PERFORMANCE OF *EUCALYPTUS CAMALDULENSIS* DEHNH. VAR *CAMALDULENSIS* PROVENANCES IRRIGATED UNDER CONDITIONS IN BURA - TANA, KENYA

James O. Maua

KENYA FORESTRY RESEARCH INSTITUTE
P. 0. Box 20412,
NAIROBI

Technical Note No. 19

PERFORMANCE OF *EUCALYPTUS CAMALDULENSIS* DEHNH. VAR *CAMALDULENSIS* PROVENANCES IRRIGATED UNDER CONDITIONS IN BURR - TANA, KENYA

KENYA FORESTRY RESEARCH INSTITUTE
P. 0. Box 20412,
NAIROBI

Technical Note No. 19

Performance of Eucalyptus ***camaldulensis*** Dhnh. Var camaldulensis provenances irrigated conditions in Bura-Tang, Kenya.

Abstract

Successful promotion of afforestation depends on selecting the most suitable species and provenances. In semi-arid areas where rainfall in less than 400 mm/year, Eucalypts do not thrive without irrigation. Twenty provenances of *Eucalyptus camaldulensis* were tested under irrigated conditions to choose the best provenances for pole production in Bura region.

The experimental design was randomized blocks with the provenances replicated four times. Each treatment had 25 trees in a 5 x 5 arrangement. Furrow irrigation method was used. Irrigation schedule was not consistently followed due to frequent breakdown of the water pumping machine. Height and diameter were measured from nine inner trees per plot whereas survival was determined by counting the surviving trees in the plot. Usable biomass was calculated using the existing biomass equation for *Eucalyptus.spp.*

river had the best performance with net Mean Annual Increment (MAI) of 9.8, 7.6 and 6.1 m3/ha/year respectively. The poorest performance was by Palmer River with a net Mean Annual Increment (MAI) of 1.0m^3/ha/year.

The best provenanccs are recommended for pole production on a large scale in the Bura region.

Key Words: Species, Eucalyptus *camaldulensis,* Provenance, Irrigation, Kenya.

Introduction

Successful promotion of afforcstation depends on selecting the most suitable species and provenances. The importance of selecting a good provenance for different tree planting purposes cannot be over-emphasized particularly when *eucalyptus* are considered. Experiments have shown that for some eases, such as E. *cainaldulensis,* the yield ratios between different provenances can be as high as 8:1 (Johansson et *al,* 1990).

Objectives of provenance trials are to select well adapted, productive populations of trees in a given region. In this experiment, twenty Australian provenanccs were tested to purpose of planting this species was for pole production.

Materials and Methods

Climate and Soils

The study area has considerable variability in the distribution and total amounts of annual rainfall which is low. The rainfall is bimodal, averaging 371 mm annually (1983-1993). Mean annual potential evaporation (Class A pan) and moisture deficit were 2336 mm and 1964 mm (range 1161-2505 mm) respectively. Mean monthly maximum and minimum temperatures were 33.4° C (March) and 22.5° C (July) respectively. Whereas the absolute maximum and minimum temperature recorded were 39.5°C and 17.0°C.

The area lies at an elevation of 100 m above see level. The soil belongs to aridisols, vertisols and entisols (according to the US Soil Taxomony). Most soils have non-saline, non-alkaline top soil and saline - alkaline subsoil.

The texture classes are sandy loam, sandy-clay and clay (ILACO, 1977). Natural woody vegetation of the area was originally Acacia-commiphora bushland (Pratt et al, 1966).

Twenty provenances of E. *camaldulensis* under irrigated conditions were established on 9th May 1990 (Table 1). The provenances were in randomized blocks replicated four times. Land was prepared by Martiini site preparation plough which made long furrows 0.5 m deep. Furrow irrigation method was used. Seedlings were planted on the shoulders of the furrow at a spacing of 1.8 m x 3.5 m resulting in 1587 trees/ha. Height, diameter at breast height and survival were used in determining the best provenance.

The distance between the plots along furrows was 5m and 3.6m across furrows. Pre-irrigation was done to saturation point one week prior to planting. Thereafter, irrigation was done one week after planting, followed by a two weeks' interval upto 3 months, 7 weeks' interval upto one year and 10 weeks' interval after the first year. However, beginning of June 1993, irrigation was not regular because of a breakdown of the pumping machines and lack of operational funds. Before that, irrigation was not strictly followed as per schedule due to the highlighted problems.

1.	14518	Tennant, C.K., NT
2.	13923	Katharine, NT
3.	13928	Victoria River, NT
4.	13980	Camel Creak, WA
5.	13931	Ord River, WA
6.	13933	N. Fitzroy Crossing, WA
7.	13939	Pentecost River, WA
8.	14529	Dunham River, WA
9.	14530	Wyndam, WA
10.	15050	Gibbo River, WA
11.	15051	Lennard River, WA
12.	15052	Isdell River, WA
13.	15053	Murchison River, WA
14.	16230	Emu Creek, QLD
15.	16316	Wrothan Park, QLD
16.	17367	Palmer River, NT***
17.	17478	Pine Hill Station, NT***
18.	17483	Barrow Creek, NT***
19.	17494	Blackgin Waterhide, NT
20.	17531	Bamboo Creek Degrey, WA

Numbers refer to CSIRO collection references
WA = Wester Australia
These treatments did not have enough seedlings for all replications
NT= Northern Territories QLD = Queenland

Height and diameters were measured from nine inner trees per plot. Usable biomass was determined using the equation for total volume by (Sarkeala *et al, 1986).*

$Y_a = (0.076 \times DBHTOT^{1.757}) \times HEIGHT^{0.955}$---------------(I)

$Y_b = 0.0376 \times DBHTOT^{1.757}$ ---------------------------------- (2)

Where Y_a = total volume of the tree including .stump.

HEIGHT = height of the tallest stem in meters.

DBHTOT = total diameter at breast height (1.30m) in centimeters.

Y_b = volume of the stump in decimeters (dms).

Usable biomass is therefbre $Y_a - Y_b$

The net Mean Annual Increment (MAI) was determined by multiplying the MAI by survival per provenance. Survival of trees was assessed for the whole plot.

Statistical Analysis

Parameters considered were survival, height and yield per hectare. Net yield was used to select superior provenance at 5% significant level.

Results

At age of 3.5 years, five provenances (Isdell River, Western Australia's; Pine Hill Station, Northern Territories, Dunhan River, Western Australia, Bamboo Creek Degrey, Western Australia, Katharine, Northern Territories, and Wrotham park, Queensland) showed net MAI of over 5.0m^3/ha/year (Table 2).

Table 2: Performance of 20 provenances of E. *camaldulensis* at age 3.5 years

PERFORMANCE										
Treat No.	Mean I-lt. (m)	Mean DBH (cm)	Total vol. (m'/ha)	Stump VOL (m'/ha)	Usable Vol. (m'/ha)	MAI	Survival (%)	Net MAI M'/ha/yr	Ranking (Top-Down)
1	6.6	6.0	17.06	1.48	15.57	4.4	82	3.6	9
2	8.0	6.2	21.72	1.58	20.14	5.8	90	5.2	
3	7.2	6.0	18.54	1.49	17.05	4.9	95	4.6	7
4	5.4	3.8	6.3	0.66	5.64	1.6	75	1.2	9
	6.0	4.5	9.4	0.89	8.51	2.4	89	2.2	14
6	5.8	5.1	11.3	1.11	10.19	2.9	75	2.2	14
7	7.2	4.7	12.23	0.61	11.62	3.3	81	27	13
8	82	6.6	24.82	1.77	23.05	6.6	92	6.1	3
9	6.9	5.2	13.85	1.15	12.70	3.6	86	3.1	10
10	7.3	4.4	10.90	0.86	10.04	2.9	78	2.2	14
11	6.0	5.6	13.00	1.32	12.48	3.6	88	3.1	10
12	9.1	8.1	39.29	2.66	36.73	10.5	93	8.8	1
13	5.9	4.5	9.25	0.89	8.36	2.4	80	1.9	18
14	7.1	4.6	11.47	0.93	10.54	3.0	74	2.2	14
15	8.1	6.1	21.36	1.54	19.82	5.7	92	5.2	5
16	5.5	5.6	7.99	1.32	6.67	1.9	52	1.0	20
17	9.4	7.2	32.95	2.07	30.88	8.8	86	7.6	2
18	7.4	5.5	16.34	1.28	15.06	4.3	88	3.7	8
19	8.2	6.2	13.99	1.58	12.41	3.5	82	2.9	12
20	8.0	6.1	21.11	1.54..	19.57	5.6	97	5.4	4

Table 3: Anova of Total Volume (dm^3)

Total volume (dm^3)

Source of variation	S.S.	d.f.	M.S.	F
Blocks (b)	1046.913	3		
Treatments (t)	1681.101	19	88.479	0.859
Error	5460.679	53	403.031	
Total	8188.693	75		

Table 4: Ranked Performance of six provenances of E. ***camaldulensis*** Provenances

_Treatment No.	Seedlot No.	Locality	Net MAI
12	15052	Isdell River, WA	9.8
17	17478	Pine Hill Station	7.6
8	14529	Dunham River, WA	6.1
20	17531	Bamboo Creek Degrey, WA	5.4
15	16316	Writham Park, QLD	5.2
2	13923	Katharine, NT	5.2

Ku,
WA: Western Australia
NT: Northern Territories
QLD: Queensland

Discussion/Conclusions

It has been reported that provenances show varying characteristics in terms of yields, drought resistance, pest and disease susceptibility (Evans, 1986). It has been found that different varieties and provenances often perform differently when tested together on one site. The reasons for the variation within the species could be attributed to wide separation and often isolation of stands which may led to genetically different populations within one species.

During the last 20 years it has become clear that a part from choosing the species, it is necessary to take full advantage of available genetic potential, that is, various provenances. In this study, there was a big difference between the lowest and highest yield among the provenances. This agrees with previous studies of provenance trials on E. *carnaldulensis which* have *shown* differences in yield rations of upto 8:1 (Johansson et *al* 1990). In this case, it was higher than this.

Other studies have shown that the relative growth of different provenances of Pinus *caribeea var. hondurensis* is closely related to site. Superiority of one provenance in one trial does not mean it will be best on all sites (Evans 1986). This emphasizes the need for provenance trials in different sites.

are often about 5 - 10m^3/ha of a year on 10-20 years rotations. In wetter regions upto 30m^3ha/year may be achieved (Evans, 1986). The results in this study concurs with the above findings. However, most provenances had MAI of less than 5m^3/ha/year and also the rotation age is projected at 6 - 10 years, for pole production. It is worthwhile noting that no irrigation on the trial was done for over five months prior to assessment for yield. Irrigation was not consistently done because of lack of water. Yield obtained in moist regions may be possible in arid regions provided water availability is guaranteed. In Israel, irrigated plantations of E. *camaldulensis* produced 14.6 - 16m while the un-irrigated produced only 7.7m3 (FAO, 1981).

At two years, the provenance from Katharine, Australia has the best MAI of 8-12 (Kaarakka *et al* 1990, Kaarakka, 1993) but over time it was outperformed by other provenances. This shows that the growth characteristics of various provenances change over time, possibly due to environmental and soil changes such as moisture stress. Studies on provenance trials therefore needs close monitoring over a long time.

In Bura, the interest is a provenance which gives higher yield per annum. Due to shortage in irrigation water, it is recommended that future studies consider provenances and recover fast when irrigation is resumed.

Acknowledgement

"The study was conducted under the auspices of the Bura Fuelwood Project financed by FINNIDA/KEFRI. The author wishes to express his gratitude to the KEFRI field staff for assisting infield work and to the KEFRI Editorial Committee for revising the manuscript."

References

Evans, J. (1986). Plantation Forestry in Tropics. Oxford University Press. 472p.

FAO (1981). Eucalyptus for planting. FAO Forestry series No. 11. 675p.

ILACO (1977). Bura Irrigation Scheme. Soil survey report. Republic of Kenya and Kingdom of the Netherlands.

Johansson, S., Kaarakka, V., Luukkannen, O. and Mulatya, J. (1990). Forestry in irrigation schemes I. Research Activities at Bura, Kenya 1984-87. Tropical Forestry Reports 4 Helsinki University Press 141 p.

Tropical Forestry Reports 9:51-60. University of Helsinki.

Kaarakka, V., Maingi, K.J., and Maua, J.O (1990). Species and provenance recommendations for Bura Fuelwood Project. Working Paper 46. Kenya Forestry Research Institute and University of Helsinki.

Pratt, D.J., Greenway, P.J. and Gawynene, M.D. (1966). A classification of E. African Rangeland, with an appendix on terminology, J. Appl. Ecol Vol 3 pp. 369-362.

Sarkeala, J., Johansson, S. and Luukannen, O. (1986) Volume functions for *Eucalyptus camaldulensis* and *Terminalia brownii* on irrigated fuelwood plantations in Tana River District, Kenya. Bura Forestry Research Project Technical Report No. 4. Kenya Forestry Research Institute and University of Helsinki.