Growth and biomass yield of two *Panicum maximum* varieties as affected by weed management and fertilizer application methods in the Humid Savannah zone of Nigeria

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Abstract

A field trial was conducted at the Teaching and Research Farm of the Federal University of Agriculture, Abeokuta, Nigeria to evaluate the effects of weed management and fertilizer application methods on growth and biomass yield of two Panicum maximum varieties. The experiment was laid out in a randomized complete block design with two fertilizer application methods. Two weed managements (weeded versus not weeded) and two Panicum varieties {(P. maximum local (unimproved) versus P. maximum Ntchisi (improved)}and two fertilizer application methods (single dose versus split) were set out in a 3x2x2 factorial arrangement. The unimproved P. maximum variety attained significantly ($P<0.05$) greater height compare to the improved variety while weed management and fertilizer application methods were not significant ($P>0.05$). Although the unimproved Panicum recorded higher values in leaf length (89.23 versus 76.01 cm) when compared with the improved variety while the leaf width (3.37 versus 3.67 cm), leaf density (639.24 versus 1 004.99 leaf m^{-2}), tiller density (130.82 versus 215.11 tiller m^{-2}) and herbage yield (20.56 versus 26.21 t ha^{-1}) produced were higher ($P<0.05$) for the improved P. maximum variety. Split application method significantly enhanced better herbage yield as compared to the single application and the unfertilized (control) treatment. The interaction between variety and time of harvest was highly significant ($P<0.001$) in growth parameters and biomass yields of the two grass varieties.

Key words: Tiller density, split fertilizer application, single dose fertilizer application, harvest time, growth parameters

Introduction

Forage is the major nutritional resource for ruminants particularly in sub-Saharan African countries (Akinsoyinu and Onwuka, 1988). In most of these countries concentrate rations are unaffordable to smallholder livestock owners, while forages provide most of the animal nutrition and are supplied by the natural vegetation, generally referred to as natural pastures. The natural pastures occupy vast areas of land without any management input to improve their biomass yield and nutritive quality. Even though the natural pastures provide the 'cheapest feed', it is deficient in nutritional quality for most of the year and so is incapable of sustaining the animals year-round (Ademosun, 1973). The natural pasture consists mainly of mixtures of unimproved native grasses (such as Panicum, Andropogon, Pennisetum and Hyparrhenia) that grow rapidly during the early rains. The grasses become fibrous and deficient in essential nutrients soon after, leading to poor utilization by animals that are also overwhelmed by the large amounts that become rapidly available (Atta-Krah and Reynolds, 1989).

Guinea grass (*Panicum maximum*) is a prominent grass in the natural pastures in the humid savannah zone of Nigeria, notable and highly valued for its high yields of palatable herbage (Sukkasame and Krongyuti, 1999). In view of its importance in the expansion of ruminant production in the area, the grass has received considerable research interest covering a wide range of topics over the years (Bayorbor *et al*., 1992; Olanite *et al*., 2004). Two major varieties of *P. maximum* are well known in the area; one is generally found as a component of the natural vegetation and is widespread while the other is more or less restricted to research environment where it is more often used as a research material. The former, though unimproved, forms a major component of the grazing resource for traditionally managed cattle in the area and is commonly referred to as 'local variety', while the latter, 'Ntchisi' is an improved species believed to have originated from Kenya. Although the *P. maximum* Ntchisi has shown superiority over the local variety in dry matter productivity and leaf density (Aken'Ova, 1993; Olanite, 2003; Olanite *et al*., 2006; 2012), this has not led to its being appreciably adopted as a feed resource for commercial ruminant production.

The main objective of the present study was to evaluate the effects of variety, weed management and methods of fertilizer application on the growth performance and biomass yields of the two *P. maximum* varieties in the humid savannah zone of Nigeria.

Materials and methods

Description of experimental sites

The study was carried out at the Teaching and Research Farm, College of Animal Science and Livestock Production, Federal University of Agriculture, Abeokuta, Nigeria. The farm site is situated in the humid zone of the derived savannah area of Southwest Nigeria on latitude 7^0 13' 49.46"N and longitude 3^0 26' 11.98"E (Google Earth, 2006).

Land preparation

The land was cleared of trash, ploughed twice and harrowed once two weeks after the second ploughing. A total area measuring 750m^2 was then mapped out and divided into three equal blocks of 250m^2 with 2m spacing. Soil samples were randomly collected at 0-15 cm depth from each block, bulked, mixed thoroughly, sub-sampled and analyzed to determine the pre-planting nutrient status of the soil (Table 1). Each block was sub-divided into twelve equal plots measuring 3m x 4m with 1m inter-plot spacing.

Sourcing of planting material and planting

The unimproved *Panicum maximum* variety was sourced from the existing natural vegetation and *P. maximum* (Ntchisi) from the established field on the farm. Split crowns of the grasses were planted at a spacing of 0.5m x 0.5m, such that each plot had a plant population of 48 plants.

Experimental design and plot management

Treatments were arranged in a 2 x 2 x 3 factorial in a randomized complete block design with 3 replicates. Two fertilizer application: 400kg/ha (single application) and 400kg/ha (equal split application) of N-P-K (15:15:15) fertilizer and control (No fertilizer); two weed managements (plots weeded; plots not weeded); and two Panicum varieties (*P. maximum* unimproved and *P. maximum* Ntchisi) were used. The plots were either weed by using machete to keep them weed-free throughout the experimental period or not weeded at all from planting till end of the experiment as appropriate. The plots with single fertilizer application received the full dose of 400 kg/ha N-P-K at the 4th week after planting (WAP) while those with split application had the fertilizer divided into two equal halves (200 kg ha^{-1}) with each half applied repeatedly at the 4th and 8th WAP.

Phenological measurements

Tiller density

The tiller density of the two grasses was estimated by counting the number of tillers within $1m^2$ quadrat from six weeks after planting (WAP) and subsequently at regular intervals of six weeks.

Plant height

Plant heights were measured with the aid of a meter rule from the base of plants to the point of emergence of the flag leaf on the stem. Ten plant stands were randomly selected per plot for measurement every six weeks.

Leaf density

Leaf density was estimated by counting all the leaves on plants within each of two $1m^2$ quadrats randomly located on each plot. The leaves were counted from the old ones at the base to the newly emerged at the top of the stem every six weeks

Leaf length and width

Leaf length was measured from the tip to the ligules with the aid of a meter rule on ten randomly selected plants from each plot at six weeks intervals. Leaf width was estimated by measuring at the broadest point in cm on ten randomly selected stands from each plot every six weeks.

Leaf/stem ratio

A fresh grass sample weighing 100g was taken and separated into leaf blade and stem fractions and the proportion of each was calculated as follows:

Proportion of leaf/stem = Weight of stem or leaf fraction / Weight of sample x 100

Dry matter yield

The dry matter yield of the grasses was estimated by cutting the two grasses 24 weeks after planting. This was carried out with the use of two $1m^2$ quadrat randomly placed on each plot. Cuttings were made at 15 cm above ground level with the use of a sickle. The cut fresh materials within the quadrat were weighed and sub-samples of 1kg taken and oven-dried at 65°C to constant weight for determination of percent dry matter (% DM). The % DM was used to estimate the DM yield of the grasses.

Statistical analysis

Data collected were subjected to analysis of variance (SAS, 1999) and means separated using the Duncan's Multiple Range Test (Duncan, 1955)

Results and Discussion

Rainfall

The amount of rainfall recorded for each month during the period of experiment (January-December, 2007 and 2008) is shown in Figure 1. The bimodal rainfall pattern characteristic of the study area is observed with the highest amounts recorded in June (176 mm) and September (197mm). There was a somewhat steady increase in the amounts of rainfall from January until it peaked in June followed by heavy and steady declines in July and August. In southwest Nigeria, the period between late October and April is an established annual long dry season which represents the most critical period for ruminants as forage availability is generally insufficient and the nutritive quality of the little is very poor reducing intakes below levels that could sustain production when animals are not supplemented. The rainfall pattern however, appears to be changing in recent times as indicated in Figure 1 with

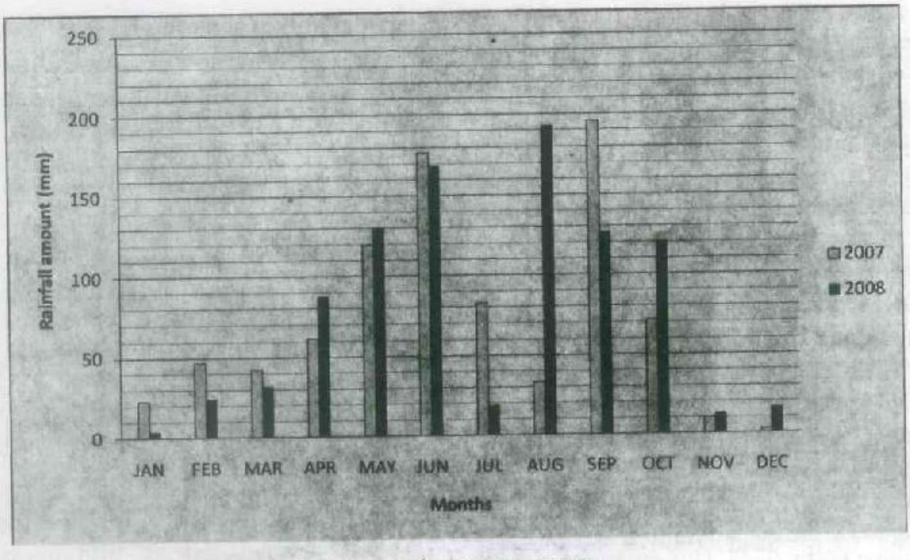

Figure 1: Rainfall data recorded for Abeokuta in 2007 and 2008

Source: Federal Department of Agriculture, Abeokuta

some amounts recorded every month of the year except in December when there was no rainfall at all. This change has been attributed to effects of global warming on the climate which might have negative consequences for agricultural production in the area (Olaniran, 2002; Odjugo, 2005).

Soil characteristics

The physico-chemical characteristics of the soil of experimental site indicated low level of total nitrogen and available phosphorus (Table 1). The soils are also fairly acidic, low in organic carbon content and sandy. Apart from the low genetic potential of the unimproved native forage species for good yield and high quality, low soil nutrient, especially available nitrogen and phosphorus, is one major factor generally implicated for low herbage yield and nutrient content of the natural pasture in the tropics (Mohamed-Saleem, 1994). This has led to recommendations of various levels of fertilizers to ensure improved yield and quality of sown or improved pastures in most part of the tropics, especially in southwest Nigeria (Onayinka, 1973).

Plant height

The values for the height of the two *Panicum maximum* as shown in Table 2 indicated that the unimproved local variety attained greater height than the improved 'Ntchisi' variety at the same ages of observation. The values for the Ntchisi were significantly lower ($P<0.05$) than those for the unimproved variety at all the growth stages in both years of study. The height of the two grasses, however, increased progressively from week four to twenty-four. The values recorded for the two grasses were within the ranges reported elsewhere and in southwest Nigeria (Usberti-Filho *et al.*, 2002 and Van Oudtshoorn, 2004, Olanite *et al.*, 2006). However, the main effects of weed management and fertilizer application

Table 1: Physico-chemical characteristics of the composite soil samples taken at the depth of 0-15cm at the experimental site before planting in 2007.

Physical/Chemical property	Values
pH	5.76
Total nitrogen (%)	0.13
Organic carbon (%)	3.69
Available P (mg/kg)	83.87
Acidity (cmol/kg)	0.23
C:N ratio	28.38
Exchangeable cations (cmol/kg)	
Sodium (Na)	0.20
Potassium (K)	0.20
Calcium (Ca)	0.87
Magnesium (Mg)	0.52
Particle size (%)	
Sand	94.33
Silt	4.37
Clay	1.30

methods did not produce any significant differences in the values recorded at all the growth stages for the two grasses, except for effect of weed management which was significant ($P<0.05$) at 6 weeks after planting in 2008. Various reports from southwest Nigeria (Onayinka and Akinyemi, 1976; Olanite, 2003; Olanite *et al.*, 2004) and elsewhere (Costa *et al.*, 1989; Jank *et al.*, 1989) have also shown that irrespective of the weed and fertilizer managements employed, the unimproved variety usually grows taller. The height of a forage plant could have considerable impact on its nutritive quality as stems tend to become rapidly lignified thereby diluting the nutrient content in the forage. The greater height of the local variety and the general increase in the height of the two grasses over time therefore have implications for the nutritive quality of the pasture produced by them as most of the nutrients taken up by the grasses are mobilized for formation of structural and reproductive components, such as cellulose, hemi-cellulose and lignin (Butterworth, 1985). This makes the forage so produced to be of lower nutritive quality with respect to important nutrients, especially the crude protein (Gohl, 1975), and to be higher in fibre components leading to reduced digestibility, animal intake and utilization (Minson, 1983). Arising from the greater values of the height of the unimproved *P. maximum* in this study, that grass would probably have lower nutritive quality and intake. It is for this reason that tropical grasses are widely recommended to be utilized at the growth stage when the amounts of stem components are minimal. Harvesting at 24 weeks after planting in the present study could have mainly contributed to the high proportion of the stem fraction in the forage.

Leaf length and width

The values for leaf length of *P. maximum* (unimproved) ranged from 77.21-106.29 cm as against 67.38-87.00 cm for *P. maximum* (Ntchisi) across the two years of study with the unimproved grass having higher (P<0.05) values for all the periods. The range of values was similar to that reported (34 - 91 cm) by Usberti-Filho *et al.* (2002) for two weeks old fifteen Guinea grass hybrids. The much younger age of the plants reported in that study might be responsible for the wider the range of values than recorded in the present study. The values for the present study appeared to decline slightly as the harvest interval extended to 24 WAP for both grass varieties which might be due to advancement of the plants into maturity and the declining soil moisture as dry season approached (Begg, 1980; Hopkins, 1995). The decline in the mean leaf length might also be due to progression of the plants to floral initiation since measurements were taken on randomly selected leaves which might also have included floral leaves. Fertilizer application methods and weed management did not significantly (P>0.05) affect leaf length for all the harvest intervals in both years. Similarly, as shown in Table 4, variety and weed management did not affect (P>0.05) leaf width except at 12 WAP when the values (3.89 - 4.03 cm) for *P. maximum* Ntchisi was higher (P<0.05) than for *P. maximum* unimproved (3.64 -3.67 cm). Even though the values were generally higher than those reported by Usberti-Filho *et al.* (2002) they were within 3.5 – 4.19 cm reported by Chen and Hutton (1992) and

Table 2: Effect of variety, weed management and fertilizer application method on plant height of two varieties of *P. maximum* (cm)

	Weeks after planting in 2007				Weeks after planting in 2008			
	6	12	18	24	6	12	18	24
Variety								
P. maximum Unimproved	96.93^{a}	163.24^{a}	226.02	275.53^{a}	100.71^{a}	233.39^{a}	300.24^{a}	307.18^{a}
P. maximum Ntchisi	82.64^{b}	135.75^{b}	214.96	229.09^{b}	86.13^{b}	214.40^{b}	263.68^{b}	269.68^{b}
SEM	4.94	9.41	8.34	14.16	4.74	4.37	5.81	12.53
Weed management								
Weeded	88.89	153.05	223.63	255.04	96.86^{a}	221.57	283.80	284.73
Not weeded	90.67	145.93	217.37	249.58	89.98^{b}	226.22	280.12	282.13
SEM	4.94	9.41	8.34	14.16	4.74	4.37	5.81	12.53
Fertilizer treatment								
No Fertilizer	89.85	148.18	217.14	250.98	93.64	223.04	279.21	284.10
Single fertilizer application	88.29	150.72	223.00	254.44	91.90	224.61	284.53	289.07
Split fertilizer application	91.21	154.56	221.35	251.52	94.72	224.03	282.14	287.11
SEM	3.29	6.27	5.56	9.44	3.16	2.91	3.87	8.33
Levels of significance								
Variety	***	***	NS	***	***	***	***	***
Weed Management	NS	NS	NS	NS	*	NS	NS	NS
Fertilizer treatment	NS	NS	NS	NS	NS	NS	NS	NS
Variety x weed Mgt	*	NS	NS	NS	NS	NS	*	NS
Variety x Fertilizer	*	NS	NS	NS	NS	NS	NS	NS
Weed Mgt x Fertilizer	NS	NS	NS	NS	NS	NS	NS	NS
Variety x Weed Mgt x Fertilizer	NS	NS	NS	NS	NS	NS	NS	NS

SEM = Standard Error of Means; a,b...: Means in each column with different superscripts are not significantly different (P<0.05); * = P<0.05, ***= P<0.001; NS =Not significant; Mgt = Management

Table 3: Effect of variety, weed management and fertilizer application method on leaf length of two varieties of *P. maximum* (cm)

	Weeks after planting in 2007				Weeks after planting in 2008			
	6	12	18	24	6	12	18	24
Variety								
P. maximum Unimproved	77.21[a]	92.20[a]	92.86[a]	78.43[a]	86.36[a]	106.29[a]	95.62[a]	84.83
P. maximum Ntchisi	67.38[b]	76.09[b]	75.18[b]	68.86[b]	69.07[b]	87.00[b]	84.20[b]	80.23
SEM	5.21	4.52	3.60	4.76	5.65	2.91	3.39	4.00
Weed management								
Weeded	71.48	86.41	85.09	72.32	77.31	96.35	90.47	82.85
Not weeded	73.12	81.89	82.94	74.97	78.13	96.95	89.38	82.21
SEM	5.21	4.52	3.60	4.76	5.65	2.91	3.39	4.00
Fertilizer treatment								
No Fertilizer	71.77	84.35	80.89	72.45	76.98	97.07	87.43	79.42
Single fertilizer application	71.16	83.27	84.04	74.25	76.47	97.16	91.84	93.61
Split fertilizer application	73.96	84.83	87.13	74.23	79.70	95.71	90.46	84.56
SEM	3.47	3.01	2.40	3.17	3.76	1.94	2.26	2.67
Levels of significance								
Variety	**	***	***	**	***	***	***	NS
Weed Management	NS	NS	NS	NS	NS	NS	NS	NS
Fertilizer treatment	NS	NS	NS	NS	NS	NS	NS	NS
Variety x weed Mgt	*	*	***	NS	*	*	*	NS
Variety x Fertilizer	**	NS	NS	NS	NS	NS	NS	NS
Weed Mgt x Fertilizer	NS	NS	NS	NS	NS	NS	NS	NS
Variety x Weed Mgt x Fertilizer	NS	NS	NS	NS	NS	NS	NS	NS

SEM = Standard Error of Means; [a, b]: Means in each column with different superscripts are significantly different (P<0.05); * = P<0.05, **= P<0.01, ***= P<0.001; NS =Not significant; Mgt = Management

Table 4: Effect of variety, weed management and fertilizer application method on leaf width of two varieties of *P. maximum* (cm)

	Weeks after planting in 2007				Weeks after planting in 2008			
	6	12	18	24	6	12	18	24
Variety								
P. maximum Unimproved	3.55	3.64[b]	3.62	3.35	3.62	3.67[b]	3.57	3.36[b]
P. maximum Ntchisi	3.47	4.03[a]	3.78	3.42	3.55	3.89[a]	3.61	3.59[a]
SEM	0.06	0.13	0.13	0.14	0.09	0.04	0.06	0.08
Weed management								
Weeded	3.50	3.85	3.78	3.38	3.60	3.76	3.59	3.48
Not weeded	3.52	3.82	3.63	3.38	3.57	3.81	3.57	3.49
SEM	0.06	0.13	0.13	0.14	0.09	0.04	0.06	0.08
Fertilizer treatment								
No Fertilizer	3.49	3.69[b]	3.55[b]	3.34	3.55	3.77	3.54	3.41[b]
Single application	3.51	3.83[ab]	3.79[b]	3.38	3.63	3.81	3.63	3.55[a]
Split application	3.52	3.98[a]	3.77[a]	3.43	3.59	3.77	3.58	3.49[ab]
SEM	0.04	0.08	0.08	0.09	0.06	0.02	0.04	0.05
Levels of significance								
Variety	NS	*	NS	NS	NS	***	NS	***
Plot Management	NS	NS	NS	NS	NS	NS	NS	NS
Fertilizer treatment	NS	*	*	NS	NS	NS	NS	*
Variety x weed Mgt	NS	NS	NS	NS	NS	NS	NS	*
Variety x Fertilizer	NS	NS	NS	NS	NS	NS	NS	**
Plot Mgt x Fertilizer	NS	NS	NS	NS	NS	NS	NS	*
Variety x Weed Mgt x Fertilizer	NS	NS	NS	NS	NS	NS	NS	NS

SEM = Standard Error of Means; [a, b]: Means in each column with different superscripts are significantly different (P<0.05); * = P<0.05, **= P<0.01, ***= P<0.001; NS = Not significant; Mgt = Management

Table 5: Effect of variety, weed management and fertilizer application method on leaf density of two varieties of *P. maximum* (leaf number m^{-2}).

	Weeks after planting in 2007				Weeks after planting in 2008			
	6	12	18	24	6	12	18	24
'ariety								
'. *maximum* Unimproved	259.90^{b}	579.13^{b}	611.50^{b}	963.40^{b}	319.99^{b}	571.68^{b}	896.83^{b}	911.50^{b}
'. *maximum* Ntchisi	302.51^{a}	937.38^{a}	997.00^{a}	1824.90^{a}	370.71^{a}	966.27^{a}	1172.10^{a}	1473.01^{a}
EM	23.71	122.33	115.51	204.02	30.31	49.31	60.21	257.13
Veed management								
Veeded	277.51	819.13	802.88	1468.80	340.96	769.48	1057.34	1212.20
lot weeded	284.90	789.38	713.63	1319.50	349.74	768.46	1011.60	1172.12
EM	23.71	122.33	115.51	204.02	30.31	49.31	60.21	257.13
ertilizer treatment								
lo Fertilizer	263.04^{b}	580.69^{b}	649.31^{b}	1134.60	323.75	722.57	950.00^{b}	1101.23
ingle fertilizer application	302.40^{a}	775.88^{a}	852.56^{a}	1406.60	370.57	844.82	1095.72^{a}	1233.51
plit fertilizer application	278.18^{b}	910.88^{a}	918.19^{a}	1434.20	341.74	739.52	1057.68^{ab}	1241.90
EM	15.81	81.53	77.04	136.01	20.92	32.78	40.10	171.50
evels of significance								
'ariety	***	***	***	***	**	***	***	***
Veed Management	NS	NS	NS	NS	NS	NS	NS	NS
ertilizer treatment	**	*	**	NS	NS	NS	*	NS
'ariety x Weed Mgt	**	NS	NS	NS	NS	NS	NS	*
'ariety x Fertilizer	***	*	NS	NS	**	NS	*	NS
Veed Mgt x Fertilizer	**	NS	NS	NS	NS	NS	NS	NS
'ariety x Weed Mgt x ertilizer	NS	NS	NS	NS	NS	NS	NS	NS

SEM = Standard Error of Mean; $^{a, b...}$: Means in each column with different superscripts are significantly different ($P<0.05$); * = $P<0.05$ ** = $P<0.01$, *** = $P<0.001$; NS = Not significant; Mgt = Management

Olanite *et al.* (2012). The physiological significance of these leaf parameters lies in efficiency of light utilization for photosynthesis. Although this is not within the scope of this study, it could be inferred that *P. maximum* (Ntchisi) which recorded higher leaf width could be more efficient and this could translate to higher dry matter yield (Wilhelm and Nelson, 1978).

Leaf density

The higher leaf proportion recorded for *P. maximum* (Ntchisi) apparently translates to higher leaf density for it than its counterpart in this study and this was supported by values for leaf density in both years and at all the growth stages (Table 5). Although single and split methods of fertilizer application recorded similar values for leaf density theses were significantly ($P<0.05$) higher than the control indicating that fertilizer, irrespective of method of application, positively influenced leaf density as also reported by Wolfson and Cresswell (1989). Nitrogen fertilizer helps rapid cell division in the meristematic area resulting in increased leaf production, and apparently high leaf density. The report by Santos *et al.* (2002) that the number of leaf of *P. maximum* increased with increased nitrogen supply is also corroborated by findings in the present study. Hacker (1999) also reported that fertilizer nitrogen enhances tiller development which subsequently leads to increased leaf number. High leaf density enhances prehension, bite volume, number of bites per unit time and overall intake of grazing animals (Stobbs, 1973; Zhang, 2004). Grazing animals on *P. maximum* (Ntchisi) pasture would therefore probably have higher intake and attain rumenal fill earlier than on *P. maximum* (unimproved) pastures at corresponding stages of growth.

Tiller density

The values recorded for tiller density of *P.*

Table 6: Effect of variety, weed management and fertilizer application method on tiller density of two varieties of *P. maximum* (tiller number m^{-2}).

	Weeks after planting in 2007				Weeks after planting in 2008			
	6	12	18	24	6	12	18	24
Variety								
P. maximum Unimproved	72.85^{b}	94.38^{b}	109.88^{b}	197.25^{b}	80.23^{b}	103.51^{b}	179.92^{b}	208.51^{b}
P. maximum Ntchisi	81.28^{a}	195.13^{a}	189.00^{a}	398.00^{a}	89.15^{a}	184.57^{a}	238.95^{a}	344.80^{a}
SEM	5.68	22.78	21.35	39.54	5.59	14.32	17.72	49.32
Weed management								
Weeded	81.13^{a}	149.63	154.25	302.50	88.99^{a}	147.01	212.50	279.95
Not weeded	73.00^{b}	139.88	144.63	272.75	80.39^{b}	141.08	206.37	273.35
SEM	5.68	22.78	21.35	39.54	5.59	14.32	17.72	49.32
Fertilizer treatment								
No Fertilizer	71.74^{b}	109.50^{b}	113.06^{b}	275.25	79.06^{b}	128.55	187.91^{b}	258.31
Single fertilizer application	78.07^{a}	157.31^{a}	154.69^{a}	290.81	85.76^{ab}	157.78	222.81^{a}	285.45
Split fertilizer application	81.37^{a}	167.44^{a}	180.56^{a}	296.81	89.25^{a}	145.80	217.58^{a}	286.19
SEM	3.78	15.18	14.23	26.36	3.72	9.54	11.81	32.88
Levels of significance Variety	**	***	***	***	**	***	***	***
Weed Management	**	NS	NS	NS	*	NS	NS	NS
Fertilizer treatment	*	**	**	Ns	*	NS	*	NS
Variety x Weed Mgt	NS	NS	NS	NS	NS	NS	NS	NS
Variety x Fertilizer	*	NS	NS	NS	*	NS	NS	NS
Weed Mgt x Fertilizer	**	NS	NS	NS	**	NS	NS	*
Variety x Weed x Fertilizer	**	NS	NS	NS	*	NS	NS	NS

SEM = Standard Error of Mean; a,b: Means in each column with different superscripts are significantly different (P<0.05); * = P<0.05, **= P<0.01, ***= P<0.001; NS =Not significant; Mgt = Management

maximum (Ntchisi) was significantly higher than *P. maximum* (unimproved) for both years, ranging between 81.3 – 398 tillers m^{-2} and 72.9 – 208.5 tillers m^{-2} respectively. This finding is consistent with earlier reports (Onayinka and Akinyemi, 1976; Olanite, 2003; Olanite *et al.,* 2004) and indicated that irrespective of the management practice adopted 'Ntchisi' shows superiority over the local variety for tiller production. The values recorded for both grasses in this study were however higher than earlier reported by Olanite (2003) which might have been due to extension of the tiller estimation to 24 WAP. The fertilizer treatments produced significant effect only at the 12th and 18th week of growth, respectively for first and second year with the non-fertilized (control treatment) consistently recording lower (P<0.05) values than the fertilized plots. The method of fertilizer application did not also show any significant difference as similar values were recorded irrespective of method of application. Rapid tiller significant effect only at the 12th and 18th week of growth, respectively for first and second year with the non-fertilized (control treatment) consistently recording lower (P<0.05) values than the fertilized plots. The method of fertilizer application did not also show any significant difference as similar values were recorded irrespective of method of application. Rapid tiller production, especially at the early establishment stage is desirable in forage grasses for good weed control, high dry matter yield and persistence (Leach *et al.*, 1976). The higher tiller density recorded for the fertilized treatments was supported by earlier reports by Ramivez Ariles (1993) and Akinola *et al.*,(1971). The tiller density recorded almost more than doubled that reported by Rickert (1970) and Olanite *et al.*, (2004) but was similar to Lloyd (1971) for common *P. maximum*.

Leaf/stem ratio

The values for leaf proportion of *P. maximum* (Ntchisi) were higher (P<0.05) than those for *P. maximum* (unimproved) in

Table 7: Effect of variety, weed management and fertilizer application method on leaf/ stem (%) and biomass yield (t ha^{-1}) of two varieties of *P. maximum*.

	Weeks after planting in 2007			Weeks after planting in 2008		
	Leaf	Stem	Yield	Leaf	Stem	Yield
Variety						
P. maximum Unimproved	26.22^{b}	73.78^{a}	19.4^{b}	27.62^{b}	72.38^{a}	21.65^{b}
P. maximum Ntchisi	58.68^{a}	41.32^{b}	22.1^{a}	50.17^{a}	49.86^{b}	30.31^{a}
SEM	1.41	2.86	4.21	2.03	3.59	4.67
Weed management						
Weeded	39.30^{a}	60.70^{b}	20.3	39.38	60.62	26.42
Not weeded	35.78^{b}	64.28^{a}	21.2	36.38	63.62	25.54
SEM	1.41	2.86	4.21	2.03	3.59	4.67
Fertilizer treatment						
No Fertilizer	34.87^{b}	65.13^{a}	14.6^{b}	36.98	63.02	13.90^{c}
Single application	36.85^{b}	63.15^{a}	22.6^{ab}	37.99	62.01	28.30^{b}
Split application	40.51^{a}	59.49^{b}	25.0^{a}	41.66	58.38	35.74^{a}
SEM	0.94	1.90	2.81	1.35	2.39	3.11
Levels of significance Variety	***	***	*	***	***	***
Weed Management	*	*	NS	NS	NS	NS
Fertilizer treatment	*	*	***	NS	NS	***
Variety x Weed Mgt	*	*	NS	NS	NS	NS
Variety x Fertilizer	**	**	*	NS	NS	***
Weed Mgt x Fertilizer	NS	NS	*	NS	NS	NS
Variety x Weed Mgt x Fertilizer	NS	NS	*	NS	NS	**

SEM = Standard Error of Mean; $^{a, b...}$: Means in each column with different superscripts are significantly different (P<0.05); * = P<0.05, **= P<0.01, ***= P<0.001; NS =Not significant; Mgt = Management

both year of study while the values for the stem component followed a direct reverse trend for the two grasses (Table 7). The main effects of weed management and fertilizer treatment were significant only for the first year with grasses in the weeded plots producing more leaves (P<0.05) than stem materials compared to those whose plots were not weeded. The leaf and stem proportions was a reflection of the plant height which was higher for the unimproved Panicum and further indicates that the grass might be less attractive to animals than the 'Ntchisi', especially at the latter stage of growth. Many reports have shown that higher leaf proportion is a desirable quality index in forages (Stobbs, 1975; Minson, 1990). Generally leafiness is an important quality attribute in forage which indicate that the leafier a species the higher its quality (Omaliko, 1980). The leaf proportion recorded in this study was lower than that reported by Asiegbu and Onyeonagu (2008) probably due to the more mature plants of 24 weeks growth evaluated in this study than the earlier study in which the grasses were harvested for evaluation between 3 – 12 weeks of growth. This further indicates that species that tend to develop more stems with advancing maturity should be utilized at an early growth stage when their leaf component would be more.

Herbage yield

The herbage yield for *P. maximum* (Ntchisi) was significantly higher than *P. maximum* (unimproved) for both years. This observation was in line with earlier findings (Onayinka and Akinyemi, 1976; Olanite, 2003; Olanite *et al.*, 2004). The herbage yield recorded on the plots with split fertilizer application was also much higher than that reported by Ezenwa *et al.* (1996) for *P. maximum* (Ntchisi). Mohamed-Saleem and Chheda (1972) recorded more biomass yield for split than single application of nitrogen fertilizer. The lowest herbage yield (14.6 and 13.9 t/ha) recorded for 2007 and 2008 respectively from the control plots in this study were higher than 12.4 t ha^{-1} reported by Aken'Ova (1993) for these grasses under similar management. Aken'Ova and Chheda (1986) and Akinola *et al.* (1971) also noted the positive effect of nitrogen fertilizer in enhancing the leaf area and tiller density of elephant grass and Cynodon strains which translated to increased herbage yield of the grasses. Olanite (2003) reported lower dry matter yield for *P. maximum* (Ntchisi) than values obtained in this study as a result of the higher rate of fertilizer applied. The high herbage yield recorded for the two *P. maximum* varieties fertilized with N-P-K as compared with the unfertilized grasses in this study further confirms long-standing observation in southwest Nigeria and the roles of inorganic fertilizers in improving biomass yield of forages (Akinyemi and Onayinka, 1982). A highly significant ($P<0.001$) interaction between variety and age of harvest existed for all the growth parameters and biomass yields of the two Panicum grass varieties and various levels of inconsistent interaction were also observed between fertilizer application method and age of harvest; as well as between variety and fertilizer application method, while interactions between weed management and variety, weed management and fertilizer application method, and that of variety by weed management by fertilizer application method were not significant ($P>0.05$).

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