COMPARATIVE GROWTH ANALYSIS OF TWO WOODY LEGUMES AT A RAINFOREST LOCATION IN NIGERIA

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ABSTRACT

Non-reproducibility of positive results of alley cropping by researchers on farmers' field has led to low adoption of the technology. Field studies were conducted at Ile-Ife between 2000 and 2002 to compare the growth of Leucaena leucocephala (Lam) de Wit cv. 28 and Gliricidia sepium (Jacq.) Walp cv. ILG50 at the early stages of growth (2-16 months after planting) (MAP) to know which of the species has greater potential as alley intercrop under no-external input system being practiced by farmers. The two species had similar stem heights except at the early stage of growth (4-8 MAP) when that of G. sepium (1.55 m) was significantly ($P<0.05$) higher than that of L. leucocephala (0.85m). The leaf area of G. sepium was 128.05 m^2 and significantly ($P<0.05$) wider than that of L. leucocephala (70.10 m^2) between 14 and 16 MAP. Between 12 and 16 MAP, the biomass yield of G. sepium (5.10 kg/plant) was significantly ($P<0.05$) higher than that of L. leucocephala (1.35 kg/plant). The average plant growth rate (PGR) and relative growth rate (RGR) of G.sepium were 688.75 g/month and 1.97 g/g/month, respectively between 12 and 16 MAP while those of L. leucocephala were142.00 g/month and 1.56 g/g/month for PGR and RGR, respectively at the same period. Net assimilation rate (NAR) of G. sepium (118.25 g/m^2/month) was significantly ($P<0.05$) higher than the NAR of L leucocephala(40.84 g/m^2/month). It was concluded from the study that G. sepium has higher productivity than L. leucocephala in terms of growth rate, photosynthetic efficiency and biomass production under no-external input field conditions. The implications of this on alley cropping are discussed.

Key words: Canopy diameter, *G. sepium*, *L. leucocephala* ,leaf area, net assimilation rate

INTRODUCTION

Growth of woody legumes is soil, relief and ecology specific, hence several leguminous trees have been tested for suitability for alley farming in the tropics (Kang *et al.* 1984). Out of the leguminous trees evaluated, *Leucaena leucocephala* (Lam) de Wit and *Gliricida sepium* (Jacq) Walp were the best performing in the humid and sub-humid tropics (Oikeh, 1999). To know which of the two species is more productive and to ascertain which advantages make them important alternative or companion to each other, a comparative growth evaluation of the two species was given research priority. Plant height and biomass yield of *G.sepium* were significantly greater than *L. leucocephala* at 10 weeks (Fayemilihin and Kang, 1989) and at 16 weeks after planting (Kadiata and Mulongoy, 1992). Ezenwa and Atta-krah (1992) reported no significant difference in their dry matter and shoot heights at 10 weeks after planting. Biomass yield varied with growth stages in both species and they partitioned more dry matter into the shoot over time (Kadiata *et al.*, 1995). The apparent inconsistency in reports of workers, which was due to short-term, and greenhouse nature of most of the studies (Kadiata *et al.*, 1995), has led to inability to select either of the two species for alley intercrop in the tropics.

Furthermore, a pitfall in alley cropping technology is the non-reproducibility of positive results from research station experience on farmers' farms (Coe, 1994). Evidence from a long-term trial indicated that researchers have overestimated the capacity of the technology to increase crop yield due to experimental and interpretational problems (Ong, 1994). As a result, significant numbers of farmers who had earlier adopted the technology had abandoned it (IITA, 2000). Most of the evaluation studies that led to the suggestion of inclusion of the two species in alley cropping were short-term and greenhouse experiments. In addition, external inputs and treatment of the trees were features of most of the studies. These included phosphorus and nitrogen applications and inoculation of seeds with rhizobium strains. Farmers do not observe all these practices for economic reasons. They practice no external input alley cropping. Thus, a disparity exists between the conditions under which the trees were evaluated and the farmers' field conditions. This disparity is attributed to non-reproducibility of researchers' results on farmers' field. Hence, the need for a re-evaluation of the woody legumes under no-external-input field conditions. Mulongoy and Owoaje (1992) had earlier cautioned on extrapolation of greenhouse results to field conditions when they failed to reproduce greenhouse results under field conditions on the two species. Earlier, Evans (1972) had suggested the use of estimate of growth analysis such as RGR, NAR and specific leaf weight in combination with mensurational data like plant height, crown diameter and stem circumference to asses plant productivity. These have been used to a limited extent on the two species. The objective of the study reported herein was to compare the growth characteristics of *L. leucocephala* and *G. sepium* under no-external -input field conditions. It is hoped that the study would reveal the suitability or otherwise of the tree species for alley cropping on farmers' field.

MATERIALS AND METHODS

The study was conducted at the Teaching and Research Farm of Obafemi Awolowo University, Ile-Ife (07°28'N,04°33'E), Nigeria between 2000 and 2002 cropping seasons. Ile-Ife has a bimodal rainfall pattern with peaks in June and September and a short break in August. The total annual rainfall for 2000, 2001 and 2002 were 939.90, 1017.0, 1001.2 mm^2 ,respectively. Ile-Ife had mean daily maximum temperatures of 34.6^{0}C, 35.6^{0}C and 33.5^{0}C in 2000, 2001and 2002, respectively and the mean daily minimum temperatures were 18.9^{0}C, 17.0^{0}C and 17.6^{0}C for 2000, 2001 and 2002, respectively.

Land preparation, experimental design and trees establishment

The experimental plot was cleared of secondary vegetation. The site had no history of tree legumes. The plot was then disc ploughed and harrowed to get a well-pulverized seed bed prior to seed sowing. Soil samples were taken from surface soil (0-20 cm) for determination of soil physical and chemical properties. A total of six core samples were taken per replicate .The soil samples from each replicate were bulked, air dried and sieved through a 2 mm mesh. The sieved soil samples were analysed for pH, total nitrogen, organic carbon available phosphorus, exchangeable cations and some physical properties at the Soil Science Laboratory of the University.

Each year, the experiment was set up in a randomized complete block design in three replications. The study was a single-factor experiment. The two woody legumes, *L. leucocephala* cv. 28 and *G. sepium* cv. ILG50 constituted the factor. The cultivars were selected based on the report that they were the best performing woody legumes in the tropics (Oikeh. 1999). Trees were spaced 4 m x 0.5 m to create a 4 m -alley and give 3727 trees per hectare. Individual plots measured 4 m x 4 m.

The trees were raised directly from seed. Seeds were collected from the International Institute of Tropical Agriculture (IITA), Ibadan. They were chemically scarified by soaking in 60% sulphuric acid for 30 minutes before sowing as described by Kadiata and Mulongoy (1992). Four seeds were sown per hole at 4 m x 0.5 m spacing on June 15,2000 and June 18,2001. Two weeks after emergence, seedlings were thinned to one per hole based on the visual observation of vigour. Weed control was effected by hoeing at 3 weeks interval for the first 8 months after planting and thereafter slashing was done at a regular interval of 7 weeks. Dry seasons in 2000 and 2001 were relatively wet which made manual irrigation unnecessary. Litterfall was monitored during a dry spell for final leaf biomass determination.

Sampling and data collection

Fifteen plants were randomly selected and tagged from the two middle rows in each plot. Data were collected at two monthly intervals (2,4,6,8,10,12,14 and 16 months after planting) on the tagged plants on the following parameters: seedling emergence and survival, stem height, canopy diameter, stem diameter, number of branches per tree, number of leaves per tree and leaf area. Canopy diameter was determined by placing a steel tape on two horizontal directions at the broadest position of the canopy and averaged (Siregar, 1986). Stem diameter was determined at 5 cm above ground level by an hand-held vernier caliper. Leaf area was determined with the aid of a LiCor-3100 area meter. Because of the destructive the nature of biomass yield determination, it was done at 4,8,12 and 16 months after planting. Plants were carefully uprooted after pouring water into the root area when necessary for easy removal. The plant materials were washed with water to remove soil particles. The phytomass was separated into roots, stem plus branches and leaves and dried in a Gallenkamp Oven at 80°C for 72 hours or constant weight. From the biomass yield and leaf area measurements, growth analysis was carried out with the following growth estimate formulae, as outlined by Watson (1952) and Radford (1967):

Leaf area index (LAI) = A/L,

Leaf weight ratio (LWR)= $LW_1/W_1+LW_2/W_2$,

Relative growth rate (RGR) = InW_2- $InW_1/t_2 - t_2$ (gg^{-1}month^{-1}),

Plant growth rate (PGR) = $W_2 - W_1/t_2 - t_1$ ($gmonth^{-1}$),
Leaf area ratio (LAR) =L_1+L_2/W_1+W_2 (m^2g^{-1}),
Net assimilation rate (NAR)=InL_2 - InL_1/t_2-t_1 (W_2-W_1/L_2-L_1) ($gm^{-2}month^{-1}$),
Specific leaf weight (SLW) =LW_1+LW_2/L_1+L_2 (gm^{-2})
Where A =total leaf area of the plant at harvest (m^2), L=ground cover (m^2), In = natural logarithm, W_1 and W_2 = dry weight (g) on two successive occasions t_1 and t_2, L_1 and L_2 = total leaf area of the plant on two successive occasions t_1 and t_2, and LW_1 and LW_2 = total leaf weight on two successive occasions t_1 and t_2.

Statistical analysis
Analysis of variance was performed on data using randomized complete block models. Because primary interest was in the comparison of species and variability was anticipated to change across harvest dates because of plant growth, separate analyses were performed for each harvest date. Means were separated using LSD at 5% level of probability. Since, the results of the two studies were not significantly different, data collected for 2000 and 2001 studies were averaged and the means were presented.

RESULTS

Preplanting soil physical and chemical properties
The textural class of the soil was sandy loam (Table 1). The soil was slightly acidic (pH 6.4). The total nitrogen (%), organic carbon

Establishment and morphological characteristics
The emergence counts of *L.leucocephala* and *G. sepium* were 96 and 84% ,respectively. Out of these, the establishment of *L. leucocephala* decreased from 92% at two months after planting (MAP) to 74% at 10 MAP and remained constant thereafter whereas the establishment of *G. sepium* remained constant at 76% throughout the duration of the study (Fig.1). The establishment of *L.leucocephala* was significantly ($P<0.05$) higher than that of *G.sepium* only between 2 and 4 MAP. The stem height of *L. leucocephala* increased from 0.4 m at 2 MAP to 3.7 m at 16 MAP while that of *G. sepium* increased from 0.6 m at 2 MAP to 3.9 m at 16 MAP (Fig.1). *G. sepium* stem height (averaged 1.55 m) was significantly ($p<0.05$) higher than that of *L. leucocephala* (av.0.85 m) between 4 and 8 MAP although both species showed similar phases of stem growth. Towards the end of the study (10-16 MAP), the stem diameter of *G. sepium* (av.0.05) was significantly ($P<0.05$) larger than that of *L. leucocephala* (av.0.04) (Fig. 1). The pattern of growth of stem diameter was similar to stem height in both *L. leucocephala* and *G. sepium*. Similarly, the canopy diameter of *G. sepium* (av.1.70 m) was significantly ($P<0.01$) larger than that *of L. leucocephala* (av.1.00 m) between 10 and 16 MAP (Fig.1). The number of branches in *L. leucocephala* (av.6.0/plant) were significantly ($P< 0.05$) higher than in *G. sepium* (1.0/plant) except between 2 and 6 MAP. An increase in number of branches did not occur in *G.sepium* until 12 MAP whereas it had occurred in *L. leucocephala* as early as 6 MAP. The leaf area of *L. leucocephala* increased from 2.3 m^2 at 2 MAP to 75.0 m^2 at 16 MAP while the leaf area of *G. sepium* increased from 2.4 m^2 at 2 MAP to 184.8 m^2 at 16 MAP (Fig.2). The leaf area in *G. sepium* (av.128.05 m^2) was significantly ($P< 0.05$) larger than in *L. leucocephala* (av.70.10 m^2) between 14 and 16 MAP (Fig.2). Similarly, the number of leaves of *G. sepium* was significantly ($P<0.05$) higher than that of *L. leucocephala* (av.734/plant vs 442/plant) at 14 and 16 MAP.

Gradual increase occurred in the number of leaves produced by both species over time with a dramatic increase between 14 and 16 MAP in *G.sepium*. The number of leaflets in *L. leucocephala* was significantly ($P< 0.05$) higher than in *G. sepium* (av.118/leaf vs14/leaf). The number of leaflets remained fairly constant for both species over time. The leaf lengths of both species were not (%), available phosphorus (ppm), cation exchange capacity

Table 1: Pre-planting chemical and physical properties of soil at the experimental site, Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife

Property	Value
pH (H_2O)	6.40
Total Nitrogen (%)	0.12
Organic Carbon (%)	1.49
Available P (ppm) Bray I	5.52
Cation exchange capacity (meq/100g)	15.24
Exchangeable cations (meq/100g):	
K	1.41
Mg	2.51
Ca	0.21
Sand (%)	80.02
Silt (%)	9.86
Clay (%)	10.12
Textural class	Sandy loam

(cmol/kg),K (cmol/kg), Mg (cmol/kg) and Ca (cmol/kg) of the soil were 6.40, 0.12, 0.94, 5.52, 15.4, 1.41, 2.51 and 0.21 respectively (Table 1)significantly different while the leaf breadth of *L. leucocephala* was significantly ($P<0.05$) broader than that of *G. sepium*.

Biomass accumulation and partitioning

The biomass yield of *L. leucocephala* increased from 0.09 kg/plant at 2 MAP to 1.51 kg/plant at 16 MAP, in contrast the biomass yield of *G. sepium* increased from 0.28 kg/plant at 2 MAP to 6.56 kg/plant at 16 MAP (Fig. 3). The total biomass accumulation in *G. sepium* (av.5.10 kg/plant) was significantly ($P < 0.05$) greater than in *L. leucocephala* (av.1.35 kg/plant) between 12 and 16 MAP (Fig.3). In *L. leucocephala* increase in biomass accumulation was gradual throughout the duration of the study whereas in *G. sepium*, a gradual increase in biomass accumulation occurred at the initial stage, and this was followed by a sharp increase between 12 and 16 MAP. Up to 8 MAP, both species partitioned more dry matter into the root than any other part of the plant;thereafter, *L. leucocephala* partitioned more dry matter into the stem while *G. sepium* still partitioned more dry matter into the root than any other part. In general, both species partitioned more dry matter into the shoot than the root over time.

Growth analysis

The RGR of *L. leucocephala* ranged from 1.12 to 1.69 g/g/month while that of *G. sepium* varied from 1.41 to 1.99 g/g/month (Fig.4). The RGR of *G. sepium* (1.99 g/g/month) was significantly ($P<0.05$) higher than that of *L. leucocephala* (1.43 g/g/month) only at 16 MAP. PGR of *L. leucocephala* increased from 22.50 g/month at 4 MAP to 217.00 g/plant at 12 MAP before it declined while that of *G. sepium* increased from 70.00 g/month at 4 MAP to 730.00 g/month at 16 MAP (Fig.4). Between 12 and 16 MAP,PGR of *G.sepium* (av.688.75 g/month) was significantly ($P<0.05$) higher than that of *L. leucocephala* (av.142.00 g/month). Leaf area index (LAI) of *L. leucocephala* ranged from 0.39 to 7.64 while that of *G. sepium* varied from 1.41 to 3.31(Fig.4).LAI of *L.leucocephala* was significantly ($P< 0.05$) larger than in *G. sepium* at 12 and 16 MAP (Fig.4). LAI increased steadily in *L. leucocephala* with a sharp increase between 8 and 12 MAP whereas in *G. sepium*, LAI increased up to 8 MAP and decreased thereafter. Leaf weight ratio (LWR) of *L.leucocephala* varied from 0.22 to 0.31 while that of *G.sepium* ranged from 0.23 to 0.31 which were significantly ($P<0.05$) different except at 16 MAP.In *L. leucocephala*, LWR declined with age whereas in *G. sepium* LWR remained fairly constant with age except for a rise at 12 MAP.

The specific leaf weight (SLW) of *L .leucocephala* increased from 2.96 g/m^2 at 4 MAP to 4.86 g/m^2 at 12 MAP before declining while that of *G.sepium* increased from11.84 g/m^2 at 4 MAP to 15.87 g/m^2 at 12 MAP before declining (Fig.5).The specific leaf weight of *G. sepium* was significantly ($P< 0.01$) higher than in *L. leucocephala (*Fig. 5*)*. The leaf area ratio (LAR) of *L. leucocephala* varied from 0.02 to 0.11 m^2/g while that of *G. sepium* ranged from 0.01 to 0.02 m^2/g. LAR of *L. leucocephala* was significantly ($P< 0.05$) higher than in *G. sepium* at 4 and 8 MAP (Fig.5). LAR decreased with age in *L. leucocephala* whereas it increased with age in *G. sepium* except for a decrease at 8 MAP. The net assimilation rate (NAR) of *L. leucocephala* inreased from 10.18 g/m^2/month at 4 MAP to 4.86 g/m^2/month at 12 MAP before declined whereas that of *G.sepium* varied from 70.50 to 166.00 g/m^2/month (Fig.5) NAR in *G. sepium* was higher significantly ($P< 0.05$) than in *L. leucocephala* except at 16 MAP. In *L leucocephala* NAR increased steadily over time whereas in *G. sepium* it declined after reaching its peak at 8 MAP.

DISCUSSION

Similarity in the establishment of the two woody legumes suggested equal adaptation of the legumes to the local environment. Similarity, in the establishment rates of both tree legumes in north central Nigeria was reported by Tarawali (1991). The significant difference in the stem height of the two species between 4 and 8 MAP is consistent with the findings of Fayemilihin and Kang (1989) and Kadiata and Mulongoy (1992) which was explained to be due to genetic differences between the woody legumes. However, values of the parameters obtained in the present study were higher than those reported by the authors. This could be attributed to different growth conditions of the studies as theirs were conducted under greenhouse conditions. The bigger stem diameter (5.5 cm for *L. leucocephala* and 6.2 cm for *G. sepium* at 16 MAP) reported in this study confirms the findings of Britwum (1988) and Kadiata and Mulongoy (1992), who suggested different degree of meristematic activities in the vascular cambium as one of the reasons for the observed results. Higher number of branches in *L. leucocephala* compared to *G. sepium* confirms the report of Britwum (1988). This suggested a lack of apical dominance in *L. leucocephala*. These conditions might promote bud formation and branch development. The delay in branch formation in *G. sepium* compared to *L. leucocephala* might allow *G. sepium* to concentrate its growth on stem height, stem diameter and canopy formation hence higher values of these parameters in *G. sepium* than in *L. leucocephala*. High number of leaves, leaf length and breadth combined to give *G. sepium* larger leaf area than *L. leucocephala*. Leaf area (53.1 m^2 at 12 MAP) in *L. leucocephala* was of higher value than what was reported by Prasad and Rajeswar (1989). This could be due to dissimilar growth conditions of the two studies. Result on number of leaves and leaf length confirms the findings of Mohatkar (1984) and Gupta and Patil (1984) respectively. Differences in number of leaflet, leaf length and breadth between *L. leucocephala* and *G. sepium* could be attributed to genetic differences between the two species.

In relation to food production, the aggressive growth habit of *G.sepium* as shown by its stem height, stem diameter, canopy diameter and leaf area is a disadvantage as a result of competition for growth requirements with companion food crops. The fast rate of stem height attainment and canopy growth of *G.sepium* compare to that of *L .leucocephala* make planting food crops in *G.sepium* alleys even before first pruning to appear unproductive as the crop will be shaded shortly after emergence. Thus, it is C3 crops, which are shade tolerant that may be adapted to *G.sepium* alleys.

The significantly higher biomass accumulation of *G. sepium* than *L. leucocephala* reported by Avim (1988) and Kadiata and Mulongoy (1992) was confirmed by this study. Greater leaf area, SLW, RGR, NAR and nodulation of *G. sepium* might account for this. However, Ezenwa and Atta-Krah (1992) reported no significant difference in biomass accumulation of the two species, which could be due to binding effect of pot on the growth of the species. Though both species partitioned more dry matter into the shoot than root which confirm the work of Kadiata *et al* (1995), yet the proportion of total dry matter partitioned into root by *G. sepium* was greater than that of *L. leucocephala* over time. This increases the potential of *G.sepium* root competition with food crops and disturbance of plouhging and harrowing activities in alley cropping.

Leaf area index is the ratio of leaf surface area of a plant canopy to ground surface area. The difference in LAI of the two species means they have different foliage density that could be attributed to their different leaf area and canopy diameter. The decline in LAI of *G. sepium* at later stage of growth was due to the dramatic increase in its canopy growth while the upsurge in LAI of *L. leucocephala* between 8 and 12 MAP reflected limited growth in its canopy at rapid leaf formation. Leaf area ratio is the ratio of leaf area to whole-plant dry matter and is an indicator of leafiness of a plant. Results of this study suggest that leafiness was higher in *G. sepium* than *L. leucocephala* because leaf area produced per gramme of dry matter remained fairly constant in *G. sepium* but decreased in *L. leucocephala* with age. Specific leaf weight is the ratio of leaf dry matter to leaf area of a plant. It measures the thickness of leaf. Result showed that *G. sepium* had thicker leaf than *L. leucocephala*. This indicates that productivity in *G. sepium* will be higher because thicker leaves have a large actual photosynthetic cell when light is not limiting than thin leaves (Kallis and Tooming, 1974). NAR which measures the rate of increase in whole-plant dry matter per unit leaf area showed that *G. sepium* had capacity to increase dry weight in terms of its assimilatory surface indicating that *G. sepium* is more photosynthetically efficient than *L. leucocephala*. This is not real photosynthesis; it represents the net result of photosynthesic gain over respiratory loss and may therefore vary according to the magnitude of respiration. *G. sepium* might have combined high leaf area, high LAI, and SLW to achieve higher photosynthetic efficiency over *L. leucocephala*. LWR , the ratio of leaf weight to total dry weight of the plant , is the decimal equivalent of the percentage of total biomass partitioned into leaves. Data on LWR confirms the report of Osman (1986) in *L. leucocephala*. RGR is the increase in dry matter per unit of original dry matter over a time interval. *G. sepium* drew from its high NAR and LAR to outperform *L. leucocephala* since RGR = NAR x LAR (Watson, 1952).

CONCLUSION

In general, *G. sepium* had higher values than *L. leucocephala* in most morphological characteristics and growth estimates measured in this study. This suggests high productivity potential in *G. sepium* compared to *L. leucocephala*. However, values of growth characteristics of both woody legumes measured in this study were higher than what had been reported in the literature. This has led to an underestimation of management problems the two species could pose under field conditions. The two species had similar PGR, RGR and SLW trends while they were different in NAR, LWR, LAI and LAR. This difference might explain differential growth earlier reported between the two species. Though *G. sepium* could be more productive than *L. leucocephala* as shown by its fast growth rate and large biomass accumulation, yet competition with companion crops for growth requirements and management difficulty could be a problem in using *G. sepium* in alley cropping. It is, therefore, suggested that *L .leucocephala* could be used for no-external input alley cropping in the tropical rainforest ecology.

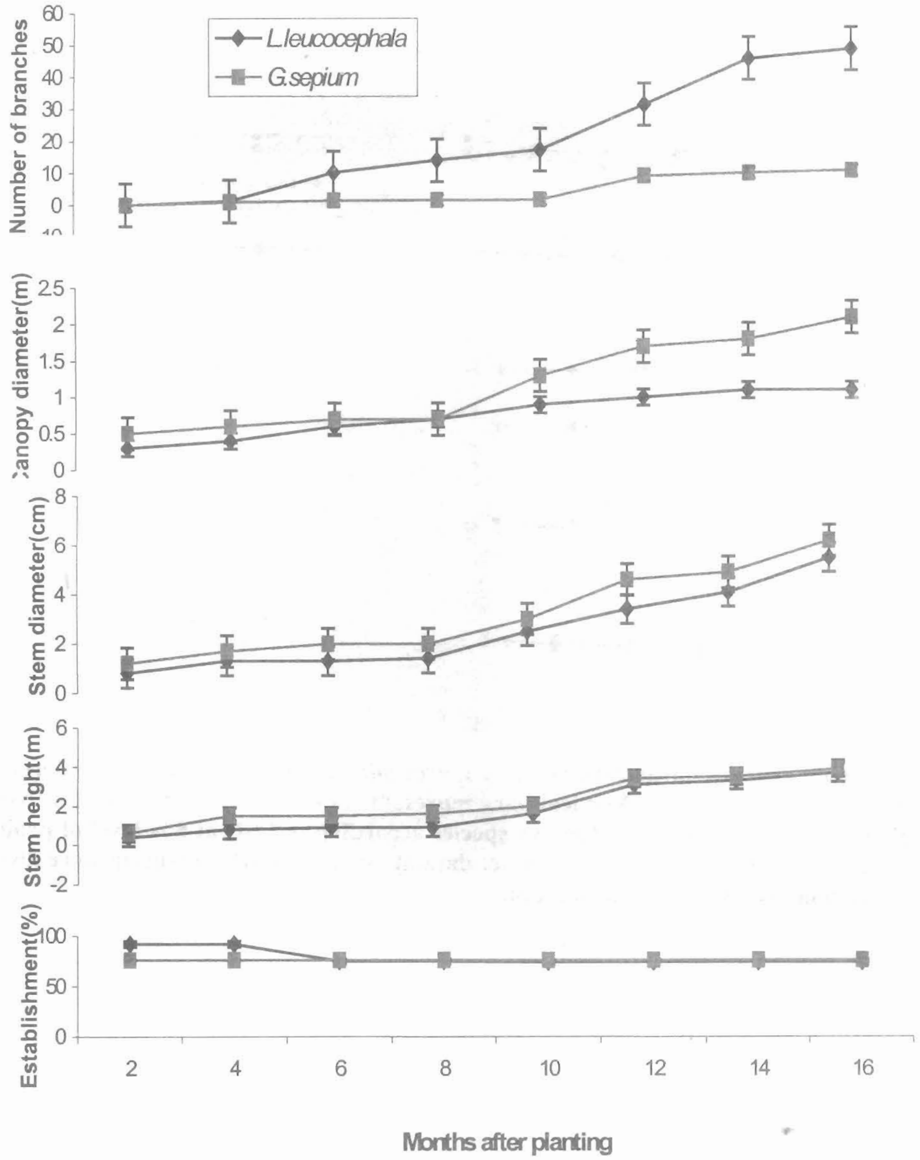

Figure 1: Establishment and some morphological characteristics of *L.leucocephala* and *G. sepium* at different months after planting. Vertical bars represent standard error of the mean. Asterisks indicate significant difference between the species according to LSD at 5% level of probability. Values are mean of 2000 and 2001 studies.

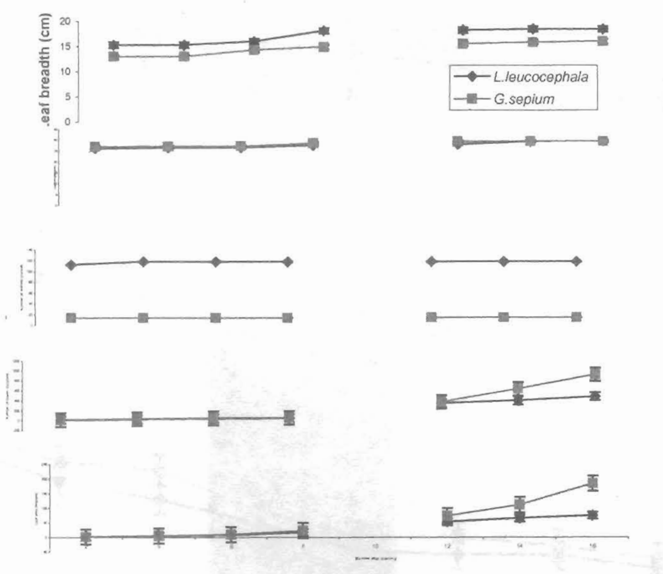

Figure 2. Leaf morphological characteristics of *L. leucocephala* and *G.sepium* at different months after planting at Ile-Ife, Nigeria .Vertical bars represent standard error of the mean. Asterisks indicate significant difference between the two species according to LSD at 5% level of probability. Values are mean of 2000 and 2001 studies. Note: data at 10 months after planting were discarded because of defoliation occasioned by harmattan.

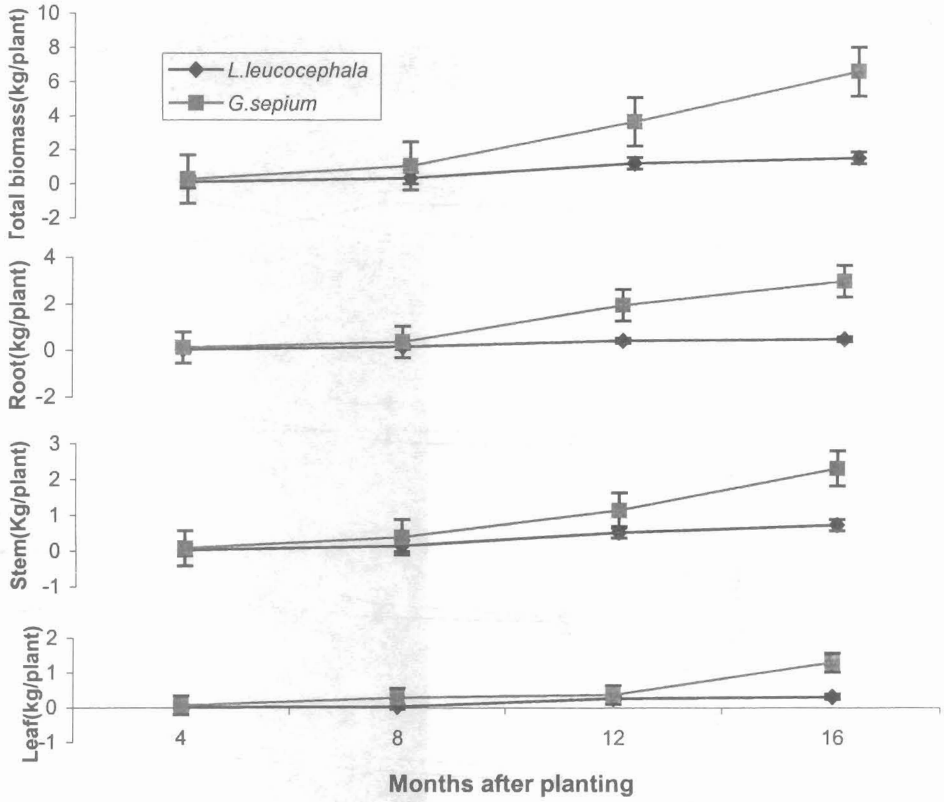

Figure 3. Biomass yield and partitioning of *L. leucocephala* and *G. sepium* at different months after planting at Ile-Ife, Nigeria. Vertical bars represent standard error of the mean. Asterisks indicate significant difference between the two species according to LSD at 5% level of probability. Values are means of 2000 and 20001 studies.

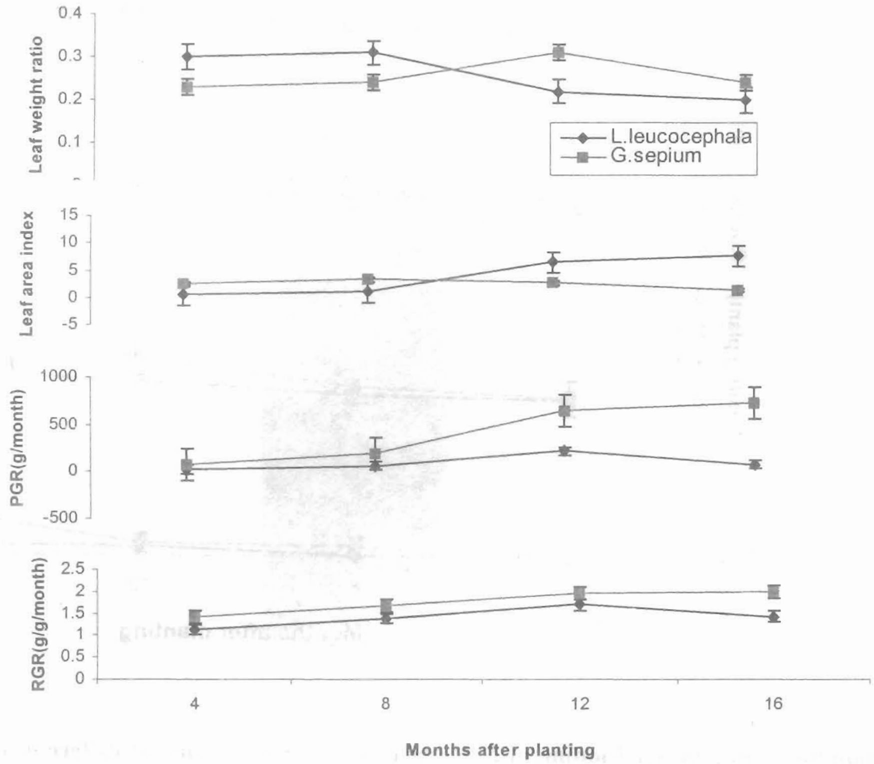

Figure 4: Relative growth rate (RGR), plant growth rate (PGR), leaf area index and leaf weight ratio of *L. leucocephala* and *G. sepium* at different months after planting at Ile-Ife, Nigeria. Vertical bars represent standard error of the mean. Asterisks indicate significant difference between the two species according to LSD at 5% level of probability. Values are mean of 2000 and 2001 studies

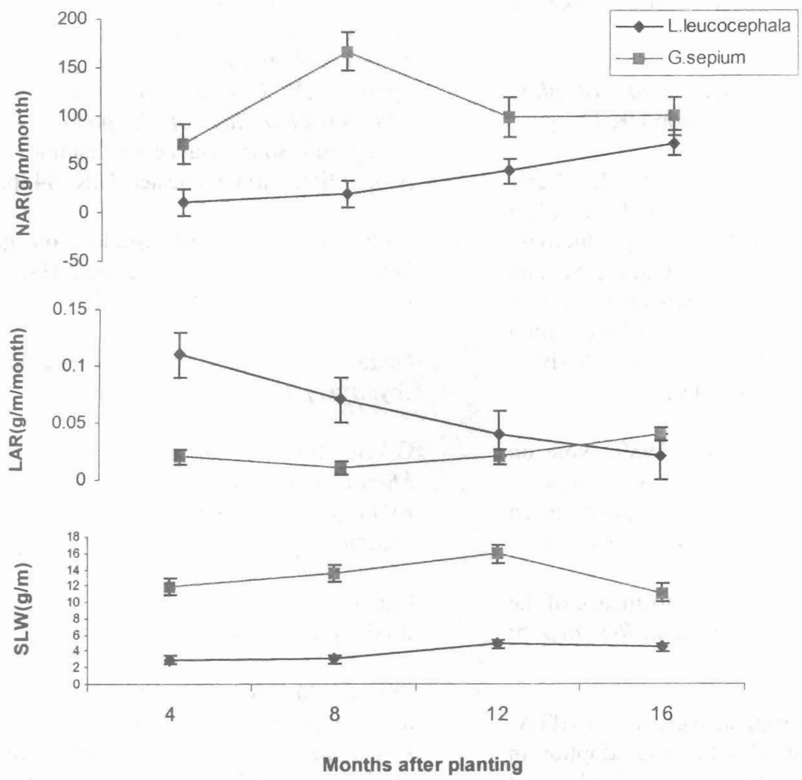

Figure 5: Specific leaf weight (SLW), leaf area ratio (LAR), net assimilation Rate (NAR) of *L. leucocephala* and *G. sepium* at different months after planting at Ile-Ife, Nigeria. Vertical bars represent standard error of the mean. Asterisks indicate significant difference between the two species according to LSD at 5% level of probability. Values are mean of 2000 and 2001 studies.

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