GROWTH AND BIOMASS PRODUCTION OF SOME *LEUCAENA LEUCOCEPHALA* ACCESSIONS GROWN AT MAKOKA, MALAWI

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MAGHEMBE, J.A. & CHIRWA, P.W. 1996. Growth and biomass production of some *Leucaena leucocephala* accessions grown at Makoka, Malawi. The objective of this study was to compare growth, coppicing, and biomass production of 17 accessions of *Leucaena leucocephala* widely distributed for planting in East and Southern Africa by National Tree Seed Centres in Malawi, Tanzania, Zambia and Kenya. A widely used accession in alley cropping in West Africa was also included. The trial was established in 1989 on a sandy loam soil in a sub-humid unimodal rainfall area at Makoka, Malawi. Assessments were done for survival at 3 months and at 15 and 30 months after establishment for height, diameter at the root collar, number of branches and biomass production. Survival was generally good for most accessions (> 90%) with the exception of an accession from Machakos, Kenya (No. 84511) which had a survival of only 67%. Fifteen months after establishment, accessions from Yimbo (Kenya), and two K8 accessions from Kasama (Zambia) and Machakos (Kenya) achieved the best height of over 3.2 m. Poor accessions included accession No. 84511 from Machakos (Kenya), Peru (ex. Makoka, Malawi), and the West African accession from IITA (Nigeria) whose height was less than 2.5 m. At 15 months, 12 of the accessions tested showed high total biomass production (dry wt), 25 - 38 t ha^{-1}. The foliage biomass (leaves, twigs and pods) yields exceeded 10 t ha^{-1} in all but one accession from Makoka, Malawi and another from Korogwe, Tanzania. After clear cutting, all the *Leucaena* accessions coppiced and grew exceptionally well, achieving very high biomass production in only 15 months. The highest yields were produced by accessions from Isiolo, Kenya (47.7 t ha^{-1}); Namiyanga, Malawi (42.2 t ha^{-1}); Yimbo, Kenya (36.3 t ha^{-1}) and accession Pursa from Kasama, Zambia (35.6 t ha^{-1}). Poor accessions yielded less than 20 t ha^{-1} and included local seed sources of Peru and Cunningham from Makoka, Malawi and the West African accession from IITA, Ibadan, Nigeria.

Key words: *Leucaena leucocephala* - accessions - biomass - coppice

MAGHEMBE, J.A. & CHIRWA, P.W. 1996. Pertumbuhan dan pengeluaran biojisim beberapa aksesi *Leucaena leucocephala* yang tumbuh di Makoka, Malawi. Kajian ini bertujuan untuk membandingkan pertumbuhan, pengkopisan dan pengeluaran biojisim 17 aksesi *Leucaena leucocephala* yang diagihkan dengan meluas untuk penanaman di Timur dan Selatan Afrika oleh Pusat-pusat Biji Benih Pokok Kebangsaan di Malawi, Tanzania, Zambia dan Kenya. Satu aksesi yang digunakan dengan meluasnya di dalam penanaman di lorong-lorong di Afrika Barat juga disertakan. Percubaan ini telah ditubuhkan dalam tahun 1989 di atas tanah berpasir lom di kawasan hujan turun unimod sublembab di Makoka, Malawi. Penilaian dijalankan untuk kemandirian selepas tiga bulan dan penilaian ketinggian, garispusat gelangan akar, bilangan dahan serta pengeluaran biojisim dijalankan pada bulan ke-15 dan ke-30. Kemandirian pada umumnya adalah baik bagi kebanyakan aksesi (>90%) kecuali satu aksesi daripada

Machakos, Kenya (No. 84511) yang mempunyai kemandirian hanya 67%. Lima belas bulan selepas penubuhan, aksesi daripada Yimbo (Kenya), dan dua aksesi K8 daripada Kasama (Zambia) dan Machakos (Kenya) mencapai ketinggian terbaik iaitu melebihi 3.2 m. Aksesi yang lemah termasuklah aksesi No. 84511 daripada Machakos (Kenya); Peru (ex. Makoka, Malawi); dan aksesi Afrika Barat daripada IITA (Nigeria) yang mana ketinggiannya adalah kurang daripada 2.5 m. Pada 15 bulan, 12 daripada aksesi yang diuji menunjukkan jumlah pengeluaran biojisim yang tinggi (berat kering), 25-38 t ha^{-1}. Hasil biojisim daun (daun, ranting dan lenggai) mencapai 10 t ha^{-1} di dalam semua aksesi tetapi satu aksesi daripada Makoka, Malawi dan yang lainnya daripada Korogure, Tanzania. Selepas penebangan bersih, semua aksesi *Leucaena* mengkopis dan tumbuh dengan baik, dengan mencapai pengeluaran biojisim yang sangat tinggi dalam masa hanya 15 bulan. Hasil tertinggi dikeluarkan olah aksesi-aksesi daripada Isiolo, Kenya (47.7 t ha^{-1}); Namiyanga, Malawi (42.2t ha^{-1}); Yimbo, Kenya (36.3 t ha^{-1}); dan Pursa daripada Kasama, Zambia (35.6 t ha^{-1}). Aksesi-aksesi yang lemah menghasilkan kurang daripada 20 t ha^{-1} dan termasuk sumber-sumber biji benih tempatan Peru dan Cunningham daripada Makoka, Malawi dan aksesi Afrika Barat daripada IITA, Ibadan, Nigeria.

Introduction

Leucaena leucocephala (Lam.) de Wit. has been introduced into East and Southern Africa as the single most important multipurpose tree for agroforestry. Its wide use has been due mainly to its multiple uses, fast growth, high biomass production, heavy seeding at early age (6 - 12 months), ease of management by farmers and extensive promotion by national and international agencies (Brewbaker 1987, Hughes 1993). Many of the K - varieties, fodder hybrids (Cunningham) and some unclassified accessions were included in the introductions in East and Southern Africa. From these *Leucaena leucocephala* accessions, National Tree Seed Centres in Kenya, Tanzania, Malawi, Zambia and Zimbabwe have established seed stands for routine collection of seed for agroforestry and reafforestation programmes.

Although large growth and yield variations occur among *Leucaena leucocephala* provenances (Hu *et al.* 1980, Siddiqui & Khan 1983, Sanginga *et al.* 1991), no systematic evaluation of the widely used *Leucaena* germplasm has been undertaken in this part of Africa. Data exist on growth and production of individual accessions (Maghembe *et al.* 1986) but no growth comparisons between seed sources exist to guide choice of appropriate regional accessions and seed exchange among the countries. Where these comparisons have been made, they have provided choices of *Leucaena leucocephala* accessions for reafforestation and improvement (Hutton & Gray 1959, Brewbaker *et al.* 1972). We report here a comparison of the growth, coppicing and biomass production of 17 accessions of *Leucaena leucocephala* routinely distributed to researchers, extension specialists and farmers by the National Tree Seed Centres in Malawi, Tanzania, Zambia and Kenya. An accession (IITA, Ibadan, Nigeria) used widely for alley cropping in the humid zone of West Africa (Kang *et al.* 1981) was also included in the study.

Materials and methods

Site description

The study was carried out at Makoka, Malawi located at 15° 30' S and 35° 15' E. The elevation is 1030 m above sea level with mean day time temperatures varying from 16 to 24 °C. The total annual rainfall ranges from 850 to 1250 mm with a mean of 1024 mm. The rainfall is unimodal, most of it coming from November to April. This experimental site was on a slope of 7.5% with a sandy loam top soil while the subsurface soil was a sandy clay loam (ferric lixisols). The soils are generally low in nitrogen, phosphorus and exchangeable bases (Table 1).

Table 1. Some soil chemical characteristics in a typical soil profile at Makoka, Malawi

Profile depth (cm)	pH (H_2O)	Organic carbon %	Total nitrogen %	Bray 1 available P*(ppm)	Exchangeable cations,*me/100g soil.				
					K	Na	Ca	Mg	*CEC
0 - 10	6.00	1.03	0.09	8.00	0.41	0.03	3.93	1.67	7.37
11 - 30	6.00	0.93	0.08	7.00	0.47	0.03	3.50	2.06	7.29
31 - 50	6.10	0.76	0.06	7.00	0.38	0.04	4.80	1.78	8.12
51 - 70	6.30	0.58	0.05	7.00	0.42	0.04	4.92	2.31	8.62

*me = milli equivalents; ppm = parts per million; CEC = cation exchange capacity excluding H^+ and Al^{3+}.

Experimental design and management

The test material were 17 *Leucaena leucocephala* accessions (uninoculated seed sources) described in Table 2. Potted seedlings of these accessions were planted out in a randomized complete block design replicated six times. The land was ploughed and harrowed and seedlings planted on ridges in January, 1989. Each plot had 25 trees planted as a 5 × 5 tree square at a spacing of 1.5 × 1.5 m. The plots were kept free of weeds at all times and fertiliser was not applied to the trees.

Data collection and analysis

Survival was assessed three months after establishment. Measurements for growth and yield (dry wt) are reported for assessments done 15 and 30 months after establishment. Parameters measured included total height, diameter at the root collar and number of branches per plant. Biomass of leaves + twigs, pods and wood were assessed when plots were clear felled (cut at the ground level) 15 months after planting. Coppice regrowth was allowed after clear felling and it was assessed for growth and biomass production 30 months after planting (or 15 months after clearfelling). Survival data was subject to angular transformation before analysis. All data were subject to analysis of variance followed by the separation of means using the least significant difference (LSD).

Table 2. Seed sources of *Leucaena leucocephala* accessions planted at Makoka, Malawi in 1989

	Seed Origin	Latitude	Longitude
1.	Namiyanga, Machinga, Malawi	14^0 47' South	35^0 31' East
2.	Tengani, Nsanje, Malawi	16^0 43' South	35^0 15' East
3.	*H.Giant: Kasama, Zambia	10^0 10' South	31^0 11' East
4.	Peru: Makoka, Zomba, Malawi	15^0 31' South	35^0 14' East
5.	Cunningham: Makoka, Malawi	15^0 31' South	35^0 14' East
6.	IITA, Ibadan, Nigeria	7^0 23' North	3^0 56' East
7.	K8: Kasama, Zambia	10^0 10' South	31^0 11' East
8.	K8: Machakos, Kenya	1^0 32' South	37^0 36' East
9.	Pursa: Kasama, Zambia	10^0 10' South	31^0 11' East
10.	Yimbo, (Embu), Kenya	1^0 10' South	37^0 30' East
11.	Nkhozo, Rumphi, Malawi	10^0 48' South	33^0 33' East
12.	K8: Makoka, Zomba, Malawi	15^0 32' South	35^0 14' East
13.	Isiolo, Kenya	0^0 20' North	37^0 36' East
14.	No. 84511: Machakos, Kenya	1^0 32' South	37^0 36' East
15.	Korogwe, Tanzania	5^0 10' South	38^0 30' East
16.	K500 Cunningham: Kasama, Zambia	10^0 10' South	31^0 11' East
17.	Kawinga, Machinga, Malawi	14^0 32' South	14^0 17' East

*H. Giant is Hawaiian Giant.

Results

Survival and growth

There were significant differences ($p \leq 0.01$) in survival among the accessions of *Leucaena leucocephala* grown in Makoka. An accession from Machakos, Kenya (No. 84511) showed only 67% survival three months after establishment compared to all the other accessions whose survival ranged from 88 to 99% (Table 3).

Height growth in different *Leucaena* accessions 15 months after planting were significantly ($p \leq 0.001$) different. Good height growth ranging from 320 to 328 cm was achieved by accessions from Yimbo in Kenya, K8 from Kasama, Zambia and K8 from Machakos, Kenya. Poor height growth was in accession 84511 from Machakos, Kenya; Peru from Makoka, Malawi and accessions from Korogwe Tanzania and from IITA Ibadan, Nigeria (< 260 cm) (Table 3). The height of the rest of the accessions were generally similar and ranged from 268 to 310 cm.

The differences in root collar diameter among the *Leucaena* accessions were highly significant ($p \leq 0.0001$). *Leucaena leucocephala* K8 from Machakos, Kenya had the largest root collar diameter (4.5 cm) while accessions of *L. leucocephala* Peru from Makoka, Malawi, K-500 Cunningham from Kasama, Zambia, 84511 from Machakos, Kenya, and accessions from IITA Ibadan, Nigeria and from Korogwe in Tanzania produced the smallest root collar diameters (< 3.3 cm).

There were significant differences ($p \leq 0.01$) in the number of branches among the *Leucaena* accessions. Three months after planting, the most heavily branched accession was the K8 from Machakos, Kenya while the least branched were three local accessions of Cunningham and Peru from Makoka and an accession from Tengani, Malawi.

Table 3. Growth and biomass production (dry weight) by *Leucaena leucocephala* accessions fifteen months after planting at Makoka, Malawi.

Origin of *L. leucocephala*	Survival %	Height (cm)	Collar diameter (cm)	Number of branches	Biomass production (t ha^{-1})			
					Leaves +twigs	Pods	Woody	Total
Namiyanga, Machinga, Malawi	98.7	292.5	4.0	12.9	7.6	12.2	16.2	36.0
Tengani, Nsanje, Malawi	99.3	296.8	3.6	10.5	5.6	9.1	11.0	25.7
Kasama, Zambia	97.3	276.0	3.8	16.4	6.0	9.7	12.3	28.0
Makoka, Zomba, Malawi	97.3	235.5	3.2	11.2	2.6	6.1	6.3	15.0
Makoka, Zomba, Malawi	98.0	268.5	3.5	12.1	3.5	13.2	9.2	25.9
IITA, Ibadan, Nigeria	92.7	224.3	3.1	14.0	2.7	8.0	5.7	16.4
Kasama, Zambia	97.3	324.7	4.1	15.6	10.2	8.8	13.6	32.6
Machakos, Kenya	98.0	321.8	4.5	17.6	7.8	7.3	14.6	29.7
Kasama, Zambia	95.3	306.6	4.0	14.8	6.8	11.2	14.6	32.6
Yimbo, Embu, Kenya	98.0	328.3	4.2	13.4	6.7	10.3	15.4	32.4
Nkhozo, Rumphi, Malawi	99.3	281.4	3.7	15.0	5.6	8.3	11.3	25.1
Makoka, Zomba, Malawi	96.0	289.1	3.9	14.7	5.8	11.3	12.6	29.7
Isiolo, Kenya	98.0	310.7	4.0	16.5	10.9	10.6	16.7	38.2
Machakos, Kenya	67.3	249.4	3.1	14.1	4.6	9.3	9.5	23.4
Korogwe, Tanzania	88.0	258.2	3.2	12.7	4.1	7.4	9.3	20.8
Kasama, Zambia	97.3	274.2	3.7	15.4	4.6	8.8	10.5	23.9
Kawinga, Malawi	97.3	309.6	4.2	12.5	6.7	8.3	13.2	28.3
LSD (0.05)	7.1	51.6	0.6	3.6	3.1	ns	6.6	13.6
CV%	9.0	17.0	17.0	25.0	58.7	57.7	53.6	48.2

Biomass production

Biomass production was partitioned into three components, leaves and twigs, pods and woody biomass (branches and stems). The amounts of leaves + twigs produced by different accessions were significantly different ($p \leq 0.0001$). The highest leaf and twig production was found in accessions from Isiolo, Kenya and K8 from Kasama, Zambia which produced 10.9 and 10.2 t ha^{-1} respectively. The lowest foliage biomass was produced by accessions of Cunningham and Peru from Makoka, Malawi and an accession from IITA, Ibadan, Nigeria. However, there were no significant differences in the production of pods among the *Leucaena* accessions, which ranged from 6.1 to 13.2 t ha^{-1} (Table 3). Local accessions from Makoka and Namiyanga produced relatively more pods than the rest of the accessions.

There were significant differences ($p \leq 0.03$) in the woody biomass produced by the different *Leucaena* accessions. Most of the accessions produced woody biomass ranging from 9.0 to 17 t ha^{-1} with the exception of an accession of Peru from

Makoka, Malawi and one from IITA Ibadan, Nigeria which produced biomass of below 6.3 t ha^{-1}. There was high variability in the biomass produced by different accessions (Table 3). The significant differences ($p \leq 0.05$) in total biomass production was mainly due to differences between the accession from Isiolo, Kenya which produced the most biomass of 38.2 t ha^{-1} and accessions from Korogwe, Tanzania; Ibadan, Nigeria; and an accession of Peru from Makoka, Malawi which produced low biomass values of 20.8, 16.4 and 15.0 t ha^{-1} respectively.

Coppice regrowth and biomass production

The biomass production and growth assessment of the coppice was done 15 months following clearcutting. The *Leucaena* accessions had great differences in coppice regrowth for height ($p \leq 0.0001$). Accessions that achieved the greatest height included K8 from Kasama, Zambia and from Isiolo Kenya. The accessions showing poor height regrowth were generally the same ones showing poor growth before clearfelling. They included Peru from Makoka, Malawi; 84511 from Machakos, Kenya; Hawaiian Giant from Kasama, Zambia; and an accession from Ibadan, Nigeria. Most of the other accessions were generally similar in their height growth with a range of 247 to 315 cm (Table 4).

Table 4. Coppice regrowth and coppice biomass production (dry weight) in different *Leucaena leucocephala* accessions 15 months after harvesting the first rotation at Makoka, Malawi

Origin of *L. leucocephala*	Height (cm)	Collar diameter (cm)	Biomass production (t ha^{-1})			
			Leaves + twigs	Pods	Woody	Total
Namiyanga, Machinga, Malawi	313.0	6.3	4.0	12.9	25.3	42.2
Tengani, Nsanje, Malawi	273.2	5.4	2.1	9.6	15.5	27.2
Kasama, Zambia	232.2	5.4	2.7	12.0	15.1	29.8
Makoka, Zomba, Malawi	218.5	4.4	1.8	4.3	7.3	13.4
Makoka, Zomba, Malawi	251.6	5.1	2.5	6.2	9.0	17.7
IITA, Ibadan, Nigeria	219.3	4.6	1.3	4.3	5.3	10.8
Kasama, Zambia	355.5	7.0	4.0	9.8	21.8	35.6
Machakos, Kenya	312.5	6.6	3.3	12.1	17.9	33.3
Kasama, Zambia	310.6	6.1	3.8	12.0	19.8	35.6
Yimbo, Kenya	314.0	6.1	3.3	15.9	17.0	36.2
Nkhozo, Rumphi, Malawi	276.7	5.1	2.2	7.3	11.7	21.2
Makoka, Zomba, Malawi	293.0	5.2	3.9	10.8	16.2	30.9
Isiolo, Kenya	348.4	6.6	9.2	11.9	26.6	47.7
Machakos, Kenya	230.8	5.6	3.5	7.2	12.7	23.4
Korogwe, Tanzania	269.6	5.3	3.1	8.3	12.3	23.7
Kasama, Zambia	247.4	5.0	2.7	6.5	10.5	19.7
Kawinga, Machinga, Malawi	315.4	6.0	4.7	13.4	21.8	39.9
LSD (0.05)	65.6	1.0	3.5	5.7	10.4	16.7
CV%	24.0	19.0	60.0	58.0	67.0	60.0

There were also highly significant differences ($p \leq 0.001$) in diameter at the root collar among the *Leucaena* accessions. Two K8 accessions from Kasama, Zambia and Machakos, Kenya and an accession from Isiolo Kenya had particularly larger diameters compared to Peru from Makoka, Malawi and an accession from Ibadan, Nigeria which had small diameters (Table 4). The diameter for the rest of the accessions was rather uniform and ranged from 4.9 to 6.2 cm.

The significant difference ($p \leq 0.03$) in biomass of leaves and twigs was due to the high biomass of 9.2 t ha^{-1} produced by an accession from Isiolo, Kenya compared to the other accessions which produced comparable biomass (Table 4). There were also differences ($p \leq 0.002$) in the amount of pods produced among the *Leucaena* accessions with more pods in accessions from Yimbo, Kenya, and Kawinga, Malawi and lower pod yields realised from an accession of Peru from Makoka, Malawi and an accession from Ibadan, Nigeria. Intermediate pod yields from the majority of accessions ranged from 8.0 to 12.9 t ha^{-1} (Table 4).

The woody biomass of the different accessions was significantly different ($p \leq 0.001$). Appreciable differences occurred in the amounts of biomass realised from accessions from Kawinga (21.8 t ha^{-1}) and Namiyanga (25.3 t ha^{-1}) in Malawi, K8 from Kasama, Zambia (21.8 t ha^{-1}) and from Isiolo in Kenya (26.6 t ha^{-1}), compared to accessions that produced low biomass including the Cunningham hybrids, Peru from Makoka, Malawi and an accession from Ibadan, Nigeria (Table 4).

Highly significant differences ($p \leq 0.0001$) in total biomass production among accessions were observed. Accessions from Isiolo, Kenya; Namiyanga, Malawi; Yimbo, Kenya; and accession Pursa from Kasama, Zambia produced 47.7, 42.2, 36.2 and 35.6 t ha^{-1} total biomass respectively compared to the other accessions that had intermediate biomass ranging from 21 to 33 t ha^{-1} (Table 4). Accessions that produced low biomass included Peru and Cunningham from Makoka, Malawi, and an accession from Ibadan, Nigeria (< 20 t ha^{-1}).

Discussion

The growth assessment based on height, girth and root collar diameter showed that there were significant differences among the *Leucaena* accessions. The best performing accessions with respect to the above growth parameters were from Yimbo, Kenya; K8 from Machakos, Kenya; K8 from Kasama, Zambia; Isiolo, Kenya; and Kawinga, Malawi.

Five accessions: Peru, IITA, Korogwe, 84511 Machakos, and Cunningham from Kasama, Zambia performed poorly when compared to the rest of the accessions. The remaining seven accessions were generally uniform in growth. The mean annual increment (MAI) in height growth of > 2 m achieved by most accessions was comparable to that of *Gliricidia sepium* and *Calliandra callothyrsus* grown at the same site (Maghembe & Prins 1994), *Eucalyptus* species in Malawi (Chapola & Ngulube 1991, Chirwa 1992) and *Leucaena leucocephala* in Tanzania (Maghembe *et al.* 1986). However, lower values for MAI in the same ecological zone in Chalimbana, Zambia have been reported at wider spacing than used in this study

(Kamara & Maghembe 1994) and attributed to differences in spacing and the management regimes used.

The growth characteristics of these *Leucaena* accessions did not seem to be important criteria for determining the end uses. In this study, the *Leucaena* accessions that had the greatest number of branches did not necessarily produce the greatest biomass. Hughes (1993) suggested that some of the *Leucaena leucocephala* 'so called' progenies may have been collected from one or a few cultivated trees. This narrow genetic variation seems to apply to the accessions tested in the current study, resulting in the lack of clearly superior accessions among the tested germplasm. When grouped on the basis of growth in height, root collar diameter and crown development, these accessions seem to belong mainly to Brewbaker's arboreal K8 hybrids (Brewbaker 1975 1987). Only a few accessions from IITA, Ibadan, Nigeria; Peru ex Makoka; 84511 from Machakos, Kenya and the two Cunningham accessions may belong to the shorter fodder hybrids of Hutton (Hutton & Gray 1959, Brewbaker 1987). In previous studies, none of these hybrids has shown resistance to the psyllid (Wheeler *et al.* 1987, Stewart *et al.* 1991, Hughes 1993). Testing of new *Leucaena* species and provenances to find productive and psyllid resistant alternatives to the *Leucaena leucocephala* is therefore critical for providing farmers with the fodder, green manure and wood they need (Hughes 1993).

The average production of foliage (including leaves, twigs and pods) was over 12 t ha^{-1} y^{1} in most accessions tested. This was more than the 1.5 to 10 t ha^{-1} y^{1} that has been documented in the literature for *Leucaena leucocephala* in many tropical and sub-tropical environments (NFTA 1985). Accessions from Isiolo, Kenya; Namiyanga, Malawi; and a K8 accession from Kasama, Zambia produced foliage biomass of over 19 t ha^{-1} within 15 months after establishment. Following clearfelling, only an accession from Isiolo, Kenya maintained the high foliage production from coppice regrowth. This production is also higher than that reported for *Leucaena* in studies done in Tanzania and Zambia (Maghembe *et al.* 1986, Lulandala & Hall 1990, Kamara & Maghembe 1994). The high pod production displayed by these *Leucaena* accessions (>10 t ha^{-1} y^{1}) support concerns raised for the possibility of the species becoming a weed when grown under favourable conditions (Hughes 1993). Thus, management practices such as pruning or coppicing should be timed to minimize seed dispersal under favorable conditions.

The total biomass production of the *Leucaena* accessions at the site was generally high. This production of *Leucaena* is also superior to that reported for *Eucalyptus grandis, Pinus caribaea, P. patula* and *Gmelina arborea* in plantation forests in the tropics (Ariel *et al.* 1988). Studies elsewhere have shown biomass production for *L. leucocephala* accessions to vary from 1.6 and 6.2 t ha^{-1} y^{1} to as much as 66 t ha^{-1} y^{1} under intensive management regimes (Maslekar 1984, Nerkar 1984, Desai *et al.* 1988). The productivity of *L. leucocephala* has also been shown to be site specific (NFTA 1985). Glumac *et al.* (1987) reported biomass production ranges of 1.5 to 10 t ha^{-1} y^{-1} which was attributable to soil variability. Greater biomass production has also been associated with narrower spacing. In India, Desai *et al.* (1988) reported biomass production of as much as 198 t ha^{-1} in three years at a spacing of 60 × 60 cm with irrigation and fertilisation. Maghembe *et al.* (1986) reported 36% higher biomass in clean weeded *L. leucocephala* (at the same spacing) compared to the species in spot weeded stands. In other studies, the differences in linear growth were not consistent and did not show any variation among accessions tested (Wheeler *et al.* 1987).

The biomass production from coppice regrowth was generally higher than production from seedling growth. This is in general agreement with results reported elsewhere (Brewbaker 1987). In fact the coppice regrowth of the *Leucaena* accessions was far more superior than that of *Gliricidia sepium* and *Cassia spectabilis* grown at the same site (Maghembe & Prins 1994). The resilience of *Leucaena* after cutting has made it the most widely used multipurpose tree species pantropically. The high foliage production (> 12 t $ha^{-1} y^{-1}$) and the associated high foliar nitrogen (3.4 - 4.0%) of *Leucaena* also makes it a potential source of green manure for soil amendment in Southern Africa (P. Chirwa, unpublished data).

Conclusion

Based on growth and biomass production, the accessions of *Leucaena leucocephala* widely distributed by National Tree Seed Centers in East and Southern Africa seem to be mainly the K8 arboreal varieties. Among these, accessions from Isiolo, Kenya; Nyimbo, Kenya; Machakos, Kenya; K8 Kasama, Zambia; and Kawinga, Malawi gave the highest growth and yield. Those planting *Leucaena leucocephala* are recommended to use these accessions for fuelwood and biomass production. A few accessions tested including Peru, Makoka, Malawi; IITA, Ibadan, Nigeria; 84511, Machakos, Kenya; Cunningham, Kasama, Zambia; and Korogwe, Tanzania gave poor yield and may belong to the fodder hybrids of Hutton.

The production of biomass by the best accessions compared well with *Leucaena leucocephala* and other multipurpose trees grown under intensive culture. Since none of the K8 and Cunningham *L. leucocephala* varieties has been shown to be psyllid resistant, finding resistant new varieties of *Leucaena* should be a priority in spite of the high production reported. This is urgent in view of the recent psyllid invasion in Southern Africa.

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