Microelement contents of two *Panicum maximum* varieties as influenced by manure type and season

Dele, P. A. [1]*, Olanite, J. A. [1], Arigbede, O. M. [1], Sowande, O. S. [2], Ojo, V. O. A. [1], Jolaosho, A. O. [1], Idehen, J. O. [1] and Amole, T. A[3].

[1]Department of Pasture and Range Management, Federal University of Agriculture, Abeokuta, Nigeria. [2]Department of Animal Production and Health, Federal University of Agriculture, Abeokuta, Nigeria. [3] Institute of Food Security, Environmental Resources and Agricultural Research, Federal University of Agriculture, Abeokuta, Nigeria.

*Corresponding Author: delepeter2003@yahoo.com

Abstract

A study was carried out to determine the influence of variety, manure type and season on the micro mineral content of two P. maximum varieties. The trial included: two Panicum varieties (Local and Ntchisi), three manure types (cattle dung, swine dung and poultry droppings) plus control (No manure) and two seasons (rainy and dry). Samples were harvested from each plot to estimate dry matter yield (DMY), crude protein, neutral detergent fibre, acid detergent fibre and microelements (Cu, Zn, Fe and Mn). The DMY of Ntchisi variety was higher (P<0.01) than that of the Local variety. Grasses fertilized with swine manure had the best (P<0.001) DMY while yield was better in the rainy season compared with dry season. There was season difference in the mineral contents except (P>0.05) for Fe. Manure differences were only noticed in the Zn and Mn contents of the grasses. Despite these differences, the grasses contained adequate amount of microelements required by ruminants, with the exception of Cu content in the dry season. In production systems where the two Panicum varieties constitute the major diets of grazing animals, it would be necessary to offer supplementary Cu in the dry season.

Keywords: Panicum, microelements, manure type, season, variety.

Introduction

Grass forages are important sources of minerals in the diet of ruminants. In the case of grazing ruminants, they may be the only source of both macro and micro elements available to meet the animal's requirements. However, variability in the mineral contents of forages has been shown to be very high (Adams, 1975; Gralak et al., 1996; Thompson and Warren, 1995). A wide range of variation has been noticed in the mineral content of forages (Kabaija and Smith, 1988; Olanite, 2003; **Onyeonagu et al., 2013**) across the agroecological zones of Nigeria. This variation has made it difficult to predict the mineral intake of ruminant animals on forage as predicted by NRC (1989) or in formulating supplement for ruminants on range.

All plants depend upon the soil for their supply of mineral nutrients, and grazing ruminant animals obtain the majority of their mineral nutrients from plants grown on these soils. Concentrations of mineral elements in forage are dependent upon the interaction of a number of factors, including soil, plant species, stage of maturity, yield, pasture management and climate (McDowell *et al*., 1983). Most naturally occurring mineral deficiencies in herbivores are associated with specific regions and are directly related to soil characteristics (Underwood, 1981: McDowell *et al*., 1983). When mineral nutrients in herbage are marginal in respect of animal requirements, changes in concentrations brought about by climatic, managerial or, seasonal influences as well as plant maturity can be significant factors in incidence or severity of deficiency states by livestock wholly or largely dependent on these plants (Underwood, 1981).

Findings have shown that the application of fertilizer is needed to improve the fertility of the soil and consequently, the productivity and quality of the pasture (Olanite *et al*., 2004; Dele, 2008; Onyeonagu and Ukwueze, 2012).

With the exception of health and environmental hazards associated with the prolonged and heavy use of inorganic fertilizers, their availability and affordability by livestock producers have also been major constraints to their uses, especially for pasture production in developing countries where the market prices of the animal products may not justify such huge investment. Thus, an alternative method is to make use of organic fertilizer, such as farmyard manure. It is available locally and the pollution of water resources from leaching and runoff as obtained in inorganic fertilizer is significantly reduced. The constraints posed by dry season on continual availability of pasture to livestock in the tropics, has been a matter of concern in animal production too. Dry season is a key factor that predisposes ruminants fed with standing hay and low protein roughages to consistent weight loss (Babayemi and Bamikole, 2006). Blakely and Blade (1994) asserts that the climate of an area affects the nutrient composition of the forage species growing in that area.

Since animal performance is directly related to forage quality, information is therefore needed on the effects of manure type and season on forage quality. Hence the objective of this study was to investigate the effects of season and manure type on the mineral content of two *P. maximum* varieties.

Materials and methods

Experimental sites

The field experiment was carried at the Organic Research Farm, Federal University of Agriculture, Abeokuta (FUNAAB), Ogun State, Nigeria, while the analyses of the samples were carried out at the laboratory of the Institute of Subtropical Agriculture (ISA), Chinese Academy of Science (CAS), Changsha, Hunan Province, China. The experimental site lies within the savanna agro-ecological zone of South Western Nigeria (latitude: 7°N, longitude 3.5°E). The average annual rainfall of the experimental site is 1037 mm. The Institute of Subtropical Agriculture, Changsha lies on latitude 28°12'N longitude 113° 05' E with an elevation of 135ft (Google earth, 2011).

Land preparation

The experimental land was cleared, followed by ploughing and the land was allowed to rest for a period of two weeks before harrowing. After land preparation and before planting, soil samples were randomly collected from the plots at the depth of 0-15 cm (top soil) with the aid of a soil auger in May 2010. The samples were bulked per replicate, mixed thoroughly and sub-samples taken for analysis to determine the pre-planting nutrient status of the soil (Table 1).

Manure collection, analyses and application

Manure from cattle, swine and poultry were used for the study, while plots without manure served as control. These manures were sourced from the Teaching and Research Farm, Federal University of Agriculture, Abeokuta. The manures were collected 14 days before the application and sub-samples were taken from each manure

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

Chemical properties	Values
pH	7.03
Total nitrogen (%)	0.11
Organic carbon (%)	1.29
C:N ratio	28.38
Available P (mg/kg)	53.87
Acidity (cmol/kg)	0.13
CEC	1.79
Exchangeable cations (cmol/kg)	
Sodium (Na)	0.80
Potassium (K)	0.20
Calcium (Ca)	2.77
Magnesium (Mg)	2.72
Particle size	
Sand (%)	77.93
Silt (%)	17.33
Clay (%)	4.73

type and analyzed prior to application to determine their nutrient composition. The rate of application was 300 kgN ha^{-1} and quantities of the manures were determined based on the nitrogen content of the manure and nutrient compositions of the manures as presented in Table 2.

Source of planting materials and planting method

Guinea grass varieties used for the trial include vegetative materials or crown splits of *Panicum maximum* (Local) and *P. maximum* (Ntchisi). The vegetative materials were sourced from established plots within the University campus. The plant materials were planted at a spacing of 0.5 m x 0.5 m to produce 48 plant stands per plot with dimension 3m x 4m. The plots were well labelled with the treatments indicated.

Experimental design and plot management

The study was a 2 x 4 x 2 factorial experiment in a randomized complete block design (RCBD) with two grass varieties (*P. maximum* Local) and *P. maximum* Ntchisi), four manure treatments (cattle, swine, poultry manures and no manure (control)), and two seasons (dry and rainy) with four field replicates. Both inter-plots and intra-plots were kept weed-free throughout the experimental period by hand weeding.

Forage harvesting and sampling

The grasses were harvested (at the stubble height of 15 cm above ground level) at 8 weeks after planting and 8 weeks after cutback for the rainy and dry seasons, respectively. At harvest, total yield from each plot were measured and sample obtained for the estimation of dry matter

Table 2: Nutrient composition of three animal manures

Parameters	Cattle dung	Swine dung	Poultry droppings
Nitrogen (g kg^{-1})	15.6	16.9	30.2
Phosphorus (g kg^{-1})	6.9	6.3	10.6
Potassium (g kg^{-1})	7.3	7.6	10.3
Calcium (g kg^{-1})	21.2	31.6	37.2
Magnesium (g kg^{-1})	11.7	19.2	17.3
Sodium (g kg^{-1})	1.1	1.6	2.1
Iron (mg kg^{-1})	614.6	650.7	630.9
Zinc (mg kg^{-1})	54.8	81.2	75.4
Copper (mg kg^{-1})	29.1	27.3	32.7
Manganese (mg kg^{-1})	321.9	260.3	217.9

using a forced air drying oven until constant weights were achieved. The dried samples were ground through a 1 mm screen and milled samples packed in plastic bags for subsequent chemical analyses.

Chemical analyses

The dried samples were milled through a 1 mm screen mill and analyzed for crude protein (CP) content according to AOAC (1995) method. The neutral detergent fibre (NDF) and acid detergent fibre (ADF) contents were analyzed according to the methods described by Van Soest *et al*. (1991).

Plant wet digestion method for mineral content

Samples of 1.0 g were prepared for mineral analysis by the wet digestion method. The samples were placed in digestion vessels, kjeldhal flasks, using concentrated Nitric acid and 70% Perchloric acid heated slowly at low temperature. After digestion, the samples were diluted to the appropriate volume with deionized water. Working standards prepared using the extracting solution. Iron (Fe), Manganese (Mn), Zinc (Zn), and Copper (Cu) were determined using air/acetylene flame and D-corrector of the Atomic Absorption Spectroscopy.

Statistical analyses

Data collected were subjected to analysis of variance using the Statistical package (SAS, 1999) and significant means were separated using Duncan Multiple Range Test.

Results

The effect of season and manure type on dry matter yield (DMY), CP, NDF and ADF of the two *P. maximum* varieties are shown in Table 3. The effect of season on the yield was significantly ($P<0.05$) higher for grasses harvested in the rainy season. The CP (10.42% DM) content of the grasses was higher ($P<0.05$) as well during the rainy season. Season had no effect ($P>0.05$) on the NDF content of the grasses.

The influence of manure on DMY was highest ($P<0.05$; 16 t ha^{-1}) for grasses fertilized with swine manure while the least DMY (9.29 t ha^{-1}) was recorded for unfertilized grasses. The CP content of the grasses was significantly ($P<0.05$) affected by the manure type with grasses fertilized with cattle dung been the highest. However, there was no effect of manure on the NDF content ($P>0.05$) of the grasses.

The yield of *P. maximum* Ntchisi was significantly ($P<0.05$) higher than the yield of *P. maximum* Local whereas the varietal effect was not significant on the CP and ADF. The NDF content was affected by the variety as *P. maximum* Local had a higher NDF (61.03% DM) content.

The micro element content of the grasses in this study is presented in Table 4. The Cu and Zn contents of the grasses as affected by the season were significantly ($P<0.05$) higher for the grasses harvested in the rainy season while the Mn content for the grasses harvested in the dry season was higher than those harvested in the rainy season. The effect of manure on the Zn and Mn contents of grasses were significantly ($P<0.05$) higher in unfertilized grasses with the lowest Zn and Mn content in grasses fertilized with swine and poultry waste, respectively. *P. maximum* Ntchisi variety had higher Cu and Fe contents than *P. maximum* Local. The Zn and Mn contents were not ($P>0.05$) affected by varietal effect.

The relationship between the DMY, CP, NDF, ADF and micro element content of the two *P. maximum* varieties are presented in Table 5. The CP content was negatively correlated with NDF, DMY and Mn ($P<0.05$), it was also positively correlated with the ADF ($P<0.05$) content. The NDF content was positively correlated with the

Table 3: Effect of season and manure type on yield, crude protein, neutral detergent fibre and acid detergent fibre of two *P. Maximum* varieties

	Dry matter yield (t ha^{-1})	CP (%)	NDF (%)	ADF (%)
Season				
Dry	12.20^{b}	8.61^{b}	60.56	32.57^{a}
Rainy	14.55^{a}	10.42^{a}	59.87	30.35^{b}
SEM	0.65	0.22	0.41	0.23
Manure				
Cattle	14.01^{ab}	10.54^{a}	60.66	31.81^{a}
Swine	16.65^{a}	10.09^{a}	60.73	32.30^{a}
Poultry	13.21^{b}	9.00^{b}	59.40	31.52^{a}
Control	9.29c	8.43^{b}	60.07	30.21^{b}
SEM	0.78	0.33	0.58	0.38
Variety				
P. maximum Local	12.32^{b}	9.41	61.03^{a}	31.66
P. maximum Ntchisi	14.26^{a}	9.62	59.39^{b}	31.25
SEM	0.66	0.26	0.40	0.03
Manure	<0.0001	<0.0001	0.1684	<0.0001
Season	0.0016	<0.0001	0.1523	<0.0001
Variety	0.0143	0.4527	0.0009	0.1390
Season x Manure	0.9109	0.6403	0.0823	0.0006
Manure x Variety	0.8757	0.3427	0.1133	0.0086
Season x Variety	0.7136	0.7566	0.0001	0.7201
Season x Manure x Variety	0.9998	0.7311	0.0005	0.0009

CP=crude protein, NDF=neutral detergent fibre, ADF=acid detergent fibre

ADF ($P<0.01$) content and negatively correlated with Fe ($P<0.05$) content. The ADF content was negatively related ($P<0.001$) with the Mn content, while the DMY was also negatively related with the Zn content of the grasses. The Cu content was positively related with the Zn ($P<0.05$) content and negatively related with the Mn ($P<0.01$) content. The Zn content was negatively related with the Mn ($P<0.05$) content, whereas the Zn content was positively related with the Mn ($P<0.01$) content.

Discussion

The variation in the DMY as reported in this study with the yield in the rainy season been higher than the yield in the dry season is in line with the findings of Omaliko (1983), Onyeonagu (2005) and Onyeonagu and Ugwuanyi, (2012). This could be attributed to reduced moisture and nutrient availability at the dry periods of the year (Campbell and Grime, 1993). The highest DMY recorded for swine manure fertilized grasses might be as a result of the high rate of N mineralization that the manure is noted for in the year of application of the manure (Waskom, 1994). Nitrogen is known to promote plant productivity in terms of DMY (Sun et al., 2008). The DMY of *P. maximum* (Ntchisi) was higher than that of *P. maximum* (Local). This is in line with the findings of Onayinka and Akinyemi, 1976, Olanite *et al.* (2006) and Dele (2008).

Seasonal difference in the CP of the grasses as recorded in the present study is consistent with the findings of Tergas and

Table 4: Effect of season and manure type on micro element content (mg kg^{-1}) of two *P. Maximum* varieties

	Cu	Zn	Fe	Mn
Season				
Dry	6.91^{b}	43.45^{b}	305.04	192.48^{a}
Rainy	8.55^{a}	73.34^{a}	281.24	132.20^{b}
SEM	0.46	4.05	17.70	6.99
Manure				
Cattle	8.90	54.93^{ab}	265.64	168.87^{ab}
Swine	7.18	49.68^{b}	297.41	148.83^{bc}
Poultry	8.36	60.34^{ab}	311.65	134.81^{c}
Control	7.08	68.61^{a}	297.88	196.84^{a}
SEM	0.67	6.04	24.70	10.56
Variety				
P. maximum Local	7.03^{b}	56.76	262.71^{b}	164.10
P. maximum Ntchisi	8.73^{a}	60.03	323.58^{a}	160.57
SEM	0.46	4.50	16.98	8.23
Manure	0.0596	0.0631	0.5788	<0.0001
Season	0.0008	<0.0001	0.3240	<0.0001
Variety	0.0033	0.5220	0.0131	0.6748
Season x Manure	0.0003	0.0021	0.4078	0.0276
Manure x Variety	0.2358	0.0802	0.1263	0.2907
Season x Variety	0.8872	0.0853	0.3390	0.1346
Season x Manure x Variety	0.0615	0.0397	0.1929	0.2392

Table 5: Correlation coefficients between the micro element content, yield, CP, NDF and ADF in two *P. maximum* varieties

	CP	NDF	ADF	YIELD	Cu	Zn	Fe	Mn
CP	-	-0.75	0.24*	-0.19	0.06	0.18	0.09	-0.20*
NDF		-	0.36**	0.17	0.08	0.11	-0.23*	-0.14
ADF			-	0.10	0.02	0.14	-0.21*	-0.53***
YIELD				-	0.15	-0.25**	0.02	-0.13
Cu					-	0.20*	-0.12	-0.34**
Zn						-	0.05	-0.21*
Fe							-	0.34**
Mn								-

*P=0.05; **P=0.01; ***P=0.001

CP=crude protein, NDF=neutral detergent fibre, ADF=acid detergent fibre

Urrea (1985). Decrease in the CP of the grasses in the dry season might be as a result of increased temperature in the season, a factor that is known to promote more rapid metabolic activity, which decreases the pool size of metabolites in the cellular content. This has the effect of decreasing nitrate, protein and soluble carbohydrates (Taute, 2000). The crude protein (CP) content of the grasses in the present study as affected by the different manures applied fell within the range of 8.2– 11.28% reported by Bilal *et al.* (2001) for *P. purpureum* when farmyard manure was applied. The CP content of the grasses affected by the manures is above the critical limit below which intake of forages by ruminants and rumen microbial activity would be adversely affected (Van Soest, 1994) and these values are above the minimum range of 65–80 g/kg prescribed for optimum performance of tropical ruminant animals (Minson, 1981). The grasses are therefore adequate for meeting the protein requirement of growing calves to generate a high level of ammonia in the rumen from degradable protein to ensure an efficient digestion process (Ørskov, 1995). Higher CP content recorded for grasses fertilized with cattle and swine manure might be attributed to high carbon content in the manure (Muyekho *et al.,* 2000) as they are known to have high carbon:nitrogen ratio suggesting that manure mineralization takes place at different rates between different animal species.

The values of the NDF and ADF of the grasses as influenced by the animal manures are lower than that reported by Olanite *et al*. (2006) for the two varieties of Panicum which was fertilized with inorganic nitrogen fertilizer. The varietal effect of the grasses as recorded in this study on NDF and ADF is lower to those reported by Man and Wiktorsson (2003). The NDF recorded is within the range of 600-650 g/kg suggested as the critical limit above which efficiency of utilization of tropical forages by ruminants would be impaired (Van Soest, 1982; Muia, 2000) and the consistent increase in the concentration of NDF with advancement in plant age is in line with the study carried out by Arthington and Brown (2005). Moderate fibre levels of the grasses in this study will be of help in facilitating the colonization of ingesta by rumen microorganisms which in turn might induce higher fermentation rates, hence improving digestibility, intake and animal performance.

Higher Cu content of the grasses in the rainy season in the present study is in line with the findings of Sousa (1978). This might be as a result of extractable soil copper that are readily available in the rainy season. Sousa (1978) also reported that the higher Cu content during the rainy season in forages might be as a result of new tissues development that is rapid in plants during this season. The Cu content of the grasses in the rainy season in this study was slightly higher than the critical level (< 8 mg/kg DM) as reported by McDowell and Conrad (1977) and NRC (1981) and fell within the recommended range in ruminant diets (7-11 mg/kg DM) for the normal physiological functions of the animals (NRC, 2001). The manure effect was not pronounced on the Cu content of the grasses but all fell within the range reported by NRC (2001) as normal for the physiological functions of ruminant animals. The Cu content of the two Panicum varieties were higher than those reported by Tona (2011) and Sodeinde *et al*. (2006) for *P. maximum* T58. The difference in the Cu content of the two varieties of Panicum reflects the submission of McFarlane *et al*. (1990) that noted species and strain variation as a factor in Cu content of forages. The Cu content of *P. maximum* Ntchisi in this study was found to be higher than the average Cu content (7.8 mg/kg DM) reported for tropical grasses by Minson (1990)

The Zn content of the grasses in both season were higher than (< 40 mg/kgDM) considered to be the critical level (McDowell and Conrad, 1977) and higher Zn content of grasses in the rainy season in this study is consistent with the report of Shamat et al. (2009). This might be as a result of moisture that is readily available for mobility of nutrient from the soil to the plant tissues. The effect of manure on the Zn content showed that Zn can form chelates with manure as the grasses not fertilized had the highest Zn content thereby aligning with the report of Minson (1990) that soil Zn status has a major influence on the forage Zn content. The slight difference between the two varieties is in line with the findings of Minson (1984) that reported variation in the Zn content of five species of *Digitaria.*

The Fe content of the grasses was higher than the critical level (<50 mg/kg DM) reported by McDowell and Conrad (1977) and in line with the desirable threshold concentration (>30 mg/kg DM) as well as 100 mg/kg DM reported as the desirable threshold concentration in the diets of claves (MacPherson, 2000). Higher Fe content for grasses in the dry season is in line with the report of Shamat et al. (2009). Forage Fe levels during the study season were sufficient for the requirements of ruminants for optimal performance. Variations in the contents of Fe observed between the two Panicum varieties could partly be explained by the forage varietal differences and the observed levels are higher than the critical levels of Fe in animal tissues (30-50 mg/kg DM). Fe levels in this study, it shows that Fe deficiencies are rare in sub-Saharan soils which are due to the large pools of Fe in weathered soils.

The seasonal differences were highly significant in the Mn content of the two Panicum varieties being higher in the dry season; higher Mn content in the dry season in this study might be attributed to the low rates of Mn translocation and accumulation of Mn in older tissues (Sousa, 1978). This is also consistent with the findings of Kabaija and Smith (1988). The Mn content of the grasses as affected by the varietal differences was not significant but *P. maximum* Local had higher Mn content. Similarly, Minson (1990) noted no difference in Mn content of different species, cultivar or varieties. The two varieties had higher levels of Mn than the normal dietary requirements of 20 – 40 mg/kg DM (ARC, 1980, Meschy, 2000, NRC, 2001), although, its supply could be lowered by its low absorbability efficiency. However Mn concentrations may interfere with the metabolism of other minerals and has been observed to result in low reproductive rates of cattle (McDowell *et al*., 1984) especially when the Mn content is above the tolerable level.

In this study there were fairly negative correlation between DMY and Zn and Mn. Previous studies affirmed this relationship (Gralak et al., 1996; Gralak *et al*., 2006). The relationship between the DMY and fibre fractions is a positive one as it proves that the higher the DMY the higher the NDF and ADF contents. Positive correlations between the CP content of the grasses and the Zn and Cu contents are consistent with previous studies (Fleming and Murphy, 1968; Fisher and Bates, 1986; Gralak *et al*., 2006)

Conclusion

It could be concluded from the results of this study that the two Panicum varieties were good sources of microelements supplement in both dry and rainy seasons, except for the Cu content which may be supplemented during the dry season. One method of improving the Cu status of the Panicum varieties during dry season is to introduce foliar dusting of Cu, provided excess amount of Cu are not deposited on the vegetation so as to avoid Cu toxicity. In both varieties of Panicum, the Fe and Mn concentrations are above ruminant livestock requirements. It is recommended that further research be carried out to elucidate any detrimental effects to livestock that might be associated with high Fe and Mn concentrations. Further studies are needed in analyzing forages for quality factors and analyses of other microelements so that appropriate supplements may be formulated if need be.

References

Adams, R. S. 1975. Variability in mineral and trace mineral content of dairy feeds. *Journal of Dairy Science* 58: 1538-1548.

Agricultural Research council (ARC) 1980. The nutrient requirement of ruminantlivestock. Technical Review. Commonwealth Agricultural Bureaux.

AOAC. 1995. Official Methods of Analysis, 16th edn. (Association of Official Analytical Chemist, Airlington, VA)

Arthington, J. D. and Brown, W. F. 2005. Estimation of feeding value of four tropical forage species at two stages of maturity. *Journal of Animal Science* 83:1726-1731

Babayemi, O. J. and Bamikole, M. A. 2006. Supplementary value of *Tephrosia bracteolata*, *Tephrosia candida*, *Leucaena leucocephala* and *Gliricidia sepium* hay for West African dwarf goats kept on range. *Journal of Central European Agriculture* 2:323-328.

Bilal, M. Q., Sarwar, M. and Ahmad, S. 2001. Effect of Stage of Growth and Nitrogen Fertilization on Protein Contents of Mott Grass and its Morphological Fractions. *International Journal of Agriculture and Biology* 3(1):39–41

Blackely, A. and Blade, A. L. 1994. An evaluation of Kentucky Bluegrass. *Journal of Agronomy* 37:259-267.

Campbell, B. D. and Grime, J. P. 1993. Prediction of grassland plant responses to global change. In: Brougham R (ed.) Grassland for our world. SIR Publishing, Wellington, New Zealand. Pp. 406 – 415

Dele, P. A. 2008. Effect of plot management and fertilizer treatments on the growth, biomass yield and seed quality of two Guinea grass varieties. M. Agric Dissertation, Department of Pasture and Range Management, University of Agriculture, Abeokuta 84pp.

Fisher, L. J. And Bates, D. L. 1986. The relationship between mineral elements and quality factors in forages. *Canadian Journal of Animal Science*. 66: 1198 (Abst.).

Fleming, G. A. and Murphy, W. E. 1968. The uptake of some major and trace elements by grasses as affected by season and stage of maturity. *Journal of British Grassland Society* 23: 174-185.

Google Earth, 2011. *http//www.google.earth*

Gralak, M. A., Bates, D. L., Keyselingk, M. A. G., Von-Fisher L. J. and Shelford, J. A. 1996. Influence of species, cultivar and cut on the mineral content of grasses. In: *Proceedings of American forage and grassland council.* Vancouver: B.C., 1996, 155-159.

Gralak, M. A., Bates, D. L., von Keyserlingk, M. A. G. and Fisher, L. J. 2006. Influence of species, cultivar and cut on the microelement content of grass forages. *Slovak Journal of Animal Science 39, (1-2): 84 – 88*

Kabaija, E. and Smith, O. B.1988. Effect of season, fertilizer application and age of regrowth on mineral content of Guinea grass (*Panicum maximum*, Schum) and Giant Star grass (*Cynodon nlemfuensis*, Chedda).In: Dzowela, B. H. (ed). Pasture Network for Eastern and Southern Africa (PANESA). 1988. *African forage plant genetic resources, evaluation of forage germplasm and extensive livestock production systems*. Proceedings of the Third Workshop held at the International Conference Centre, Arusha, Tanzania, 27-30 April 1987. ILCA, Addis Ababa.

MacPherson, A. 2000. Trace-mineral Status of Forages. In: D.I. Givens, E. Owen, R.F.E. Axford and H.M. Omed (eds) *Forage Evaluation in Ruminant Nutrition* CAB *International* pp 345-372

Man, N. V. and Wiktorsson, H. 2003. Forage yield, nutritive value, feed intake and digestibility of three grass species as affected by harvest frequency. *Tropical Grasslands* 37:101-110

McDowell, L. R. and Conrad, J. H. 1977. Trace mineral nutrition in Latin America. *World Animal Review* 24: 24-33.

McDowell, L. R., Conrad, J. H., Ellis, G. L. and Loosli, J. K. 1983. *Minerals for grazing ruminants in tropical regions*. University of Florida, Gainesville, Florida.

McDowell, L. R., Conrad, J. H. and Ellis, G. L. 1984. Mineral deficiencies and imbalances and their diagnosis. In: F.C.M. Gilchrist and R.J. Mackie (eds), Herbivore nutrition in the subtropics and tropics. The Science Press.

McFarlane, J. D., Judson, J. D. and Gouzos, J. 1990. Copper deficiency in ruminants in the south east of Australia. *Australian Journal of Experimental Agriculture* 30, 187–193.

Meschy, F. 2000. Recent progress in the assessment of mineral requirements of goats. *Livestock Production Science* 64: 9-14.

Minson, D. J. 1981. Nutritional differences between tropical and temperate pastures In: Grazing animals. Disciplinary Approach. World Animal Science Volume 34, Elsevier, Amsterdam, Netherlands. Pp143-157

Minson, D. J. 1984 Digestibility and voluntary intake by sheep of five *Digitaria* species. *Australian Journal of Experimental Agriculture and Animal Husbandry* 24, 494–500.

Minson, D. J. 1990 *Forages in Ruminant Nutrition*. Academic Press, San Diego, California, pp. 208–229.

Muia, J. M. K. 2000. Use of Napier grass to improve smallholder milk production in Kenya PhD Thesis. Wageningen Agricultural University. The Netherlands.

Muyekho, F. N., Cheruiyot, D. T. and Kapkusum, G. 2000. Effects of the "Tumbukiza" method of planting napier grass (*Pennisetum purpureum*) on the quantity and quality of forage on smallholder farms in Kenya. In: Murethi, Gachene, Muyekho, Onyengo, Mose & Magenya (eds). Participatory Technology

Development for soil management by smallholders in Kenya. *Proceedings of the 2nd Scientific Conference of the Soil Management and Legume Research Network Projects June 2000, Mombasa, Kenya 551 pp.*

NRC. 1981. National Research Council. Nutrient requirements of goats, Washington, DC. National academy of Sciences.

NRC.1989. National Research Council. Nutrient requirements of dairy cattle. 7th rev. ed. National Research Council. Washington, DC: National Academy Press, 1989.

NRC. 2001. National Research Council. Nutrient requirements of dairy cattle,7th rev. ed. Washington, D.C.

Olanite, J. A. 2003. Evaluation of selected grass-legume mixtures as feed for weaner calves under traditional cattle management in Ibadan, Nigeria. Ph. D. Thesis. Department of Agronomy, University of Ibadan, Ibadan.

Olanite, J. A., Arigbede, O. M., Jolaosho, A. O. and Onifade, O. S. 2004. Preliminary studies on the comparative effects of a branded organo-mineral fertilizer and N-P-K on the dry matter yield and quality of two Panicum species in Abeokuta, Southwest, Nigeria. Proceedings of 29th Annual Conference of Nigerian Society for Animal Production. March 21-25, 2004, Pp306-309

Omaliko, C. P. E. 1983. Stockpiling of three tropical forage grass species. *Agronomy Journal* 75 (2): 677 – 979

Onayinka, E. A. O. and Akinyemi A. A. 1976. The effects of nitrogen and interval of cutting on the dry matter yield and crude protein content of some guinea grass varieties. 1. Dry matter yield. *Nigerian Agricultural Journal* 13: 36-43

Onyeonagu C. C. and Ugwuanyi, B. N. 2012. Dry matter yield of guinea grass (*Panicum maximum* Jacq) in response to cutting height and nitrogen fertilizer application**.** *International Journal of AgriScience Vol. 2(12): 1084-1092*

Onyeonagu, C. C. 2005. Reclamation of a rundown pasture through improved management. M.Sc. Thesis submitted to the Faculty of Agriculture University of Nigeria, Nsukka 65p.

Onyeonagu, C. C. and Ukwueze, C. C. 2012. Anti-nutrient components of guinea grass (*Panicum maximum*) under different nitrogen fertilizer application rates and cutting management. *African Journal of Biotechnology* 11(9):2236-2240

Onyeonagu, C. C., Obute, P. N. and Eze, S. M. 2013. Seasonal variation in the anti-nutrient and mineral components of some forage legumes and grasses. *African Journal of Biotechnology* 12(2) 142-149

Ørskov, E. R. 1995. Optimizing rumen environment for cellulose digestion. In *Rumen Ecology Research Planning* (eds. R. J. Wallace and A. Lahlou-Kassi). Proceedings of a Workshop held at ILRI, Addis Ababa, Ethiopia, 13-18 March 1995 pp. 177-182.

Shamat, A. M., Babiker, I.A, Mukhtar, A. M. S. and Ahmed, F. A. 2009. Seasonal and Regional Variations in Mineral Content of Some Important Plants Species Selected by Camels (*Camelus dromedaries*) in Arid and Semi-arid Lands (ASAL) of Sudan**.** *Journal of Applied Sciences and Research* 5(10): 1676-1684

Sodeinde, F. G., Asaolu, V. O., Akingbade, A. A., Adeleye, I. O. A., Olabode, O. A. and Amao, S. R. 2006.Feed utilization and growth performance of WAD sheep fed space imposed and nitrogen fertilized Panicum maximum cv T58 in the derived savanna zone. *Research Journal of Biological Sciences* 1(1-4): 93-97

Sousa, J.C. de., 1978. Interrelationships among mineral levels in soil, forage and animal tissues on ranches in Northgen Mato Grosso, Brazil. Ph.D. dissertation, Unv. of Florida, Gainesville, Florida.

Statistical Analysis System Institute Inc., 1999. SAS/ 24. STAT Programme, Carry, NC: SAS Institute Inc.

Sun, X., Luo, N., Longhurst, B. and Luo, J. 2008. Fertiliser Nitrogen and Factors Affecting Pasture Responses. ***The Open Agriculture Journal* 2: 35-42 35**

Taute, A. 2000. The influence of nitrogen fertilization, physiological stage and season on qualitative and quantitative characteristics of P. maximum cv. Gatton for sheep. M.Sc (Agric) Dissertation, University of Pretoria, South Africa 127pp.

Tergas, L. E. And Urrea, G. A. 1985. Effect of fertilization on the yield and nutritive value of tropical forages on an ultisol in Colombia. *Tropical Animal Production* 10:68-75

Thompson, J. K. and Warren, R. W. 1979. Variations in composition of pastures herbage. *Grass and Forage Science* 34, 1979, p. 83-88

Tona, G. 2011. Chemical composition and nutrient digestibility of *Panicum maximum* and *Piliostigma thonningii* leaves fed to West African dwarf rams as dry season feed. *Ozean Journal of Applied Sciences* 4(3) 189-194

Underwood, E. J. 1981. *The mineral nutrition of livestock*. 2nd edition. Commonwealth Agricultural Bureau, London.

Van Soest, P. J. 1982. Nutritional Ecology of the Ruminant: Ruminant Metabolism, Nutritional Strategies, the Cellulolytic Fermentation and the Chemistry of Forages and Plant Fibres, O. & B. Books, Corvallis, Oregon 375 pp

Van Soest, P. J. 1994. Nutritional ecology of the ruminant, 2nd edn. Ithaca, NY USA: Comstock Publishing Associates/Cornell University Press. 476pp

Van Soest, P. J., Robertson, J. B. and Lewis, B. A. 1991. Methods for dietary fibre, neutral detergent fibre and non-starch polysaccharides in relation to animal nutrition. *Journal of Dairy Science* 74 (10): 3583-3597. http://jds.fass.org/cgi/reprint/74/10/3583.pdf

Waskom, R. M. 1994. Best management practices for manure utilization. Colorado State University Cooperative Extension. Bulletin # XCM-174 Pg 5

Received: 20/12/12
Accepted: 03/05/13