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Comparative performance of fertilizer types on growth, yield of *Panicum maximum* var. Ntchisi (JAC) and *Andropogon tectorum* during early rainy season in Abeokuta South West, Nigeria

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Target Audience: Forage Scientists, Livestock farmers and Animal Scientists,

Abstract

An experiment was conducted to examine comparative performance of fertilizer types on growth and yield of Panicum maximum and Andropogon tectorum during the early rainy season in Abeokuta. It consists of three factors namely: 4 fertilizer types, 2 grass species and 2 age at harvest allotted to main plots, sub plots and sub-sub-plots respectively. It is therefore factorial experimental arrangement (4 x 2 x 2) laid out in a split-split-plot design with three replicates having a total number of sixteen (16) treatments. The fertilizer types were N.P. K. 20:10:10 (NPK), Aleshinloye organo-mineral (AOM) and poultry manure (PM) and a control. These were applied at the rate of 120 kgN/ha based on their nitrogen content. The grasses were Panicum maximum (Ntchisi) and Andropogon tectorum which, were harvested at 6 and 8 weeks after cut back (i.e. 6 WAC and 8WAC) for determination of dry matter yield. Growth parameters such as leaf length (LL), leaf width (LW), number of tillers (TN) and number of leaves (LN) were estimated from 2 to 6 weeks after cut back in the early rainy season following the year of establishment. The results show that fertilizer types did not significantly affect (P>0.05) the LL and LW of A. tectorum and P. maximum. There were significant differences (P<0.05) among the mean values of LL and LW due to effect of grass species. Similarly, the mean values obtained for TN and LN were not different (P>0.05) under the influence of fertilizer types, but TN and LN were (P<0.05) affected by grass species. There were no significant differences among the mean values of LW but the mean values of LL were different (P<0.05) as a result of interaction effects of fertilizer types and grass species. The mean values of TN and LN were different (P<0.05), though not in a specific trend. However, the mean values of LN were (P>0.05) differed at 4 and 6 WAC.The fertilizer types and grass species did not influence (P>0.05)the mean values of dry matter yield (DMY), forage proportion (FP) and weed proportion (WP). The mean values presented in the result indicated that age at harvest affected (P<0.05) DMY, FP and WP. The highest DMY and FP (29.89 t/ha and 99.82 %, respectively) were observed at 8 weeks. The highest WP (0.89%) was recorded at 6 weeks. It could be concluded that when moisture content is inadequate, fertilizer application may not elicit any significant influence on the growth and biomass production of forage plants.

Keynote: Comparative performance, fertilizer types, early rainy season, *Panicum maximum, Andropogon tectorum*

Description of Problem

Livestock provide more than half of the value of global agricultural productivity and one third in developing countries (1). The significance of livestock and their products globally is increasing due to high consumer's interest in the developing countries expands with population growth and rising in individual incomes (2). Pasture is the fundamental of any livestock operation that purports to be truly sustainable as a result of moderate financial requirement in the maintenance of natural grassland or sown pasture. High productivity of sown pasture has been attributed to heavy inorganic fertilizer input (3). However, applications of mineral fertilizers have been attributed to soil toxicity, mineral imbalance and environmental pollution (4). These detrimental effects of mineral fertilizers apart from high cost, has drawn attention of many farmers to utilization of organically produced fertilizers. These organic fertilizers are environmental friendly, and reduce soil mineral imbalance among many other benefits. Meanwhile, bulkiness and slow nutrient release nature of organic fertilizer have placed major limitation or setback to wide adoption of organic fertilizers by many farmers. The outstanding performance of the complementary application of poultry manure and urea has been reported (5, 6). This was attributed to the synergistic effect of combining organic and inorganic fertilizer which resulted in high nutrient concentration at relative optimal levels (5). In addition, studies have shown the superior manifestation of integrated nutrient supply over sole use of inorganic or organic source in terms of balanced nutrient supply, improved soil fertility and crop yield (7). Synergistic effects of mineral fertilizers with organic fertilizers accumulate more soil total N (8, 9). Therefore, this experiment was conducted to evaluate the possible influence of fertilizer types on growth and yield of *Panicum maximum* (Guinea grass) and *Andropogon tectorum* (Southern Gamba grass) during early rainy season in Abeokuta.

Materials and Methods

Experimental site

The study was conducted at the Teaching and Research unit of Directorate of University Farms (DUFARMS). The site lies within the savanna agro-ecological Transition zone Southwest Nigeria (latitude7.2^0N, longitude 3.5^0E) with average annual rainfall of 1037mm (10).

Experimental design

A total of 1320 m^2 land area was mapped out for the experiment. The study was factorial experimental arrangement (4 x 2 x 2) laid out in a split-split-plot design with three replicates. The dimension of the main plot was 9 m x 9 m, sub-plot was 9 m x 4 m and sub-sub-plot was 4 m x 4 m. The space between sub-plots and sub-sub-plots was 1 m while that between the main plots was 2 m. The replicates were spaced 3 m apart.

There were 16 treatment combinations obtained from the three factors as follow; fertilizer types (4), grass species (2) and harvest age (2). Fertilizer treatments were allotted to the main plots, grass species were allotted to sub-plots while harvest age was allotted to sub-sub plots. The fertilizer types were N.P. K. 20:10:10 (NPK), Aleshinloye organo-mineral (AOM) and poultry manure (PM) and a control. These were applied at the rate of 120 kgN/ha based on their nitrogen content. The grasses were *Panicum maximum* (Ntchisi) and *Andropogon tectorum* which were harvested at 6 and 8 weeks after cut back (i.e. 6 WAC and 8WAC).

Manure and fertilizers application

Poultry manure was incorporated into the soil two weeks before planting, while NPK and AOM were applied two weeks after planting.

The rate of application for the three fertilizers was 120 kgN/ha calculated based on the nitrogen content of each fertilizer earlier obtained.

Data collection

In late October, 2015 (i.e. two weeks after the establishment of the experimental plots) the rainfall stopped and this did not allow the fertilizers applied to be properly incorporated into the soil. Following early rains in March, 2016 the plots were cut back to about 20 cm height above the ground in order to stimulate new re-growth on 16th of April, 2016. Growth data were collected at intervals of two weeks for six weeks on the following parameters:

i. Tiller number/stand
ii. Leaf number/stand
iii. Leaf length (cm)
iv. Leaf width (cm)

Harvest of forage materials

Samples were harvested at 6 and 8 weeks after cut back using $1m^2$ quadrat. Two quadrat samples were taken from each plot to determine the botanical composition and dry matter yield. Sub–samples were taken, weighed and oven dried at 65^0C to constant weight.

Estimation of Botanical composition

The total harvested plant materials from each quadrat (X) were separated into individual plant species present in the pasture (Y) and each component was weighed separately and recorded. The botanical composition (A) was estimated as of total quadrat harvest.

i.e. A= (Y/X) x 100

Estimation of dry matter yield

The dry matter yield (DMY) of harvested materials in hectare was determined according to the formulae used by (11).

DMY Kg ha^{-1} = (Total FY (kg) x (DWSS/ FWSS) x10

Where Total FY = Total Fresh yield per m^2
DWSS = Dry weight of the sub-sample (m^2)
FWSS = fresh weight of the sub-sample (m^2)

Statistical analysis

The data collected were subjected to analysis of variance using SAS (R) package and significant means were separated using Duncan's Multiple Range Test (12) at 5% level.

Experimental model

$Y_{ijkl} = \mu + F_i + S_j + H_k + (FS)_{ij} + (FH)_{ik} + (SH)_{jk} + (FSH)_{ijk} + \sum_{ijkl}$

μ = population mean
F_i = effect of fertilizer types
S_j = effect of grass species
H_k = effect of age at harvest
$(FS)_{ij}$= interaction of fertilizer types and grass species effects
$(FH)_{ik}$=interaction of fertilizer types and age at harvest effects
$(SH)_{jk}$= interaction of grass species and age at harvest effects
$(FSH)_{ijk}$ = interaction of fertilizer types, grass species and age at harvest effects
$\sum_{ijkl}$ = Residual error estimate

Results and Discussion

The growth performances of the two grasses as affected by fertilizer types are presented in Table 1. The effect of fertilizer types did not significantly affect ($P>0.05$) the leaf length (LL) and leaf width (LW) of *A. tectorum* and *P. maximum*. There were significant differences ($P<0.05$) among the mean values of LL and LW due to effect of grass species. *Panicum maximum* recorded higher LL (57.25cm, 78.20 cm and 75.50 cm) than *A. tectorum* at 2, 4 and 6 WAC, respectively. Higher ($P<0.05$) LW (4.00 and 4.37 cm) were recorded in *A. tectorum* at 4 WAC and 6 WAC than for *P. maximum*.The mean values obtained for TN and LN were not different ($P>0.05$) under the influence of

fertilizer types (Table 2). Higher (P<0.05) TN (43.07 and 56.54 tillers/stand) was observed in *A. tectorum* at 2 and 4 WAC respectively than *P. maximum*. Considering the LN, *A. tectorum* had the higher values (104.32 and 169.62 leaves/stand) at 2 and 4 WAC respectively than *P. maximum*.

Table 3 shows the interaction effects of fertilizer types and grass species on leaf length and leaf width in the early rainy- season. There were no significant differences (P>0.05) among the mean values of LW but the mean values of LL were significantly different (P<0.05). The highest LL (72.82 and 78.54cm) were observed in *P. maximum* fertilized with AOM at 4 and 6 WAC, respectively, while the lowest LL (50.00 and 47.56cm) were observed in *A. tectorum* fertilized with AOM and N.P.K at 4 and 6 WAC, respectively.The interaction effects of fertilizer types and grass species on number of tillers (TN) and leaf number (LN) in the early rainy- season are presented in Table 4. The highest TN (45.94 tillers/stand) was noticed in *A. tectorum* fertilized with AOM at 2 WAC, while that of *P. maximum* fertilized with AOM had the lowest TN (24.11tillers/stand) at 2 WAC. The highest TN (62.39 tillers/stand) was observed in *A. tectorum* under control treatment (i.e. no fertilizer) and the lowest TN (32.28 tillers/stand) was noticed in *P. maximum* under control treatment at 4 WAC. In addition, at 6 WAC, the highest mean value (75.78tillers/stand) was recorded in *A. tectorum* under AOM for TN, while the lowest TN (42.61tillers/stand) was observed in *P. maximum* under control treatment (i.e. no fertilizer). Meanwhile, *A. tectorum* fertilized with AOM at 6 WAC had the highest LN (209.67) and that of *P. maximum* under control treatment observed to be the lowest LN at 6 WAC.

It was evident from the outcomes that at the early stage of growth, fertilizer types did not confer comparative benefits over the control. The noticeable effects observed as grasses advanced in age on *P. maximum* (Ntchisi) fertilized with NPK improvement in leaf length and tiller production. This could be attributed to increase nutrient uptake as a result of improvement of root systems and photosynthetic activity as the plant advanced in age. This is in accordance with (13) that the first response of pastures to N fertilizer application is a rapid plant uptake of N.

There was however, no particular trend for the influence of fertilizer types, because at six weeks after cut back, *A. tectorum* fertilized with AOM took the leading position for leaf length, number of tillers and number of leaves. The reason that might be adduced for this observation is availability of moisture in the soil, which is essential for nutrient uptake by plants. At the initial stage of this trial, the amount of rainfall might not be sufficient to support adequate uptake of the available nutrients by the plants in AOM fertilizer, which consequently released more nutrients when the moisture contents increased. Coupled with the fact that the root system of the newly planted grasses might not have been fully established, to be able to explore the soil efficiently, this might be responsible for initial poor performance of AOM. This corroborated report by (13) who expressed that nitrogen response on the plants are affected by climate, geographical factors, and soil factors such as texture, drainage, pH, fertility, moisture availability and temperature. Mineral uptake by plants is not only affected by the cumulative amounts of minerals in the soil, as the availability of minerals in soils also depends on the effective.

Table 1: Main effects of fertilizer types on leaf length and leaf width of two tropical grasses in the early rainy- season

Factors	Leaf length (cm)			Leaf width (cm)		
	2 WAC	4 WAC	6 WAC	2 WAC	4 WAC	6 WAC
Fertilizer types						
Control	55.34	59.25	64.62	4.00	4.50	4.73
AOM	56.25	63.00	72.25	3.50	4.00	4.73
NPK	54.30	61.42	74.45	4.50	4.54	4. 47
PM	50.25	57.45	62.34	3.00	4.00	4.32
SEM	0.30	0.35	0.32	0.00	0.00	0.02
Grass species						
A. tectorum	50.20 [b]	60.35[b]	65.50[b]	4.00	4.00[a]	4.37 [a]
P. maximum	57.25 [a]	78.20[a]	75.50[a]	3.00	3.40[b]	3.84 [b]
SEM	0.20	0.25	0.17	0.00	0.02	0.04

[a, b]: means in the same columns with different superscripts are significant different (P<0.05)
SEM = Standard error of mean
WAC= weeks after cut back
AOM=Aleshinloye organo-mineral fertilizer
PM=Poultry manure
NPK=N.P.K. 20:10:10

Table 2: Main effects of fertilizer types on number of tillers and leaf number of *Panicum maximum* (Ntchisi) *and Andropogontectorum* during the early rainy- season

Factors	Number of tillers /stand			Leaf number /stand		
	2 WAC	4 WAC	6 WAC	2 WAC	4 WAC	6 WAC
Fertilizer types						
Control	37.33	52.64	60.40	93.47	142.13	163.08
AOM	34.73	43.56	55.56	81.88	130.68	166.68
NPK	37.19	58.35	72.64	103.44	175.05	217.92
PM	32.67	45.30	57.25	74.81	135.90	171.75
SEM	2.82	3.65	4.62	7.70	19.13	24.56
Grass species						
A. tectorum	43.07 [a]	56.54[a]	68.43	104.32 [a]	169.62[a]	205.29
P. maximum	28.24 [b]	45.34[b]	59.76	91.42 [b]	158.69[b]	191.23
SEM	1.81	2.25	4.65	5.60	12.58	17.68

[a, b,] : means in the same columns with different superscripts are significant different (P<0.05)
SEM = Standard error of mean
WAC= 2 weeks after cut back
AOM=Aleshinloye organo-mineral fertilizer
PM=Poultry manure
NPK=N.P.K. 20:10:10

concentration in soil solution, and on the soil characteristics such as soil texture, soil pH, moisture content, drainage capacity and organic matter content (14, 15).

Table 5 shows the dry matter yield and botanical composition of *Panicum maximum* and *Andropogon tectorum* as affected by fertilizer types and age at harvest. The

fertilizer types and grass species did not influence (P>0.05) the mean values of dry matter yield (DMY), forage proportion (FP) and weed proportion (WP). The mean values presented in the result indicated that age at harvest affected (P<0.05) DMY, FP and WP. The highest DMY and FP (29.89 t/ha and 99.82 %, respectively) were observed at 8 weeks. The highest WP (0.89%) was recorded at 6 weeks. The dry matter yield and botanical composition of two grass species as affected by the interaction effects of age at harvest and fertilizer types during the early-rainy season are presented in Table 6. The mean values of the DMY, FP and WP were different (P<0.05). The highest DMY (39.61t/ha) was observed in *A. tectorum* under control treatment (i.e.no fertilizer) at 8 weeks, while *A. tectorum* fertilized with NPK fertilizer at 8 weeks had the highest forage proportion (99.86%). However, *A. tectorum* fertilized with NPK harvested at 6 weeks recorded the highest weed proportion (1.58%).

The higher dry matter (DM) yield of *A. tectorum* under the control treatment (i.e. no fertilizer application) at eight weeks after cut back, indicated that fertilizer treatments failed to improve the DM yield of that grassover the control. This could be attributed to the fact that at the early period of fertilizer application, the nutrients released might be insufficient to elicit a visible change in plants growth because it needs to be properly absorbed and sometimes mineralized in the soil especially poultry manure. Poultry manure could have taken a longer time than NPK and AOM before it is finally mineralized to release the nutrients in it due to its nature as an organic fertilizer which releases small amounts of nutrients in the first year than the subsequent years following application (16). This observation is not in conformity with the findings by (17) that fresh forage yield and dry matter (DM) yield were significantly affected by nitrogen sources during the first two seasons after planting. Furthermore, it was reported that DM and fresh forage yield were increased progressively by NPK compared with other nitrogen sources which was not the case in the present study. Similarly, (18) observed that number of tillers and dry matter yield were significantly (P<0.05) affected by grass species and their interaction with urea fertilizer level as against observation in the current trial. This variation might be as a result of inability of the plants in the present study to utilize the nutrients released by the fertilizer treatments or the nutrients released might not available for uptake by the plants due to leaching or denitrification.

Table 3: Interaction effects of fertilizer types and grass species on leaf length and leaf width in the early rainy- season

Treatments		Leaf length (cm)			Leaf width (cm)		
		2 WAC	4 WAC	6 WAC	2 WAC	4 WAC	6 WAC
Grass species	**Fertilizer types**						
A. tectorum	Control	48.25	52. 45^{bs}	55.20^{bcd}	3.20	3.50	4.00
	AOM	56.64	50.00^{c}	54.28^{cde}	4.00	4.00	4.00
	NPK	50.32	50.25^{c}	47.56^{e}	4.00	4.20	5.00
	PM	47.25	48.50^{c}	50.34^{de}	3.00	4.00	4.00
P. maximum	Control	62.68	65.25^{ab}	70.50^{ab}	4.02	4.00	4.03
	AOM	55.65	68.43^{a}	64.24^{abc}	3.20	4.00	4.30
	NPK	59.45	72.82^{a}	78.54^{a}	3.00	4.00	4.30
	PM	54.26	66.30^{ab}	70.65^{ab}	3.00	3.50	4.00
SEM		0.40	0.29	0.30	0.01	0.01	0.03

$^{a, b, c, d}$: means in the same column with different superscripts are significant different (P<0.05)SEM = Standard error of mean
WAC= weeks after cut back
AOM=Aleshinloye organo-mineral fertilizer
PM=Poultry manure
NPK=N.P.K. 20:10:10

Table 4: Interaction effects of fertilizer types and grass species on number of tillers and leaf number in the early rainy- season

Treatments		Number of tillers/stand			Leaf number/stand		
		2 WAC	4 WAC	6 WAC	2 WAC	4 WAC	6 WAC
Grass species	**Fertilizer types**						
A. tectorum	Control	39.83^{ab}	62.39^{a}	69.11^{a}	113.06	108.50	197.56^{a}
	AOM	45.67^{a}	50.06^{abc}	75.78^{a}	81.80	123.89	209.67^{a}
	NPK	45.94^{a}	56.78^{ab}	66.37^{a}	112.33	125.44	181.78^{a}
	Poultry	40.06^{ab}	45.72^{bcd}	62.94^{a}	106.33	130.44	160.06^{ab}
P. maximum	Control	27.67^{c}	32.28^{d}	42.61^{b}	73.89	100.06	105.00^{c}
	AOM	24.11^{c}	43.44^{bcd}	45.83^{b}	81.94	95.39	117.39^{c}
	NPK	28.83^{bc}	37.61^{cd}	57.45^{b}	94.56	105.11	130.56^{bc}
	Poultry	26.39^{c}	39.61^{cd}	59.56^{b}	115.28	79.22	145.94^{bc}
SEM		2.67	3.28	2.98	10.42	7.47	10.36

$^{a, b, c, d,}$: means in the same column with different superscripts are significantly different (P<0.05)
SEM = Standard error of mean
WAC= 2 weeks after cut back
AOM=Aleshinloye organo-mineral fertilizer
PM=Poultry manure
NPK=N.P.K. 20:10:10

Conclusions and Application

1. *Panicum maximum* fertilized with NPK had the highest leaf length and *A. tectorum* fertilized with AOM produced the highest tillers and leaf number during the early rainy-season.
2. *Andropogon tectorum* under control treatment (no fertilizer) at eight weeks produced the highest dry matter yield.
3. It could be recommended that for efficient nutrients uptake by the plants, fertilizer should be applied when there will be adequate moisture for proper absorption by the soil.

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