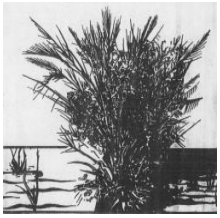

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FORAGE YIELD AND NUTRITIVE VALUE OF *Pennisetum pedicellatum* AS INFLUENCED BY NPK (20:10:10) FERTILIZER RATES

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ABSTRACT: The study was conducted during the 2024 rainy season to evaluate forage yield and chemical composition of *Pennisetum pedicellatum* as influenced by NPK (20:10:10) fertilizer rates at different ages. The experiment was laid out in 4 x 3 factorial arrangements in split-plot and replicated three (3) times. The 2 factors were fertilizer levels (0, 50, 100 and 150 Kg/ha NPK 20:10:10) as main plot and harvest time (8, 12 and 16 WAS) as sub-plot. Data generated were analyzed using the SAS and significant means were separated using Duncan Multiple Range Test. There was significant (P<0.05) effect of NPK rates on PH, NL, LL, TN, fresh and dry forage yields while there was no-significant (P>0.05) effect of NPK rates on LW. Higher (P<0.05) PH (85.63cm), NL (46.59), LL (41.26cm), TN (10.42), fresh (8.17 t/ha) and dry (3.99 t/ha) forage yields were obtained at 150 kg/ha NPK. Leaf width ranged from 1.67 – 2.06 cm. Non-significant (P>0.05) age of harvest effect was observed on all PH, NL, LL, LW and TN which ranged from 51.96 – 62.73 cm, 29.45 – 31.70, 32.43 – 36.10 cm, 1.60 – 2.14 cm and 8.60 – 9.80, respectively. There was significant (P<0.05) effect of age of harvest on fresh and dry forage yields in which higher (P<0.05) fresh (10.18 t/ha) and dry (3.10 t/ha) forage yields were obtained at 16WAS for *P. pedicellatum*. There was significant (P<0.05) effect of age of harvest on chemical composition of *P. pedicellatum*. Higher (P<0.05) DM (90.36%), CF (16.98%), ash (8.20%), NFE (47.92%), NDF (27.21%) and ADF (16.50%) were recorded at 16WAS while CP (23.18%) was higher (P<0.05) at 8WAS. Ether extract (2.18%) was higher (P<0.05) at 12WAS. In conclusion, the growth, forage yields and chemical composition of *P. pedicellatum* forage were improved when NPK was applied at 150 kg/ha while *P. pedicellatum* forage harvested at 16WAS gave higher growth and better forage yield. Crude protein content of *P. pedicellatum* forage fertilized with NPK fertilizer across all ages was good enough to meet the protein requirement of ruminant animals. It can be recommended that for better growth, yield and quality of *P. pedicellatum* forage, 150 kg/ha NPK (20:10:10) should be applied and harvested at 16WAS.

Keywords: Chemical, Growth, Fertilizer, Forage, *Pennisetum,* Yield

INTRODUCTION

Natural grasslands constitute the major feed resources of ruminants, either by grazing or as conserved forages (Shuaibu *et al*., 2020). However, in the tropics, the inadequacies of feed and its low nutritive quality during the dry season are major limitation to successful ruminant production (Fasae *et al*., 2019). Most of the animals suffer from seasonal nutritional stress, resulting in weight loss, reproductive inefficiency and even death (Yohanna *et al*., 2015). This seasonal shortage can be mitigated by the use of sown forage of better nutritional value and purposely managed.

A common plant species found in tropical regions is *Pennisetum* sp. It belongs to *Poaceae* family (Ismail *et al*., 2018). This species is well distributed and has adapted well in this country. *Pennisetum sp*. can be spread easily by wind and colonization of new areas and undergo rapid multiplication (Ismail *et al*., 2015). This grass forage is easy to establish and respond well to nitrogen fertilization (Ettbeb *et al*. 2020). However, to maintain the quality and year round

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production, there is need for water and nutrient to be supplied especially during the dry season to enable continuous production.

The nutrients necessary for plants to grow exist naturally in the soil. The NPK fertilization served as an alternative source of nutrients that are required by the plants due to insufficient amount in the soil (Ettbeb *et al*. 2020). To promote initial germination of a particular plant, different ratios of NPK at different stages of growth is usually supplied. Nitrogen (N) is an important nutrient for the plants, in which N is an essential component for synthesis of proteins, nucliec acids, enzymes and promotes vigorous vegetative growth. Therefore, demand for N by plants is higher compared to the other nutrients. It has been reported that the supply of sufficient amount of nitrogen at the early stages of plant growth is critical for the initiation of leaves and primordial (Lampayan *et al*., 2010).

Phosphorus (P) is the second vital nutrient in the soil with more widespread influence on both natural and agricultural ecosystems than any other essential plant elements (Fageria *et al*., 2017). This element plays an important role in plant metabolism, respiration and photosynthesis (Narayana *et al*., 2018; El-Desuki *et al*., 2006). Most of the terrestrial plants cannot survive without potassium (K) (Mengel, 2007). This macro nutrient is essential and it plays major functions in plant cells including enzyme activation, osmoregulation and charge balancing (Wakeel *et al*., 2011; Ettbeb *et al*., 2020). Wang *et al*. (2013) also reported that an adequate supply of K has beneficial effects on maintaining or improving dry mass production, leaf area, water retention and membrane stability, as compared to low K nutrition under drought stress conditions.

Maturity stage at harvest is the most important factor determining forage quality and forage quality decrease with delay in harvest time. Also, the maturity of forage crop influence digestibility and consumption by animals (Ball *et al.,* 2001; Ahmed, 2023). Stage of maturity also affects the quality and quantity of grasses, *Pennisetum pedicellatum* inclusive. Dry Matter yield increases with advancing maturity, but quality declines (Taute *et al.,* 2002). Studies on the productivity of *Pennisetum pedicellatum* as influenced by inorganic fertilizer and age of harvest in Nigeria is limited, hence the need for the study. The objective of the study is to evaluate the forage yield and nutritive value of *Pennisetum pedicellatum* as influenced by NPK (20:10:10) fertilizer rates at different harvesting ages.

MATERIALS AND METHODS

Location of the Study

The study was conducted at the Pasture Experimental Field of the Teaching and Research Farm of the Department of Animal Science, University of Maiduguri. Maiduguri is situated at latitude 11^0 5' North, longitude 30^0 0' East and an altitude of 354m above sea level (GPS, 2023). Maiduguri falls within the Sehelian Region (Semi-Arid Zone) of West Africa which is characterized by short duration of rainfall varying from 2-4 months (June-September). The rainfall varies from 300-500 mm per annum and the ambient temperature rises from 25^0 C - 28^0 C in December to January and higher in April and May which range from 39^0 C - 40^0 C (NiMet, 2023). The soil of the experimental site is typical of tropical region that is low in total nitrogen and available phosphorus with sandy loam textural class.

Sources of Experimental Materials

The seeds of *Pennisetum pedicellatum* was sourced from the Feeds and Nutrition Research Programme of National Animal Production Research Institute, Shika, Ahmadu Bello University, Zaria while the NPK fertilizer (20:10:10) was procured from Open Market in Maiduguri. The field was ploughed, harrowed and leveled to provide a good seedbed for proper seed germination and seedlings establishment.

Experimental Design and Layout

The experiment was laid out in 4 x 3 factorial arrangements in split-plot replicated three (3) times. The 2 factors were fertilizer levels (0, 50, 100 and 150 Kg/ha NPK 20:10:10) as main plots and stage of harvest (8, 12 and 16 weeks after sowing, WAS) as sub-plot. The field was divided into 3 blocks of 9 x 3m ($27m^2$) and 1m apart. Each block contains 4 experimental plots which were 2 x 3m ($6m^2$) at 0.5m apart. Seeds were drilled in rows 50cm apart in June 2024 at the rate 20kg/ha. The fertilizer was applied as a single dose at 3 weeks after planting. All plots were hand weeded as the need arose. The forage was harvested at 16th week after planting.

Parameters measured: Data on plant height, number of leaves, leaf length, leaf width and tiller number, per plant were taken at 8, 12 and 16 weeks after planting. Five (5) plants per plot were randomly selected and tagged for the various measurements according to the methods of Tarawali *et al.* (1995).

***Forage yield*:** This was determined at 8, 12 and 16 WAS by cutting plants within a $1m^2$ quadrant with a sickle to the height of 10 cm above the ground level. The fresh forage was weighed in the field using a sensitive weighing scale and sub-samples was oven dried at 65^0C for 48 hours and reweighed to estimate dry matter yield according to Tarawali *et al.* (1995).

Dry matter production was calculated as:

Dry matter (kg/ha) = Total FW x (DWss/FWss) x 10

Where:

Total FW = Total fresh weight from 1 m^2 in (g)
DWss = Dry weight of the sub-sample in (g)
FWss = Fresh weight of the sub-sample in (g)

Chemical Analysis: Standard analytical methods (AOAC, 1990) was used to determine Dry Matter (DM), Crude Protein (CP), Ether Extract (EE), Crude Fiber (CF), and Nitrogen Free Extract (NFE). Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) were determined by the Method of Van Soest (1991). Cellulose and hemicellulose will be calculated as differences between ADF and ADL and NDF and ADF, respectively.

Statistical Analysis: Data collected were subjected to the analysis of variance procedure using SAS (2005) significant means were separated using the Duncan's Multiple Range Test (DMRT) (Duncan, 1955).

RESULTS AND DISCUSSIONS

Growth components of *Pennisetum pedicellatum* as influenced by NPK (20:10:10) fertilizer rates, age of harvest and their interaction

The growth components of *Pennisetum pedicellatum* as influenced by NPK (20:10:10) fertilizer rates, age of harvest and their interaction is shown in Table 1. There was significant ($P<0.05$) effect of fertilizer rates on growth components of *Pennisetum pedicellatum* except leaf width. Higher ($P<0.05$) plant height (85.63 cm) was recorded at 150 kg/ha NPK, followed by that of 100 kg/ha (67.52 cm) which was similar with that of 50 kg/ha (57.18 cm) while lower ($P<0.05$) plant height (48.20 cm) was obtained at 0 kg/ha NPK which was also similar to that of 50 kg/ha for *Pennisetum pedicellatum*. Number of leaves (46.59) and leaf area index (LAI) (95.94) were higher ($P<0.05$) at 150 kg/ha NPK while lower ($P<0.05$) number of leaves (26.18) and LAI (28.25) was obtained at 0 kg/ha NPK which was similar with that of 50 (30.00 and 32.97) and 100 (33.87 and 40.14) kg/ha NPK of *Pennisetum pedicellatum*, respectively.

Higher ($P<0.05$) leaf length (41.26 cm) was recorded at 150 kg/ha NPK which was at par with that of 100 kg/ha NPK (35.72cm) while lower ($P<0.05$) leaf length (32.21cm) was obtained at 0 kg/ha NPK which was similar with that of 50 (33.52 cm) and 100 (35.72 cm) kg/ha NPK, respectively. Tiller number (10.42) was higher ($P<0.05$) at 150 kg/ha NPK which was at par with that of 50 (9.53) and 100 (9.75) kg/ha NPK while lower ($P<0.05$) tiller number (8.42) was recorded at 0 kg/ha NPK which was similar with that of 50 and 100 kg/ha NPK of *Pennisetum pedicellatum*. Leaf width ranged from 1.67 cm at 0 kg/ha NPK to 2.06 cm at 150 kg/ha NPK of *Pennisetum pedicellatum*. There was no significant ($P>0.05$) effect of age of harvest on growth components of *Pennisetum pedicellatum* in which plant height ranged from 57.84 cm at 8 WAS to 62.73 cm at 16 WAS. Number of leaves ranged from 29.45 at 8 WAS to 31.70 at 16 WAS. Leaf length ranged from 32.43 cm at 12 WAS to 36.10 cm at 16 WAS. Leaf width ranged from 1.60 cm at 12 and 16 WAS to 2.14 cm at 8 WAS. Leaf area index (LAI) ranged from 32.23 at 12 WAS to 36.27 at 8 WAS while tiller number ranged from 8.60 at 8 WAS to 9.80 at 12 WAS. There was no significant ($P>0.05$) interaction effect between fertilizer rates and age of harvest on growth components of *Pennisetum pedicellatum*.

Plant height, number of leaves, leaf length and number of tillers were significantly affected with increase in the quantity of fertilizer application. These parameters are important growth parameters that have great influence on biomass yield production. Hazrat *et al*. (2004) found that plant height generally depends on internode expansion which caused an increase in height with an increase in water depth resulting in the taller plant. The significant ($P<0.05$) effect

of fertilizer rates on plant height as reported in this study concur with the findings of Ahmed (2019) for *Brachiaria ruziziensis* when NPK (15:15:15) was applied at 0 – 60 kg/ha. While the non-significant (P<0.05) effect of fertilizer on leaf width concurs with the report of Ahmed (2019). Whereas the significant (P<0.05) effect of fertilizer for number of tillers contradicts the findings of Ahmed (2019). The variations observed might be attributed to the amount and concentration of the fertilizer used and climatic conditions. The non-significance (P>0.05) of age of harvest on all growth components studied contradicts the findings of Na Allah *et al*. (2020) who reported significant effect of age of harvest for *Pennisetum pedicellatum* when cutting age was delayed from 4 to 10 WAS. The plant height and tiller numbers recorded in this study were within the range of values (25.24 – 110.01cm and 3.50 – 38.67) reported by Na Allah *et al*. (2020) Meanwhile, same authors (Na Allah *et al.,* 2020) reported higher values for number of leaves, leaf length and leaf width (3.00 – 6.39, 18.82 – 30.69cm and 1.34 – 2.03cm) for *Pennisetum pedicellatum* in Sokoto, Nigeria.

Table 1: Growth components of *Pennisetum pedicellatum* as influenced by NPK (20:10:10) fertilizer rates, age of harvest and their interaction

Treatments	PH (cm)	NL (No.)	LL (cm)	LW (cm)	TN (No.)
Fertilizer Rate (kg/ha)					
0	48.20^{c}	26.18^{b}	32.21^{b}	1.67	8.42^{b}
50	57.18^{bc}	30.00^{b}	33.52^{b}	1.68	9.53^{ab}
100	67.52^{b}	33.87^{b}	35.72^{ab}	2.04	9.75^{ab}
150	85.63^{a}	46.59^{a}	41.26^{a}	2.06	10.42^{a}
SEM	8.70*	5.07*	4.19*	0.24^{NS}	0.83*
Age of Harvest (WAS)					
8	57.84	29.45	33.30	2.14	8.60
12	51.96	31.30	32.43	1.60	9.80
16	62.73	31.70	36.10	1.60	9.28
SEM	11.60^{NS}	6.76^{NS}	5.59^{NS}	0.32^{NS}	1.11^{NS}
Interaction					
F x W	0.858	0.499	0.927	0.749	0.711

^{abcd}Means with different superscript within column differed significantly (P<0.05), SEM = Standard error of the mean, PH = Plant height, NL = Number of leaves, LL = Leaf length, TN = Tiller numbers, WAS = Weeks after sowing, F = Fertilizer rate, W = Weeks

Fresh and dry forage yield of *Pennisetum pedicellatum* as influenced by NPK (20:10:10) fertilizer rates, age of harvest and their interaction

The fresh and dry forage yield of *Pennisetum pedicellatum* as influenced by NPK (20:10:10) fertilizer rates, age of harvest and their interaction is presented in Table 2. There was significant (P<0.05) effect of fertilizer rates on fresh and dry forage yields of *Pennisetum pedicellatum.* Higher (P<0.05) fresh forage yield (8.17 t/ha) was recorded at 150 kg/ha NPK which was similar with that of 100 kg/ha NPK (5.14 t/ha) while lower (P<0.05) fresh forage yield was obtained at 50 kg/ha NPK (3.34 t/ha) which was also similar with 0 (3.34 t/ha) and 100 (5.14 t/ha) kg/ha NPK. Dry forage yield (3.99 t/ha) was higher at 150 kg/ha NPK, followed by that of 100 kg/ha NPK (2.62 t/ha) which was similar with that of 0 kg/ha NPK (2.52 t/ha) while lower (P<0.05) dry forage yield (1.53 t/ha) was recorded at 50 kg/ha NPK (1.53 t/ha). There was significant (P<0.05) effect of age of harvest on fresh and dry forage yields of *Pennisetum pedicellatum.* Higher fresh forage yield (10.18 t/ha) was obtained at 16 WAS which was at par with that of 12 WAS (6.31 t/ha) while lower (P<0.05) fresh forage yield was recorded at 8 WAS (5.76 t/ha) which was also similar with that of 12 WAS. Higher (P<0.05) dry forage yield (3.10 t/ha) was recorded at 16 WAS while lower (P<0.05) dry forage yield (1.91 t/ha) was obtained at 12 WAS which was at par with that of 8 WAS (1.97 t/ha). There was non-significant (P>0.05) interaction effect on fresh and dry forage yields of *Pennisetum pedicellatum*.

The significant (P<0.05) effect of NPK fertilizer obtained in this study validates the findings of Ezenwa *et al*. (1996), Sani *et al*. (2015) and Ahmed (2019) who reported significant (P<0.05) effect of fertilizer on fresh and dry forage yields of grasses. The result obtained for the fresh and dry matter yield was higher than that obtained by Ezenwa *et al.* (1996) for *Brachiaria ruziziensis* grown as a sole crop with nitrogen fertilizer and harvested at 24 WAS; Sani *et al.* (2015) at 12 weeks after sowing and Ahmed (2019). The dry forage yield for *Pennisetum pedicellatum*, obtained in this study (1.53 – 3.99 10 t/ha), is lower than range of 10.00 – 25.00 t/ha DM reported for the same species under varying seeding rates (10 – 40kg/ha) in the dry Sudan savanna zone of Nigeria (Yakubu and Magaji, 2004) The

comparatively lower herbage yield obtained for *P. pedicellatum*, in this study, could be attributed to the low rainfall and poor soil conditions (Muhammad *et al*., 2010) in the study area.

Table 2: Fresh and dry forage yield of Pennisetum *pedicellatum* as influenced by NPK (20:10:10) fertilizer rates, age of harvest and their interaction

Treatments	Fresh forage yield (t/ha)	Dry forage yield (t/ha)
Fertilizer Rate (kg/ha)		
0	4.54[b]	2.52[b]
50	3.34[b]	1.53[c]
100	5.14[ab]	2.62[b]
150	8.17[a]	3.99[a]
SEM	1.54*	0.41*
Age of Harvest (WAS)		
8	5.76[b]	1.97[b]
12	6.31[ab]	1.91[b]
16	10.18[a]	3.10[a]
SEM	2.06*	0.54*
Interaction		
F x W	0.448	0.550

[abcd]Means with different superscript within column differed significantly (P<0.05), SEM = Standard error of the mean, WAS = Weeks after sowing, F = Fertilizer rate, W = Weeks

Chemical composition of *Pennisetum pedicellatum* as influenced by age of harvest

The chemical composition of *Pennisetum pedicellatum* as influenced by age of harvest is presented in Table 3. There was significant (P<0.05) effect of age of harvest on the parameters of chemical composition of *Pennisetum pedicellatum*. Higher (P<0.05) dry matter (90.36%), crude fibre (16.98%), ash (8.20%), nitrogen free extract (47.92%), neutral detergent fibre (27.21%) and acid detergent fibre (16.50%) were obtained at 16 WAS, followed by those of 12 WAS (89.85, 14.23, 7.79, 46.18, 22.79 and 13.97%) while lower (P<0.05) dry matter (88.18%), crude fibre (10.57%), ash (6.68%), nitrogen free extract (45.86%), neutral detergent fibre (16.87%) and acid detergent fibre (10.48%) were recorded at 8 WAS, respectively. Crude protein (23.18%) was higher (P<0.05) at 8 WAS, followed by that of 12 WAS (19.46%) while lower (P<0.05) crude protein (15.16%) was obtained at 16 WAS. Higher (P<0.05) ether extract (2.18%) was recorded at 12 WAS which was similar with that of 16 WAS (2.10%) while lower (P<0.05) ether extract (1.88%) was obtained at 8 WAS for *Pennisetum pedicellatum*.

Table 3: Chemical composition of *Pennisetum pedicellatum* as influenced by age of harvest

Parameters	8 WAS	12 WAS	16 WAS	SEM
Dry matter	88.18[c]	89.85[b]	90.36[a]	0.10*
Crude protein	23.18[a]	19.46[b]	15.16[c]	0.07*
Crude fibre	10.57[c]	14.23[b]	16.98[a]	0.05*
Ether extract	1.88[b]	2.18[a]	2.10[a]	0.07*
Ash	6.68[c]	7.79[b]	8.20[a]	0.06*
Nitrogen free extract	45.86[c]	46.18[b]	47.92[a]	0.10*
Neutral detergent fibre	16.87[c]	22.79[b]	27.21[a]	0.03*
Acid detergent fibre	10.48[c]	13.97[b]	16.50[a]	0.16*

[abc]Means with different superscripts within row differed significantly (P<0.05), SEM = Standard error of the mean, NS = Not significant

Dry matter, crude fibre, ash, nitrogen free extract, neutral detergent fibre and acid detergent fibre increased as age of harvest was delayed from 8 WAS to 16 WAS. The higher dry matter, crude fibre, ash, nitrogen free extract, neutral detergent fibre and acid detergent fibre obtained at 16 WAS could be attributed to the accumulation of cell wall resulting from adequate growing period. Crude protein and nitrogen free extract obtained in this study is higher than the values (7.67% and 47.16%) reported by Mustapha *et al*. (2018) for *Pennisetum pedicellatum* in Wamakko, Sokoto, Nigeria. Whereas, Mustapha *et al*. (2018) reported higher dry matter (96.97%) and crude fibre (19.33%) compared to the values recorded in this study. The CP content must be equal to or higher than 7.0% to be valuable to

ruminants. Crude protein content of all the plant materials analyzed met the minimum requirements for ruminants (>7%), i.e., 6.9 % for maintenance, 10.0 % for beef production and 11.9 % for milk production (Singh, 2009). These nutrients in forages vary according to many factors such as forage species and climate (Baron and Belanger, 2007).

CONCLUSION AND RECOMMENDATION

The growth components, fresh and dry forage yields and chemical composition of *Pennisetum pedicellatum* forage were improved when NPK fertilizer was applied at 150 kg/ha while *Pennisetum pedicellatum* forage harvested at 16WAS gave higher growth components and better fresh and dry forage yield. Crude protein content of *Pennisetum pedicellatum* forage fertilized with NPK fertilizer across all ages was good enough to meet the protein requirement of ruminant animals. For better growth, yield and quality of *Pennisetum pedicellatum* forage therefore, it can be recommended that 150 kg/ha NPK (20:10:10) should be applied and harvested at 16WAS.

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