Yield and chemical composition of Pennisetum hybrid fertilized with animal manures and harvested at different times

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Abstract

The experiment was conducted at the Federal University of Agriculture, Abeokuta, Nigeria to evaluate the effects of animal manures and harvest times on the growth, dry matter yield and chemical composition of Pennisetum hybrid. The vegetative planting materials were sourced from a previously established plot and were planted in 5-litre capacity pots filled with a mixture of soil and manure at 3:1 ratio with the exception of the control that contained solely soil. The experiment was a 5x3 factorial design with four animal manure types: cattle, swine, poultry, goat and a control and three harvest times of 4, 8 and 12 wk after planting. The grass was evaluated for growth and proximate, fibre and mineral composition. The interaction effects of manure type and harvest interval were significant for all the parameters evaluated. Leaf and tiller numbers of grass fertilized with animal manures were higher ($p<0.05$) at 12 wk than unfertilized grass. Dry matter yield at 12 wk was lower ($p<0.05$) for unfertilized grass (4.94 kg/stand/pot) compared to grass fertilized with cattle, goat, poultry and swine manures at 12 wk (9.45, 16.02, 10.11 and 6.32 kg/stand/pot, respectively). The grass fertilized with goat and swine manures had higher ($p<0.05$) ash content than other treatments at 4 wk. The crude protein contents of Pennisetum hybrid grass fertilized with cattle, goat, poultry, and swine manures were higher ($p<0.05$) at 4, 8 and 12 wk than the control. The fibre contents were higher in unfertilized grass at 12 wk than in grass fertilized with animal manures. The grass fertilized with cattle manure had the highest ($p<0.05$) Na (0.62 %) and Mg (1.12 %) contents while grass fertilized with poultry manure had the highest ($p<0.05$) Ca and K contents (1.37 and 1.4 %, respectively) at 12 wk. Harvesting at 12 wk resulted in increased dry matter yield and mineral compositions while harvesting at 4 wk resulted in increased CP, EE and ash values for grass fertilized with animal manures. Application of animal manure improved the yield and chemical composition of Pennisetum hybrid.

Keywords: Animal manures, dry matter yield, Pennisetum hybrid, after planting

Introduction

Forages constitute more than 90% of the diets of sheep (*Ovis aries*), goats (*Capra hircus*), and horses (*Equus caballus*), indicating the importance of forages (Mays *et al.,* 1980). Provision of a continuous supply of forage of good quality is inevitable to enhance animal productivity. As the number of ruminant livestock animals increase, greater feed supply is required calling for intensified pasture production systems.

There has been a renewed interest in the use of *Pennisetum purpureum* grass for ruminant feed in the tropics, since it has been identified as a high yielding forage species (Braun *et al.,* 1997). However, hybrids of Pennisetum have been reported to be superior to their parents. Burton (1944) used *P. purpureum* as the female to produce an F_1

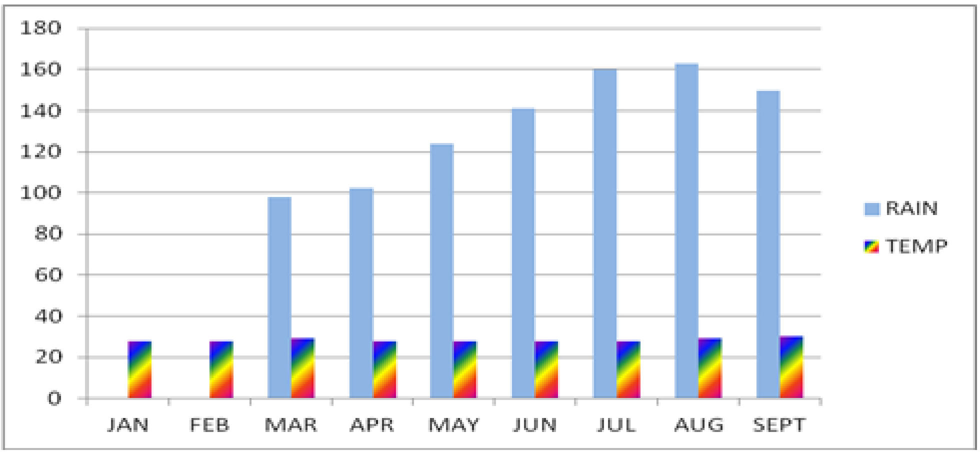
hybrid with *Pennisetum glaucum*, a late maturing millet which was superior to the parents. This hybrid was found to combine the high yielding characteristics and perennial habit of elephant grass with the rapid early growth and the superior nutritive value of millet. Forage resource improvement with emphasis on management practices that promote yield and nutritive value is, therefore, one of the important measures that has to be taken to reverse the prevailing scenario of poor animal productivity. Harvesting of forage species at the right stage of growth with proper grazing management is among the strategies towards improving the nutritive values of natural pasturelands (Valdes *et al.*, 1998).

Animal manures, however, can be an effective source of nutrients for forages, and their application to pastures could add substantial amounts of nutrients, that can be recycled through herbage production. Animal manures have been used in agricultural production systems especially crop for centuries (Simpson, 1991). Perennial pastures are desirable recipients of animal manures because of the ease and low application cost (Edwards *et al.*, 1996). Usage of animal manures for agricultural purposes is also useful in controlling environmental pollution. Farm yard manure application needs to be geared towards meeting requirements for optimal production of a given pasture (Cihacek, 1993). The objective of this study was to evaluate the effects of animal manures and harvesting times on the growth, dry matter yield and chemical composition of Pennisetum hybrid.

Materials and Methods

The experiment was conducted at the Teaching and Research Farm of the College of Animal Science and Livestock Production, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria between March and September, 2009. The site is situated in the derived savanna zone of the Southwestern Nigeria on latitude 7^{0} 13’ 49.46’’N and longitude 3^{0} 26’ 11.98’’E (Google Earth, 2009). It has a bimodal rainfall pattern with a mean annual rainfall of 1037 mm and monthly mean temperature ranging between 22.5 ^{0}C and 33.7 ^{0}C (Figure 1).

Figure 1: Temperature (^{o}C) and rainfall (mm) for the experimental period (January to September, 2009)



Source: Ogun-Osun River Basin Development Authority, Abeokuta, Nigeria.

The treatments consisted of four animal manure types: cattle, swine, poultry, goat and a control of 11-mo fallowed soil and three harvesting times: 4, 8 and 12 wk after planting making 15 treatment combinations with four replicates. The stem cuttings with four nodes each were sourced from the demonstration plot of the Department of Pasture and Range Management, College of Animal Science and Livestock Production, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria and were planted in 5-litre capacity pots. These pots were previously filled with a mixture of soil and various animal manure types at 3:1 ratio that were allowed to mineralize for 4 wk with the exception of the control that solely contained soil. Soil and animal manure samples were previously bulked per replicate, mixed thoroughly and sub-samples taken for analysis to determine the pre-planting nutrient status of the soil and nutrient compositions of the manures (Table 1). The plants were rain-fed throughout the period of the experiment. Agronomic data such as plant height, leaf length, leaf width and tiller number were taken at every harvesting interval. The plants were harvested at 10 cm above the soil level at 4, 8 and 12 wk and were weighed fresh. Sub samples were taken, weighed and oven-dried at 65 ^{0}C to constant weight for chemical analyses.

Table 1: Physico- chemical characteristics of the composite soil samples and the nutrient composition of animal manures

Parameter	Animal manure type				Control (soil)
	Cattle	Goat	Poultry	Swine	
pH	6.5	6.9	7.4	6.0	7.1
Organic carbon (%)	5.7	7.2	2.6	5.7	12.2
Organic matter (%)	9.7	12.3	4.4	9.9	1.7
Total Nitrogen (%)	2.2	1.9	3.3	2.3	0.1
Calcium (%)	2.7	2.5	7.4	1.6	0.7
Magnesium (%)	1.5	1.4	1.7	1.2	0.6
Sodium (%)	0.3	0.5	0.3	0.5	0.4
Potassium (%)	0.4	0.4	0.5	0.1	0.4
Phosphorus (%)	1.2	0.8	2.6	1.5	0.3
Ca:P ratio	2.3	3.1	2.8	1.0	2.0

The following chemical analyses were carried out on 1-mm sized ground samples: Proximate composition: crude protein, ether extract and ash were determined according to AOAC (2000). Organic matter was determined by subtracting ash contents from 100. Carbohydrate was determined with the formula OM content – (CP + EE) according to Arieli *et al*. (1999). Digestible Dry Matter (DDM) was determined with the formula 88.9 - (0.779 x % ADF) and Relative Feed Value was determined with the formula [(88.9 – (0.78 x % ADF)) x (120/ % NDF)]/ 1.29 (Agric-Facts, 2006).

Fibre fraction analyses: Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF), Acid Detergent Lignin (ADL) were performed following the method of Van Soest *et al*. (1991), cellulose was taken as the difference between ADF and ADL while hemicellulose was calculated as the difference between NDF and ADF. The concentration of potassium (K) was estimated with a flame photometer after wet digestion in nitric acid and per chloric acid. Concentration of calcium, phosphorus, magnesium and zinc were determined with atomic absorption spectrophotometry (Fritz and Schenk, 1979). Data were subject to two-way analysis of variance using SAS (1999). Level of significance was taken at 5% probability. Significant means were separated using Duncan's Multiple Range Test (Duncan, 1955).

Results and Discussion

At 4 wk, swine manure fertilized grass produced the longest ($p<0.05$) leaves, plant height and dry matter yield were highest ($p<0.05$) for those fertilized with poultry manure, while the tiller number was highest ($p<0.05$) for the ones fertilized with goat manure (Table 2). Grass that was fertilized with goat manure produced the highest ($p<0.05$) leaf number, leaf length and plant height while the ones fertilized with poultry manure had the largest ($p<0.05$) DM yield at 8 wk after planting, At 12 wk of harvesting, grass fertilized with goat manure yielded the highest ($p<0.05$) leaf number and length, tiller number and DM yield while the tallest ($p<0.05$) were those fertilized with cattle manure. The plant height ranged from 43.00 cm for unfertilized grass (control) at 4 wk to 108 cm for grass fertilized with cattle manure at 12 wk. These values were lower than the range reported by Bilal *et al.* (2000) for *Pennisetum purpureum* when nitrogen fertilizer and farmyard manure were applied. This difference however, could be a result of the inorganic fertilizer applied as nitrogen source in that study while animal manures were used in the current study. Moreover, significant increase was reported for growth attributes when animal manure was applied (Hassan, 2002; Adam, 2004; Olanite *et al.*, 2014). The greater height of grass fertilized with animal manures at 12 wk has significant impact on the nutritive quality of the grasses. It contributes to the dilution of the nutrient contents of the forages and most of the nutrients taken up by the plants from the soil are mobilized for formation of structural (cellulose, hemicelluloses and lignin) and reproductive components (inflorescence and seeds) (Abbass, 2003).

Table 2: Effects of manure types on the growth parameters and dry matter yield of Pennisetum hybrid at different harvesting times

Harvesting time	Manure type	Leaf number	Leaf length (cm)	Leaf width (cm)	Plant height (cm)	Tiller number	Dry matter yield (kg/pot)
	Cattle	24.00	27.87^{c}	1.83	69.67^{b}	4.00^{c}	1.58
	Goat	21.00	49.50^{b}	2.91	59.13^{c}	5.70^{a}	1.90
4 wk	Poultry	20.00	48.00^{b}	2.43	81.00^{a}	4.00^{c}	2.07
	Swine	24.00	54.00^{a}	2.57	80.33^{a}	4.70^{b}	1.81
	Control	19.00	27.67^{c}	2.43	43.00^{d}	2.30^{d}	1.87
SEM		0.58	2.62	0.35	3.29	0.25	0.34
P-value		**	***	NS	***	***	NS
	Cattle	30.00^{c}	56.00^{c}	2.80	89.67^{b}	4.70^{b}	2.69^{ab}
	Goat	44.00^{a}	68.00^{a}	3.00	98.00^{a}	6.70^{a}	3.89^{ab}
8 wk	Poultry	32.00^{bc}	62.00^{b}	3.13	87.33^{bc}	4.70^{b}	4.82^{a}
	Swine	34.00^{b}	56.33^{c}	3.30	86.67^{c}	4.00^{c}	1.95^{b}
	Control	21.00^{d}	49.33^{d}	2.80	80.00^{d}	2.70^{d}	1.97^{b}
SEM		1.73	1.48	0.35	1.37	0.30	0.43
P-value		**	**	NS	**	**	NS
	Cattle	64.00^{b}	64.33^{c}	4.20	108.00^{a}	6.70^{c}	9.45^{b}
	Goat	70.00^{a}	79.00^{a}	4.17	101.00^{c}	8.73^{a}	16.02^{a}
12 wk	Poultry	69.00^{a}	67.00^{b}	4.10	100.67^{c}	7.70^{b}	10.11^{b}
	Swine	41.00^{d}	81.33^{a}	4.03	105.00^{b}	6.30^{d}	6.32^{c}
	Control	49.00^{c}	62.33^{c}	3.43	100.00^{c}	4.70^{e}	4.94^{c}
SEM		2.67	1.82	0.35	0.79	0.29	0.95
P-value		**	**	NS	**	**	**
Harvesting time x manure type		**	**	NS	**	**	**

[abce] Means in the same column with different superscripts are significant ($p<0.05$)
SEM = Standard Error of Mean; ** $p<0.01$, NS $p>0.05$

The leaf number, leaf length and leaf width were higher ($p<0.05$) for grass that was fertilized with animal manures than unfertilized grass. The leaf number ranged from 19 for unfertilized grass at 4 wk to 70 for grasses fertilized with goat manure at 12 wk, leaf length ranged from 27.67 cm for unfertilized grass at 4 wk to 81.33 cm for grass fertilized with swine manure at 12 wk while leaf width ranged from 1.83 cm for grass fertilized with cattle manure at 4 wk to 4.20 cm for grass fertilized with cattle manure at 12 wk. Research have shown that higher leaf proportion is a desirable attribute in forage species because the leaves have higher nutritive quality thereby, making them more digestible and improve animal dry matter intake (Adam, 2004). Higher leaf number will also give the plant the opportunity to trap enough sunlight for photosynthesis to take place.

The grass that were fertilized with animal manures produced higher ($p<0.05$) number of tillers compared to the unfertilized grass. Tiller numbers at 12 wk for grass fertilized with various manure types recorded the highest tiller numbers which were higher

($p<0.05$) than those harvested at 4 and 8 wk after planting. Rapid production of tillers, especially close to time of establishment is a desirable characteristic for high dry matter yield, persistence and good weed control (Olanite, 2003). This could have contributed to the highest dry matter yield (16.02 kg/pot) recorded for grass that were fertilized with goat manure at 12 wk as a result of higher leaf number and tiller number recorded. The dry matter yield of Pennisetum hybrid grass increased linearly with increased harvesting times. This corroborates earlier report that extended harvesting interval of tropical forages encouraged high dry matter yield (Okwori, 1989).

Nutritional quality of the grass declined as the harvesting times extended from 4 to 12 wk (Table 3). The CP recorded for the grass as affected by different animal manures were within the range of 8.2-11.28% reported by Bilal *et al.* (2001) when farmyard manure was applied to *P. purpureum*. These values are generally above the critical limit which forage intake by ruminants and rumen microbial activity could be negatively affected (Van Soest, 1994). The CP contents of the grass in this study were also above the minimum range of 6.5–8.0% prescribed for optimum performance of tropical ruminant animals (Minson, 1981). It can also be observed that manures increased ($p<0.05$) the CP content of forage at all stages of harvest. Crude protein content of grasses is expected to depreciate below CP requirement of ruminants at longer period of harvest (Olanite *et al.,* 2006). However, the hybrid nature of the grass combines with manure effect improves the CP retention thereby reducing the effect of longer harvesting age on the CP content. Ash contents in grasses were not affected ($p>0.05$) by manure application at the various harvesting times. Application of animal manures to grasses have been reported to improve the mineral contents of soil thereby improves nutrient uptake of plant especially at early harvesting stage (Ansah *et al.,* 2010). Fertilization with manure did not affect ($p>0.05$) the EE values of the grasses. There was no significant difference ($p>0.05$) among the treatments on the organic matter (OM) content of Pennisetum hybrid grass. However, these values were slightly higher than those reported by Katuramuda *et al.* (2011). The unfertilized grass had higher ($p<0.05$) NFC and CHO compared to the grass that were fertilized with animal manures. This might be attributed to the chemical components of the soil (Yossif and Ibrahim, 2013).

Table 3: Effects of manure types on the proximate and carbohydrate composition (%) of Pennisetum hybrid at different harvesting times

Harvesting time	Manure type	CP	Ash	EE	NFC	OM	CHO
	Cattle	13.16[a]	11.43	1.26[a]	18.23[b]	88.57	74.15[b]
	Goat	13.22[a]	12.54	0.21[b]	15.14[c]	87.46	73.03[b]
4 wk	Poultry	13.30[a]	11.85	1.21[a]	17.86[bc]	88.15	73.64[b]
	Swine	13.24[a]	12.55	1.22[a]	16.40[bc]	87.45	73.01[b]
	Control	8.42[b]	12.11	1.24[a]	21.69[a]	87.89	78.23[a]
SEM		0.47	0.18	0.11	0.61	0.36	0.56
P-value		**	NS	**	**	NS	**
	Cattle	12.52[a]	11.30	1.28	16.39[b]	88.70	74.90[b]
	Goat	12.62[a]	12.33	1.27	15.46[b]	88.67	73.70[b]
8 wk	Poultry	12.72[a]	11.43	1.30	15.75[b]	88.57	74.55[b]
	Swine	12.66[a]	12.20	1.32	15.20[b]	87.80	73.82[b]
	Control	7.67[b]	12.01	1.43	19.80[a]	87.90	78.90[a]
SEM		0.48	0.18	0.02	0.52	0.36	0.56
P-value		**	NS	NS	**	NS	**
	Cattle	11.64[a]	11.02	1.46	14.86[ab]	88.98	75.98[b]
	Goat	12.89[a]	12.22	1.40	11.86[c]	87.78	73.49[b]
12 wk	Poultry	11.73[a]	11.01	1.44	13.60[bc]	88.99	74.82[b]
	Swine	12.06[a]	11.90	1.41	11.90[c]	88.10	74.63[b]
	Control	7.11[b]	11.70	1.42	16.60[a]	88.30	79.77[a]
SEM		0.49	0.19	0.02	0.54	0.36	0.59
P-value		**	NS	NS	**	NS	**
Harvesting time x manure type		NS	NS	**	NS	NS	NS

[abc] Means along the same column with different superscripts are significant (p<0.05).
SEM = Standard Error of Mean; **p<0.01, NS p>0.05

Animal manures application had little effect on fibre fractions of Pennisetum hybrid (Table 4). The highest NDF (63.11%) value of unfertilized grass at 12 wk was below the critical level as reported by Buxton (1996). However, ADL value of grasses fertilized with cattle manure was higher (p<0.05) than in other treatments. This value was lower than those reported by Katuramuda *et al.* (2011) when combined application of cattle manure and mineral fertilisers were applied to *P. purpureum*. Relative feed value (RFV) reflects how well an animal will eat and digest particular forage if it is fed as the only source of energy (Ward, 2008). Grass fertilized with cattle manure had higher (p<0.05) RFV at 4 and 12 wk of harvesting compared to other treatments. This result was in line with Lanyasunya *et al.* (2007) who reported 122.9 % for RFV at 6 wk for *Sorghum almum*. The RFV decreased with advancing age as noted in this study which reflects the importance of age during harvesting of forage grass. Digestible dry matter (DDM) was predicted from the analyzed ADF content of the forage (Ward, 2008). There was no effect of treatments on the DDM of the grass. Türk (2007) reported that fertilization enhances not only dry matter production, but also the chemical contents of the forage. Stage of maturity is probably the most important factor influencing forage mineral composition (Gomide *et al.,* 1969;

Olanite *et al.,* 2006). The Ca, P and K contents of the grass were not affected by application of animal manure at the 3 stages of harvest (Table 5). However, Mg and Na contents were higher ($p<0.05$) in grass fertilized with cattle manure at 12 wk of harvest. Calcium content of the forages was also in line with the report of Muinga *et al*. (2007) for *P. purpureum*. The Ca content in this study was above the critical value and higher than that reported by Njoka-Njiru *et al*. (2006) for *P. purpureum*. It is also in line with the findings of NRC (2000) for milk producing cattle.

Table 4: Effects of manure types on the fibre composition, dry matter digestibility (%) and relative feed value of Pennisetum hybrid at different harvesting times

Harvesting time	Manure type	NDF	ADF	ADL	HEM	CEL	DDM	RFV
4 wk	Cattle	55.92	28.92	6.74[a]	27.00	22.18	66.37	110.40[a]
	Goat	57.89	28.78	6.30[ab]	29.11	22.48	66.48	106.83[b]
	Poultry	55.78	28.71	5.87[ab]	27.07	22.84	66.54	110.96[a]
	Swine	56.61	28.80	5.80[ab]	27.81	23.00	66.47	109.22[ab]
	Control	56.54	29.11	5.11[b]	27.43	24.00	66.22	108.98[ab]
SEM		0.38	0.34	0.20	0.39	0.37	0.34	0.47
P-value		NS	NS	NS	NS	NS	NS	*
8 wk	Cattle	58.51	30.22	6.22	28.29	24.00	65.36	103.91
	Goat	58.32	30.12	5.69	28.20	24.43	65.44	104.37
	Poultry	58.80	30.54	6.14	28.26	24.40	65.11	103.01
	Swine	58.60	30.67	5.96	27.93	24.71	65.01	103.20
	Control	59.10	30.92	5.99	28.18	24.93	64.81	102.02
SEM		0.35	0.35	0.16	0.34	0.35	0.35	0.39
P-value		NS	NS	NS	NS	NS	NS	NS
12 wk	Cattle	61.12	31.22	5.64	29.88	25.60	64.56	98.27[a]
	Goat	61.63	31.43	5.62	30.20	25.81	64.42	97.23[b]
	Poultry	62.22	31.63	5.61	30.59	26.02	64.26	96.07[ab]
	Swine	62.73	31.84	5.60	30.89	26.24	64.10	95.05[b]
	Control	63.11	31.54	5.64	31.57	25.90	64.33	94.82[b]
SEM		0.38	0.35	0.15	0.37	0.35	0.34	0.45
P-value		NS	NS	NS	NS	NS	NS	NS
Harvesting time x manure type		NS	NS	NS	NS	NS	NS	*

[ab] Means along the same column with different superscripts are significant ($p<0.05$).
SEM = Standard Error of Mean; *$p<0.05$, NS $p>0.05$.

Table 5: Effects of manure types on the mineral composition of Pennisetum hybrid at different harvesting times

Harvesting times	Manure type	Ca (%)	P(%)	Mg(%)	K(%)	N(%)a	Zn (ppm)
	Cattle	1.05	0.88	0.83	1.25	0.42[c]	87.67
	Goat	1.02	0.91	0.80	1.24	0.43[bc]	89.33
4 wk	Poultry	1.04	0.89	0.77	1.21	0.42[c]	90.33
	Swine	1.06	0.88	0.78	1.24	0.45[ab]	92.67
	Control	1.09	0.92	0.81	1.23	0.47[a]	92.67
SEM		0.15	0.02	0.01	0.02	0.01	0.93
P-value		NS	NS	NS	NS	**	NS
	Cattle	1.13	0.96	0.87	1.27	0.48[bc]	95.33[b]
	Goat	1.16	0.98	0.90	1.29	0.50[ab]	99.33[ab]
8 wk	Poultry	1.17	1.02	0.93	1.31	0.47[c]	99.67[ab]
	Swine	1.18	1.04	0.91	1.32	0.47[c]	102.33[a]
	Control	1.17	1.03	.092	1.29	0.51[a]	104.33[a]
SEM		0.15	0.02	0.01	0.02	0.00	1.08
P-value		NS	NS	NS	NS	**	NS
	Cattle	1.23	1.08	1.12[a]	.137	0.62[a]	114.00
	Goat	1.25	1.20	1.00[b]	1.39	0.54[c]	112.00
12 wk	Poultry	1.37	1.12	1.02[b]	1.40	0.57[b]	112.00
	Swine	1.28	1.05	1.04[ab]	1.38	0.60[a]	115.67
	Control	1.28	1.13	1.02[b]	1.37	0.53[c]	118.67
Ruminant needs[1]		0.24	0.12	0.12	0.6-0.8	0.07	49.0
SEM		0.15	0.02	0.01	0.02	0.01	1.00
P-value		NS	NS	NS	NS	**	NS
Harvest x manure		NS	NS	NS	NS	**	NS

[abc] Means in the same column with different superscripts are significant ($p<0.05$).
SEM = Standard Error of Mean; **$p<0.01$, NS $p>0.05$
[1]Requirements for cattle (200 kg LWt) with average live weight gain of 100 g/d (Rivière 1991 for Ca, P; NRC 2000 for K, Na, Zn; and Underwood and Suttle, 1999 for Mg).

Phosphorus content of grass increased progressively with increased harvesting time, however, these values were lower than those reported by Katuromunda *et al.* (2011). This could be attributed to differences in weather condition and soil type. Phosphorus content was less than the normal requirement for growing cattle (1.1 – 4.8%) except in grasses fertilized with goat and poultry manures and unfertilized grass all at 12 wk. This result is in line with the findings of McDowell *et al.* (1984) which concluded that the most common mineral deficiency in forage throughout the globe was P. Increase in lignin fraction was reported to limit P concentration in grasses (Gomide, 1978), however, reduction in lignin content in this study might have caused a proportional increase in P content.

Grass fertilized with cattle manure had highest ($p<0.05$) Mg (1.12%) value at 12 wk. This result agrees with Snijders *et al.* (1992) that up to 40% of Mg in cattle dung was available for plant uptake. Tropical plants are known to be excellent dietary sources of Mg for ruminants because of the presence of Mg in chlorophyll (Wilkinson *et al.*, 1990), and that deficiency is likely to be rare (Minson and Norton, 1984).

The K content of the grass was highest at 12 wk (1.4%) when poultry manure was used as fertilizer. This was a result of slow release of K in the poultry manure to the grass. The K content was lower than that reported by Muinga *et al*. (2007) for Napier grass but higher than that reported by Ammerman and Goodrich (1983) for the dietary requirement of finishing steers. This also confirms that tropical grasses have higher K content required by ruminants (Ammerman and Goodrich, 1983). Excess K content has also been noted not to be toxic to animals as they are rapidly excreted (Ammerman and Goodrich, 1983).

The value recorded for the Na uptake (0.62%) of grass fertilized with cattle manure was highest ($p<0.05$) at 12 wk. This reflects the concentration of Na in the cattle manure (Idota, 2004). The Na content recorded in this study except in grasses fertilized with cattle and swine manures at 12 wk was lower than that recommended by ARC (1980). The deficiency can mainly be remedied by providing common salt *ad libitum* to the ruminants or serving them salt block during grazing (McDowell, 1992). This shows that Na content of tropical grasses falls under the critical values of less than 0.6% as reported by Shamat *et al*. (2009).

The Zn content recorded was higher than the minimum requirement for all classes of ruminants (NRC, 2000) and lower than the maximum tolerable level of dietary for ruminants (NRC, 1980). This is an indication that the Pennisetum hybrid studied can sufficiently meet the Zn required by ruminants.

Conclusion

The general indication from this study is that Pennisetum hybrid grass fertilized with animal manures is indeed superior to the unfertilized grass in terms of dry matter yield and nutritive quality at the three stages of harvest. However, for quantity and quality balance as related to age at harvest, the grass can be grazed by animals or harvested for conservation at 8 wk after planting.

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