya 2006).

Table 3: Growth of seven provenances of *Eucalyptus urophylla* at ten years grown at Gede

Provenance	Height (m)	Diameter (cm)	Stemform (grade)	Over bark volume (m^3ha^{-1})	Survival (%)
Mt. Wuko Fores	25.0[a]	17.2[a]	1	550[a]	76
Mt. Boleng	24.7[a]	15.3[b]	1	425[b]	88
Mt. Lewotobi	24.3[a]	14.7[c]	1	400[b]	85
Mt. Langkoeroe	24.2[a]	17.1[a]	2	525[a]	73
Mt. Egon	22.3[b]	15.3[b]	1	375[c]	89
Bessilaou	22.1[b]	15.6[b]	2	400[b]	60
Mt. Mandiri	20.5[c]	16.6[a]	2	425[b]	87
LSD 5%	s	s	s	s	

Note: There is no significant difference among values with similar letters along each column.

From the first to the fourth year, the height growth was faster at about 5 m per year the which was superior to *Eucalyptus tereticornis* and *E. camaldulensis* grown the along the Kenyan coast, but slowed down to 2.5 m at ten years. The height growth of *E. urophylla* was lower than that reported in Congo (Martin, 1977), but was above average compared to other *Eucalyptus* species grown along the Kenyan coast. Mt. Wuko Fores provenance had a mean height of 9.6 m at two years. This was comparable to height growth in other parts of the world. For example, in Congo in Pointe - Noire and Loudima, the mean height of *E. urophylla* was 7.8 m at two and half years and 9.9m at two years respectively (FAO 1979).

The largest diameter was also recorded for Mt. Wuko Fores provenance which attained 17.2 cm followed by Mt. Langkoeroe with 17.1 cm. The smallest diameter was recorded for Mt. Lewotobi provenance which attained 14.9 cm. There were significant differences in diameter among the provenances at $P \leq 0.05$.

The highest volume overbark was for Mt. Wuko Fores provenance which had 550 $m^3 ha^{-1}$, and the lowest was Mt. Egon with 375 $m^3 ha^{-1}$. The difference between the highest and the lowest was 175 $m^3 ha^{-1}$. The volume overbark of Mt. Wuko Fores provenance of 550 $m^3 ha^{-1}$ was 2.5 times higher than that of *Eucalyptus camaldulensis* which had 200 $m^3 ha^{-1}$ grown at the same site (Kiriinya 2006).

The mean survival was 79.7% and there were significant differences among the provenances at $P \leq 0.05$ (Table 3). The highest survival was 89% and the lowest 60%. The difference in survival in the field among provenances may have been due to climatic and environmental factors, such as drought and competition from weeds due to insufficient tending.

The overall stem form was excellent as very few trees from the seven provenances were of poor form thus all the provenances may be grown for poles and posts. Performance of the Mt. Wuko Fores provenance was better compared to others. Bessilaou provenance from Timor performed poorly probably because it is adapted to humid climate and higher altitude of about 1100 m a.s.l., whereas Gede has a low altitude of 15 m a.s.l.

Conclusion

Eucalyptus urophylla provenance Mt Wuko Fores from Indonesia was the best in all the growth parameters and exhibited high volume overbark. This provenance is recommended to be grown in Gede and other sites of similar climatic and edaphic conditions.

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