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FORAGE YIELD AND QUALITY OF TWO TROPICAL GRASS SPECIES AS INFLUENCED BY FERTILIZER TYPES DURING LATE RAINY SEASON IN ABEOKUTA, SOUTH- WESTERN, NIGERIA

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ABSTRACT

This experiment was carried out to evaluate forage yield, chemical composition and *in vitro* digestibility of *Panicum maximum* and *Andropogon tectorum* as affected by fertilizer types during the late rainy-season in Abeokuta, Ogun State. The study consisted of four fertilizer treatments (NPK 20:10:10 [NPK] fertilizer, Aleshinloye organo-mineral [AOM] fertilizer, poultry manure [PM], without fertilizer i.e. control) and two grass species (*P. maximum* var Ntchisi and *A. tectorum*). The laid out was 4 x 2 factorial arrangement in split-plot design, forming a total of 8 treatments replicated thrice. Eight weeks after cut back (WAC), forage was harvested for determination of botanical composition, yield and nutrient quality. Results revealed that *P. maximum* fertilized with AOM had the highest values (12.58 t/ha and 99.42%) for dry matter yield and forage proportion, respectively with the lowest value (0.58%) for weed proportion. Ether extra (EE) and hemicellulose were affected significantly ($P<0.05$) by grass species, while dry matter (DM), (EE) and non fibre carbohydrate (NFC) values were significantly different due to fertilizer types. The mineral contents of the two grasses were significantly influenced by fertilizers applied, and *P. maximum* fertilized with PM had the best performance. NPK fertilized *A. tectorum* had the highest metabolizable energy (ME) of 16.16 MJ/kg and that of control recorded the least ME of 10.96MJ/kg. Therefore, it was concluded that feed resource from dry season forage production could be achieved when AOM was properly incorporated to field where *Panicum maximum* (Ntchisi) is established.

Keywords: *Fertilizer, Season, Tropical grasses, proximate composition, fibre fractions*

INTRODUCTION

In the tropics, forage availability in adequate quantity and quality had posed serious threat to livestock production during dry season when animals would walk long distance in searching for feed and water points. Moreover, unprecedented weather condition due to global climate change could aggravate this undesirable situation, when there is a sudden change in rainfall pattern of the derived savanna agro-ecological zone in Nigeria. The associated consequences of this condition such as remarkable weight loss, declined milk production and susceptibility of animals to diseases had made livestock producers to painstakingly source for sustainable means of feeding livestock for all year-round production.

Nitrogen plays an important role in plant growth and physiological processes, as it enters all enzymes composition and enhances vegetative growth and yield (Burhan and Hago, 2000). Proper incorporation of nitrogen fertilizers from both organic and synthetic materials (Zeid *et al.*, 2015) has been utilized to enhance nitrogen deficiency in the soil.

Season during which plants up take available nutrients would be expected to exert certain influences on plant performance mainly in terms of growth and yield, since nutrients release to the plant majorly depend on temperature and moisture content availability (Jerry, *et al*., 2015). Ammonium-N is rapidly converted to nitrate-N in soil by microbes when soil moisture and temperature are suitable for microbial activities. Ammonium-N is predominant in soil during cool, wet conditions (Griffith *et al.*, 1997). Pasture species take up most of the N in the form of nitrate, Nitrate-N after being absorbed into plants will be converted to ammonium-N for incorporation into protein metabolism (Sun *et al.*, 2008).

In order to ascertain the facts given above, this study was conducted to evaluate forage yield and nutritive quality of two tropical grass species during late rainy season in Abeokuta, South-Western Nigeria.

MATERIALS AND METHODS

Experimental site

This experiment was carried out at the Teaching and Research Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The site lies within the latitude 7◦10'N, longitude 3◦2'E and altitude 76 mm. It is located in the derived savannah zone of South-western, Nigeria. It has a humid climate with average annual rainfall of 1037mm and temperature of about 34.7℃. The relative humidity ranges in the raining season (late March-October) and dry season (November-early March) is between 63-96 %, respectively, with an annual average 82% (Google Earth, 2015). The seasonal distribution of annual rainfall is approximately 44.96 mm in the late dry season (January-March); 212.4 mm in the early wet season (April-June); 259.3 mm in the late wet season (July-September) and 48.1 mm in the early dry season (October-December).

Experimental design and Plots management

The experiment comprised four fertilizer treatments (mineral fertilizer, organo-mineral fertilizer, Poultry manure, without fertilizer i.e. control) and two grass species (*P. maximum* var Ntchisi and *A. tectorum*) arranged in 4 × 2 factorial and laid out in split-plot design, where fertilizer types were assigned to main plots and grass species were allotted to sub-plots, forming total of 8 treatments replicated thrice. The fertilizers were applied at the rate of 120 kgN/ha calculated based on the nitrogen content obtained in each fertilizer.

At the late rainy period in the year 2016, the established pasture field measuring 9 m x 9 m and 9 m x 4 m for main plots and sub-plots, respectively, with 1 m space between sub-plots and 2 m space between main plots was considered for the study. The field contained fertilized grass species were cut back on 8th September, 2016. In stimulatory new re-growth, weeding operation were carried out.

Harvest of forage materials

Forages were harvested 8 weeks after cut back using 1m^2 quadrat. Samples were taken from each plot to determine botanical composition and sub-samples weighed 500g were taken, and oven dried at 65℃ to a constant weight to determine dry matter yield, chemical composition and *in vitro* digestibility.

Estimation of Botanical composition:

The total harvested plant materials from each quadrat (X) were separated into individual plant component present in the total biomass (Y) and each component was weighed separately and recorded. The botanical composition (A) was estimated as of total quadrat harvest; i.e. A= (Y/X) × 100.

Estimation of dry matter yield:

The dry matter yield (DMY) of harvested materials in hectare was determined according to the formulae used by Tarawali *et al*. (1995):

[FW x (DWss/FWss)] x 10 = DM kg/ha

Where:

FW is the fresh weight of forage material in kg

DWss is the dried weight of sub-sample in kg

FWss is the fresh weight of sub-sample in kg

Determination of proximate composition

The contents of dry matter (DM %), crude protein (CP), ether extract (EE) and ash were determined according to A.O.A.C. (2000). Non-fibre carbohydrates (NFC) was calculated as NFC = 100-(CP+ash+EE+NDF).

Determination of fibre fractions

Neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined using Van Soest *et al*. (1991) while cellulose was calculated as the difference between ADF and ADL and hemicellulose as the difference between NDF and ADF.

Determination of mineral contents

The samples were dried in a forced draught oven at 60^oC for 24 hours, thereafter wet ashed using nitric and hydrochloric acids at the ratio of 3:1. The resultant solution was analyzed for Calcium (Ca), Phosphorus (P), Potassium (K) and Magnesium (Mg) concentrations. A flame photometer was used to estimate the Potassium while Calcium, Phosphorus and Magnesium were determined using atomic absorption spectrophotometry (Fritz and Schenk, 1979).

Determination of *in vitro* digestibility

***In vitro* gas production and fermentative parameters**

The *in vitro* gas production of the forage samples was determined following the procedure of Menke and Steingass (1988). Total gas volume (GV) was expressed as ml/200mg DM, CP and Ash as g/kg DM, ME as MJ/kg DM and SCFA as µmol/g DM.

The data obtained were then fitted to the non-linear regression equation to determine fermentative parameters:

$$V \text{ (ml/200mg DM)} = b\,(1-e^{-ct})$$

Where V= potential gas production at time t, b= the volume of gas that evolved with time, and c= the fractional rate of gas production.

Post incubation kinetics determination

Organic matter digestibility (OMD) was estimated as

OMD= 14.88 + 0.889GV+ 0.45 CP + 0.651 Ash (Menke and Steingass, 1988).

Short-chain fatty acids (SCFA) was estimated as

SCFA = 0.0239GV−0.0601 (Getachew, 2004).

Metabolizable energy (ME) was calculated as ME= 2.20 + 0.1357GV+ 0.057 CP + 0.002859 EE^2 (Menke and Steingass, 1988).

***In vitro* dry matter digestibility (IVDMD)**

After 48 hours of incubation, the contents of the syringes were decanted into pre-weighed aluminium crucibles and oven-dried at 105^0C to constant weight. The dry residues were weighed and digestibility was calculated using this equation:

$$\text{IVDMD (\%)} = \frac{\text{Initial DM input} - \text{DM residue-Blank} \times 100}{\text{Initial DM input}}$$

Statistical analysis

Data collected were subjected to Analysis of variance using SAS (R) package (Muenchen, 2009) and significant means were separated using Duncan's Multiple Range Test (Duncan, 1955) at 5% level.

Experimental model

$Y_{ijk} = \mu + F_i + G_j + (FG)_{ij} \sum_{ijk}$

µ = population mean

F_i = effect of fertilizer type

G_j = effect of grass species

$(FG)_{ij}$ = interaction of fertilizer type and grass species effects

$\sum_{ijk}$ = Residual error estimate

Table 1: Chemical composition of Poultry manure (PM) and Aleshinloye organo-mineral fertilizer (AOM)

Parameters	Poultry manure	Aleshinloye organo-mineral fertilizer
Nitrogen (%)	1.56	3.0
Phosphorus (%)	3.27	2.5
Calcium (%)	2.35	-
Magnesium (%)	0.80	-
Potassium (%)	17.53	1.5
Sodium (part per million)	152.75	-

RESULTS

The main effects of fertilizer types on dry matter yield and the botanical composition of *Panicum maximum* and *Andropogon tectorum* harvested 8 WAC during the late rainy season are presented in Table 2. The grasses fertilized with AOM had the highest forage proportion (98.89%) with corresponding lowest weed components (1.11%). *Panicum maximum* (Ntchisi) recorded higher ($P<0.05$) forage proportion (99.05 %) than *A. tectorum* with corresponding lower value of (0.95%) for weed proportion. In Table 3, *Panicum maximum* (Ntchisi) fertilized with AOM had significantly ($P<0.05$) highest values (12.58 t/ha and 99.42%) for dry matter yield and grass proportion, respectively and this same treatment obtained lowest value (0.58%) for weed proportion.

Table 2: Main effects of fertilizer types on dry matter yield and the botanical composition of *Panicum maximum* and *Andropogon tectorum* during the late rainy season

Factors	DMY (t/ha)	Forage Proportion (%)	Weed Proportion (%)
Fertilizer types			
AOM	11.48	98.89[a]	1.11[b]
Control	11.48	97.67[ab]	2.32[ab]
NPK	11.48	95.55[c]	4.45[a]
PM	11.48	96.96[ab]	3.04[ab]
SEM	0.40	0.84	0.84
Grass species			

A. tectorum	12.52	95.49^{b}	4.51^{a}
P. maximum	11.48	99.05^{a}	0.95^{b}
	0.40	0.48	0.48

$^{a, b, c}$ Means in the same column with different superscripts are significantly different (P<0.05)
SEM: Standard error mean, AOM=Aleshinloye organo-mineral fertilizer, PM=Poultry manure, NPK=N.P.K. 20:10:10

Table 3: Interaction effects of fertilizer types and grass species on the botanical composition of *P. maximum* and *A. tectorum* during the late rainy season

Treatments		DMY (t/ha)	Forage Proportion (%)	Weed Proportion (%)
Fertilizer types	**Grass species**			
AOM	*A. tectorum*	11.40^{c}	98.35^{a}	1.65^{c}
	P. maximum	12.58^{a}	99.42^{a}	0.58^{c}
PM	*A. tectorum*	11.53^{b}	94.89^{b}	5.11^{b}
	P. maximum	10.39^{d}	99.03^{a}	0.97^{c}
NPK	*A. tectorum*	11.55^{ab}	91.71^{c}	8.29^{a}
	P. maximum	11.43^{c}	99.38^{a}	0.62^{c}
Control	*A. tectorum*	12.56^{a}	97.00^{ab}	3.00^{bc}
	P. maximum	11.44^{c}	98.36^{a}	1.64^{c}
SEM		0.40	0.34	0.34

$^{a, b, c:}$ Means in the same column with different superscripts are significantly different (P<0.05)
SEM: Standard error mean, AOM=Aleshinloye organo-mineral fertilizer
PM=Poultry manure, NPK=N.P.K. 20:10:10

Table 4 shows proximate composition (%) and fibre fractions of two tropical grasses harvested 8weeks after cut back during the late rainy season as affected by fertilizer types. It was revealed that ether extra (EE) and Hemicellulose were affected (P<0.05) by grass species, while dry matter (DM), (EE) and non fibre carbohydrate (NFC) values were significantly different due to influence of fertilizer types. *Andropogon tectorum* recorded the higher value (13.84%) for EE, whereas *P. maximum* had the lower value (10.77%) for this parameter. The highest values (97.33% and 13.10%) were recorded in poultry manure (PM) and Aleshinloye organo-mineral (AOM) for DM and EE, respectively. In contrast, grasses without fertilizer application (control) had the highest value (16.56%) for NFC, while grasses fertilized with NPK fertilizer obtained the lowest value (10.65%) for NFC.

Table 4: Main effects of fertilizer types on proximate composition (%) and fibre fractions of *P. maximum* and *A. tectorum* during the late rainy season

Factors	DM	CP	EE	Ash	NFC	NDF	ADF	ADL	Hem	Cel
Grass species										
A. tectorum	95.00	8.67	13.84[a]	10.52	13.55	53.42	20.92	6.67	32.50[b]	14.25
P. maximum	95.17	8.17	10.77[b]	10.94	12.37	57.75	20.83	8.25	36.92[a]	12.58
SEM	0.73	1.00	0.42	0.24	0.67	1.43	0.70	0.54	1.20	0.78
Fertilizer types										
Control	93.17[b]	9.50	10.23[b]	10.88	16.56[a]	52.83	19.67	6.83	33.17	12.83
AOM	93.67[b]	8.00	13.10[a]	10.40	11.67[bc]	56.83	21.83	7.83	35.00	14.00
NPK	96.17[ab]	7.17	13.03[a]	10.82	10.65[c]	58.33	20.67	8.17	37.67	12.50
PM	97.33[a]	9.00	12.87[a]	10.82	12.98[b]	54.33	21.33	7.00	33.00	14.33
SEM	0.76	1.37	0.77	0.34	1.16	2.17	0.91	0.84	1.90	1.16

[a, b, c:] Means in the same column with different superscripts are significantly different ($P<0.05$)
SEM= Standard error mean DM=Dry matter, CP= Crude protein, EE= Ether extra
NFC= Non fibre carbohydrate, NDF: Neutral detergent fibre, ADF: Acid detergent fibre, ADL: Acid detergent lignin, HEM: Hemicellulose, Cel: Cellulose
A. tectorum= *A. tectorum*, *P. maximum* (N) = *P. maximum*
AOM=Aleshinloye organo-mineral fertilizer
PM=Poultry manure
NPK=N.P.K. 20:10:10

Interaction effects of fertilizer types and grass species on proximate composition of *Panicum maximum and Andropogon tectorum* during the late rainy season are shown in Table 5. It was observed that only crude protein (CP) and non-fibre carbohydrate (NFC) were significantly affected by the interaction of fertilizer types and species. *Andropogon tectorum* fertilized with AOM obtained the highest CP (15.87%) but, the same grass species under control treatment had the lowest CP (9.91%). In contrast, *A. tectorum* without fertilizer application obtained the highest value (17.92%) for NFC, while *P. maximum* fertilized with NPK fertilizer had the least NFC (9.20%).

Table 5: Interaction effects of fertilizer types and grass species on proximate composition (%) of *P. maximum* and *A. tectorum* during the late rainy season

Treatments		DM	EE	CP	Ash	NFC
Fertilizer types	**Grass species**					
AOM	*A. tectorum*	94.33	10.00	15.87[a]	10.63	11.50[cd]
	P. maximum	93.00	6.00	10.32[cd]	10.17	11.84[bc]
NPK	*A. tectorum*	95.00	7.00	14.76[b]	10.80	12.11[bc]
	P. maximum	97.33	7.33	11.31[c]	10.83	9.20[d]
PM	*A. tectorum*	97.67	9.33	14.83[b]	10.47	12.70[b]
	P. maximum	97.00	8.67	10.92[cd]	11.17	13.24[b]
Control	*A. tectorum*	93.00	8.33	9.91[d]	10.17	17.92[a]
	P. maximum	93.33	10.67	10.55[cd]	11.60	15.18[a]
SEM		1.02	1.87	0.17	0.46	1.26

[a,b,c,d] Means in the same column with different superscripts are significantly different (P<0.05)
SEM= Standard error mean DM=Dry matter (%) CP= Crude protein (%) EE= Ether extra (%)
NFC= Non fibre carbohydrate
AOM=Aleshinloye organo-mineral fertilizer
PM=Poultry manure
NPK=N.P.K. 20:10:10

Main effects of fertilizer types on some macro mineral contents (g/kgDM) of *Panicum maximum* and *Andropogon tectorum* during the late rainy season

Table 6 shows main effects of fertilizer types on some macro mineral composition (g/kgDM) of two tropical grasses harvested 8weeks after cutting back during the late rainy season. The values revealed that Calcium (Ca), Magnesium (Mg), and Potassium (K) were significantly influenced by grass species and fertilizer types. The highest values (8.09 g/kgDM, 5.19 g/kgDM, and 23.42 g/kgDM) were recorded for Ca, Mg and K concentrations, respectively in *P. maximum* than that of *A. tectorum*. Considering the fertilizer types, grasses fertilized with NPK had the highest Ca concentration (9.62 g/kgDM) while grasses fertilized with AOM recorded the lowest Ca concentration (4.39 g/kgDM). Meanwhile, grasses fertilized with PM had the highest values (4.52 g/kgDM and 22.15 g/kgDM) for Mg and K concentrations, respectively.

Interaction effects of fertilizer types on some macro mineral contents (g/kgDM) of *Panicum maximum* and *Andropogon tectorum* during the late rainy season

The interaction effects of fertilizer types and grass species on some macro mineral composition (g/kgDM) of the two grasses during the late rainy season (Table 7). It was observed that the mean values were affected (P<0.05) by the interaction. *Panicum maximum* fertilized with NPK fertilizer had the highest Ca concentration (10.48 g/kgDM) while *A. tectorum* fertilized with PM recorded the lowest Ca concentration (3.72 g/kgDM). Meanwhile, *P. maximum* (Ntchisi) fertilized with PM had the highest values (6.12 g/kgDM and 28.18 g/kgDM) for Mg and K concentration, respectively.

Table 6: Main effects of fertilizer types on some macro mineral contents (g/kgDM) of *Panicum maximum* and *Andropogon tectorum* during the late rainy season

Factors	Calcium	Magnesium	Potassium	Phosphorus
Grass species				
A. tectorum	5.08[b]	2.95[b]	17.13[b]	2.44
P. maximum	8.09[a]	5.19[a]	23.42[a]	2.38
SEM	0.69	0.22	0.80	0.11
Fertilizer types				
Control	5.26[c]	4.10[b]	21.93[a]	2.20
AOM	4.39[d]	3.23[c]	18.16[c]	2.47
NPK	9.62[a]	4.44[a]	18.86[b]	2.54
PM	7.06[b]	4.52[a]	22.15[a]	2.43
SEM	0.67	0.50	1.41	0.15

a, b, c, d: Means in the same column with different superscripts are significantly different (P<0.05)
SEM= Standard error mean, A = *Andropogon*, P = *Panicum*,
AOM=Aleshinloye organo-mineral fertilizer
PM=Poultry manure NPK=N.P.K. 20:10:10

Table 7: Interaction effects of fertilizer types on some macro mineral contents (g/kgDM) of *P. maximum* and *A. tectorum* during the late rainy season

Treatments		Calcium	Magnesium	Potassium	Phosphorus
Fertilizer types	**Grass species**				
AOM	*A. tectorum*	3.92[e]	2.91[e]	17.46[cd]	2.64[ab]
	P. maximum	4.86[d]	3.56[d]	18.85[b]	2.30[ab]
NPK	*A. tectorum*	8.76[b]	3.61[d]	18.48[bc]	2.89[a]
	P. maximum	10.48[a]	5.27[c]	19.24[b]	2.18[ab]
PM	*A. tectorum*	3.72[f]	2.91[e]	16.12[e]	2.28[ab]
	P. maximum	10.41[a]	6.12[a]	28.18[a]	2.58[ab]
Control	*A. tectorum*	3.92[e]	2.37[f]	16.45[de]	1.95[b]
	P. maximum	6.60[c]	5.83[b]	27.40[a]	2.45[ab]
SEM		0.01	0.02	0.11	0.10

a, b, c, d, e, f: Means in the same column with different superscripts are significantly different (P<0.05)
SEM= Standard error mean, A = *Andropogon*, P=*Panicum*
AOM=Aleshinloye organo-mineral fertilizer
PM=Poultry manure
NPK=N.P.K. 20:10:10

Andropogon tectorum without fertilizer and fertilized with PM recorded the lowest values (2.37 g/kgDM and 16.12 g/kgDM) for Mg and K concentrations, respectively.

A. tectorum fertilized with NPK obtained the highest phosphorus (P) concentration (2.89 g/kgDM) while the same grass species without fertilizer application recorded the lowest P concentration (1.95 g/kgDM).

Table 8 presents main effects of fertilizer types and grass species on post incubation parameters of two tropical grasses harvested 8 weeks after cutting back during late rainy season**.** It was noticed that the mean values were affected (P<0.05) by fertilizer types and grass species. Higher ME and IVDMD (14.10MJ/kg and 80.45%) were observed in *A. tectorum* than in *P. maximum.*

Table 8: Main effects of fertilizer types on post incubation parameters of *Panicum maximum* and *Andropogon tectorum* during the late rainy season

Factors	OMD (%)	SCFA (µmol)	ME (MJ/kg)	IVDMD (%)
Grass species				
A. tectorum	63.22	0.89	14.10[a]	80.45[a]
P. maximum	68.49	1.06	12.55[b]	55.00[b]
SEM	2.96	0.08	0.57	2.83
Fertilizer types				
AOM	67.25	1.01	14.22	68.33
Control	65.39	0.98	11.76	75.83
NPK	67.79	1.02	14.08	60.00
PM	62.98	0.89	13.25	64.00
SEM	4.41	0.12	0.76	5.84

[a,b:] Means in the same column with the same superscripts are significantly different (P<0.05)
SEM= Standard error mean, OMD=Organic matter digestibility, SCFA=short chain fatty acid, ME=metabolizable energy, IVDMD=*in vitro* dry matter digestibility
AOM=Aleshinloye organo-mineral fertilizer
PM=Poultry manure
NPK=N.P.K. 20:10:10

The post incubation parameters of two tropical grasses harvested 8weeks after cut back during the late rainy season as affected by interaction of varying fertilizer application and grass species are shown in Table 9. The result shows that only metabolizable energy (ME) and *in vitro* dry matter digestibility IVDMD) were influenced (P<0.05) by interaction. The highest ME and IVDMD (16.16MJ/kg and 86.67%, respectively) were obtained in *A. tectorum* fertilized with NPK, while *P. maximum* fertilized with NPK fertilizer recorded the lowest value (40%) for IVDMD and that of *A. tectorum* without fertilizer obtained the lowest value (10.96MJ/kg) for ME.

Table 9: Interaction effects of fertilizer types and grass species on post incubation parameters during the late rainy season

Treatments		OMD (%)	SCFA (μmol)	ME (MJ/kg)	IVDMD (%)
Fertilizer types	**Grass Species**				
AOM	*A. tectorum*	60.36	0.78	15.22[ab]	86.67[a]
	P. maximum	74.15	1.23	13.22[ab]	50.00[ef]
NPK	*A. tectorum*	73.00	1.13	16.16[a]	80.00[abc]
	P. maximum	62.58	0.90	11.99[ab]	40.00[f]
PM	*A. tectorum*	58.59	0.75	14.05[ab]	70.00[bcd]
	P. maximum	67.36	1.02	12.45[ab]	60.00[de]
Control	*A. tectorum*	60.92	0.88	10.96[b]	81.67[ab]
	P. maximum	69.85	1.09	12.56[ab]	70.00[cd]
SEM		5.09	0.14	0.77	0.96

[a, b, c, d, e, f:] means in the same column with the same superscripts are significantly different ($P<0.05$)
SEM= Standard error mean, OMD=Organic matter digestibility, SCFA=short chain fatty acid, ME=metabolizable energy, IVDMD=*in vitro* dry matter digestibility
AOM=Aleshinloye organo-mineral fertilizer
PM=Poultry manure
NPK=N.P.K.20:10:10

Table 10 reveals interaction effects of fertilizer types on *in vitro* gas production and methane of two tropical grasses harvested 8weeks after cutting back during the late rainy season. In this result, there was inconsistence in the trend of observation. However, as the hours of incubation advanced, the mean values recorded were also generally increasing, from 18 to 36 hours of incubation. *Panicum maximum* fertilized with AOM had the highest values (23.33, 26.00, 34.00 and 39.33, respectively). Meanwhile from 12 to 30 hours of incubation, *A. tectorum* without fertilizer obtained the lowest values (6.00, 8.00, 12.00, 15.00 and 18.00, respectively), but at 36 hours of incubation, that of *A. tectorum* fertilized with AOM recorded the lowest value (20.00).

Table 10: Interaction effects of fertilizer types and grass species on *in vitro* gas production and methane (CH_4) during the late rainy season

		Incubation Periods (Hours)								
Treatments		**6**	**12**	**18**	**24**	**30**	**36**	**42**	**48**	**CH_4(ml)**
Fertilizer types	**Grass species**									
AOM	*A. tectorum*	4.00	7.33^{c}	12.00^{c}	16.00^{bc}	18.00^{b}	20.00^{c}	29.33	35.33	4.67
	P. maximum	7.33	14.00^{ab}	23.33^{a}	26.00^{a}	34.00^{a}	39.33^{a}	48.00	54.00	0.67
PM	*A. tectorum*	6.00	17.33^{a}	22.00^{ab}	23.33^{ab}	28.00^{ab}	30.00^{ab}	36.00	39.33	0.67
	P. maximum	6.00	7.33^{c}	16.00^{bc}	17.33^{bc}	21.33^{ab}	30.00^{ab}	40.00	48.00	0.67
NPK	*A. tectorum*	7.33	10.00^{bc}	14.00^{c}	19.33^{abc}	23.33^{ab}	24.00^{ab}	39.33	50.00	1.00
	P. maximum	4.00	7.33^{c}	13.33^{c}	17.33^{bc}	19.33^{b}	21.33^{b}	28.00	40.00	1.00
Control	*A. tectorum*	3.33	6.00^{c}	12.00^{c}	15.00^{c}	18.00^{b}	23.33^{b}	31.33	34.00	1.67
	P. maximum	3.33	8.00^{c}	15.33^{bc}	17.33^{bc}	25.33^{ab}	31.33^{ab}	36.00	45.33	2.33
SEM		1.18	0.90	1.39	1.47	2.47	2.75	4.41	5.71	0.55

$^{a,-c:}$ Means in the same column with the same superscripts are significantly different ($P<0.05$)
SEM= Standard error of mean AOM=Aleshinloye organo-mineral fertilizer, PM=Poultry manure, NPK=N.P.K. 20:10:10

DISCUSSION

The superior ability of the *P. maximum* (Ntchisi) grown with AOM fertilizer to utilize the nutrient made available for plant uptake with the little moisture content available during this period better than the other grass had been demonstrated in this trial by having improved forage yield with lowest weed proportion. This observation was in agreement with the report by Olanite *et al*. (2010) that maximum DM yield of 3500 and 3740 kg ha for denser row spacing was achieved at N fertilizer levels of 144 and 149 kg N ha for 2006 and 2007, respectively. This shows that the fertilizers applied had positive influence on the DM yield and the botanical composition during the late rainy season due to residual effect, and this corroborates Barnes *et al.* (2007) that botanical composition, age of sward, seasonal distribution of fertilizer N, method of harvesting, height of defoliation are the factors that determines plant responses to fertilizer application. This performance suggests that *P. maximum* (Ntchisi) grown with AOM fertilizer had ability to utilize the nutrients made available from residual effect when there is limited moisture content.

This result indicated that the CP content of the *A. tectorum* under fertilizer treatment (AOM) performed better than under control treatment. This is an indication that *A. tectorum* derived adequate nutrients from the plots that received AOM fertilizer. This might be attributed to low moisture content in the soil which might have affected the uptake of nitrogen from the control plots during this period of the study. Another reason that might be responsible for this observation if the moisture content was adequate, possibly might be microbial activities which mainly depend on soil temperature and soil moisture content. Ammonium-N is rapidly converted to nitrate-N in soil by microbes when soil moisture and temperature are suitable to microbial activities. Ammonium-N is predominant in soil during cool, wet conditions (Griffith *et al.*, 1997). However, this observation disagrees with the finding by Yossif and Ibrahim (2013) that mean values of crude protein, crude fibre and ash contents were not significantly affected by fertilizer with *Chloris gayanus*. In this study, CP content was observed to have been significantly influenced. This is in conformity with the report by Khan *et al*. (1999) that application of urea and cow manure increased the CP content of native grasses. The highest non-fibre carbohydrate (NFC) observed in *A. tectorum and P. maximum* under the control fertilizer treatments is an indication that the materials are rich in soluble sugar, attributed to the low level of fibrous components in the harvested materials.

The fibre fraction obtained in the grasses under fertilizer treatments indicates that nitrogen supplied did not influence the fibre components of the forage materials. This observation could be attributed to stage of maturity the materials were harvested and conforms with the findings by Noor *et al*. (1988) that nitrogen fertilizer did not decrease crude fibre, in variant with report by Hassan-Amin (2011) that the CP and crude fibre (CF) were significantly affected by nitrogen sources in both seasons but plants harvested at 30days interval had lower crude fibre irrespective of nitrogen levels.

The effects of fertilizer types and species on the macro mineral composition (g/kgDM) of the grasses harvested 8 weeks after cutting back during the late rainy season showed *P. maximum* (Ntchisi) fertilized with Poultry manure recorded the higher Ca, Mg and K concentrations when compared with control fertilizer treatment. While, *A. tectorum* fertilized with NPK had higher Phosphorus concentration. This shows that ammonium absorption by the grasses fertilized with AOM might reduce the Ca concentration (Wilcox and Hoff, 1974). This supports earlier report that pastures in New Zealand were observed to have little effect on the concentration of Ca in the mixed herbage due to application of N fertilizer (Molloy *et al.*, 1978). The observation in this study was in conformity with the finding by Imoro *et al.* (2012) and Abdi *et al.* (2015) who reported significant difference in the mineral composition of grass species due to fertilizer applications. The reason responsible for the observation made in this study could be related to high amount of ammonium uptake by the plant which consequently reduced Ca concentration in them.

In the late rainy season, the lowest ME recorded for *P. maximum* (Ntchisi) was an indication that nutritive value had declined. The value observed in the present study was above that reported by Bezabih *et al*. (2014), however, similar IVDMD mean value was observed by Ammar *et al*. (2010) and Sodeinde *et al*. (2009). The relatively improved ME value recorded in *P maximum* (Ntchisi) in this study as against that of Sodeinde *et al*. (2009) indicates that *P. maximum* (Ntchisi) having recorded the least ME in this present study does not necessarily make it undesirable if it was favourable in some other useful parameters determined, since the value does not fall below the recommended ME for optimum animal performance. The observed trend in this study corroborates the study by Olanite *et al*. (2014) that effects of animal manure and species showed that the values for fermentation of the insoluble fraction (b), gas production rate constant (c), *in vitro* dry matter digestibility (IVDMD), organic matter digestibility (OMD), short chain fatty acids (SCFAs) and metabolizable energy (ME) were significantly ($P < 0.05$) different. However, the highest ME value (4.71MJ/kg) observed in unfertilized *P. maximum* by Olanite *et al*. (2014) was greatly below the lowest ME (10.96MJ/kg) recorded in *A. tectorum* under control treatment (no fertilizer) in this study. This might be attributed to low fibre content in *A. tectorum* in this study.

In the present study, there was inconsistency in the trend of observation as regarding *in vitro* gas production. However, as the hours of incubation advanced, the values recorded were also generally increasing. At 36 hours of incubation, *A. tectorum* fertilized with AOM recorded the lowest gas production. This indicates that level of carbohydrate fermentation was low in this forage material. This suggests that such materials might have high nutritive value since gas production is related to fermentation of structural carbohydrates that are mainly associated with high fibre contents of the forage materials. This observation in the present study is in conformity with findings by Olanite *et al*. (2014) who observed decreased total gas production, methane production and organic matter digestibility due to increased N fertilizer application. Similar to the observation in this study, Cu *et al* (2016) also observed that increased Nitrogen fertilization resulted in lower cumulative gas production at 72hours incubation. However, the volume of gas produced at 48hours incubation (34.00-54.00 ml/200mgDM) in this study was greatly above that of Olanite *et al.* (2014) who obtained the mean values of gas production at 48 hours to be 10-35.00 and 13-35.00 ml/200mgDM for the early and the mid-rainy seasons, respectively. This variation might be attributed to higher rate of fermentation of structural carbohydrates contained in forage materials harvested in this study. This also indicates that the grasses grown with varying fertilizers had produced materials that might be poor in nutrient quality when compared with the study by Olanite *et al*. (2014).

Higher gas production recorded in this study, however established detrimental effect of fertilizer application in relation to environmental pollution, since there was an association between total gas production due to enteric fermentation and methane released by the animals. This has been a major area where livestock production had received great discrimination due to the current trend on climate change as a result of Green-house emission (methane, carbon dioxide and nitrous oxide).

CONCLUSION

In accordance of the outcomes of this study, the following conclusions were made:

- *Panicum maximum* fertilized with Aleshinloye organo mineral (AOM) had the highest forage yield with least weed invasion.
- The proximate composition of the two tropical grasses during the late wet season were not affected by fertilizer treatments except CP and NFC contents, in *Panicum maximum* was fertilized with AOM.
- The fibre fractions of the two tropical grasses during the late wet season were not influenced by the fertilizer treatments.
- The mineral concentrations of the two tropical grasses during the late rainy season were affected due to fertilizer application.
- The metabolizable energy content was enhanced due to fertilizer application as it was evident in NPK fertilized *Andropogon tectorum*. The gas production of the same grass was not affected by AOM fertilizer application.

RECOMMENDATION

Application of Aleshinloye organo mineral fertilizer having recorded the desirable performance in terms of forage yield, CP content, ME and gas production in both grasses is therefore recommended for the production of forage during late rainy-season in Abeokuta, South-western, Nigeria.

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