ISSN:
Print - 2277 - 0755
Online - 2315 - 7453

Journal of Agricultural Science and Environment

FORAGE YIELD AND NUTRITIVE QUALITY OF TWO GROUNDNUT (*ARACHIS HYPOGAEA* L) VARIETIES AS INFLUENCED BY FERTILIZER TYPES

[1]P.A. DELE, [1]O.B. KASIM, [1]B.T. AKINYEMI, [2]O.KENNETH-OBOSI, [1]F.E. SALAWU, [1]C.C.ANOTAENWERE, [1]A.O. JOLAOSHO AND [1]O.M. ARIGBEDE

[1]Department of Pasture and Range Management, Federal University of Agriculture, Abeokuta, Nigeria
[2]National Horticultural Research Institute, Ibadan, Oyo State, Nigeria
***Corresponding Author**:delepa@funaab.edu.ng **Tel**: 2348062250379

ABSTRACT

This study was carried out to investigate the forage yield and nutritive quality of two groundnut (SAMNUT 22 and local) varieties as influenced by fertilizer type in the humid ecological zone of Nigeria. The study was a 3 x 2 factorial experiment in a split-plot design with the fertilizer type (poultry droppings, NPK and the control) as the main plot and variety (SAMNUT 22 and Local) as the sub-plot which amounts to six treatments with three replicates. The inorganic-fertilized SAMNUT 22 had the highest forage dry matter (DM) yield (10.23 t/ha). The inorganic-fertilized local variety had the highest DM (94.60 %) and the least DM value (93.68 %) recorded for inorganic-fertilized SAMNUT 22. The highest and least crude protein (21.71 % vs 18.28%) contents were recorded for inorganic-fertilized local and unfertilized SAMNUT 22 variety, respectively. The neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) that were recorded for the unfertilized SAMNUT 22 were the highest with values 58.13 %, 25.86 % and 3.35 %, respectively. The highest gas (57.75 ml/200mgDM) production, methane (13.50 ml/200mgDM) and *in vitro* dry matter digestibility (70.22 %) were recorded for unfertilized local variety, unfertilized SAMNUT 22 and organic-fertilized local variety, respectively. The unfertilized SAMNUT 22 had the highest tannin content of 6.43 mg/100g and saponin content of 9.29 mg/100g whereas the organically fertilized Local variety had the highest oxalate (140.65 mg/100g) content. In conclusion, the two varieties and especially SAMNUT 22 when inorganic fertilizer was applied have proved to be good feed resource with regards to high yield, CP and low anti-nutrient quality and are recommended as forage of high nutritive values for ruminant animal production.

Keywords: Fertilizer type, forage yield, nutritive quality, groundnut.

INTRODUCTION

The world population had been noted to have increased in the last two decades and the majority of these increments have been from the tropics where many countries have been noted to be food deficit because of their inability to meet their daily protein requirement (Food and Agriculture Organization, 1993, Aderinola and Adeyemo, 2001). For instance, the Food and Agriculture Organization (FAO, 1991; 1992), recommended that an individual takes 35 g per caput of animal protein per day for sustainable growth and development from 70 g per caput of total protein. FAO (2011) reported that an average Nigerian consumes 7.9 g of animal protein instead of the 35 g recommended. To meet this animal protein requirement, there is the need to improve the nutritional requirement of the main sources of the animal protein, which are basically the ruminant animals (Nuru, 1988).

Generally, forages are considered the cheapest major nutritional component in the diets of this class of animals particularly in rural and sub-urban areas of the tropics (Akinsoyinu and Onwuka, 1988). The forages that supply the nutrition of animals are provided by the natural vegetation, commonly referred to as natural pastures, which for most part of the year do not retain sufficient nutrient and biomass to satisfy the requirements of the animals (Ademosun, 1973; Mohammed-Saleem, 1994). In order to mitigate the problem of poor nutrition for ruminant animals, the uses of sown and purposely managed pastures have been widely suggested (Olanite, 2002; Onifade *et al*., 2005; Dele, 2008). The major portion of the natural pasture are grasses which for most part of the year have less protein content to meet up the nutritional requirements. These therefore, led to the use of forage legumes especially those with dual purpose for human and animal consumption. Forage legumes have played important role in ruminant production in the tropics and with further development they can still play greater roles. Part of the roles these legumes play relates to enhancing intake which is an integral aspect in improving the productivity of the ruminant livestock production. In the tropics, legumes such as cowpea (*Vigna unguiculata*) and groundnut (*Arachis hypogaea*) have gained attention because they have dual purposes (Anele *et al*., 2011, Dube and Fanadzo, 2013, Oteng-Frimpong *et al.*, 2017) and to some extent can be referred to as multi-purpose species because of their usage in soil fertility improvement. One major factor militating against the adoption of sown pasture is the generally low nutrient status of tropical soils, especially nitrogen and phosphorus (Martínez- Sánchez, 2005). Heavy inputs of inorganic fertilizers have been recommended by various researchers in order to achieve reasonable levels of nutritive quality and dry matter yields (Olanite *et al*., 2006; Dele, 2008). Organic fertilizers, which are mainly from animal sources, have been considered to amount to environmental nuisance as they are daily generated from livestock production activities which cause pollution from gas emissions they decay and in some cases through discharge of effluent into water bodies and underground water (Dele, 2012). These manures in some cases have occupied spaces that would have been used for productive and profitable enterprises as well they are reported to be rich in major plant nutrients (Chen *et al*., 2008). The sowing of groundnut solely for fodder production for ruminant consumption has not gained much attention and is scarce in literature as well. This study is focused on evaluating the effect of fertilizer type on the forage yield and nutritive quality of two groundnut varieties in the South western part of Nigeria.

MATERIALS AND METHODS

Experiment sites

The field study was carried out at the Pasture section of the Directorate of University farms and the chemical analysis was in the laboratory of the Department of Pasture and Range Management, Federal University of Agriculture, Abeokuta, Nigeria. The experimental site lies within the savanna agroecological zone of South Western Nigeria (latitude: 7°N, longitude 3.5°E, average annual rainfall: 1037 mm). Abeokuta has a bimodal rainfall pattern that typically peaks in July and September with a break of two to three weeks in August. Temperatures are fairly uniform with daytime values of 28 to 30 ^{o}C during the rainy season and 30 to 34 °C during the dry season with the lowest night temperature of around 24 °C during the harmattan period between December and February. Relative humidity is high during the rainy season with values between 63 and 96 % compared to 55 to 84 % during the dry season. The temperature of the soil ranges from 24.5 to 31.0 °C across the seasons.

Land preparation

The land earmarked for the field study was cleared, followed by ploughing and harrowing after a period of two weeks of ploughing. The experimental land measuring 1,050 m^2 was mapped out after harrowing. After land preparation and before planting, soil samples were randomly collected from the plots at the depth of 0-15 cm using soil auger to represent the topsoil. The samples were bulked per replicate, mixed thoroughly and sub-samples taken for analysis to determine the pre-planting nutrient status of the soil. The soil was analyzed to be made up of sand 75.13 %, silt 16.70 %, clay 5.17 %, pH (in H_2O) 6.9, organic carbon 1.31 %, total nitrogen 0.10 %, available phosphorus (P) 43.82 mg/kg, potassium (K) 0.21 cmol/kg, calcium (Ca) 2.56 cmol/kg, magnesium (Mg) 2.55 cmol/kg and sodium(Na) 0.79 cmol/kg.

Experimental design and plot management

The study was a 3 x 2 factorial experiment in a split-plot design. The main plot dimension was 12 m x 5 m while that of the sub plot was 5 m x 5 m. The fertilizer types were allotted to the main plot and the groundnut varieties to the sub plot. The three fertilizer types (NPK 15:15:15, poultry (layer battery cage) manure with 30:10:10 g/kg of NPK, respectively) and unfertilized (control) and the two varieties of groundnut (SAMNUT 22 and Local) constituted six (6) treatment-combinations with three replicates. The seeds of SAMNUT 22 and local variety were sourced from Institute of Agricultural Research Shika- Zaria, Kaduna State and a local market in Abeokuta, Ogun State, respectively. The rate of fertilizer application was 60 kg P/ha and quantities of the fertilizer were determined based on the phosphorus content and the application was done at the 4th week after planting. The seeds were sown at a spacing of 0.5 m x 0.3 m with 2 seeds per hole. The inter-plot and intra-plot spaces were kept weed-free throughout the experimental period by hand weeding. The fodder (leaves and stems) of the groundnut varieties were harvested at 16 weeks after planting and to determine the dry matter yield a 1 m^2 quadrat was used which was thrown three times within a subplot at 5 cm aboveground level and weighed. Sub samples were taken, weighed and oven – dried at 65 ^{0}C to constant weight and stored for analysis.

Chemical analysis

The determination of the contents of dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE) and ash were according to A.O.A.C. (2000). The content of Non-fibre carbohydrate was calculated as NFC = 100 - (CP+Ash+EE+NDF) and Total carbohydrate (TC) = 100 - (CP+Ash+EE). Neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL) contents were analyzed according to the procedures of Van Soest *et al*. (1991). Cellulose content was taken as the difference between ADF and ADL while value of hemicellulose was calculated as the difference between NDF and ADF. The *in vitro* gas production was determined following the procedure of Menke and Steingass (1988). The Organic matter digestibility (OMD) and Metabolizable energy (ME) were estimated as postulated by (Menke and Steingass, 1988). The values for the Short-chain fatty acids (SCFA) were estimated according to Getachew *et al.* (2000). After 48 hours of incubation, methane was estimated according to the procedure of Babayemi *et al*. (2009).

Tannins were analyzed using the modified Vanillin - HCl method as described by Zia-ul-Haq *et al.* (2007). The oxalate of the sample was determined according to the procedures described by Tuleun and Patrick (2007). Saponins were extracted and estimated according to the methods of Shukla and Thakur (1986).

Statistical analysis

The data generated were subjected to Analysis of Variance using SAS (2000) statistical software and differences in means separated using Duncan Multiple Range Test at (P<0.05) level of probability.

RESULTS

The dry matter (DM) yield of the two groundnut varieties were influenced (P<0.05) by the fertilizer type as well as varietal difference (Figure 1a). The DM yield of the groundnut to which inorganic fertilizer was applied was the highest (8.26 t/ha) and the unfertilized recorded the least yield (5.47 t/ha). There was differential increment in the yield with 10.79 % and 51.00% for the organic fertilized and inorganic fertilized, respectively. The SAMNUT 22 variety recorded a higher DM yield of 7.86 t/ha than the local variety. There was fertilizer type x variety interaction for the DM yield which was significant (P<0.05) (Figure 1b). The DM yield ranged from 4.66 t/ha for the unfertilized local variety to 10.33 t/ha for inorganic-fertilized SAMNUT 22.

The proximate parameters were significantly (P<0.05) affected by the fertilizer type except for the dry matter (DM) and non-fibre carbohydrate (NFC) contents (Table 1). The groundnut to which inorganic fertilizer was applied recorded the highest content of crude protein (21.03 %), while the unfertilized recorded the least protein content. The inorganic fertilized groundnut had superior ash content (9.60 %) and the least ash content was recorded for the organic fertilized. The unfertilized and organically fertilized groundnut recorded the highest values for crude fibre and ether extract, respectively. The local variety had higher (P<0.05) CP, EE and DM contents, while the SAMNUT 22 had higher ash, NFC and total carbohydrate (TC) contents. Significant effect (P<0.05) of interaction was observed between variety and fertilizer type for the proximate parameters. The local variety fertilized with inorganic fertilizer had the highest CP (21.71 %) whereas the SAMNUT 22 receiving same fertilizer had the highest ash (10.20 %) content. The least value of CP was from unfertilized SAMNUT 22. The values of CP of other treatments were similar. The values of EE and NFC were not affected by fertilizer type for SAMNUT 22. Similar observations were recorded for the local variety with values of Ash, NFC and TC.

The effect of fertilizer type was significant (P<0.05) on the fibre composition except for the hemicelluloses (Table 2). The control plot recorded the highest values for NDF, ADF, ADL and cellulose. The values for these parameters were similar in the fertilized plots. The result of the fibre composition showed that the parameters were not significantly (P>0.05) influenced by variety except for the ADF and ADL for which SAMNUT 22 had higher values of 24.56 % and 3.13 %, respectively than that of the local variety. Interaction of variety and fertilizer type was observed to be significantly (P<0.05) affected for all the variables analyzed except for the hemicelluloses content for which the unfertilized SAMNUT 22 recorded the highest values for all variables. The application of fertilizer lowered the values for fibre composition of SAMNUT 22. There appeared to be no differences in the values for local variety across the fertilizer type (Table 2).

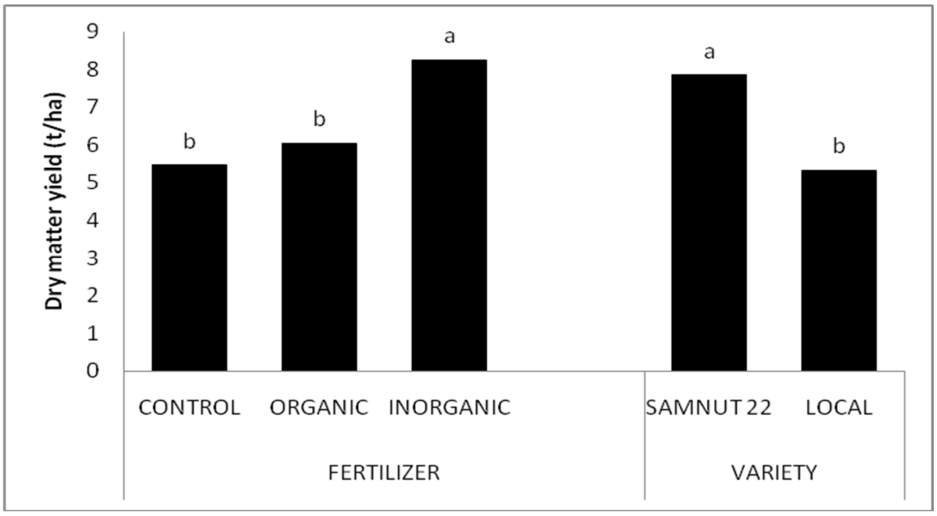

Figure1a: Main effect of fertilizer type and variety on dry matter yield of groundnut

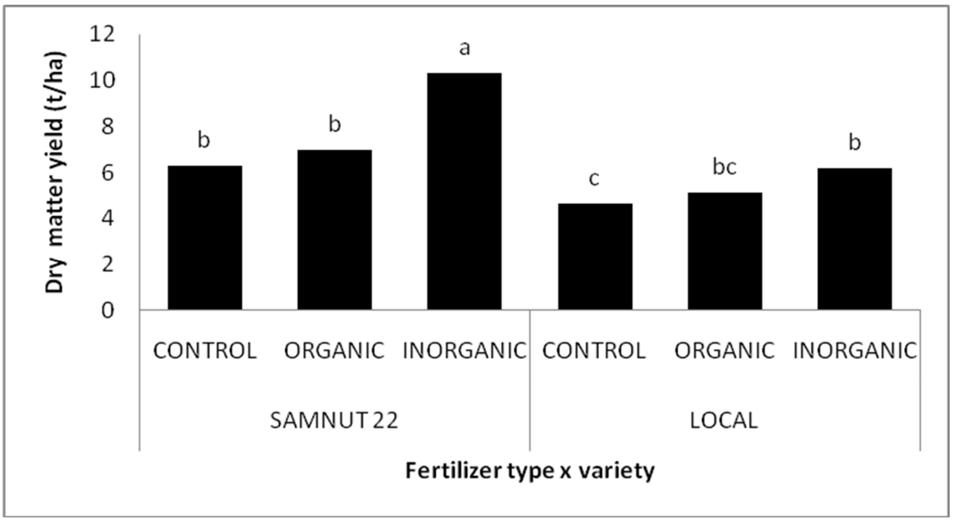

Figure 1b: Interaction effect of fertilizer type and variety on dry matter yield of groundnut

Table 1: Main and interaction effects of Fertilizer types and varieties on the proximate composition (%) of groundnut forage

Variety	Fertilizer type	DM	CP	CF	Ash	EE	NFC	TC
SAMNUT 22		93.99[b]	19.97[b]	15.12	9.50[a]	4.72[b]	8.62[a]	65.81[a]
Local		94.37[a]	20.92[a]	14.88	9.00[b]	5.40[a]	7.53[b]	64.67[b]
SEM		0.09	0.24	0.36	0.07	0.06	0.38	0.29
	Control	94.29	20.00[b]	15.86[a]	9.08[b]	4.90[b]	8.14	66.02[a]
	Organic	94.10	20.31[ab]	15.02[ab]	9.07[b]	5.40[a]	8.53	65.22[ab]
	Inorganic	94.14	21.03[a]	14.12[b]	9.60[a]	4.89[b]	7.55	64.49[b]
	SEM	0.12	0.31	0.37	0.08	0.09	0.47	0.38
SAMNUT 22	Control	94.02[bcd]	18.28[c]	17.64[a]	9.25[b]	4.54[e]	9.79[a]	67.91[a]
	Organic	94.26[abc]	20.40[b]	13.88[b]	9.02[bc]	4.94[cd]	8.78[ab]	65.63[b]
	Inorganic	93.68[d]	21.21[ab]	13.83[b]	10.20[a]	4.68[de]	7.29[ab]	63.89[c]
Local	Control	94.55[ab]	20.83[ab]	14.08[b]	8.90[c]	5.25[b]	6.50[b]	64.13[bc]
	Organic	93.95[cd]	20.21[b]	16.16[a]	9.12[bc]	5.85[a]	8.28[ab]	64.80[bc]
	Inorganic	94.60[a]	21.71[a]	14.40[b]	8.99[c]	5.09[bc]	7.80[ab]	65.08[bc]
SEM		0.07	0.19	0.26	0.07	0.06	0.29	0.24

[a, b, c, d, e]: Means in same column with different superscripts are significantly ($p<0.05$) different
SEM = Standard Error of Mean, DM = Dry matter, CP = Crude protein, CF = Crude fibre, EE = Ether extract, NFC = Non-fibre carbohydrate, TC = Total carbohydrate

The effect of fertilizer type on the fermentation gas production, CH_4 and digestibility was significant ($P<0.05$) (Table 3). The highest gas production (43.12 ml/200mg DM and 57.19 ml/200mg DM,) recorded in this study were for the unfertilized groundnut at 24 and 48 hours of incubation, respectively. However, these were similar to the values for the organic fertilized. The methane production was lowest ($P<0.05$) for inorganically fertilized groundnut while the IVDMD value was highest for the inorganic-fertilized groundnut. The IVOMD was highest in the unfertilized while the least value of SCFA and ME were recorded for the plot which received inorganic fertilizer. The varietal effect on the variables was not significant ($P>0.05$) except for the IVDMD where the Local variety had a higher digestibility value than SAMNUT 22. Significant interactions between the variety and fertilizer type were observed. For both varieties, values of all parameters except IVDMD appeared to decline from the control to organic to inorganic types of fertilizer.

Table 2: Main and interaction effects of Fertilizer types and varieties on the fibre composition (%) of groundnut forage

Variety	Fertilizer type	NDF	ADF	ADL	HEM	CEL
SAMNUT 22		57.19	24.56^{a}	3.13^{a}	32.63	21.43
Local		57.15	24.08^{b}	2.84^{b}	33.06	21.24
SEM		0.21	0.18	0.05	0.19	0.15
	Control	57.88^{a}	25.04^{a}	3.11^{a}	32.84	21.94^{a}
	Organic	56.68^{b}	23.97^{b}	2.87^{b}	32.71	21.10^{b}
	Inorganic	56.94^{b}	23.96^{b}	2.99^{ab}	32.98	20.97^{b}
	SEM	0.21	0.19	0.07	0.23	0.16
SAMNUT 22	Control	58.13^{a}	25.86^{a}	3.35^{a}	32.26	22.51^{a}
	Organic	56.85^{ab}	24.08^{b}	3.12^{ab}	33.10	20.62^{d}
	Inorganic	56.60^{b}	23.75^{b}	2.91^{b}	32.52	21.16^{bcd}
Local	Control	57.64^{ab}	24.22^{b}	2.86^{bc}	33.42	21.36^{bc}
	Organic	56.52^{b}	24.20^{b}	2.61^{c}	32.32	21.57^{b}
	Inorganic	57.28^{ab}	23.84^{b}	3.06^{ab}	33.44	20.77^{cd}
SEM		0.15	0.13	0.04	0.13	0.11

$^{a, b, c, d}$: Means in same column with different superscripts are significantly ($p<0.05$) different
SEM = Standard Error of Mean, NDF = Neutral detergent fibre, ADF = Acid detergent fibre, ADL = Acid detergent lignin, HEM = Hemicellulose, CEL = Cellulose

The anti-nutritional factors (ANFs) were significantly ($P<0.05$) influenced by the fertilizer type and varietal differences (Table 4). The unfertilized groundnut recorded the highest Tannin and oxalate contents. On the other hand, those which received inorganic fertilizer had the least values of the ANFs. The organic fertilized groundnut had the highest Saponin contents. The SAMNUT 22 recorded higher Tannin and saponin contents while the oxalate content was higher in the Local variety. For all the variables, significant effect of interaction was observed between the variety and fertilizer type, with the unfertilized SAMNUT 22 recording the highest Tannin and Saponin contents. The least contents of Tannin and Oxalate were recorded in the Local variety which received inorganic fertilizer.

Table 3: Main and interaction effects of fertilizer types and variety on the *in vitro* gas production (ml/200mgDM), methane (ml) and post incubation parameters of groundnut forage

Variety	Fertilizer Type	GV		CH_4	CH_4:GV48	IVDMD	IVOMD	SCFA	ME
		24hr	48hr	ml					
SAMNUT 22		38.00	50.87	10.71	20.65	67.08^{b}	63.83	0.85	7.48
LOCAL		36.37	49.00	9.50	18.65	68.79^{a}	62.49	0.81	7.26
SEM		2.33	2.30	0.85	1.16	0.22	1.44	0.04	0.22
	Control	43.12^{a}	57.19^{a}	13.00^{a}	22.65^{a}	67.50^{b}	68.13^{a}	0.97^{a}	8.17^{a}
	Organic	37.50^{a}	49.31^{ab}	9.94^{ab}	20.30^{ab}	67.93^{ab}	63.26^{ab}	0.84^{a}	7.41^{a}
	Inorganic	30.94^{b}	43.31^{b}	7.37^{b}	16.01^{b}	68.38^{a}	58.09^{b}	0.68^{b}	6.52^{b}
	SEM	1.63	2.53	0.88	1.25	0.33	1.48	0.16	0.22
SAMNUT 22	Control	43.50^{a}	56.62^{a}	13.50^{a}	23.99^{a}	67.02^{cd}	67.80^{a}	0.98^{a}	8.21^{a}
	Organic	37.50^{abc}	48.75^{ab}	10.25^{ab}	21.05^{ab}	66.54^{d}	63.27^{ab}	0.84^{abc}	7.41^{abc}
	Inorganic	33.00^{bc}	47.25^{ab}	8.37^{ab}	16.91^{ab}	67.67^{c}	60.41^{ab}	0.73^{bc}	6.80^{bc}
LOCAL	Control	42.75^{ab}	57.75^{a}	12.50^{a}	21.30^{ab}	68.84^{b}	68.45^{a}	0.96^{ab}	8.13^{ab}
	Organic	37.50^{abc}	49.87^{ab}	9.62^{ab}	19.56^{ab}	70.22^{a}	63.25^{ab}	0.84^{abc}	7.41^{abc}
	Inorganic	28.87^{c}	39.37^{b}	6.37^{b}	15.11^{b}	67.32^{cd}	55.78^{b}	0.63^{c}	6.24^{c}
SEM		1.18	1.66	0.60	0.83	0.21	1.03	0.03	0.16

a, b, c, d: Means in same column with different superscripts are significantly ($p<0.05$) different

SEM = Standard Error of Mean, IVDMD = *In vitro* dry matter digestibility (%), IVOMD = *In vitro* organic matter digestibility (%), SCFA = Short-chain fatty acids (μmol/g DM), ME = Metabolizable energy (MJ/kgDM)

GV = Gas volume at 24 and 48 hours

Table 4: Main and interaction effects of fertilizer types and variety on the anti nutritional factors (mg/100g) of groundnut forage

Variety	Fertilizer	TANNIN	SAPONIN	OXALATE
SAMNUT 22		5.15[a]	7.65[a]	126.97[b]
LOCAL		2.93[b]	6.43[b]	129.45[a]
SEM		0.32	0.42	0.87
	Control	4.94[a]	6.99[b]	134.70[a]
	Organic	3.92[b]	7.09[a]	130.07[b]
	Inorganic	3.27[c]	7.05[a]	119.85[c]
	SEM	0.49	0.42	4.19
SAMNUT 22	Control	6.43[a]	9.29[a]	129.35[c]
	Organic	4.18[c]	7.05[d]	119.50[d]
	Inorganic	4.84[b]	6.61[e]	132.05[b]
LOCAL	Control	3.44[d]	4.69[f]	140.05[a]
	Organic	3.66[d]	7.13[c]	140.65[a]
	Inorganic	1.69[e]	7.49[b]	107.65[e]
SEM		0.35	0.33	2.82

[a, b, c, d, e,f]: Means in same column with different superscripts are significantly ($p<0.05$) different
SEM = Standard Error of Mean

DISCUSSION

The dry matter yield of SAMNUT 22 in this study was lower than 11.7t/ha reported for same variety in Ghana (Oteng-Frimpong *et al*, 2017). This difference could be attributed to the management practice employed. The difference in the dry matter yield as influenced by fertilizer application could be attributed to the fact that fertilizer stimulates multiplication of cells leading to more yield as against the unfertilized in this study. The better yield from the inorganic fertilized plot was corroborated by Kanonge *et al*. (2015) when different organic and inorganic fertilizers were applied to soybean and cowpea that inorganic fertilizer mineralizes faster and result in better yield (Kimiti *et al*., 2009). Nitrogen has been reported to promote shoot and leaf growth and is precursor for biomass accumulation (Lunze *et al*., 2012). The low yields recorded for the unfertilized plot of both varieties could be attributed to the inherent low soil fertility that tropical soil soils are known for (Kimiti *et al*., 2009). The multi-nutrient nature of the fertilizer applied might be considered as the basis for difference in the yield according to

Nabinger (2001) that nitrogen increases the biomass of the forage peanut, which is due to the increase in carbon fixation, and nitrogen is a controller of different processes of growth and development of plants.

The yields of the fertilized plots in this study were higher than those reported Larbi *et al.* (1999) for thirty eight cultivars to which 300 kg P_2O_5 ha^{-1} was applied, the herbage differential might be attributed to the multi-nutrient fertilizer types used in this study.

The CP values in this study were higher than 10-12 % reported as good for moderate ruminant production (Gatenby, 2002) and 10-13 % which was the range suggested as adequate for maintenance and growth of beef cattle (National Research Council, 1996). The CP content was higher than the minimum value required for efficient rumen microbial function. The CP values of groundnut in this study were higher than the average value reported by Samireddypalle *et al.* (2017) for groundnut haulms across Nigeria. The difference in the CP values might be due to varietal or harvesting technique employed. The CP recorded falls within the range reported by Kaasschieter *et al.* (1998) and Anele *et al.* (2011) for cowpea haulms. The superiority in the CP values of the fertilized groundnut over the unfertilized was supported by Siam *et al*. (2015) and could be as a result of increase in amino acid and protein synthesis as suggested by Dupas *et al.* (2016).

The CP (18.28-21.71 %) content of the groundnut varieties in this study was higher than 15.2-16.0 % reported by Johnson *et al*. (1979). This difference could be attributed to the harvesting of the fodder in this study which did not include the subterranean part of the plant. This also fell within the CP range (15-22 %) reported for dried fresh forage peanut (Eckert. 2008 and Foster, 2008).

The NDF values of groundnut forage in this study fell within the range (52-59 %) reported by Etela and Dung (2011) for six improved dual purpose groundnut to which 300 kg P_2O_5 ha^{-1} was applied. The reduction in NDF content with fertilizer application especially to SAMNUT 22 in this study corroborated the study of Cherney *et al*. (1988) that nitrogen fertilization lead to reduction in NDF content of forages. This decrease in the NDF value has been associated with its relationship with CP which increased with N fertilizer application as well as other soluble contents (Peyraud and Astigarraga, 1998). The NDF content recorded in this study was lower than the range of 60-65 % suggested as the critical limit above which efficiency of utilization of tropical forages by ruminants would be impaired (Van Soest, 1982; Muia, 2000) The moderate fibre levels in this study will be of help in facilitating the colonization of ingesta by rumen microorganism which in turn might induce higher fermentation rates, hence improving digestibility, intake and animal performance. The decrease in the ADF value with fertilizer application in this study might be due to the dilution of the cell wall (Peyraud and Astigarraga, 1998; Dupas *et al.*, 2016).

The results from this trial, particularly for the Local variety, showed that the gas volume from the unfertilized groundnut was higher than those which were fertilized. This might be due to the fermentation of protein in the fertilized forage as higher nitrogen content cause the production of ammonia which inhibits the CO_2 release from the carbonate buffer (Cone *et al*., 1997). The apparent increase in the IVDMD values of the fertilized groundnut though not observed in the interactions would have probably been caused by the lower contents of NDF, ADF and lignin as reported by Cui *et al.* (2016). The IVOMD values in this study were higher than those reported by Samireddypalle *et al.* (2017) for groundnut haulms. This difference could be attributed to the quality of the forage as might have been enhanced by fertilizer application. Reduction in CH_4 production with fertilizer application in this study was similar to the studies of Takahashi and Young (1991) and Sar *et al.* (2002). Thus it was expected that application of fertilizer would result in a reduction of gas production and CH_4.

The decrease in the tannin content of the Local variety of groundnut with reference to the fertilized compared to the control is in line with the report of Kraus *et al*. (2004) which states that under condition of low nutrient availability, the content of tannin is higher than when high nutrient is available. The variation in the tannin content between SAMNUT 22 and the Local variety could be attributed to the effect of genotype (Hirpa *et al*., 2015). Tannin has been reported to have both positive and negative benefits to livestock (Hagerman and Butler, 1991). The Tannin content recorded in this study has been considered to be beneficial as is less than <50 gCTs kg^{-1} as reported by Min *et al*. (2003). The negative impact of Tannins had been linked to depression in feed intake in animals, unavailability and binding up of dietary protein and reduction in digestibility of such feed containing deleterious tannin (Aletor, 1993). The higher values of saponin for the fertilized Local groundnut variety in this study was in line with the result of Clemensen (2018) that reported the increase in the saponin content of *Medicago sativa* with the application of organic and inorganic fertilizers. The saponin contents of all samples under study were lower than the tolerable level reported by Onwuka (1983) for goats (1.5-2.0 %). The bitter taste associated with saponin (Kumar, 2003) which was been linked to lowered palatability might have less impact on samples in this study because of the low saponin content recorded. The oxalate contents recorded in this study were low compared with the range of oxalate (0.54 to 0.82 %) (Ologhobo, 2012) for forage legumes. Oxalates affect calcium (Ca) and magnesium (Mg) metabolism in ruminants (Onwuka, 1983; 1996; Hang *et al*., 2011). From the oxalate contents in this study, animals fed groundnut haulms of the two varieties will not be exposed to oxalate poisoning as reported by Ogunka-Nnoka and Mepba (2008) as they have lower oxalate contents.

CONCLUSION

In conclusion, inorganic-fertilized SAMNUT 22 had the highest forage dry matter yield with crude protein content above 20 %. Invariably, both SAMNUT 22 and Local varieties are promising feed resources for ruminant livestock production as they have potentials to meet the nutritional requirement of all classes of ruminants.

REFERENCES

Ademosun, A. A. 1973. Nutritive evaluation of Nigerian forages. The effect of stage of maturity on the nutritive value of Guinea grass (*Panicum maximum*). *Nigerian Agricultural Journal* 10: 170-177.

Aderinola, E. A., Adeyemo, A. A. 2001. "A Socioeconomic Study of Freshwater Fish Production in Osun State of Nigeria", *Applied Tropical Agriculture* 6(1):57-62.

Akinsoyinu, A. O., Onwuka, C. F. I. 1988.

Mineral constituents of some browse plants used in ruminant feeding in Southern Nigeria. *Nigerian Journal of Animal Production* 15:57-62.

Aletor, V.A. 1993.. Allelochemicals in plant foods and feeding Stuffs. Part I. Nutritional, Biochemical and Physiopathological aspects in animal production. *Veterinary and Human Toxicology* 35(1): 57-67.

Anele,U.Y., Südekum, K.H., Hummel,J., Arigbede, O.M., Oni, A.O., Olanite, J.A., Böttger, C., .Ojo, V.O Jolaosho. A.O. 2011. Chemical characterization, in vitro dry matter and ruminal crude protein degradability and microbial protein synthesis of some cowpea (*Vignaunguiculata* L. Walp) haulms varieties. *Animal Feed Science and Technology* 163:161–169.

AOAC (2000) Official Methods of Analysis. 17th Edition. The Association of Official Analytical Chemists, Gaithersburg, MD, USA.

Babayemi, O.J., Bamikole, M.A., Daodu, M.O. 2009. *In vitro* Gas Production and its Prediction on Metabolizable Energy, Organic Matter Digestibility and Short Chain Fatty Acids of Some Tropical Seeds. *Pakistan Journal of Nutrition* 8: 1078-1082.

Chen, M., Chen, J., Sun F. 2008. Agricultural phosphorus flow and its environmental impacts in China. Science of the Total Environment 405(1-3):140-152

Cherney, J.H., Johnson, K.D., Volence, J.J., Anliker, K.S. 1988. Chemical composition of herbaceous grass and legume species grown for maximum biomass production. *Biomass* 19:215-238

Clemensen, A. K. 2018. "Understanding Plant Secondary Metabolites; Above and Below Ground". All Graduate Theses and Dissertations. 7090. https://digitalcommons.usu.edu/etd/7090

Cone, J.W., van Gelder, A.H., Driehuis, F. 1997. Description of gas production profiles with a three-phasic model. *Animal Feed Science and Technology* 66:31–45.

Cui, J. H., Yang, H. J., Yu, C. Q., Bai, S., Song, S. S., Wu, T. T., Sun, W., Shao, X. M., Jiang, L. S. 2016. Effect of urea fertilization on biomass yield, chemical composition, in vitro rumen digestibility and fermentation characteristics of forage oat straw in Tibet of China. *Journal of Agricultural Science* 154: 914–927

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.

Dele, P. A. 2012. Evaluation of dry matter yield and nutritive quality of forage, hay and silage produced from three grasses fertilized with animal manures. Ph.D. Thesis, Federal University of Agriculture, Abeokuta. 263pp

Dube, E., Fanadzo, M. 2013. Maximising yield benefits from dual-purpose cowpea. *Food Security* 5:769-779.

Dupas, E., Buzetti, S., Rabêlo, F. H. S., Sarto, A. L., Cheng, N. C., Teixeira Filho, M. C. M., Galindo, F. S., Dinalli, R. P., Gazola, R. de N. 2016.Nitrogen recovery, use efficiency, dry matter yield, and chemical composition of palisade 5 grass fertilized with nitrogen sources in the Cerrado biome. *Australian Journal of Crop Science* 10(9):1330-1338.

Eckert, J. V. 2008. Digestibility and nutrient retention of perennial peanut and bermudagrass hays for mature horses. Master's Thesis, Dept. of Animal Sciences, University of Florida, Gainesville, USA.

Etela, I., Dung, D.D. 2011. Utilization of stover from six improved dual-purpose groundnut (*Arachis hypogaea* L.) cultivars by West African dwarf sheep. *African Journal of Food, Agriculture, Nutrition and Development* 11 (1): 4538-4545

Food and Agriculture Organization (FAO) 1991. *Fish for Food and Employment*. Food and Agriculture Organization, Rome, Italy

Food and Agriculture Organization (FAO) 1992. The state of food security in the world. Progress Report on World Food Hunger, Rome

Food and Agriculture Organization (FAO) 1993. Livestock and improvement of pasture, feed and forage. FAO Committee on Agriculture, 12th Session, Item 7, 26 April to 4 May 1993, Rome, Italy. 19 pp.

Food and Agriculture Organization (FAO) 2011. Country profile: Food security indicators. Country: Nigeria.

Foster, J. L. 2008. Improving the productivity of livestock with warm-season legumes. Ph. D. Dissertation, University of Florida, Gainesville, USA.

Gatenby, R. M. 2002. Sheep. The Tropical Agricultural Series. McMillan publishers. Pp. 408-515.

Getachew, G., Makkar, H. P. S., Becker, K. 2000. Stoichiometric relationship between short chain fatty acid and *in vitro* gas production in presence and absence of polyethylene glycol for tannin containing browses. In: EAAP Satellite Symposium, Gas Production: Fermentation Kinetics for Feed Evaluation and to Assess Microbial Activity, Wageningen, August 18–19, pp. 46–47.

Hagerman, A.E., Butler, L.G. 1991. Tannins and Lignins. In: *Herbivores: Their Interactions with Secondary Plant Metabolites* Rosenthal, G.A. and Berenbaum, M.R., (Eds.). Vol. I: The Chemical Participants, Academic Press, New York, 355-388.

Hang, D.T., Binh, L.V., Preston, T.R., Savage, G.P. 2011. Oxalate content of different taro cultivars grown in Central Viet Nam and the effect of simple processing methods on the oxalate concentration of the processed forages. *Livestock Research for Rural Development* 23(6):387-391.

Hirpa, L., Nigussie-Dechassa, R., Setegn, G., Bultosa, G. 2015. Chemical quality of common beans as influenced by genotype and Aluminium rates under two soil liming regimes. *African Journal of Food, Agriculture, Nutrition and Development* 15 (2):9872-9891

Johnson, J.C., Butler, J.L., Williams, E.J. 1979.Composition and Nutritive Value of Whole Plant Peanuts (*Arachis hypogaea* L.) Ensiled with and without Propionic Acid-Formaldehyde Treatment. *Journal of Dairy Science* 62:1258--1263

Kaasschieter, G.A., Coulibaly, Y., Heitkonig, I.M.A., Ketelaars, J.J.M.H. 1998. "Supplementation of cattle: a necessity. [Lasupplementationdubétail: une nécéssité!],"in *L'intensification Agricoleau Sahel*, eds H. Bremanand K. Sissoko (Paris:Karthala),79–105.

Kanonge, G., Mtambanengwe, F., Manzeke, M.G., Nezomba, H., Mapfumo, P. 2015. Assessing the potential benefits of organic and mineral fertiliser combinations on legume productivity under smallholder management in Zimbabwe. *South African Journal of Plant and Soil* 32(4): 241-248

Kimiti J.M. Odee, D.W., Vanlauwe, B. 2009. Area under grain legumes cultivation and problems faced by smallholder farmers in legume production in the semi-arid eastern Kenya. *Journal of Sustainable Development in Africa* 11 (4): 305- 315.

Kraus, T.E.C., Zasoski, R.J., Dahlgren, R.A. 2004. Fertility and pH effects on polyphenol and condensed tannin concentrations in foliage and roots. *Plant and Soil* 262**:** 95–109,

Kumar, R. 2003. Antinutritive factors, the potential risks of toxicity and methods to alleviate them. http://www.fao.org/DOCREP10031T0632E/T0632E10.htm

Larbi, A., Dung, D. D., Olorunju, P. E., Smith, J. W., Tanko, R. J., Muhammad, I. R., Adekunle, I. O. 1999. Groundnut (*Arachis hypogaea*) for food and fodder in crop-livestock systems: forage and seed yields, chemical composition and rumen degradation of leaf and stem fractions of 38 cultivars. *Animal Feed Science and Technology* 77 (1-2): 33-47

Lunze, L., Abang, M.M., Buruchara, R., Ugen, M.A., Nsharwasi, U., Nabahungu N.L 2012. Integrated soil fertility management in bean-based cropping systems of Eastern, Central and Southern Africa. In: *Soil Fertility Improvement and Integrated Nutrient Management* 13: 240-271.

Martínez-Sánchez, J. L. 2005. Nitrogen and phosphorus resorption in a neotropical rain forest of a nutrient rich soil. *Revista de Biologia Tropical* 53: 353-359.

Menke, K. H., Steingass, H. 1988. Estimation of the energetic feed value from chemical analysis and *in vitro* gas production using rumen fluid. *Animal Research and Development* 28: 7-55

Min, B.R., Barry, T.N,, Attwood, G.T., McNabb, W.C, 2003. The effect of condensed tannins on the nutrition and health of ruminants fed fresh temperate forages: a review. *Animal Feed Science and Technology* 106:3–19 (2003).

Mohammed-Saleem, M. A. 1994. Evaluation of Stylosanthes for pasture development: An overview of ILCA's experience in Nigeria. In: De Leeuw, P.N., Mohammed-Saleem, M. A., Nyamu, A.M. (Eds.), Stylosanthes as a Forage and Fallow Crop. Proceedings of the Regional Workshop on the Use of Stylosanthes in West Africa. Kaduna, Nigeria, October 23–31, 1992, pp. 17–23.

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

Nabinger, C. 2001. Defoliation management In: Symposium on Pastagem Management, 14., Piracicaba. Anais ... Piracicaba:

Agrarian Studies Foundation "Luiz de Queiroz" p.192-210

NRC (National Research Council) 1996. Nutrient Requirements of Beef Cattle, 7th edn. National Academy of Science, Washington, DC, USA.

Nuru, S. 1988. Research and development in pastoral production system in Nigeria: Past, present and future. An invited paper presented at the National Conference on Pastoralism in Nigeria held from 26 – 29th June, 1988. NAPRI, A. B. U., Zaria, Nigeria.

Ogunka-Nnoka, C.U., Mepba, H.D. 2008. Proximate composition and antinutrient contents of some common species in Nigeria. *Open Food Science Journal* 2:62-67.

Olanite, J. A. 2002. 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., Onifade, O. S., Alabi, B. O. 2006. Effect of cutting intervals on the dry matter yield and nutritive quality of two varieties of *Panicum maximum* in the humid zone of Nigeria. *ASSET Series A* 6 (1): 171-180.

Ologhobo, A.D. 2012. Mineral and antinutritional contents of forage legumes consumed by goats in Nigeria. www.fao.or/wairdocs/ILRI/x548913/ x5489b0o.htm

Onifade, O. S., Olanite, J. A., Jolaosho, A. O., Arigbede, O. M., Tijani, N. K. 2005. Response of guinea grass (*Panicum maximum*) to application of cow dung in South West, Nigeria. In: Proceedings of the XX International Grassland Congress in Dublin Ireland from 26th June to 1st July 2005. Edited by F. P. O'Mara, R. J. Wilkins, L. t'Mannetje, D. K. Lovett, P. A. M. Rogers and T. M. Boland. Pp. 396.

Onwuka, C.F.I. 1983. Nutritional evaluation of some Nigerian browse plants in the humid tropics. PhD. Thesis. University of Ibadan, Ibadan, Nigeria

Onwuka, C.F.I. 1996. Plant phytates, oxalates and their effects on nutrient utilization by goats. *Nigerian Journal of Animal Production* 23(1):53-60.

Oteng-Frimpong, R., Konlan, S.P., Denwar, N.N. 2017. Evaluation of Selected Groundnut *(Arachis hypogaea* L.*)* Lines for yield and haulm nutritive quality traits. *International Journal of Agronomy* 2017: 1-9, doi: 10.1155/2017/7479309.

Peyraud, J., Astigarraga, L. 1998. Review of the effect of nitrogen fertilization on the chemical composition, intake, digestion and nutritive value of fresh herbage: Consequences on animal nutrition and N balance. *Animal Feed Science and Technology* 72: 235–259.

Samireddypalle, A., Boukar, O., Grings, E., Fatokun, C.A., Kodukula, P., Devulapalli, R., Okike, I., Blümmel, M. 2017. Cowpea and Groundnut Haulms Fodder Trading and Its Lessons for Multidimensional Cowpea Improvement for Mixed Crop Livestock Systems in West Africa. *Frontier of Plant Science* 8:30. doi: 10.3389/fpls.2017.00030.

Sar, C., Santoso, B., Zhou, X.G., Gamo, Y., Koyama, A., Kobayashi, T., Shiozaki,

S., Takahashi, J. 2002. Effects of β1-4 galacto-oligosaccharide (GOS) and *Candida kefyr* on nitrate induced methemoglobinemia and methane emissions in sheep. In: *Greenhouse Gases and Animal Agriculture*. Takahashi J. and Young B.A. (eds), pp. 179–183. Amsterdam, The Netherlands: Elsevier Science.

SAS (2000) SAS Institute Inc. SAS/E-miner 3.0 program. SAS Institute Inc., Cary, North Carolina.

Shukla, A.Y., Thakur, R, 1986. Saponins and other antinutrients from rhizomes of *Panax pseudogenating*. *Phytochemistry* 25: 2201-2203.

Siam, H.S. , Mahmoud, S.A., Taalab, A.S., Shaban, K.A. 2015. Evaluation of Nitrogen Levels and Application Methods with or without compost on Yield and Quality of Peanut under the Newly Reclaimed Soils. *International Journal of ChemTech Research* 8(2):1-12.

Takahashi, J., Young, B.A. 1991. Prophylatic effect of L-cysteine on nitrate-induced alterations in respiratory exchange and metabolic rate in sheep. *Animal Feed Science and Technology* 35: 105–113.

Tuleun, C.D., Patrick, J.P. 2007. Effect of duration of cooking *Mucuna utilis* seeds on proximate analysis, levels of antinutritional factors and performance of broiler chickens. *Nigerian Journal of Animal Production* 34: 45-53.

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., Robertson, J. B., 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.

Zia-ul-Haq, M., Iqbal, S., Ahmad, S., Imran, M., Niaz, A., Bangher, M.I. 2007. Nutritional and compositional study of Desi chickpea (*Cicer arietinum* L.) cultivars grown in Punjab, Pakistan. *Food Chemistry* 105: 1357-1363.

(Manuscript received: 10th February, 2020; accepted: 25June, 2020).