Effect of forage combinations, cutting age and season on biomass of *Panicum maximum* intercropped with *Stylosanthes guianensis* and *Stylosanthes hamata* in the derived savanna of Nigeria

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Abstract

Fluctuations in forage quantity especially in dry season necessitate a strategic fodder production. Therefore, this study was carried out to investigate the effect of five forage combinations, three harvest ages (5, 10 and 15 weeks) post planting (PP) and seasons (early and late rain). The forage combinations were Panicum maximum (Pm), Stylosanthes guianensis (Sg), Stylosanthes hamata (Sh), Pm and Sg (PmSg) and Pm and Sh (PmSh) using Split-Plot design. Data were collected on total biomass yield (TBY) and land equivalent ratio (LER). The highest ($p<0.05$) TBY was recorded from PmSg and PmSh (0.96 and 1.02tDMha^{-1}, respectively) while the higher LER was observed for PmSh. Highest TBY (0.84tDMha^{-1}) and LER (1.79) were recorded at 10 and 15 weeks PP respectively while early rain had significantly ($p<0.05$) higher TBY (0.91tDMha^{-1}) but similar LER between the seasons. In conclusion, Panicum maximum with Stylosanthes guianensis or Stylosanthes hamata, harvested at 10 weeks post planting in early or late rainy season improved biomass yield and maximize land equivalent ratio. Thus, these can serve as fodders for ruminant production in dry season.

Keywords: Forage combination, cutting age, P***anicum maximum***, ***Stylosanthes guainensis***, ***Stylosanthes hamata***

Effet des combinaisons fourragères, de l'âge et de la saison de coupe sur la biomasse de Panicum maximum intercalé avec Stylosanthesguianensis et Stylosantheshamata dans la savane dérivée du Nigéria

Résumé

Les fluctuations de la quantité de fourrage, en particulier en saison sèche, nécessitent une production fourragère stratégique. Par conséquent, cette étude a été réalisée pour étudier l'effet de cinq combinaisons fourragères, trois âges de récolte (5, 10 et 15 semaines) après la plantation (PP) et les saisons (pluies précoces et tardives). Les combinaisons fourragères étaient Panicum maximum (Pm), Stylosanthes guianensis (Sg), Stylosanthes hamata (Sh), Pm et Sg (PmSg) et Pm et Sh (PmSh) en utilisant la conception Split-Plot. Des données ont été recueillies sur le rendement total de la biomasse (RTB) et le rapport équivalent-terre (RET). Le RTB le plus élevé ($p <0, 05$) a été enregistré pour PmSg et PmSh (0, 96 et 1, 02 tDMha-1, respectivement) tandis que le RET le plus élevé a été observé pour PmSh. Le RTB le plus élevé (0,84 tDMha-1) et le RET (1,79) ont été enregistrés respectivement à 10 et 15 semaines PP, tandis que les pluies précoces avaient un RTB significativement ($p<0,05$) plus élevé (0,91 tDMha-1) mais un RET similaire entre les saisons. En conclusion, Panicum maximum avec Stylosanthes guianensis ou Stylosanthes hamata, récolté 10 semaines après la plantation au début ou à la fin de la saison des pluies, a amélioré le rendement de la biomasse et maximisé le rapport équivalent-terre. Ainsi, ceux-ci peuvent servir de fourrages pour la production de *ruminants en saison sèche.*

Mots-clés: Combinaison fourragère, âge de coupe, Panicum maximum, Stylosanthes guainensis, Stylosanthes hamata

Introduction

Forages are considered as the cheapest major nutritional component in the diets of ruminants particularly in the rural and suburban area of the tropics (Akinsoyinu and Onwuka, 1998). The availability of forages in adequate quantity has the potential of optimizing livestock production (Oyaniran *et al.,* 2018). However, the main environmental factors limiting forage productivity in tropical region are water availability and nutrient deficiencies in soil (Lopez-Gutierrez *et al.,* 2004). Hence, basic knowledge of pasture plant and climate interrelationship will facilitate agronomic management practices for optimal production (Babayemi and Bamikole, 2006). Evans *et al*. (2001) stated that a "production system incorporating legume fodder crops can play a fundamental role in improving soil fertility, allowing efficient water and nutrient use, and bridging the fodder flow gap that is prevalent during dry spells." This reiterates the importance of grass-legume intercrops as means of improving productivity compared to grass monoculture system. Age at harvest has apparent effect on yield quantity of forages as reported by many literatures (Bamikole *et al.,* 2004; Ajayi *et al.,* 2007; Fajemilehin *et al.,* 2008).Cutting age of forages influenced their nutritional quality (Bamikole *et al.,* 2004; Fajemilehin *et al.,* 2008), dry matter degradability (Ajayi *et al.,* 2007). Season affects both quantity and quality of fodder production due to climatic variations (Mtui*et al.,* 2009). *Panicum maximum* is a grass that is well recognized as an important energy feed for ruminants especially in the derived savanna zone of Nigeria (Ajayi and Babayemi, 2008). It is one of the natural resources that are available across the entire ecological zone with possibility of herbage and nutrient enhancement especially when cultivation with legumes (Alalade *et al.,* 2013b). *Stylosanthes guainensis* and *Stylosanthes hamata* are suitable as legume in sub humid tropical and subtropical zones and can be intersown to improve natural pasture (Cook *et al.,* 2005). This research aimed atevaluating the biomass yield and relative yield of *Panicum maximum* and ortwo species of *Stylosanthes* (*guianensis* and *hamata*) as influenced by its planting combinations, cutting age and season in the derived savanna zone of Nigeria.

Materials and methods

Experimental site

The experiment was carried out at Ladoke Akintola University of Technology Teaching and Research Farm, Ogbomoso (Latitude $8^0 8^1 31.7940^{11}$N, Longitude 4^0 $14^1 42.6696^{11}$E). The experimental site was located in the derived savanna zone of Nigeria. The climate of the area is mostly influenced by the northwest trade wind characterized with cold wind, with dry effect starting from October to April. The prevailing wind during the dry season is known as harmattan. The ambients temperature ranges between 28^0C to 33^0C and relative humidity of about 74% except for January. Monthly and daily rainfalls are characterized by high temporal and spatial variation which ranges from zero (0) to 338mm and over 1673mm per annum and usually occur between April and October with a marked dry season from late October to early April of the following year (Oni *et al.,* 2015).

Experimental land, land preparation and soil sampling

The experimental land measuring 36 x 22m^2 was mapped out, partitioned into three blocks; measuring 6 x 6m^2 and pegged. Thereafter, the blocks were cleared manually to fine planting plots. Soil samples were randomly collected at five different pointsafter pegging and before planting from top soil on the plots using 30cm depth soil auger for soil sampling. The samples were bulked per replicate, mixed thoroughly, and sub-samples were taken for routine analysis to determine the pre-planting physico-chemical properties of the soilas described by AES (1998). The experimental plots were fenced round to prevent animal and human encroachment.

Experimental design and plot management

Each block was divided into five plots; each measuring 6 x 36m^2, representing the number of treatments, with 1m inter-plots spaces and 1m between replicates. Treatments in this experiment were combined in a 2 x 3 x 5 factorial arrangement within Split Plot Design with three blocks each representing a replicate. Five forage combinations of grass-legume mixture (Pm: Sole *Panicum maximum;* Sg: Sole *Stylosanthes guianensis;* Sh: Sole *Stylosanthes hamata;* PmSg: *Panicum maximum* interplanted with *Stylosanthes guianensis* and PmSh: *Panicum maximum* interplanted with *Stylosanthes hamata*) were the main plot treatments while three cutting age (5, 10 and 15)weeks post planting (PP) and two season (early and late rain) were sub-plot treatments of space and time respectively. Randomly, the forage combinations were allotted to the plots such that each treatment appeared once per block while the cutting age appeared once in each of the plots in all blocks.

Planting materials, planting and post-planting operation

The guinea grass Ntchisi *(P. maximum)* crown-split uprooted and cut to about 15cmwas planted during the early rainy season (April- July) and late rainy (August – November). The crowns-split were collected from already established paddock of the Teaching and Research Farm. Seeds of *Stylosanthes hamata* and *Stylosanthes guianensis* were procured from the National Animal Production Research Institute (NAPRI), Zaria, Kaduna State, Nigeria. *Panicum maximum* crown splits with 2 tillers cut to 15cm height were planted at a spacing of 75 by 75cm^2. The seeds of *Stylosanthes hamata* and *Stylosanthes guianensis* were scarified using hot water for about five minutes and planted into the soil by drilling along the rows with 37.5cm (single interplant) and 75cm (sole planting) inter row spacing at the seed rate of 5 kg/ha respectively. Agronomic parameters (tiller number, plant height, leaf width and biomass yields) were measured at 5, 10 and 15 weeks PP and samples of forages collected at the end of the early/late rainy season were quantified for relative yield, land equivalent ratio and analyzed for chemical compositions. Weeding was carried out manually with the aid of hoes and cutlasses every week while the weeded materials were left on the respective plots in order to return the absorbed nutrient back to the soil.

Biomass and relative yield

A square meter (1m x 1m) quadrant was thrown three times into a replicate of each treatment and total biomass yields were cut down to 10cm above ground for *P. maximum* but 5cm above the ground for *stylosanthes* and weighed to estimate the forage yield (kg) per treatment. The dry matter yield(DMY) was estimated as DMY = dry matter (%) x weight of fresh sample from 1m^2, which afterwards was extrapolated in tonnes per hectare.

Relative yield (RY) and land equivalent ratio (LER) were determined following Amole *et al.* (2015) mathematical expression as:

$$RY = RYab = DMYab/DMYaa$$

$$RYba = DMYba/DMYbb$$

$$LER = RYab + RYba$$

In the equation, the following definitions apply:
LER = Land equivalent ratio, RY = Relative yield, DMY = Dry matter yield, ab= performance of *Panicum maximum var Ntchisi*(a) mixed with either *Stylosanthes hamata* or *Stylosanthes guianensis*(b); ba= performance of either of the *Stylosanthes* (b) mixed with *Panicum maximum varNtchisi*;aa= performance of *Panicum maximum var Ntchisi* in monoculture and bb is the performance of either of the *stylosanthes* as a monoculture.

Statistical analysis

All data were subjected to analysis of variance (ANOVA) using the general linear model (GLM) procedure of the SAS (2000). Significant means were compared using Duncan's Multiple Range Test of the same Package at 5% probability.

Results and discussion

Physicochemical compositions of different plots before planting and after 15 weeks of planting are presented in Table 1. Physicochemical compositions of different plots before planting and after 15 weeks of planting are presented in Table 1. The values for pH were similar except for the plot from the sole *Panicum* stand (Pm). Lowest (p=0.003) was recorded for Pm plot (5.8%). Total nitrogen (%) was higher in plots with sole legumes (Sg and Sh) but similar to the N (%)values obtained from the plots where grass-legume mixtures (PmSg and PmSh) were established. However, lowest value was recorded for sole Pm plot. Average phosphorus (mg/kg) increased in plot where Pm was planted but recorded a decrease in other plots with lowest (p=0.001) value (2.71 mg/kg) observed for Sh plot. Organic carbon also increased in sole legumes and mixtures plots but declined in Pm plot. Compare to initial values, there was reduction of silt and clay across the plots except for PmSh and Pm plots. The highest (p=0.024) silt (11.2%) was recorded for PmShplot while highest (p=0.001) clay (5.4%) was observed for plot where Pm was established. The sand increased compared to the initial values, however, Pm plot recorded the highest value (89.3%). Table 2 reveals the agronomic performance of grass-legume mixtures (GLMs) as influenced by forage combinations (Fc), ages at harvest (AatH) and seasons (S).Forage combinations had significant effect on all observed parameters except for grass height (p=0.242). The highest (p=0.038) average number of leaf/tiller was relative for Pm and PmSg (5.08 and 5.02 respectively). Meanwhile, the highest average number of tiller/stand (T/S)was similar except for PmSg that was significantly lower to Pm (19.64 vs 26.20; p=0.046). Average leaf length (LL)was higher for PmSh and PmSg compared to Pm (75.15 and 76.14 vs 67.15 cm; p=0.039). The highest (p<0.001) legume height (68.40cm) was recorded for Sg while the least value (46.60 cm) was observed for PmSh. More so, the highest (p<0.001) legume average leaf width was similar for Sg and PmSg (0.68 and 0.71cm) while the least values (0.44 and 0.43 cm) were also relative for Sh and PmSh. The highest total biomass yield (tDMha^{-1}) was recorded for PmSh and PmSg while others were significantly lower (1.01 and 0.92 vs 0.57 - 0.65; p=0.041, respectively). Effect of age at harvest on the agronomy parameters were significantly higher for 15 weeks post planting (WPP) except for average leaf/tiller and average leaf length. The average number of leaf/tiller and leaf length were comparable for 10WPP and 15WPP (L/T: 4.92 and 5.48; p=0.021,LL: 77.54 and 76.10cm; p=0.011). The least values were recorded for 5WPP. However, the total yield was highest for 10WPP, followed by 15WPP while the least was recorded for 5WPP (0.84 $\geq$ 0.76 > 0.72tDMha^{-1}; p=0.001). Season influenced was prominent except on average number of tiller/stand (p=0.115). Hence, the highest significant agronomic parameters were recorded for early rain.

Interaction effect of planting pattern (Fc) and age at harvest (AatH) was significant on the agronomy parameters except for average number of leaf/tiller (p=0.861). However interaction of planting pattern (Fc) and season (S) was insignificant while interaction of AatH and S had significant effect except for average leaf length (p=0.139) and legume leaf width (p=0.178). The interaction effect ofFc, AatH and S was insignificant except for average height of grass (p=0.017) and total biomass yield (p=0.010). Relative yields of grass-legumes mixtures as influenced by forage combinations (Fc), ages at harvest (AatH) and seasons (S) are as shown in Table 3. Effect of planting patterns was significant except on relative yield of grass (p=0.143). The highest (p<0.001) biomass yield of grass (0.64 $tDMha^{-1}$) was recorded for sole *P. maximum* stand (Pm) while the least value (0.48 $tDMha^{-1}$) was observed for plot where *P. maximum* and *Stylosanthes guianensis* were intercropped (PmSg). However, sole *Stylosanthes hamata* (Sh) had highest legume biomass yield while the least values were similar for PmSg and PmSh (0.65 vs 0.46 and 0.49 $tDMha^{-1}$; p<0.001, respectively). The higher relative yields of legume and land efficiency ratio (LER) were recorded for plot with *P. maximum* and *Stylosanthes hamata* intercrop - PmSh (0.85 and 1.69). Ages at harvest had effect on parameters except on relative yield of legume. Highest parameters were recorded for 15 weeks post planting (WPP) except for biomass yield for grass. The yield for grass (0.67 $tDMha^{-1}$; p<0.001) was highest for 10WPP. However, the least values were obtained for 5WPP. The influence of seasons was not significant except on biomass yield of grass and legume. Hence, the biomass higher yields (p<0.001) for grass and legumes were recorded for early rain (0.69 and 0.66 $tDMha^{-1}$, respectively). The interaction of Fc and AatH was significant for all the evaluated parameters except for biomass yield of legume (p=0.445) and relative yield of legume (p=0.442). However, the interaction of Fc and S was insignificant except for biomass yield of legume (p=0.003). Interaction of AatH and S was also significant except for relative yield of grass (p=0.548) and LER (p=0.074). The interaction of Fc, AatH and S did not influence the biological indices of grass-legume mixtures (GLMs).

Table 1: Average physicochemical compositions of the soil in different plots before planting and after 15 weeks of planting (0 -30cm depth)

Parameters	Initial	Pm	Sg	Sh	PmSg	PmSh	SEM	P-value
pH	6.2^{a}	5.8^{b}	6.2^{a}	6.2^{a}	6.1^{a}	6.3^{a}	0.22	0.003*
T.N (%)	0.87^{b}	0.36^{c}	1.17^{b}	1.21^{a}	1.03^{ab}	1.13^{ab}	0.14	0.042*
AV.P(mg/kg)	4.33^{a}	4.90^{a}	3.42^{b}	2.71^{c}	3.75^{b}	3.25^{b}	0.51	0.001*
O.C (%)	0.64^{b}	0.27^{c}	0.81^{a}	0.80^{a}	0.76^{a}	0.75^{a}	0.08	0.012*
SAND (%)	82.9^{c}	89.3^{a}	80.1^{b}	82.7^{b}	81.4^{b}	82.6^{b}	2.44	<0.001*
SILT (%)	12.5^{a}	6.1^{d}	9.2^{c}	8.2^{c}	10.4^{b}	11.2^{ab}	1.02	0.024*
CLAY (%)	5.7^{a}	5.4^{a}	4.1^{b}	4.2^{b}	3.6^{c}	3.8^{c}	0.32	0.001*

*abcd = Means on the same column with the same superscrits are not significantly different (p> 0.05) * = significant ns = not significant* Pm: Sole *Panicum maximum*, Sg: Sole *Stylosanthes guianensis*, Sh: Sole *Stylosanthes hamata*, PmSg: *Panicum maximum* interplanted with *Stylosanthes guianensis*, PmSh: *Panicum maximum* interplanted with *Stylosantheshamata.*

Table 2: Agronomical performance of grass-legume mixtures (GLMs) as influenced by forage combinations (Fc), ages at harvest (AatH) and seasons (S)

Factors	Average number of		Average leaf length (cm)	Average height (cm) of		Legume average leaf width (cm)	Total biomass yield (tDMha^{-1})
	leaf/tiller	tiller/stand		Grass	Legume		
Forage combinations (Pc)							
Pm	5.08^{a}	26.20^{a}	67.15^{b}	115.64	-	-	0.64^{b}
Sg	-	-	-	-	68.40^{a}	0.68^{a}	0.57^{b}
Sh	-	-	-	-	51.64^{bc}	0.44^{b}	0.65^{b}
PmSg	5.02^{a}	19.64^{b}	76.14^{a}	120.56	46.60^{c}	0.71^{a}	0.96^{a}
PmSh	4.20^{b}	23.19^{ab}	75.15^{a}	126.84	57.10^{b}	0.43^{b}	1.02^{a}
SEM	0.26	1.82	3.05	4.65	2.24	0.02	0.08
Age at Harvest (AatH)							
5WPP	3.90^{b}	18.73^{b}	64.74^{b}	90.63^{c}	41.74^{c}	0.51^{b}	0.72^{b}
10WPP	4.92^{a}	22.47^{b}	77.54^{a}	127.60^{b}	56.46^{b}	0.55^{b}	0.84^{a}
15WPP	5.48^{a}	27.82^{a}	76.10^{a}	144.80^{a}	69.61^{a}	0.64^{a}	0.76^{ab}
SEM	0.26	1.82	3.05	4.65	1.94	0.03	0.05
Season (S)							
Early rain	5.34^{a}	24.69	77.32^{a}	162.64^{a}	64.47^{a}	0.62^{a}	0.91^{a}
Late rain	4.19^{b}	21.32	68.34^{b}	79.38^{b}	47.41^{b}	0.51^{b}	0.63^{b}
SEM	0.21	1.42	2.49	3.80	1.58	0.02	0.10
P-values							
Fc	0.038*	0.046*	0.039*	0.242^{ns}	<0.001*	<0.001*	0.041*
AatH	0.021*	0.003*	0.011*	<0.001*	<0.001*	<0.001*	0.001*
S	0.001*	0.115^{ns}	0.001*	<0.001*	<0.001*	<0.001*	0.001*
Fc x AatH	0.861^{ns}	0.027*	0.031*	0.041*	0.011*	0.026*	0.006*
Fc x S	0.139^{ns}	0.313^{ns}	0.501^{ns}	0.08^{ns}	0.516^{ns}	0.333^{ns}	0.110^{ns}
AatH x S	0.005*	0.008*	0.178^{ns}	<0.001*	<0.001*	0.360^{ns}	<0.001*
Fc x AatH x S	0.200^{ns}	0.346^{ns}	0.176^{ns}	0.0174*	0.051^{ns}	0.145^{ns}	0.010*

abc = Means on the same column with the same superscrits are not significantly different (p> 0.05)
** = significant ns = not significant* Pm: Sole *Panicum maximum*, Sg: Sole *Stylosanthes guianensis*, Sh: Sole *Stylosanthes hamata*, PmSg: *Panicum maximum* interplanted with *Stylosanthes guianensis*, PmSh: *Panicum maximum* interplanted with *Stylosanthes hamata.*

Table 3: Relative yields of grass -legume mixtures (GLMs) as influenced by forage combinations (Fc), ages at harvest (AatH) and seasons (S)

	Biomass Yield (tDMha^{-1})		Relative Yield		Land Equivalent Ratio
Factors	**Grass**	**Legume**	**Grass**	**Legume**	**(LER)**
Forage combinations (Fc)					
Pm	0.64^{a}	-	-	-	-
Sg	-	0.57^{b}	-	-	-
Sh	-	0.65^{a}	-	-	-
PmSg	0.49^{b}	0.47^{c}	0.76	0.82	1.58^{b}
PmSh	0.53^{b}	0.49^{c}	0.83	0.86	1.69^{a}
SEM	0.02	0.02	0.08	0.05	0.04
Age at Harvest (AatH)					
5WPP	0.43^{c}	0.39^{c}	0.62^{c}	0.87	1.50^{c}
10WPP	0.67^{a}	0.59^{b}	0.80^{b}	0.84	1.63^{b}
15WPP	0.53^{b}	0.65^{a}	0.98^{a}	0.81	1.79^{a}
SEM	0.04	0.02	0.03	0.05	0.05
Season (S)					
Early rain	0.69^{a}	0.66^{a}	0.77	0.83	1.66
Late rain	0.41^{b}	0.43^{b}	0.83	0.85	1.62
SEM	0.05	0.04	0.06	0.03	0.06
P-values					
Fc	<0.001*	<0.001*	0.142^{ns}	0.012*	0.001*
AatH	<0.001*	<0.001*	<0.001*	0.442^{ns}	<0.001*
S	<0.001*	<0.001*	0.181^{ns}	0.763^{ns}	0.255^{ns}
Fc x AatH	0.042*	0.445^{ns}	<0.001*	0.442^{ns}	<0.001*
Fc x S	0.486^{ns}	0.003*	0.090^{ns}	0.557^{ns}	0.265^{ns}
AatH x S	<0.001*	<0.001*	0.548^{ns}	0.002*	0.074^{ns}
Fc x AatH x S	0.233^{ns}	0.569^{ns}	0.790^{ns}	0.570^{ns}	0.714^{ns}

*abc = Means on the same column with the same superscrits are not significantly different (p> 0.05) * = significant ns = not significant* Pm: Sole *Panicum maximum*, Sg: Sole *Stylosanthes guianensis*, Sh: Sole *Stylosanthes hamata*, PmSg: *Panicum maximum* interplanted with *Stylosanthes guianensis*, PmSh: *Panicum maximum* interplanted with *Stylosanthes hamata.*

Discussion

The number of tiller/stand fell within the observation of Alalade*et al.* (2013a,b and 2014) who reported 20.00-33.00, 17.00-25.00 and 20.00-27.00 respectively for *P. maximum* interplanted with different legumes. It also agreed with 9.88 - 23.02 reported by Ojo*et al.* (2013) for *Panicum maximum* var. Ntchisi intercropped with *Lablab purpureus*. The average leaf length of *Panicum maximum* in this study also agreed with the report of Alalde*et al.*(2013b and 2014) but higher than 40.30 – 51.31cm observed by Alalde *et al.*(2013a). However, the leaf length for P. *maximum* intercropped with legumes fell within 70.18 to 93.77cm as observed by Ojo *et al.* (2013) whereas the leaf length from sole *P. maximum* was lower. The significant difference observed between leaf lengths for sole and intercropped agreed with Alalade *et al.* (2013b) and Ojo *et al.* (2013). Nelson (1992) observed that increase in leaf size of grasses is associated with increase in soil nitrogen availability to the grasses. Therefore, the resultant effect of legume on soil nutrients could have been obvious on the leaf length of *P. maximum* intercropped with legumes. Baba *et al.* (2011) reported that grass-legume improves forage productivity as compared with monocultures without any other input. The relatively higher biomass yield recorded for PmSg and PmSh depicts the significance of grass-legume interplant. There was increase in leaf length which could have been due to rate of leaves extension thus stimulate better light capture by the plant for photosynthesis, and thus improved yield. This agrees with the findings of Muinga *et al.* (2007) who asserted that forage legumes increased herbage yields of companion grass and Raynolds (1992) who reported that legume interplanted with grass promotes soil nutrient which eventually translates to improved yield. The biomass yield observed in present study for *P. maximum* was in consonance with Odedire and Babayemi (2007) who reported 567.43 – 659.42kgDM/ha but lower to Oyenuga (1960) who reported 12.0 – 23.4tDM/ha. The yield of Stylos in this study were below 10 and 17 tDM/ha reported for pure stand and 1-7 tDM/ha for grass-legume mixed stands, under favorable edaphic conditions (Edye *et al.,* 1992; Cook *et al.,* 2005). The variation could be linked to age at harvest, season of harvest, forage combination condition of planting. The significant difference observed between sole stands and intercropped could be associated with effect of legume. Both legume and their companion grass were harvested together thus increased their total biomass yield compared to monoculture grass and legumes. This agreed with the report of Amole *et al.* (2015) who evaluated the effect of intercrop and age at harvest on intercrop of *Lablab purpureus* and *Andropogon gayanus*. However, the high biomass yields DM for sole plants compared to their counterparts in mixtures could be associated to population of plants per plot. Less dense plot gives room for production and sole utilization of available soil nutrients and light thus increases the cell contents. Baba *et al.* (2011) claimed that dry matter production is a function of the nature of competition among various species in a mixture. The highest biomass yield for Sh compared to Sg could be averred to growth habit and dry matter yield. *Stylosanthes hamata* had higher DM compared to *Stylosanthes guianensis* (Heuze *et al.,* 2015). More so, higher biomass for grass compared to their companion legume is supported by the observation of Baba *et al.* (2011) for panicum intercropped with different legumes. The authors reported that monocultures produced higher yields than mixtures. Tessema and Baar (2006) also reported that the higher biomass yield DM of grass against legume in a grass/legume mixture could be averred to vigour nature of grass growth and its ability to rapidly utilize the available nitrogen in the soil couple with synthesized N by legumes. The increasing biomass yield DM with advancement in age agreed with Amole *et al.* (2015) who asserted that at advance age, both grass and legume were relatively more established and thus utilize soil resources better for optimum growth. Also, Njarui *et al.* (2007) that claimed that early harvest equates to lower yield due to the fact that forages are yet to develop longer roots needed for competing for nutrients and water.

The higher relative yield observed for *Panicum maximum* as compared to *Stylosanthes hamata* and *S. guianens is* respectively in grass-legume mixtures indicates that the *P. maximum* contributed significantly to the total biomass yield than the legumes in grass-legume mixtures. Relative yield total value one (1) suggestpartial or no competition among species in the mixtures, perhaps due to nitrogen fixing nature of legume which is beneficial to associated grass (Tessema and Baar, 2006) or no competition in any form due to different rooting pattern which determine the nutrient uptake of plants even on the same plot (Trenbath, 1974). However, relative yield total of lessthan one depicts a situation where one species is orboth are more affected than might be expected due to overcrowding for the same space. The mean relativeyield total (land equivalent yield) values for this present study were greater than one which by implication connotes the advantages of mixtures. This agreed with the observation of Tessema and Baar (2006) and Diriba (2002) who reported relative yield total values of >1 in *Panicum coloratum*-stylo mixtures. Increasing LER with increasing age at harvest is supported with the observation of Amole *et al.* (2015). The mean LERs or relative yield total for the mixtures showed that a yield advantage of 58 - 69% over that from the sole plots for either grass or legumes. However, the lower land equivalent yield (LER) for PmSg could be attributed to its growth habit which led to lower relative yield. The observed increase in agronomic performance with advancement in age agreed with Ojo *et al.* (2013) for intercropped *Panicum maximum* varNtchisi with *Lablab purpureus*. Akinola *et al.* (1971) stated that increase dry matter yield with extended cutting intervals was as a result of additional tiller, leaf formation, leaf elongation and stem development. However, similar results for total biomass yield recorded for 10 weeks PP and 15 weeks PP connects more with soil nutrients and moisture stress which has prominent effect on grass due to their rooting system. Baba *et al.* (2011) reported that if a decline in dry matter yield was observed from 2- 3 harvests; it would be as a result of reduction in the dry matter yield of grass components. They further alluded the observation to inadequate soil nitrogen following the removal of previous harvest despite the contribution of the companion legumes. Hence, effect of cutting in this study was not beyond threshold after which could be detrimental to harvest at 15WPP. However, the LER favours as age at harvest was advancing. This could probably elicit from the fact that the sole stands were much more affected by the cutting intervals and perhaps

Technology, 3(1): 224-232.

Alalade, J. A., Akinlade, J. A., Aderinola, O. A., Amao, S. R. and Adaramola, K.A. 2013a. Effect of number of *Stylosanthes hamata* rows on herbage yield, nutritive quality and performance of WAD Sheep Fed Native *Panicum Maximum. Journal of Biology, Agriculture and Healthcare*, 3(10): 73-80.

Amole, T. A., Oduguwa, B. O., Onifade, S. O., Jolaosho, A. O., Amodu, J. T. and Arigbede , M. O. 2015. Effect of Planting Patterns and Age at Harvest of Two Cultivars of *Lablab purpureus* in *Andropogon gayanus* on Agronomic Characteristic and Quality of Grass/Legume Mixtures. *Pertanika Journal of Tropical Agricultural Science*, 38 (3) 329 – 346.

Babayemi, O. J., and Bamikole, M. A. 2006. Effects of *Tephrosia candida* DC leaf and its mixtures with guinea grass on *in vitro* fermentation changes as feeds for ruminants in Nigeria. *Pakistan Journal of Nutrition,* 5 (1): 14-18.

Cook, B. G., Pengelly, B. C., Brown, S. D., Donnelly, J. L., Eagles, D. A., Franco, M.A., Hanson, J., Mullen, B. F., Partridge, I. J., Peters, M. and Schultze-Kraft, R. 2005. Tropical forages. CSIRO, DPI&F(Qld), CIAT and ILRI, Brisbane, Australia.

Diriba, G. 2002. *Panicum coloratum* and *Stylosanthes guianens is* mixed pastures under varying relative Seed proportion of the component species, Yield dynamics and intercomponent interaction during the year of establishment. Livestock in Food Security Roles and Contributions. Proceedings of the 9th annual Conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia. August, 30(31): 285-293.

Edye, L.A. and Topark-Ngarm, A. 1992. *Stylosanthes hamata*(L.)Taub. Record from Proseabase. Mannetje, L.'t and Jones, R.M. (Editors). PROSEA (Plant Resources of South-East Asia) Foundation, Bogor, Indonesia

Evans, J., Mcneill, A. M., Unkovich, M. J., Fettell, N. A. and Heenan, D. P. 2001. Net nitrogen balances for cool-season grain legume crops and contributions to wheat nitrogen uptake: a review. *Australian Journal Experimental Agriculture,* 41: 347-359.

Fajemilehin, S. O. K., Babayemi and Fagbuaro S. S. 2008. Effect of anhydrous magnesium sulphate fertilizer and cutting frequency on yield and chemical composition of *Panicum maximum. African Journal of Biotechnology,* 7(7): 907-911

Grimaud, P., Sauzier, J., Bheekhee, R. and Thomas, P. 2005. Nutritive value of tropical pastures in Mauritius. *Tropical Animal Health and Production*, 38: 159 – 167.

Johnson, W. L., Hardinson, W. A. and Castello, L. S. 1998. The Nutritive value of *Panicum maximum* Yield and Chemical Composition related to season and herbage growth stage. *Journal Agriculture of Science,* 69: 155-160.

Lopez-Gutierrez, J. C., Toro, M. and Lopez, H. 2004. Seasonality of organic phosphorus mineralisation in the rhizosphere of the native savanna grass. *Trachypogonplumosus. Soil Biology and Biochemistry*, 36:1675-1684.

Mtui, D. J., Lekule, F. P., Shem, M. N., Ichinohe, T., and Fujihara, T. 2009. Comparative potential nutritive value of grasses, creeping legumes and multipurpose trees commonly in sub humid region in the Eastern parts of Tanzania. *Livestock Research for Rural Development*, 21 (10), 1-11. http://www.lrrd.org/lrrd21/10/mtui21158.htm

Muhammad, R. 2014. Dry matter yield and nutritional quality of *Panicum maximum Centrosemapubescens* mixtures at different plant proportions and cutting intervals. *International Journal of Science, Environment and Technology*, 3(6): 223-12241.

Muinga, R. W., Mureithi, J. G., Juma, H. and Saha, H. M. 2007. The effect of supplementing Napier grass or maize stover basal diet with Gliridia, Clitoria or Mucuna on manure quality and quantity in Jersey cows. *Tropical and subtropicalAgroecosystems,* **7**(3): 157-163.

Njarui, D. M. G., Njoka, E. N., Abdulrazak, S. A. and Mureithi, J. G. 2007. Effect of planting pattern of two herbaceous forage legumes in fodder grasses on productivity of grass/legume mixture in semi-arid tropical Kenya. *Tropical and Subtropical Agroecosystems*, *7*, 73 – 85.

Odedire, J. A. and Babayemi, O. J. 2007. Comparative studies on the yield and chemical composition of *Panicum maximum* and *Andropogongayanus* as influenced by *Tephrosia candida* and *Leucaenaleucocephala.Livestock research for rural development*. Volume 20, Article#27, retrieved July 22, 2009, fromhttp://www.lrrd20/2/oded20027.htm.

Ojo, V. O. A., Dele, T. A., Amole, U. Y., Adeoye, S. A., Hassan, J. A. O. and Idowu, O. J. 2013. Effect of Intercropping *Panicum maximum* var. Ntchisi and *Lablab purpureus* on the growth, yield and chemical composition of *Panicum maximum* var. Ntchisi at different harvesting times. *Pakistan Journal of Biological Sciences,* 10:1-4.

Oni, F. G. O., Lawal, B. A. and Adejimi, O. E. 2015. Evaluation of different metrological data sources for agricultural uses in Ogbomoso, Oyo state, Nigeria. *VEF Journal of Agriculture, Rural and Community Development*, 2(1): 27 – 35.

Onyeonagu, C. C. and Asiegbu, J. E. 2012. Effects of cutting frequency and nitrogen fertilizer application on yield, proportion of crop fractions and leaf to stem ratio in guinea grass (*Panicum maximum*). *African Journal of Agricultural Research*, 7(21): 3217- 3227.

Oyaniran, D. K., Ojo, V. O. A., Aderinboye, R. Y., Bakare, B. A. and Olanite, J. A. 2018. Effect of pelleting on nutritive quality of forage legumes. *Livestock Research for Rural Development*, 30 (4), 1-8. http://www.lrrd.org/lrrd30/4/oyani30075.html

Oyenuga, V. A. 1960. Effect of stage of growth and frequencyof cutting on the yield and chemical composition of some Nigeria fodder grasses-*Panicum maximum Journal of Agricultural Science,* 25: 339-350.

Raynolds, S. G. 1992. Contribution of yield, nitrogen fixation and transfer by local and exotic legumes in tropical grass-legume mixtures in western samion. *Tropical grasslands*, 16(2): 76-80.

SAS 2000. Statistical Analysis Systems, Institute Inc., SAS/ STAT. User's guide version 6. 3rd Ed.Cary. (North Carolina, USA, 2000).

Tessema, Z. and Baar, R. M. T. 2006. Chemical composition, dry matter production and yield dynamics of tropical grasses mixed with perennial forage legumes. *Tropical grasslands*, 40:150-156.

Trenbath, B. R. 1974. Biomass productivity of mixtures. *Advance Agronomy*, 26: 177-210.

Underwood, E. J. (1981). The mineral nutrition of Livestock 2nd ed. Commonw. Agricultural Bur., Farnham Royal, England.

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