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RESULTS OF EUCALYPTUS SPECIES TRIALS AND ESTABLISHMENT METHODS ON SEASONALLY WATERLOGGED SOILS AT TURBO

J.M. KIMONDO

AND

P.K.A. KONUCHE

Summary

Three trials were established at Turbo in 1974 and 1975 to select fast growing species and to develop methods of establishing trees on seasonally waterlogged soils (vleis). The first trial tested the effects of four methods of site preparation on performance of E. saligna, E.camaldulensis and Ε. citriodora. The four methods were spot cultivation; ploughing and harrowing; ploughing, harrowing and ridging; and single moulboard furrows. The second trial compared the performance of some their and eucalyptus and pines provenances using ploughing, harrowing The results ridging methods. and indicate that the most effective and economical method was single moulboard furrows. The second best was ploughing, harrowing and ridging but was much expensive. The best species for these soils were \underline{E} . grandis and \underline{E} . saligna.

Introduction

Turbo Afforestation Scheme was set up during the late sixties to supply pulpwood to Pan African Paper Mill at Webuye. The scheme covers about 10 000 hectares and is the major source of pulpwood nearest to the Mill. The main species used for afforestation has been Pinus patula. However, this species has been found unsuitable for planting in some areas of the Scheme with shallow soils and seasonally waterlogged soils (Ball 1973a; Konuche 1979). The latter are normally referred to as vlei soils and they occur on depressions or along river valleys. Vleis cover approximately eight percent of the forest land (Konuche 1976).

Since there is shortage of land for afforestation within the pulpwood areas, there is need to utilize vlei soils to improve the supply of wood raw material.

Economic afforestation seems possible if cheap methods and fast growing species could be found. For this reason, trials with eucalypts and various methods of site cultivation were initiated during mid-seventies. From the interim results of these trials it was recommended that Eucalyptus saligna should be used for planting on vleis using either disc ridging on better sites or complete ploughing, harrowing and ridging on wetter sites (Konuche 1976). Since these recommendations were provisional, and have not been confirmed to date, this report attempts to up-date the earlier findings from the trials.

Materials and Methods

Experimental Sites

The experiments were sited at Turbo Forest Reserve which lies at $0^{\circ}38'N$

latitude and 35°41'E longitude. The altitude is approximately 1,800 m above sea level. The soil characteristics of this forest reserve have been described by Nyandat and Oswaggo (1970). The main problems with vlei soils are flooding and impeded drainage during the wet season followed by soil hardening and cracking during the dry season. The climate at Turbo has been described by Ball (1973 b). The area receives mean annual rainfall of 1250 mm falling from late March to November. The dry season is often severe and lasts from December to mid-March. The mean annual temperature is 18° C. Grass is the main natural vegetation of vleis.

Experiments

During 1974 and 1975, three experiments (367, 368 and 371) were established on the seasonally water-logged soils.

Experiments 367 compared the performance of three eucalypts growing under four types of site establishment methods. These methods were:

- 1. Spot cultivation
- 2. Complete ploughing and harrowing
- Complete ploughing, harrowing and disc ridging
- 4. Single mouldboard furrows

The three eucalypts tested were: \underline{E} . saligna, E. camaldulensis from Central Ε. and Republic (C.A.R) African citriodora from Machakos. The design of the experiment was factorial (split-plot) in four randomised blocks. The four site cultivation methods and the three species formed the main treatments and sub-There were a treatments respectively. total of forty eight sub-plots. Each sub-plot had forty trees in a row spaced at 2.0 m within the row and 3.0 m between the rows. Site preparation was completed during the dry season and the experiment was planted at the start of the rains in May 1974. In ploughed, harrowed and ridged treatment method, the trees were planted on top of the ridges. Similarly, trees were planted on top of upturned turfs under single mouldboard furrow treatment.

Experiment 371 was established as a <u>Eucalyptus</u> species and provenance trial on a vlei site that was gently sloping. The site treatment consisted of burning, ploughing, harrowing and manual ridging. The species tested and their provenances were: <u>E</u>. <u>camaldulensis</u> (two provenances from Kitale and Pakistan), <u>E</u>. <u>saligna</u> (Turbo and Kitale provenances), <u>E</u>, <u>tereticornis</u> (Kapsaret and C.A.R.) <u>E</u>. <u>grandis</u> (Muguga) and <u>E</u>. <u>robusta</u> (Turbo). The design was complete randomised blocks of four replications with twenty five trees per plot in 2.0 m by 2.0 m espacement. The aim of close spacing was 7

to obtain early canopy closure and reduce competition from grass. Planting was done in April 1975.

Management

The seedlings were raised in polythene tube and planted out when they were 20 -In all experiments site 40 cm tall. preparation was completed during the dry Weeding was carried out three season. times a year for the first three years by spot hoeing and grass slashing. There was no adequate protection of the plots from cattle grazing and some damage of ridges and trees occurred. The worst affected experiment was 368 where reridging had to be carried out during the second year. Growth of grass was dense in Experiment 368. A fire swept through Experiments 367 in 1981 but damage to trees was not severe although some died.

Assessment and Analysis

The parameters assessed were survival, height and diameter at breast height (DBH). Height was measured to the nearest half metre and diameter to the nearest one tenth of a centimetre. Both height and diameter were measured for the inner trees in a plot with the outer ones acting as guard rows. Survival percentage was based on all the trees planted in a given plot. Analysis of variance was carried out on height, diameter and in some cases, arc sine transformed survival percentage.

Results

The results from Experiments 367, 368 and 371 are given in Tables 1, 2 and 3 respectively. In Experiment 367, the effects of the four site treatment methods on growth and survival of the trees were not significant at 14.5 years. However, the trees grew better under single mouldboard furrow treatment than in the spot cultivated treatment. All site treatment methods gave moderate tree survivals. The survival of trees in ploughed, harrowed and ridged treatment was the best with 62 percent while single mouldboard furrow treatment gave the lowest survival of 46.7 percent.

Among the three species tested, \underline{E} . <u>saligna</u> and \underline{E} . <u>citriodora</u> consistently gave the best growth and survival respectively under each cultivation method. The difference between the species in height and diameter growth were significant (P=0.01) but survival difference was not significant.

			Mo	thods o	f Site Prep	arati	9					
	Spot	cultivation		Plough	ing & harro	wing	Plough ridgin	ing, harrow [.] g	ing,	Single	mouldboard f	urrow
species treatment	Ht. (m	d.b.h.(cm)	(%) S	Ht.(m)	d.b.h.(cm)	s(m)	Ht.(m)	d.b.h.(cm)	S(%)	Ht.(m)	d.b.h.(cm)	S(%)
<u>E. saligna</u>	15.0	16.4	50	14.8	16.6	48	15.1	16.1	58	16.9	19.1	45
E. camaldulensis	11.8	12.1	48	12.4	12.6	49	12.9	12.2	57	14.9	15.6	44
E. citiriodora	11.9	9.9	41	14.4	12.8	1	14.4	14.5	71	12.1	12.3	51
Means	12.9	12.8	49.2	14.2	14.0	52 7	14.1	14.3	62	14.6	15.7	46.7

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site the among interactions The cultivation methods and the species was and in height significant (P=0.01) The diameter but not in survival. combination that gave the best growth was single using saligna planting E. mouldboard furrow treatment. The poorest growth was obtained by planting either \underline{E} . camaldulensis or E. citriodora using spot The highest cultivation treatment. survival of 71 percent was achieved by \underline{E} . citriodora on ploughed, harrowed and while Ε. method ridged treatment camaldulensis under single mouldboard treatment gave the poorest survival of 44 percent.

While <u>E</u>. <u>camaldulensis</u> gave the best growth under single mouldboard treatment, <u>E</u>. <u>citriodora</u> had the best growth on ploughed, harrowed and ridged treatment. Both species had the poorest growth in the spot cultivated treatment.

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		Ŵ	ean at 9 yea	ırs	Mean at	c 12 years	
Species	Seed Origin	Ht.(m)	d.b.h.(cm)	Ht.(m)	d.b.h.(cm	Survival (%	G
<u>E.saligna</u>	Turbo	8.9	11.9	12.8	14.6	11	
<u>E.camaldulensis</u>	C.A.R.	10.8	12.0	11.9	13.2	77	
<u>E.grandis</u>	Muguga	7.3	9.3	12.4	13.3	50	
<u>E.maculata</u>	Machakos	6.7	8.0	10.5	11.2	51	
<u>E.tereticornis</u>	C.A.R.	10.3	13.1	14.6	15.8	64	
<u>E.maculata</u>	Kitale	6.9	9.2	10.7	11.3	17	
<u>E.robusta</u>	Turbo	6.8	10.1	10.7	13.5	73	
L.S.D. P=0.05		n.s	s.r	1.6	. ч	n.s	
]

Experiment height, diameter (d.b.h.) and survival in years Summary of mean 386 at 9 and 12 2 Table

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In Experiment 368, the three pine species had failed by the ninth year but the survival of the eucalyptus was generally good. At nine years (Table 2)

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there was significant difference among the species in height growth but not in diameter. Ε. camaldulensis and E.teriticornis had the best growth at nine years but the former did not do well thereafter. At twelve years, E. tereticornis was still the best in growth and was 1.8 m taller than the second best species, E. saligna. However, between the two ages, E. grandis had the best growth increment. E. maculata and E. robusta had the smallest trees at both ages. The growth rates of E. saligna and E. camaldulensis in this trial agree closely with the results in Experiment 367 under ploughing, harrowing and ridging method.

As shown in Table 3, the differences in growth and survival among the species and provenances tested in Experiment 371 were significant at seven and thirteen years. Growth of \underline{E} . grandis and the two provenances of \underline{E} . saligna was much better

	A	ge 7 ye	ars	A	ge 13 y	ears
Species	Ht.(cm)	d.b.h. (cm)	Surv(%)	Ht.(m)	d.b.h. (cm)	Surv(%)
<u>E</u> . <u>saligna</u> (Turbo)	15.4	13.6	86	21.9	16.3	86
<u>E.grandis</u> (Muguga)	14.8	12.7	78	24.9	17.4	64
<u>E.saligna</u> (Kitale)	14.2	11.4	70	21.0	15.7	67
<u>E.robusta</u> (Turbo)	10.9	10.2	75	17.0	12.9	58
<u>E</u> . <u>camaludensis</u> (Kitale)	8.4	7.4	78	15.5	12.9	42
<u>E</u> . <u>camaldulensis</u> (Pakistan)	8.7	7.4	64	13.7	11.4	39
<u>E</u> . <u>tereticornis</u> (C.A.R.)	9.4	8.6	78	17.8	13.5	44
<u>E</u> . <u>tereticornis</u> (Kapsaret)	10.2	9.0	95	17.4	12.1	69
LSD 0.05	-	-	20.0	-	1.9	33.0
LSD 0.01	1.8	1.90		2.4		

Table 3: Mean Height and diametre of eucalypts in Experiment 371 at 7 and 13 years

than the other eucalypts and their provenances. At thirteen years, E. grandis was superior and its growth was 13 and 19 per cent better than the Turbo and Kitale provenances of E. saligna respectively. The growth of Ε. tereticornis was better than Ε. camaldulensis like in Experiment 368.

Discussion

The purpose of conducting these trials was to investigate on fast growing species for planting on vleis and also to find out cheap and effective method of establishing the trees. Results from Experiment 367 show that the most effective method was single mouldboard furrow treatment and the least effective was spot cultivation. Though the difference was not significant, it was of practical importance since arowth differed by 1.7 m and 2.9 cm in height

and diameter respectively. In the earlier report, ploughing, harrowing and ridging had given better growth than single mouldboard furrow treatment (Konuche 1976). The present results are more reliable. The better performance of trees planted on top of upturned turfs compared to those planted on top of the ridges may be attributed to cattle damage which caused the ridges to flatten out and therefore becoming less effective in improving drainage.

From the interactions of site preparation and species, the results methods indicated that the best combination was planting E. saligna on upturned turfs made with single mouldboard plough. The next best combination was the same species planted on ploughed, harrowed and ridged site. In the earlier results, the best combination was E. camaldulensis planted on ploughed, harrowed and ridged The consistently better treatment.

growth of \underline{E} . <u>saligna</u> in all the site preparation methods suggest that this species is most suitable for planting on vlei soils.

Results from Experiment 368 showed that although the site was slightly better being near the edge of the vlei, tree growth rate was generally the same as in the ploughed, harrowed and ridged treatment in experiment 367. The trees did not perform better as expected in this trial because wider spacing between the strips increased grass competition when weeding was stopped in the third The damage to ridges by cattle year. also reduced their effectiveness. Though inferior to E. tereticornis in growth, \underline{E} . saligna and \underline{E} . grandis showed good viqour and acceptable growth rate particularly during the last few years. The failure of the three pine species in this experiment confirms earlier observations that pines are unsuitable

for planting on vleis.

Conclusions and Recommendations

The earlier conclusion on unsuitability of pines for planting on vlei soils is still valid. The best species for planting on these soils are <u>E</u>. <u>grandis</u> and <u>E</u>. <u>saligna</u>. The most effective and cheapest method of establishment is planting tree on top of upturned turfs as stipulated in Forest Department Technical Order No.50 of 1971. However, as vleis are mainly covered by grass, good weeding and effective protection from animals are required for successful afforestation.

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