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EVALUATION OF THE AGRONOMIC PERFORMANCE AND NUTRITIVE VALUES OF *TEPHROSIA BRACTEOLATA GUILL. & PERR.* AND *GMELINA ARBOREA ROXB* PRUNNINGS AT DIFFERENT STAGES OF GROWTH

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ABSTRACT

This study was carried out to investigate the growth, dry matter yield and chemical composition of *Tephrosia bracteolata* and *Gmelina arborea* at Teaching and Research Farm, Federal University of Agriculture, Abeokuta, Nigeria. The objective of this study was to evaluate the effect of different stages of growth of *T. bracteolata* and *G. arborea* on their agronomic performance, herbage yield and nutritive value in the humid zone of Nigeria. Data were collected at 8, 12, 16 and 20 weeks after planting (WAP). Results showed that *T. bracteolata* attained the height of 161 cm at 20 WAP, though not significantly different from the height at 16 WAP. The leaf number (24), branch number (7) and dry matter yield of *T. bracteolata* were recorded highest at 16 WAP. The height of *G. arborea* was on constant increase throughout the experimental period. The crude protein (CP) and ether extract (EE) contents of the two browse plants were highest at 8 WAP and thereafter, declined throughout the experimental period. Fibre fractions, the neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) had a least value for both browse species at 8 WAP and highest values at 20 WAP. From the study, considering the dry matter yield and nutritive value, *T. bracteolata* being an annual species, can be harvested at 16 WAP when the quality and quantity will support livestock productivity and can be conserved to be fed to ruminant animals during dry season when feed availability and quality are extremely low. However, planting of *G. arborea* should be encouraged being a perennial browse plant that will support livestock productivity during the dry season in the tropics. In conclusion, *T. bracteolata* and *G. arborea* grow rapidly and are recommended as forage of high nutritive values that meet ruminant animal protein requirements especially during the dry season.

Keywords: *Tephrosia bracteolata, Gmelina arborea,* agronomic performance, stage of growth.

INTRODUCTION

In recent years, the use of forage legumes in livestock production systems for ruminants in the tropics has increased with the benefits such as conversion of atmospheric nitrogen to forms of nitrogen which plants can take up and be recycled within the plant-animal-soil system (Said and Tolera, 1993).

Forage legumes can be grazed, harvested and fed fresh or stored as hay or silage (Harricharan *et al*., 1988). A better way to improve the feeding value of these tropical pastures especially for the poor resource small holders is through supplementation of grasses with browse plants especially during the dry season when the quality of grasses cannot meet the nutrient requirements of the ruminant animals. Supplying feed in adequate amount and quality demand that concerted efforts be directed to sourcing locally available high quality forages that can be easily grown to give good yield for the production of cheap animal protein (Reynolds *et al.,* 1988). Tedonkeng *et al*. (2006) observed that deficiencies in feed quality could be corrected by the addition of herbaceous legumes or multi-purpose trees to the basal diet. *Tephrosia bracteolata* being a leguminous shrub is very rich in protein and grows to about 2 m in height (Ayoade *et al.,* 1998). *Gmelina arborea* is particularly notable for its fast growth, large green leaves and very high DM yield. It has been reported that the leaves and fruits can serve as feed resources for ruminant feeding (Ramachandran, 1993). These browse plants are low in fibre, high in crude protein and available all year round (Babayemi *et al*., 2004).

MATERIALS AND METHODS

The experiment was carried out at the Teaching and Research Farm of the Federal University of Agriculture, Abeokuta, Ogun State, Nigeria (7°58'N; 3°20'E) in the savannah agro-ecology zone of south- western Nigeria. The area is characterized by a bi-modal rainfall pattern that typically peaks around June and September with a break of about two to three weeks in August. The area has a mean annual rainfall of 1250 mm. The soil at the experimental site belongs to the Iwo series of the Alfisol soil order. A total land area of 50 m^2 was cleared, ploughed and harrowed. Soil samples were collected using an auger to a depth of 15cm from the experimental site. The sampled soils being a composite of four cores were spread in the laboratory for air-drying. The routine soil pH and nitrogen were determined while exchangeable K, Na, Ca and Mg were extracted as described (Black, 1965) for routine nutrient determination before and after experiment (Table 1).

The species evaluated were *T. bracteolata* and *G. arborea*. The seeds of *T. bracteolata* were scarified in 80°C for 30 seconds and air dried (Crowder and Chheda, 1982). They were later planted by drilling in rows 1 m apart at the seed rates of 10 kg ha^{-1}. Seedlings of *G. arborea* were got from the nursery unit of the Department of Forestry and Wildlife Management, Federal University of Agriculture, Abeokuta and were transplanted from nursery pots after 28 days post planting at a spacing of two meters between plants. The plots were not fertilized but were regularly weeded. The study was conducted in a randomized complete block design with four replicates which included two forage species (*T. bracteolata* and *G. arborea*) and four harvesting times (8, 12, 16 and 20 weeks after planting -WAP)

The plant heights were measured using a measuring tape from 10 randomly selected plants in the plot every 4 weeks starting from 8 weeks after planting. During sampling, 1 m^2 quadrats were randomly placed on each plot of *T. bracteolata* and all the plants within each quadrat were cut at 10cm above ground level. Plant edible fractions (Leaves and tiny twigs) of leaves of *G. arborea* were harvested from each stand. Care was taken to ensure that each sample contained fairly equal quantities of young and mature leaves. Four stands of *G. arborea* were sampled for each harvesting time. The plant materials harvested were weighed and sub-samples weighing 300 g were taken. The sub-samples were oven-dried at 65 °C until constant weight to obtain the percent dry matter (% DM). The DM yield was then estimated by multiplying the fresh weight by the % DM and the total DM yields was obtained in relation to the area of the land used.

The oven-dried samples were ground in a hammer mill to pass 1.0 mm sieve for the determination of crude protein (CP) and ether extract (EE) which were estimated using the procedure of AOAC (2000), while neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were assessed by the method of Van Soest *et al.* (1991). Cellulose was taken as the difference between ADF and ADL while hemicellulose was calculated as the difference between NDF and ADF. Data were analysed by the analysis of variance technique and means were compared by the Duncan Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

The physical and chemical properties of soil before and after planting are shown in Table 1. The pH level of the experimental soil indicated that it was a fairly neutral soil. This was in line with what was reported by AFNETA (1992) and Babayemi *et al.* (2002) for soils in plot of *T. bracteolata.* The N level of the soil for this study was within the range of 0.07 – 0.11 % reported by Tening *et al.* (1994) for the establishment of Stylosanthes. The increase in the N level of the soil after the experiment confirmed that *T. bracteolata* being a leguminous shrub had fixed atmospheric N into the soil. The seeming improvement in soil mineral contents was shown by the increase in the values of the mineral contents (K, Ca, Mg and Na) after the experiment.

Table 1: Physical and chemical properties of soil at 15cm depth of the experimental plot before and at 20 weeks of the experimental

Measurement	Before experiment	After experiment
pH (H_2O) 1:1	6.30	6.95
Nitrogen (%)	0.10	0.71
Exchangeable Cations (cmol kg-1)		
Potassium	0.18	0.21
Calcium	0.68	0.92
Magnesium	0.45	0.47
Sodium	0.19	0.32
Soil particles		
Sand (%)	86.76	86.76
Silt (%)	7.64	7.64
Clay (%)	5.60	5.60

There was a significant ($P < 0.05$) and steady increase in plant height, leaf number, leaf length and branching of *T. bracteolata* from 8 to 16 WAP (Figures 1, 2, 3), thereafter, there was a sharp decline in leaf number, leaf length and branching at 20 WAP. The heights of *G. arborea* (Figure 5) increased with the age of plants. Heights of both species at 20 WAP were 3 times their heights at 8 WAP. The value for the plant height of *T. bracteolata* (160.90 cm) was significantly higher at 16 and 20 WAP compared with other harvesting times. This shows that it exhibits determinate growth pattern. This value was higher than the one reported by Babayemi *et al.* (2002) for the same species. This could be because of differences in soil composition of the experimental sites. The same plant height values reported at 16 and 20 WAP for *T. bracteolata* could be due to the emergence of flowers and pods, indicating that nutrients have been diverted from plant growth (Davies, 1997). Meanwhile, the height of *G. arborea* continued to increase throughout the period of the study, since it had not reached maturity and is a perennial plant. It is expected that *G. arborea* plant will grow taller and produce more biomass for feeding of ruminant animals.

Higher leaf proportion is a desirable attribute in forage species as leaves have higher nutritive value in addition to being generally more digestible thereby eliciting higher animal intake (Minson, 1990). Higher leaf number will also give the plant the opportunity of being able to trap enough sunlight for photosynthesis to take place. As indicated in Figure 2, higher leaf number (24.4) was recorded for *T. bracteolata* at 16 WAP, indicating that it will be consumed better by ruminant animals at this stage. Highest leaf number (155) (Figure 6) was recorded for *G. arborea* at 20 WAP. This could be because the plant was still growing. Higher value for branch number (Figure 2) at 16 WAP for *T. bracteolata* shows that rapid branch production and elongation, especially at the early stage of growth is important for early soil coverage, high dry matter yield and suppression of weed that is usually a major problem at the early establishment stages of sown pastures in south west Nigeria (Olanite, 2003). This could have contributed to the higher DM yield (970 kg DM ha^{-1}) recorded for *T. bracteolata* at 16 WAP above other harvesting times (Figure 4). The DM yield of *T. bracteolata* increased linearly with increased interval of cutting, corroborating earlier report that extended harvesting time of tropical forages encourages high DM yield (Chheda and Akinola, 1971).

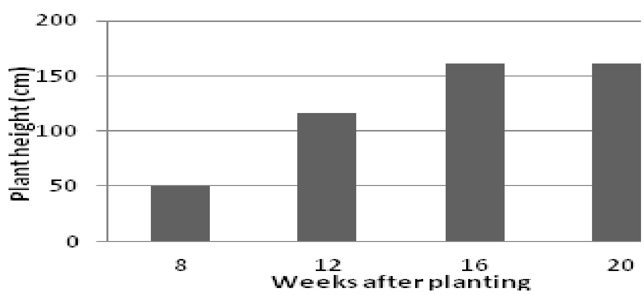

Figure 1: Plant height of *T. bracteolata* at different harvesting time

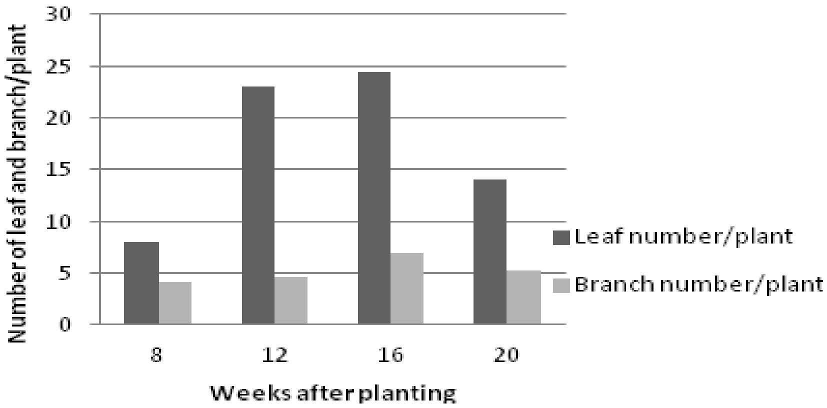

Figure 2: Leaf and branch number of *T. bracteolata* at different harvesting time

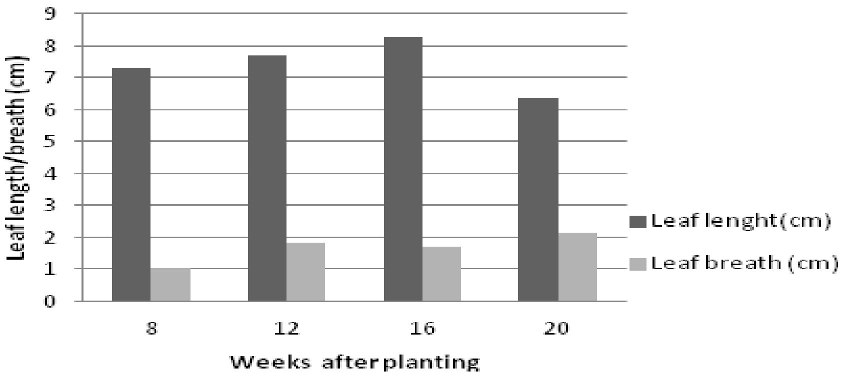

Figure 3: Leaf length and breath of *T. bracteolata* at different harvesting time

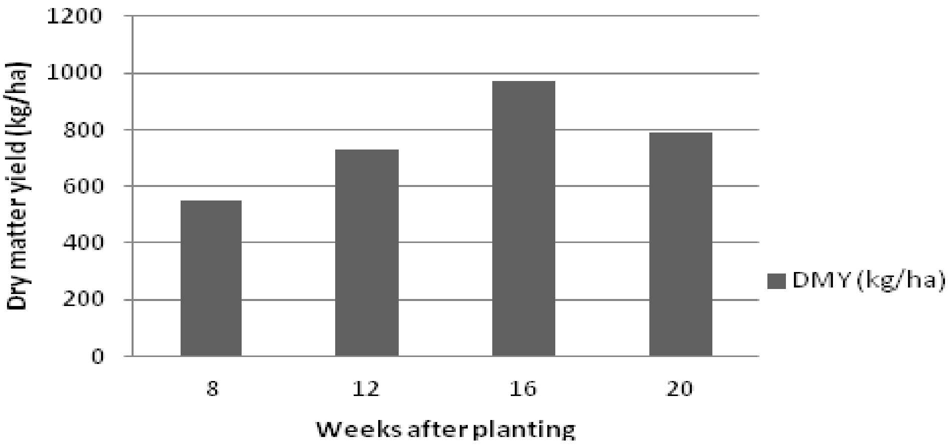

Figure 4: Dry matter yield of *T. bracteolata* at different harvesting time

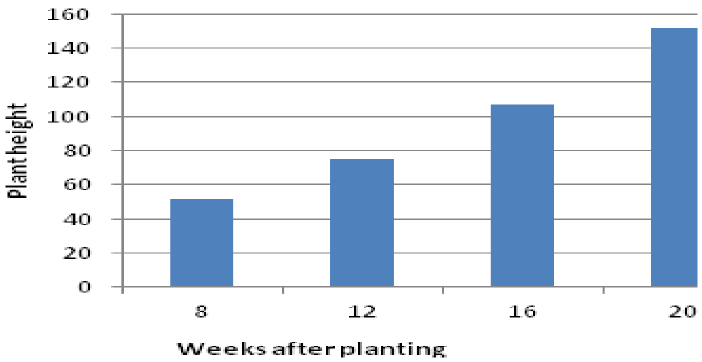

Figure 5: Plant height of *G. arborea* at different harvesting time

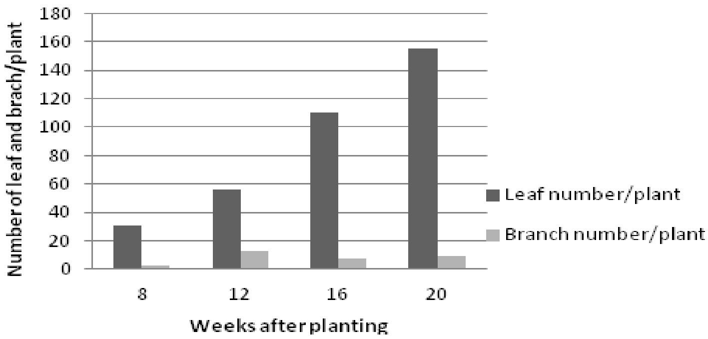

Figure 6: Leaf and branch number of *G. arborea* at different harvesting time

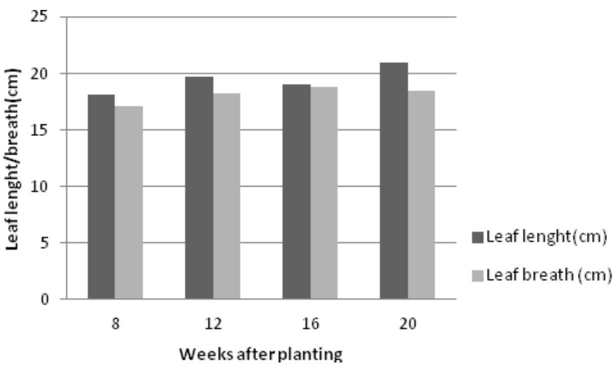

Figure 7: Leaf length and breadth of *G. arborea* at different harvesting time

From Table 2, the nutritive values of the two forage species declined as the harvesting times extended from 8 to 20 WAP as depicted by the CP, NDF and ADF components. This agreed with the work of (Olanite *et al.*, 2006). At the commencement of harvesting at 8 WAP, the CP values were 15.91 % and 16.02 % and fell to 13.61 % and 13.33 % for *T. bracteolata* and *G. arborea* respectively as harvesting times increased. The values for both species were within the minimum range of 6.5 – 8.0 % prescribed for optimum performance of tropical ruminant animals (Minson, 1981). The 13.61 to 15.91 % CP recorded for *T. bracteolata* agrees with the report of Adeloye (1994) who obtained 15.31 % CP. On the other hand, Babayemi *et al*. (2002) reported a much higher value of 24.30 %. The variation may be attributed to differences in the parts of the plant sampled, stage of growth and the season of sampling. The authors sampled only leaves between March and July, whereas in this study, both leaves and tiny twigs were sampled between June and November. The CP content of *G. arborea* in this study agrees with 13.47 % reported by Fajuke (2002) who harvested fresh leaves from older plants.

The general increase in the height of *T. bracteolata* from 8 to 20 WAP have implications for the nutritive quality of browse produced by contributing to the dilution of the nutrient content of the forages, as most of the nutrients taken up by the plants from the soil were mobilized for formation of structural and reproductive components, such as cellulose, hemicelluloses and lignin (Butterworth, 1985). The forage so produced was thus lower in important nutrients, especially crude protein (Gohl, 1975). This could be responsible for decrease in the crude protein content of *T. bracteolata* as the height of the plant increased and increase in fibre fractions. Greater proportion (64.51%) of the dry matter content produced by *T. bracteolata* at 20 WAP compared with (25%) at 8 WAP was stem material. Stem fractions of the forage are usually fibrous, low in nutrient density and digestibility and are thus poorly utilized by animals (Ndlovu, 1991). Given the choice to select, animals will select forages with lower stem materials. The cell wall fractions (NDF, ADF, ADL, Hemicellulose and Cellulose) increased with maturity. This can be associated with lignifications. McDonald *et al.* (1998) reported an increase in DM content of plants with advancing maturity which is reflected in increased cell wall contents (NDF, ADF, ADL and NFE) and a decrease in cell contents (CP, EE and ash). Sibanda and Ndlovu (1992) noted that tree density was important in indicating the amount of biomass available to livestock, while CP and NDF contents indicated the quality of the biomass. In general, feed quality increased with increase in CP content and with a decrease in NDF. The NDF values for the species were however, within the range of 25-71% reported for some valuable multipurpose trees in Nigeria (Larbi *et al.,* 1993). Thus, in order to have sufficient forage for livestock with good nutritive value, *T. bracteolata* could be harvested at 16 WAP and conserved as hay. This is because an optimal harvest scheme is necessary to obtain a balance between quality and herbage yield (McDonald *et al.*, 1998). *Gmelina arborea* plants, being generally deep rooted and tending to store food in their stems rather than in the roots can be used as supplementary diets for ruminant animals, during the dry season when most other feed resources depreciate in quantity and quality.

Table 2: The proximate composition and cell wall contents of *Tephrosia bracteolate* and *Gmelina arborea* prunings at different stages of growth

Weeks after planting										
T. bracteolata						G. arborea				
Parameters (%)	8	12	16	20	SEM	8	12	16	20	SEM
DM	25.00c	25.24c	30.63b	64.51a	4.98	32.34c	33.50bc	35.76ab	37.40a	0.72
CP	15.91	15.05	14.30	13.61	0.51	15.95a	15.28ab	13.94ab	13.33b	0.41
EE	3.05a	2.74a	2.21b	1.91b	0.14	11.54a	8.45b	6.01b	5.95b	0.76
ASH	8.43a	6.70b	5.34c	3.11d	0.59	12.35a	10.10b	9.00bc	7.80c	0.56
NDF	40.11d	45.24c	50.17b	67.51a	3.14	36.32b	39.87b	47.44a	49.60a	1.71
ADF	25.00c	28.22bc	30.12b	42.13a	2.00	23.10c	25.90bc	29.38ab	31.54a	1.09
ADL	10.11c	11.84bc	13.60ab	15.11a	0.69	9.50c	10.56bc	12.30ab	13.93a	0.50
HEMI	15.11b	17.02b	20.05b	25.38a	1.36	13.22b	13.97ab	18.06a	18.06a	0.88
CELL	14.89b	16.38b	16.52b	27.02a	1.62	13.60	15.34	17.08	17.61	0.90

a,b,c,d Means on the same row with different superscripts are significantly different ($P < 0.05$)

SEM: Standard Error of Means
DM: Dry matter, CP: Crude protein, EE: Ether extract, NDF: Neutral detergent fibre, ADF: Acid detergent fibre, ADL: Acid detergent lignin, HEMI: Hemicellulose, CELL: Cellulose

CONCLUSION

Tephrosia bracteolata is a shrub legume, early maturing and possesses high nutritive value. The implication of this is that, its use would not only enrich the soil but also improve the performance of livestock when fed. *Gmelina arborea* which was perennial species can be pruned to feed animals during the dry season, since it retains it quality and quantity during this period. This will go a long way to alleviate inadequate feed supply in the dry season when the problem of feeding of ruminant animals becomes critical.

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