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EFFECT OF FERTILIZER TYPES ON YIELD AND QUALITY OF NAPIER (*Pennisetum purpureum*) GRASS ESTABLISHED IN MAKURDI AND HARVESTED AT DIFFERENT GROWTH STAGES DURING THE WET SEASON

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ABSTRACT

Organic fertilizers may be alternatives to inorganic sources for improved pasture productivity. This research investigated the comparative performance of *Pennisetum purpureum* pasture as affected by use of organic and inorganic fertilizer types and sampled at different ages during the wet season. The study was a factorial experimental arrangement (4 x 3) laid out as split plot design with six replicates. The two factors were fertilizer type (control-no fertilizer, Urea, Poultry droppings and cow dung) and harvesting age (60, 90 and 120 days). Fertilizer application was at the rate of 300 kg/ha in two and three equal split applications for organic and urea fertilizers, respectively. Data collected were subjected to analysis of variance using SPSS version 23 at 5% probability level. Dry matter yield was not influenced ($p>0.05$) by all the factors in this experiment. Plant height increased ($p<0.05$) in pasture fertilized with urea compared to other organic fertilizers, while number of leaves and length reduced ($p<0.05$) in pasture fertilized with cattle manure only. Tiller diameter was higher ($p<0.05$) in pastures fertilized with urea compared to organic fertilizer. All chemical parameters measured were not affected ($p>0.05$) by the different sources of fertilizer used, but crude protein and ash content reduced ($p<0.05$) with increasing age, while crude fibre, nitrogen free extract, neutral detergent fibre and acid detergent fibre were increased ($p<0.05$) with increasing age of sampling. This study established that use of poultry droppings compared favourably with urea fertilizer and may be the alternative source of fertilizer for urea.

Keywords: Napier, Urea, Poultry droppings, Cow dung, Chemical composition, Morphological parameters

INTRODUCTION

There are 92.4 million hectares of land in Nigeria out of which about 44% are under permanent pastures supporting over 101 million ruminant population in Nigeria. From the land available for grazing, its domestic ruminants of over 101million. It is estimated that, only about 3% of this number of animals are reared on improved pastures, while the remaining 97% are raised on low nutrient native pastures and farmlands under the open grazing systems (Kubkomawa and Kenneth-Chukwu, 2019). However, livestock productivity in Nigeria when compared to the livestock potential is low due to the attributes of inefficient nutritional and management practice. Attempts must be made to improve on feed supply for the growing ruminant population through establishment and adoption of management practices that will enhance the yield and quality of pastures for livestock development.

The over reliance on low quality natural pasture for feeding ruminant will mean the animals will not have sufficient and balanced nutrients from natural pasture. Also crop residues which are substitute to natural pastures in the dry season are also high in fibre with low protein content (Gashaw and Defar, 2017). Therefore, to minimize such kinds of feed challenges, it is important to produce improved forages with fertilization rather than depending on natural pasture and crop residue and this makes the productions stable improved forage in the livestock sector is important. For that reason, the application of fertilizer to Napier grass that was established in Makurdi is important to increase the biomass and quality of the pasture. The report of Talukder *et al.* (2021) has suggested that Napier grass require high fertilizer input to enhance the yield and quality. Among the various factors, fertilizer application and the age of the plant are important indices which directly contributes to the quality and quantity of fodder production. Application of fertilizer gradually increased plant height, stem diameter, number of leaves per plant, leaf area per plant and fodder yield (Khalid *et al*., 2003) Hence, Napier grass (*Pennisetum purpureun*) are known for their higher plant height, biomass yield and nutritional values, and the application of fertilizer to enhance the forage yield and quality (Mihret *et al*., 2018).

However, the existing inorganic fertilizers in the market are often very expensive especially to small scale farmers. On the other hand, there is an abundance of unutilized animal manure, which can also be used to increase fodder yields. The use of organic fertilizers must not compromise the effect that inorganic sources will bring to the yield and quality of the pasture. This is why this study investigated the effect of both inorganic and organic sources of fertilizer on the morphological and biomass yield, and chemical composition of Napier grass established in Makurdi.

MATERIALS AND METHODS

Description of the study area

The study was conducted at the pasture unit of the College of Animal Science Teaching and Research Farm, Joseph Sarwuan Tarka University, Makurdi (Latitude 7º44'01" N and Longitude 8º31'17" E). Makurdi falls within the Guinea savanna agro-ecological zone of North Central Nigeria. It experiences a tropical climate with prominent wet and dry seasons characterized by an average annual rainfall of 1290 mm and a daily temperature of 40ºC maximum and a minimum of 22.5ºC (Ekhuemelo *et al*., 2019). Soil chemical-physical properties of the experimental sites with its description for soil depth of 0-20 cm are presented in Table 1.

Experimental design and arrangement

A total land area of 2184 m^2 was mapped out for this experiment. The study was a factorial experimental arrangement (4 x 3) laid out as split plot design with six replicates. The dimension of the main plot was 6 m x 8 m, while that of subplot was 2 m x 2 m. The layout was such that there were four main plots arranged in a block with a spacing of 1 m between plots and 2 m between blocks. The layout had a total of six blocks and 24 plots. The Napier grass was planted in rows with 75 cm spacing between rows and 50 cm within rows. There were twelve treatments obtained from the two factors including fertilizer type (4) and harvesting age (3). Fertilizer treatments were allotted to the main plots while harvest age was allotted to sub plots. The fertilizer types were Control (No fertilizer application), Urea, Poultry droppings and cow dung. These were applied at the rate of 300 kg/ha in two equal split application (before planting and after 60 days of planting). Urea (inorganic sources) was applied three times during the experiment (before, 60 and 90 days after planting. The Napier grass was sampled at 60, 90 and 120 days of age during the experiment.

Sampling and harvesting of forage materials

Data on morphological parameters and harvesting of forage materials were sampled 60, 90 and 120 days. From each subplot, 5 plants were randomly selected and sampled for plant height, number of tillers, tiller diameter, number of leaves, leaf length and leaf width. Plant height was estimated using measuring tape by taking the height of the plant from the base to the tip of the tallest leaf. Number of tillers and leaves were counted from each plant sampled. Tillers which had at least one visible leaf were counted. Tiller diameter, leaf length and leaf width were estimated using a measuring tape and expressed in centimeters. Leaf width and length measured for the central leaf at center of the leaf for selected plants. All fodder from the five representative samples were cut and weighed at the field using a spring balance to estimate the fresh yield. Thereafter, 400 g sub-samples from the cut forage were taken, packed in brown envelopes and oven dried at 65 ℃ to constant weight. Dry matter yield was computed by multiplying fresh matter yield by dry matter percent of the dried forage, and these were converted dry mater yield/ha. After drying, samples were ground to pass a 2 mm sieve using milling machine and kept for further chemical analysis.

Determination of chemical composition

The contents of crude protein (CP), ether extract (EE) and ash and crude fibre were determined according to AOAC (2005). Nitrogen free extract (NFE) was estimated from the equation %NFE= 100 – (%moisture + % crude fibre + % crude protein + % ether extract + % ash) Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined according to Van Soest *et al.* (1991).

Statistical analysis

The field and laboratory data collected were subjected to analysis of variance using SPSS version 23 and significant means were separated using Duncan's Multiple Range Test (contained in the statistical software) at 5% probability level.

RESULTS AND DISCUSSION

Soil chemical and physical properties of experimental site

The chemical and physical properties of the experimental site is represented in Table 1. The physical properties indicate that the textural class of the soil is sandy-loam, and this is suitable for forage production. The pH of soil is 6.61, which is slightly acidic in nature and may be a favorable pH for microbial activities in the soil. Ewetola *et al*. (2020) has reported that pH of 6.5 is favorable for activities of microbes in the soil. Other chemical properties of the experimental site indicate 1.65% organic carbon, 2.86% organic matter, 0.51% nitrogen, 5.91% phosphorus with 85.83% base saturation. The exchangeable base, exchangeable acid and cation exchange capacity for the experimental site was 6.78, 1.1 and 7.86 centimole/kg, respectively.

Table 1: Soil Chemical and Physical Properties of the Experimental Sites

Properties	Quantity in Soil
Physical properties	
Sand	68.81
Clay	19.30
Silt	11.23
Textural class	Sandy Loam
Chemical Properties	
pH	6.61
Organic Carbon (%)	1.65
Organic Matter (%)	2.86
Total Nitrogen (%)	0.51
Total Phosphorus (%)	5.91
Base Saturation (%)	85.83
Exchangeable Cation (Centimole)	
Potassium	0.32
Sodium	0.38
Magnesium	3.1
Calcium	3.2
Exchangeable Base (Centimole/kg)	6.78
Exchangeable Acid (Centimole/kg)	1.1
Cation Exchange Capacity (Centimole/kg)	7.86

Effect of fertilizer types and age of harvesting on the yield and morphological parameters of Napier grass established in Makurdi

The effect of fertilizer type, age of harvest and their interaction on the morphological parameters of Napier pasture established in Makurdi is presented in Table 2, 3 and 4. The dry matter yield was not significantly ($p>0.05$) influenced by all the factors in this experiment. Plant height was higher ($p<0.05$) in Napier grass pastures fertilized with urea fertilizer (274.96 cm) compared to those in control and other organic fertilizers (251.38, 251.18 and 257.64 cm for control, cattle and poultry fertilizers, respectively). Similarly, plant height increased ($p<0.05$) with increasing age at harvesting. However, plant height of the Napier grass at 90 days of harvesting in urea fertilizer (285.00 cm) was higher ($p<0.05$) than the height in cattle manure (237.30 cm) at the same age of harvesting. The higher plant height in the Napier grass that was fertilized with urea compared to cattle manure and control is explained by the higher nitrogen content in urea fertilizer (46% CP) compared to cattle manure (3% CP). In affirmation of this claim, Abera *et al*. (2021), reported higher plant height in *Pennisetum glaucifolium* with increasing levels of nitrogen in the soil. Urea is a synthetic fertilizer that releases nitrogen (N) quickly, thus providing an immediate boost to plant growth, but may not last long in the soil, while cattle manure is characterized by slow and sustained release of nitrogen for plant uptake. This is true because plant height over a sixty-day period was similar in all organic and synthetic fertilizer sources in this current study. However, with split application of the urea after the first 60 days at every 30 days, urea fertilizer gave higher plant height compared to control and other organic fertilizer types. It is possible that urea fertilizer can only give better results of plant height compared to organic sources if it is applied every 30 days, but may not be same if under 60 days. The number of leaves reduced ($p<0.05$) in pastures fertilized with cattle manure (100.49) compared to control and other fertilizer types (131.88, 121.71 and 127.63 in control, poultry and urea fertilizers, respectively). Leaf length also reduced ($p<0.05$) in pasture on control and cattle manure (180.38 and 182.74 cm) compared to urea fertilizer (216.99 cm). However, the leaf length in poultry manure (198.49 cm) was similar ($p>0.05$) to urea fertilizer. On the other hand, number of leaves and leaf length only increased ($p<0.05$) at 120 days of harvesting compared to 60 and 90 days. From interaction between fertilizer type and age of harvest, number of leaves at 60 and 90 days of harvesting in control compared ($p>0.05$) with the pasture in cattle, poultry and urea at same age, while number of leaves in control, cattle and urea fertilizers at 120 days was higher ($p<0.05$) than the pastures at same age fertilized with poultry droppings. The reduction in number of leaves in Napier grass fertilized with cattle manure compared to non-fertilized pasture may be due to the presence of some phytohormones which may be present in the manure of cattle. Cattle manure has been reported to have abscisic acid which is likely to come from cow's diet (plants containing abscisic acid), gut microbiome (microbes producing abscisic acid) and endogenous production (cow's own hormonal production). This acid is said to retard the growth of a large variety of plants tissues, and organs including leaves, coleoptiles, stems, roots etc (Walton, 2003). However, this was not same for other fertilizer type including poultry and urea fertilizer. The number of leaves were similar across the different fertilizer types and age of sampling explaining that effect of cow dung on number of leaves were not seen over time. Similarly, higher leaf length in Napier grass fertilized with urea compared to control and cattle manure may be because of the higher nitrogen content in the urea fertilizer. Also, a higher leaf length at 120 days of sampling compared to 60 and 90 days means the plant was still growing beyond 90 days of planting.

The tiller diameter was higher ($p<0.05$) in pasture fertilized with urea fertilizer (9.39 cm) compared to control and pastures fertilized with organic, while other parameters such as number of tillers and leaf width of the Napier grass were not influenced ($p>0.05$) by the fertilizer type. Similarly, the age of harvesting did not affect ($p>0.05$) number of tillers, leaf width and tiller diameter in this experiment. On other hand, tiller diameter of pasture fertilized with urea at 60 days was higher ($p<0.05$) compared to those in other treatments on the same age of sampling. The higher nitrogen content of urea may be responsible for the higher tiller diameter in Napier grass fertilized with urea. There have been reported differences in stem diameter among the levels of N fertilizer (100-1600 kg N $ha^{-1)}$ in the report of Oliveira *et al*. (2015). On the contrary, Stida *et al.* (2018) reported that tiller diameter of Napier was not affected by dose of N fertilizer. Sollenberger *et al*. (2014) and Wangchuk *et al*. (2015) reported a tiller diameter ranging from 1.1 to 1.9 cm, which is lower than the reported range (7.59-9.39 cm) in this current study. Sinaga *et al*. (2016) found a thicker tiller (3.5–7 cm) without N fertilizer application which is also lower than the reported values in this current research. Similar to this current study, Norsuwan *et al*. (2014) did not observe any difference in the number of tillers with application of N fertilizer. On the other hand, there are reports that N fertilizers doses affected the number of tillers in Napier grass (Oliveira *et al*., 2015; Stida *et al*., 2018).

Table 2: Effect of Fertilizer type on Yield and Morphological Parameters of Napier Grass Established in Makurdi

Parameter	Control	Cattle manure	Poultry manure	Urea	SEM
Yield (DM/ha)	11663.95	96662.03	21645.72	63594.10	22597.58
Plant height (cm)	251.38^{b}	251.18^{b}	257.64^{ab}	274.96^{a}	4.56
Number of leaves	131.88^{a}	100.49^{b}	121.71^{ab}	127.63^{ab}	2.59
Number of tillers	9.20	7.26	8.71	8.50	0.15
Leaf width (cm)	4.02	3.98	4.27	4.92	0.12
Leaf length (cm)	180.38^{b}	182.74^{b}	198.49^{ab}	216.99^{a}	6.90
Tiller diameter (cm)	8.02^{b}	7.59^{b}	7.67^{b}	9.39^{a}	3.78

^{a,b} Means with different superscript along the row are significantly ($p<0.05$) different
SEM- Standard error of mean

Table 3: Effect of age of harvesting on yield and morphological parameters of Napier grass established in Makurdi

Parameter	60 days	90 days	120 days	SEM
Yield (DM/ha)	814.13	75592.61	68767.61	22597.58
Plant height (cm)	168.89^{c}	258.28^{b}	349.20^{a}	4.54
Number of leaves	89.53^{b}	104.55^{b}	167.21^{a}	3.88
Number of tillers	9.19	7.32	8.75	0.25
Leaf width (cm)	4.28	4.08	4.53	0.19
Leaf length (cm)	114.85^{b}	119.91^{b}	349.20^{a}	8.66
Tiller diameter (cm)	8.77	8.01	7.72	0.55

^{a,b}Means with different superscript along the same row are significantly ($p<0.05$) different

Table 4: Interactions between fertilizer type and age of cutting on yield and morphological parameters of Napier grass established in Makurdi

Parameter	Control			Cattle			Poultry			Urea			SEM
	60days	**90days**	**120days**	**60days**	**90days**	**120days**	**60days**	**90days**	**120days**	**60days**	**90days**	**120days**	
Yield (DM/ha)	451.34	11584.00	22956.51	622.92	17403.47	46910.77	612.81	253800.35	35572.93	1569.46	19582.62	169630.21	2259.58
PH(cm)	171.08^{d}	253.08^{bc}	329.98^{a}	168.64^{d}	237.30^{c}	366.97^{a}	148.46^{d}	257.75^{bc}	347.33^{a}	187.38^{d}	285.00^{b}	352.50^{a}	4.56
NoL	80.83^{e}	107.80^{de}	207.00^{a}	96.80^{de}	96.83^{de}	171.50^{ab}	72.14^{e}	100.67^{de}	128.67^{bcd}	108.33^{de}	112.90^{cde}	161.67^{abc}	2.59
NoT	8.33^{ab}	8.60^{ab}	10.67^{a}	10.80^{a}	5.83^{b}	9.50^{ab}	7.29^{ab}	7.17^{ab}	7.33^{ab}	10.33^{a}	7.67^{ab}	7.50^{ab}	2.81
LW(cm)	3.29^{b}	4.20^{ab}	4.57^{ab}	4.10^{ab}	4.34^{ab}	4.37^{ab}	3.24^{b}	3.99^{ab}	4.72^{ab}	6.48^{a}	3.79^{b}	4.48^{ab}	2.23
LL(cm)	100.15^{c}	111.01^{c}	329.98^{a}	112.14^{c}	116.37^{c}	366.97^{a}	91.48^{c}	109.41^{c}	347.33^{a}	175.86^{b}	122.60^{bc}	352.50^{a}	6.90
TD (cm)	8.33^{b}	8.01^{b}	7.72^{b}	7.80^{b}	8.38^{b}	6.83^{b}	7.10^{b}	7.80^{b}	7.87^{b}	11.85^{a}	7.87^{b}	8.45^{b}	3.78

^{a,b,c,d} Means with different superscript along the row are significantly ($p<0.05$) different

SEM- Standard error of mean;

PH- Plant height; NoL- Number of leaves; NoT- Number of tillers; LW- Leaf width; LL- Leaf length, TD- Tiller diameter

Effect of fertilizer types and age of harvesting on the chemical composition of Napier grass established in Makurdi

Table 5. 6 and 7 represent the chemical composition of Napier grass established in Makurdi as affected by different fertilizer types, age of harvest and the interaction of the two factors. All the chemical constituents were not influenced (P>0.05) by the application of the different fertilizer types in Napier grass pastures established in Makurdi, and this is consistent with findings of Yossif and Ibrahim (2013) who reported that crude protein (CP), crude fibre, and ash content of *Chloris gayana* were not influenced by fertilizer application. Ewetola *et al*. (2020), also did not report any significant difference in the crude protein, ether extract, ash and non-fibre carbohydrates of two tropical grass species (*Panicum maximum* and *Andropogon tectorum*) with fertilizer application. On a contrary, Hassan-Amin (2011) reported that the CP and crude fibre of fodder maize were affected by varying nitrogen sources including urea, nitrophoska (NPK), ammonium sulphate nitrate (ASN) and ammonium sulphate (AS). The variations in the reports on nutrient composition as affected by the nitrogen sources could be as a result of season and the type of pasture investigated. The crude protein content of the Napier across the various treatment in this current study is enough to meet the protein requirement for ruminants and exceeds the recommended levels of 10-12% for cattle (Schick and Beckman, 2023). In forages, roughly 20 to 30 percent of the protein taken in by the animal is by-passed to the intestines (Rinehart, 2008). With values of crude protein obtained from the Napier grass across the different fertilizer sources, between 2.6 to 3.9 of the crude protein is expected to by-pass the rumen and still left with enough protein for rumen degradation as rumen degradable protein. Rumen degradable protein is essentially food for rumen bacteria. When the microbes die, they are passed through to the stomach and small intestines where they are digested by the animal and these supply about 60-85% of amino acids, maximizing the efficiency of protein production and consequently improving productivity of the animals. The crude protein content of the Napier pasture was higher (p<0.05) in the pastures sampled at 60 days (15.02%) compared to those at 90 and 120 days (10.94 and 13.82% respectively). A decrease in crude protein of the Napier grass after 60 days of establishment is supported by report of Perez *et al*. (2010), where crude protein decreased from over 14 % at 18 days to almost 6 % at 81 days. This can be explained by the increase in dry matter content and fibrous nature of the grass with increasing age. In a similar vein, Wadi *et al*. (2004) reported that the most important factor affecting crude protein content of elephant grass is age at harvest or cutting interval. In this current study, the decrease observed in crude protein although not showing a definite pattern with increasing age of harvest, also corresponds with an increase in crude fibre in the Napier grass. To support this assertion, the report of Perez *et al*. (2010) also indicated that decrease in crude protein from 14% to 6% corresponded with an increase in crude fibre from 30% to 38%. The interactions between the two factors indicate that crude protein obtained in Napier grass on cattle and urea fertilizers (15.61 and 14.73%) at 120 days was higher (p<0.05) and compared to those on control, cattle, poultry and urea at 60 days (15.61, 14.73, 14.73, 14.87%, respectively). Crude protein from Napier fertilized with poultry manure and urea fertilizer and harvested at 120 days compares with the Napier harvested at 60 days across all the treatment groups. This shows that fertilizing Napier pastures with poultry and urea fertilizers and harvesting at a later date (120 days) supports favourably, a management strategy aimed at harvesting at different stages than without fertilizing at all or fertilizing with cattle manure. The crude protein content across all treatments and age of harvesting in this current study across the treatments is higher that 9.2 to 12.1% reported by Halim *et al.* (2013) at cutting intervals of 7 to 8 weeks while Njoka-Njiru *et al*. (2006) and Bayble et *al*. (2007) reported CP ranges of 8.1% and 7.8% to 14.1% respectively at cutting interval of 8 weeks. The ash content progressively decreased (p<0.05) as the pasture matured in age. The mean value of ash content obtained in this study are above 5.75 to 6.88% reported by Ewetola *et al*. (2020) for tropical grasses like *Panicum maximum* and *Andropogon tectorum* fertilized with different types of fertilizer. The different soil types and species of the grasses may have accounted for the differences. Macpherson (2000) reported that mineral content of forages varies widely with soils, forage species, grassland management and climatic conditions. On the other hand, fibre content increased (p<0.05) from 23.92 to 28.94% with increase in age of sampling (60, 90 and 120 days, respectively). Nitrogen free extract (NFE) was similar (p>0.05) at 90 and 120 days of sampling (47.07 and 49.15%, respectively), but lower (p<0.05) at 60 days (41.95%). Similarity in NFE with fertilizer application in this current study is consistent with reports that non fibre carbohydrates in *Panicum maximum* and *Andropogon tectorum* were unchanged after fertilizing with Aleshinloye organo-mineral fertilizer, poultry manure, and NPK (N.P.K. 20:10:10) (Ewetola *et al.*, 2020). As in the crude fibre content, neutral detergent fibre and acid detergent fibre increased (p<0.05) with increase in the age of the Napier grass. The neutral detergent fibre was 51.53, 53.75 and 57.49% at 60, 90 and 120 days, respectively while the acid detergent fibre was 29.36, 33.78 and 40.18% at 60, 90 and 120 days of sampling, respectively. The result of neutral detergent fibre (NDF) at 120 days was higher (p<0.05) and comparable in control and all fertilizer types (58.63, 54.97, 59.07 and 57.30% for control, cattle, poultry and urea fertilizers, respectively). Similar to this trend, least (p<0.05) neutral detergent fibre was comparable across all treatment groups at 60 days of sampling (52.57, 52.43, 51.07, and 50.07% for control, cattle, and poultry and urea fertilizers, respectively). Acid detergent fibre (ADF) was higher (p<0.05) in pastures on control and all the other fertilizers sampled at 120 days (38.07, 40.03, 39.53 and 43.10% for control, cattle, poultry and urea fertilizers, respectively) and the least (p<0.05) ADF was found in pasture from control, cattle, poultry and urea sampled at 60 days (28.17, 28.10, 28.77 and 32.40 for control, cattle, poultry and urea fertilizers, respectively) which compared to pasture sampled at 90 days from control and cattle fertilizer (32.40 and 33.53%, respectively). The NDF values reported in this study were less than 56.13% and 56.63% for *Panicum maximum* and *Andropogon tectorum* fertilized with different fertilizer types reported by Ewetola *et al.* (2020). These values are likely to support good intake by livestock unlike NDF values up to 80% obtained in various straws. Contrary to findings of this study, on NDF as affected by the different fertilizer types, report by Johnson *et al*. (2001) and Adeli *et al*. (2005) indicated that fertilizer application significantly decreased the NDF content of *Cynodon dactylon* with increase in application rate. However, the observation in this study support previous reports that fertilizer application had no effect on NDF contents of native grasses (Ewetola *et al.*, 2020). In a related development, there is report that acid detergent fibre varied with application of different fertilizer sources (organic and inorganic) to *Panicum maximum* and *Andropogon tectorum* during the early wet-season (Ewetola *et al*., 2020). An increase in the NDF with increasing age of harvest on the other hand is explained by the structural

components of the Napier grass with age. This can result from accumulation of hemicellulose and cellulose, complex cell wall and reduced pectin (a soluble carbohydrate).The more mature a plant becomes, the more structural components it accumulates, resulting in higher NDF readings and poorer quality feed (Schick and Beckman, 2023). On the other hand, ADF values obtained from Napier fertilized with cattle, poultry and urea fertilizer were slightly above 31.54% and 33.63% for *Panicum maximum* and *Andropogon tectorum* fertilized with different fertilizer types reported by Ewetola *et al.* (2020). However, the ADF values in this current study are comparable to 30-35% for early bloom alfalfa reported by (Schick and Beckman, 2023) which is a highly digestible forage. A similar reason as explained for NDF may have been responsible for increasing ADF with increase in the age of the Napier grass in this study. The highest ADF of 40.18% observed in Napier grass harvested at 120 days is closely related to 40% from late bloom alfalfa forage reported by Schick and Beckman (2023). The values of ADF for Napier in this current study agree with those of Olajumoke (2003) who reported 30.6 to 40.2% ADF for elephant grass cut at 4 to 8 weeks of regrowth and Teklesadik *et al*. (2004) who reported 31.2 to 34.3% ADF for Dwarf elephant grass. The reported ADF values in this study are less than less than 40% ADF categorized as high-quality forage and those with greater than 40% as poor quality (Akinjoye and Olorunnisomo, 2018). Unlike this current study ADF, hemicellulose and cellulose were affected by fertilizer types in other reports (Balabanli *et al*., 2010; Hassan *et al*., 2015; Ewetola *et al*., 2020). With the interactions between the fertilizer types and age of harvesting, Napier grass harvested from pasture fertilized with different fertilizer types and at different age had NDF and ADF less than 60% and 40%, respectively, indicating that the pastures will sufficiently support good feed intake and digestibility irrespective of the fertilizer type and age they are harvested. However, harvesting at 120 days, irrespective of the fertilizer type is likely to reduce intake and digestibility of the pasture.

Table 5: Effect of Fertilizer type on Chemical Composition of Napier Grass Established in Makurdi

Parameter	Control	Cattle Manure	Poultry Manure	Urea	SEM
Crude Protein	12.98	13.81	12.74	13.51	0.37
Ether extract	2.06	2.19	2.21	2.36	0.08
Ash	11.71	11.97	10.78	11.91	0.83
Crude Fibre	26.50	27.14	26.66	27.24	0.41
Nitrogen-free extract	46.74	44.89	47.61	44.97	0.66
Neutral detergent fibre	55.03	53.61	54.72	53.68	0.56
Acid detergent fibre	32.88	33.89	34.43	36.57	0.89

Table 6: Effect of Age of Harvesting on Chemical Composition of Napier Grass Established in Makurdi

Age of Harvest	60 days	90 days	120 days	SEM
Crude Protein	15.02^{a}	10.94^{c}	13.82^{b}	0.37
Ether Extract	2.15	2.24	2.23	0.08
Ash	16.96^{a}	11.95^{b}	5.86^{c}	0.83
Crude Fibre	23.92^{c}	27.80^{b}	28.94^{a}	0.41
Nitrogen-free Extract	41.95^{b}	47.07^{a}	49.15^{a}	0.66
Neutral detergent fibre	51.53^{c}	53.75^{b}	57.49^{a}	0.56
Acid detergent fibre	29.36^{c}	33.78^{b}	40.18^{a}	0.89

^{a,b,c}Means with different superscript along the row are significantly ($p<0.05$) different

Table 7: Interactions between Fertilizer type and Age of Cutting on Chemical Composition of Napier grass Established in Makurdi

Parameter (%)	Control			Cattle			Poultry			Urea			SEM
	60	90	120	60	90	120	60	90	120	60	90	120	
Crude Protein	15.61^{a}	10.94^{c}	12.39^{bc}	14.73^{ab}	10.94^{c}	15.61^{a}	14.73^{ab}	10.94^{c}	12.54^{bc}	14.87^{ab}	10.94^{c}	14.73^{ab}	0.37
Ether Extract	2.32^{ab}	1.73^{b}	2.15^{ab}	2.29^{ab}	2.27^{ab}	2.01^{ab}	2.27^{ab}	2.26^{ab}	2.11^{ab}	1.71^{b}	2.71^{a}	2.66^{a}	0.08
Ash	17.33^{a}	11.87^{c}	5.93^{d}	18.56^{a}	11.37^{c}	5.98^{d}	16.02^{ab}	10.93^{c}	5.39^{d}	15.95^{ab}	13.64^{bc}	6.14^{d}	0.83
Crude Fibre	23.98^{c}	27.74^{ab}	27.79^{ab}	24.52^{c}	28.39^{ab}	28.82^{ab}	23.00^{c}	27.13^{b}	29.85^{a}	24.52^{c}	27.91^{ab}	29.30^{ab}	0.41
NFE	40.77^{g}	47.72^{abcd}	51.73^{a}	40.08^{g}	47.02^{bcde}	47.58^{abcd}	43.98^{defg}	48.74^{abc}	50.10^{ab}	42.95^{efg}	44.79^{cdef}	47.17^{bcde}	0.66
NDF	52.57^{cd}	53.89^{bcd}	58.63^{a}	52.43^{cd}	53.42^{bcd}	54.97^{abc}	51.07^{cd}	54.03^{bcd}	59.07^{a}	50.07^{d}	53.67^{bcd}	57.30^{ab}	0.56
ADF	28.17^{e}	32.40^{de}	38.07^{abc}	28.10^{e}	33.53^{cde}	40.03^{ab}	28.77^{e}	35.00^{bcd}	39.53^{ab}	32.40^{de}	34.20^{cd}	43.10^{a}	0.89

^{a,b,c,d,e} Means with different superscript along the row are significantly ($p<0.05$) different

SEM- Standard error of mean; NFE- nitrogen-free extract; NDF- Neutral detergent fibre; ADF- Acid detergent fibre

CONCLUSION

The application of urea fertilizer to Napier grass established in Makurdi led to higher plant height, leaf length and tiller diameter of the pasture compared to cattle manure and control, with leafier pasture observed when Napier grass were fertilized with urea or poultry droppings. Plant height increased at every harvesting age (60, 90 and 120days), while the number of leaves and leaf length were only higher at 120 days, compared to 60 and 90 days. Crude protein, ash content, crude fibre, nitrogen-free extract, neutral detergent fibre and acid detergent fibre were affected by the different age of sampling. It is recommended that poultry droppings can effectively serve as alternative to urea fertilizer in pasture production for environmentally sustainable pasture production. Harvesting at the age of 60 days after planting is likely to give better quality pasture with application of poultry droppings as alternative source of fertilizer.

REFERENCES

Abera, M., Tolera, A., Nurfeta, A. and Geleti, D. (2021). Herbage accumulation and nutritive value of mixtures of desho grass and Vicia spp. in southern Ethiopia. Agronomy Journal, 114:165–172.

Adeli, A., Varco, J. J., Sistani, K. R. and Rowe, D. E. (2005). Effects of swine lagoon effluentrelative to commercial fertilizer applications on warm-season forage nutritive value. *Agronomy Journal*, 97:408–417.

Akinjoye, D. J. and Olorunnisomo, O. A. (2018). Chemical composition and nutrient digestibility of three varieties of elephant grass (*Pennisetum purpureum*) by Sokoto Gudali heifers. *Nigerian Journal of Animal Production*, 45(2): 273 – 278.

AOAC (2005) Official method of Analysis. 18th Edition, Association of Officiating Analytical Chemists, Washington DC, Method 935.14 and 992.24

Balabanli, C., Albayrak, S., and Yuksel, O. (2010). Effects of Nitrogen, Phosphorus and Potassium fertilization on the quality and yield of native rangeland. *Turkish Journal of Field Crops*, 15(2): 164–168.

Bayble, T., Melaku, S. and Prasad, N. K. (2007). Effects of cutting dates on nutritive value of Napier (*Pennisetum purpureum*) grass planted sole and in association with Desmodium (*Desmodium intortum*) or Lablab (*Lablab purpureus*). *Livestock Research for Rural Development*, 19(1): 27

Ekhuemelo, D.O., E.T. Tembe and M. Abah, (2019). Investigation of charcoal production in Makurdi and Guma local government areas of Benue State, Nigeria. Sustainability Agriculture, Food and Environmental Resources, 7: 69-86.

Ewetola, I. A., Amisu, A. A., Jimoh, S. O., Muraina, T. O., Olanite, J. A. and Arigbede, O. M (2020). Impact of fertilizer types on the nutritive quality of two tropical grass species harvested at different stages of growth during wet season. *Nigerian Journal of Animal Production*, 47(3):309 – 322.

Gashaw, M., and Defar, G. (2017). Livestock feed resources, nutritional value and their implication on animal productivity in mixed farming system in Gasera and Ginnir Districts, Bale Zone, Ethiopia. International Journal of Livestock Production. 8 (2): 12-23.

Halim, R. A., Shampazuraini, S. and Idrus, A. B. (2013). Yield and nutritive quality of nine Napier grass varieties in Malaysia. *Malaysian Journal of Animal Science*, 16(2):37–44.

Hassan Amin, M. M. (2011). Effect of different nitrogen sources on growth, yield and quality of fodder maize (Zea mays Li). *Journal of the Saudi Society of Agricultural Sciences*, 10(1): 17–23.

Hassan, A., Zewdu, T., Urge, M. and Fikru, S. (2015). Effect of nitrogen fertilizer application on nutritive value of C. ciliaris and P. maximum grown under irrigation at Gode, Somali region. *Journal nutrition food Science*, 11: 005

Khalid, M., Ijaz, A. and Muhammad, A. (2003). Effect of nitrogen and phosphorus on the fodder yield and quality of two Sorghum cultivars (Sorghum bicolor L.). Int. J. Agri. Biol., 5(1): 61-63.

Kubkomawa H.I., and Kenneth-Chukwu O.M. (2019). Forage resource utilization and management for greater ruminant production: a review. International Journal of Agricultural Research, Sustainability, and Food Sufficiency (IJARSFS), 6(01):295-314

Macpherson, A. (2000). Trace-mineral Status of Forages. In: Givens DI, Owen E, Axford RFE, Omed HM, eds. 2000. Forage Evaluation in Ruminant Nutrition. C A B International, UK. pp. 345-371.

Mihret, B., Asmare, B., and Mekuriaw, Y. (2018). Effect of fertilizer type and plant spacing on plant morphological characteristics, yield and chemical composition of desho grass (Pennisetum pedicellatum Trin.) in Northwestern Ethiopia. Journal of Agricultural Science and Technology, 10(2):107 - 114

Njoka-Njiru, E., Njarui, M. G., Abdulrazak, S. and Mureithi, N. (2006). Effect of intercropping herbaceous legume on dry matter yield and nutritive value of the feedstuffs in semi-arid region of eastern Kenya. Agricultura Tropica et Subtropica, 39(4): 255 –262.

Norsuwan, T., Marohn, C., and Jintrawet, A. (2014). Effects of irrigation treatments and nitrogen applications on Napier grass planted in dry season as energy crop at Chiang Mai province. Khon Kaen *Agricultural Journal*, 42(2): 1–7

Oliveira, S., Daher, R.F., Ponciano, N.J., Gravina, G.D.A., Augusto, J. (2015). Variation of morpho-agronomic and biomass quality traits in elephant grass for energy purposes according to nitrogen levels. *American Journal of Plant Sciences*, 6:1685–1696.

Perez, A. A.S., Lopez, A. P. and Acosta, M.E.F. (2010). Optimal harvest age for napier grass (Pennisetum purpureum Schum.) during the rainy season based on yield and nutritional value. *Tecnica Pecuaria en Mexico*, 48(3):277-286

Rinehart, L. (2008). Ruminant Nutrition for Graziers. A Publication of ATTRA - National Sustainable Agriculture Information Service. Pp 9-10

Schick, B and Beckman, B. (2023). Pasture and Forage Minute: Understanding ADF and NDF, Hay Quality after

Calving. Institute of Agriculture and Natural Resources. CropWatch. University of Nebraska–Lincoln (Accessed November, 2024)

Sinaga, D.M., Aprilia, D., Zuhro, F., Setiawati, R., Siswi, R. (2016). Elephant Grass Planting Plan at Eruption-affected Areas in Mount Merapi: Methods and Harvesting Time. 12–13 May 2016, Proceedings of 4th Asian Academic Society International Conference (AASIC), Indonesia. Pp. 599–605

Sollenberger, L.E., Woodard, K.R., Vendramini, J.M.B., Castillo, M.S., Gallo, M. (2014). Invasive populations of elephant grass differ in morphological and growth characteristics from clones selected for biomass production. *Bioenergetic Research*, 7: 1382–1391.

Stida, W.F., Almeida, B.D.O., Daher, R.F., Roberta, C., Moraes, D.O. (2018). Effect of nitrogen and potassium fertilization doses on elephant-grass genotypes for energy purposes. *Journal of Agricultural Science*, 10(10): 446–459.

Talukder, M., Shahjahan, M., Khandaker, Z and Billah, M.D. (2021). Effect of organic fertilizer on morphological characteristics, biomass yield and chemical composition of Napier and Jumboo grass. Conference: Annual Research Review Workshop 2020, Bangladesh Livestock Research Institute, Savar, Dhaka-1341.

Tekletsadik, T., Tudsri, S., Juntakool, S. and Prasanpanich, S. (2004). Effect of dry season cutting management on subsequent forage yield and quality of ruzi (*Brachiaria ruziziensis*) and dwarf Napier (*Pennisetumpurpureum* L.) in Thailand. *Kasetsart Journal (NaturalScience),* 38:457–467.

Van Soest, P. J., Robertson, J. B. and Lewis, B. A. (1991). Techniques for dietary fiber, neutral detergent fiber, and non-starch polysaccharides in re-flection to animal production. Journal of Dairy Science, 74:358–3597.

Wadi, A., Ishii, Y. and Idota, S. (2004). Effect of cutting interval and cutting height and dry matter yield and overwintering ability at the established year in *Pennisetum* species. *Plant Production Science* 7:88–96.

Walton, D. C. (2003). Biochemistry and Physiology of Abscisic Acid. *Annual Review of Plant Physiology*, 31(1):453-489

Wangchuk, K., Rai, K., Nirola, H. and Dendup, C. (2015). Forage growth, yield, and quality responses of Napier hybrid grass cultivars to three cutting intervals in the Himalayan foothills. Tropical Grasslands – Forrajes Tropicales, 3: 142–150.

Yossif, A. M. and Ibrahim, Y. M. (2013). Effect of fertilizers (Urea, farmyard and chicken manure) on Growth and yield of Rhodes grass (Chloris gayana L. Knuth.). *Universal Journal of Plant Source,* 1(3): 85–90.