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EFFECT OF PLANTING PERIOD ON DRY MATTER YIELD AND CHEMICAL COMPOSITION OF GAMBA GRASS (*Andropogon gayanus* Kunth) IN THE SEMI-ARID ZONE OF NIGERIA

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ABSTRACT

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The objective of this study was to evaluate the performance of Gamba grass (*Andropogon gayanus*) in response to varying planting periods on dry matter yield and chemical composition. The trial was conducted at the Kano University of Science and Technology Teaching and Research Farm, Gaya in the semi-arid zone of Nigeria during the 2015 growing season. Plots measuring 3m x 3m were laid in a randomized complete block design and seeds of Gamba grass were planted at 37.5cm x 37.5cm spacing. The test periods were early June, mid-June, late June, early July, mid-July and late July, and harvesting was done at twelve weeks of the trial. The six treatments were replicated three (3) times. The results showed significant ($P < 0.05$) differences in tiller counts, culm height and dry matter yield across treatments, but there was no significant ($P > 0.05$) difference in chemical composition of the grass. Planting in early July was significantly ($P < 0.05$) higher in tiller counts, culm height and subsequently, dry matter yield (10.20 tons/ha) relative to other planting periods. In conclusion, Gamba grass planted in early July establishes better and produces higher fodder yield. It is therefore recommended that Gamba grass be established in early July in the semi-arid zone of Nigeria for higher fodder yield. However, values obtained for chemical composition suggest that animals raised on pure Gamba grass may respond positively to protein supplementation.

INTRODUCTION

Feed availability is a limiting factor to livestock production in the high livestock producing zones of Nigeria (Muhammad *et al.*, 2004). The limiting supply of animal protein in the diets of Nigerians is due to low productivity, which has been attributed to poor husbandry practices, inadequate feed supply and disease (FAO, 2006; Ashiru *et al.*, 2009). Nutrition influences growth and fertility particularly in the tropics where there is seasonal changes in quality and quantity of feed (Eroarome, 2009).

Obviously, most of the beef that reaches the market comes from the traditional cattle owners' herds whose input into production is very minimal and depends mostly on natural range to feed their stock with little or no supplementation (Richard & Church, 2010). Despite the fact that forages provide the cheapest and most important feed for ruminant animals, their availability is one of the major constraints to livestock production in the tropics (Ademosun, 1998).

Sub Saharan livestock production is increasingly constrained by feed shortage both quantitatively and qualitatively. Savadogo *et al.* (1999) stated that natural forage is not sufficient to satisfy animal requirement in the dry season when the quantity decreases by 24 to 50% and peak biomass and nitrogen content falls below 1%. Furthermore, Abubakar (1998) reported that non availability of adequate feeds for most parts of the year in Nigeria is a major constraint to livestock production. Generally, Nigerian livestock population depends mostly on the available natural pastures for their feed. As part of the new technology in animal husbandry, improved pastures produce more dry matter of high nutritive value and lead to greater animal productivity than do native pastures (Nuru, 1996). Muhammad and Abubakar (2004) also reported that sown pastures, where properly managed, have the potential to improve forage quality and increase herbage yield several folds over that of natural grasslands, and thus leads to marked increase in animal production.

Gamba (*Andropogon gayanus* Kunth) is a multipurpose grass used in animal production and is one of the major native grass species found in the semi-arid zone (Ibrahim *et al.*, 2011). It is a perennial grass, established from both seeds and stocks, persistent to grazing and fire (Bogdan, 1977). A well-established Gamba grass can remain productive for years if it is mowed manually for hay, burnt every 2 to 3 years, top dressed with nitrogen and phosphorous fertilizers or leniently grazed by livestock (Ibrahim *et al.*, 2011). It is one of high-yielding grasses in Nigeria and is valued for its productivity, drought resistance, reasonable dry season production and excellent palatability particularly at vegetative stage (Pressland & Watson, 2008). However, planting period is a critical factor in Gamba establishment particularly in areas with low rainfall regimes such as semi-arid zone. For most of the grasses grown in the northern guinea and Sudan savannas, the period between mid-June to early July is most suitable for pasture development. In Shika, Zaria for example, higher plant height, density and forage yield were obtained by planting in mid-June to early – July, and planting at mid-

June produces a second ratoon crop later in the year (Muhammad *et al.*, 2004). Furthermore, the establishment of effective rains in these zones is between mid-June to early July. Thus, in order to obtain higher forage yield there is the need to plant at an appropriate time. The present study was therefore undertaken to evaluate the performance of Gamba grass (*Andropogon gayanus*) in response to varying planting periods on dry matter yield and its chemical composition.

Materials and Methods

Description of the Study Location

The experiment was conducted at the Kano University of Science and Technology (KUST) Teaching and Research Farm, Gaya (11° 51' N; 9° 20' E; alt. 430m above sea level) in the semi-arid zone of Nigeria (Dambazau, 2008). The mean annual rainfall is about 800mm, while the mean annual temperature is about 26°C (Olofinet *et al.*, 2008). The study area is characterized by a defined wet season which normally begins in May and ends in October. The dry season therefore lasts from October to May. The soil of the study area is loamy sand with little organic matter (Adamu *et al.*, 2014). The natural vegetation is the savanna type which consists of moderately tall grasses such as *Andropogon gayanus*, *Panicum maximum*, *Pennisetum pedicellatum* etc and scattered browses such as *Acacia*, *Balanites*, *Faidherbia*, *Piliostigma* and *Zizipus spp* (Gefu & Amodu, 2004). The area supports good agricultural activities with sorghum, millet, cowpea and groundnut being the major crops cultivated (Dambazau, 2008). The most common livestock found are the Bunaji, Yankasa and the Red Sokoto breeds of cattle, sheep and goats, respectively.

Experimental Procedure

The field on which the trial was conducted was initially cleared, ploughed and harrowed to provide a fine seed bed for better seedling establishment. Subsequently, plots measuring 3m x 3m were laid in a randomized complete block design (RCBD). Soil samples were taken at two depths (0-15 & 15-30cm) using auger, for fertility evaluation, after which seeds of Gamba grass were planted, by drilling, to a depth of 3cm at 37.5cm interval (both intra- and inter-row) (Ibrahim *et al.*, 2011).

The test periods were early June, mid-June, late June, early July, mid-July and late July, 2015. The six treatments were replicated 3 times. Two weeks post emergence, the seedlings were thinned to five (5) shoots per stand (Ibrahim *et al.*, 2011). Thereafter, weeding was done and compound fertilizer (NPK 15: 15: 15) was applied at the rates of 100kgN/ha, 30kgP/ha and 30kgK/ha in split doses (Muhammad & Abubakar 2004). Subsequent weedings were done fortnightly according to planting period.

Field samplings were done fortnightly from six (6) weeks post planting and the parameters measured were tiller counts and culm height (m).

Yield was determined at twelve (12) weeks post planting. At harvest, the entire plant population per plot was harvested manually with sickle at 15cm above the ground level (Muhammad & Abubakar 2004). The harvested material was weighed fresh after which representative grab samples were taken, weighed and oven-dried at 65°C for 48 hours for dry matter yield determination.

Chemical Analysis

The oven-dried samples were milled in the laboratory and sieved using 1mm sieve and then analyzed chemically. Nitrogen in the plant material was determined by Micro-Kjeldhal method. Percent crude protein (CP) was calculated as %N x 6.25. Crude fibre (CF), ether extract (EE) and nitrogen free extract (NFE) were determined according to the procedures described by A.O.A.C. (2005). Fibre fractions (ADF and NDF) were analyzed by the procedures of Van Soest *et al.* (1991).

Data Analysis

The data collected were subjected to analysis of variance (ANOVA) using the general linear model (GLM) of SAS (2002) statistical package. Significant means were compared at 5% level of probability using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Results of soil analysis showed that the soil of the study area belongs to the textural class of loamy sand and its chemical properties are shown in Table 1. The pH suggests that the soil ranges from slightly acidic to mildly alkaline,

and although its chemical properties suggested that it has low organic matter, it could favour pasture production since the pH value is within the range for normal growth of crops. Muhammad and Abubakar (2004) reported that forage crops generally grow better on well drained fertile loamy than shallow, stony or gravelly soils. Steve and Martin (2008) also reported that Gamba grass is tolerant to low soil fertility, but seedling growth may be slow unless some additional nitrogen and phosphorus are applied on deficient soil. Similarly, Cook *et al.* (2005) reported that the grass grows on a wide range of soil type ranging from light sands to clay loams, but not on very heavy clays which become water logged. It can also tolerate highly acidic soil (pH of 4.0 to 7.5) and high levels of aluminum (Floreset *et al.*, 2005).

Table 2 presents the effect of planting period on mean tiller counts of established Gambagrass at weeks 6, 8, 10 and 12 post planting. Planting period significantly ($P < 0.05$) affected tiller counts of the grass in all the weeks evaluated. Planting in early July had significantly ($P < 0.05$) higher tiller counts relative to other planting periods. Tiller counts ranged from 35.70 (mid-June planting) to 81.00 (early July planting) at 12 weeks post planting. The value (81.00) obtained in early July planting in the present study was however, lower than the value (86.43) reported by Ibrahim *et al.* (2011) in similar study area. The differences observed could probably be attributed to differences in management practices. Steve and Martin (2008) also reported that Gamba is a tussock grass that has high tillering ability and establishes more readily in cultivated paddocks. The higher number of tillers obtained in early July planting could be due to the fact that rains have fully established at that period. Muhammad and Abubakar (2004) reported that rain fall is a critical factor in pasture establishment, and the establishment of effective rains in the Sudan savanna is usually from mid-June to early July. The tiller counts of the grass increased consistently with increase in growth period. This observation is in line with the earlier reports by Ibrahim *et al.* (2011).

The profusely tillering ability of Gamba and the corresponding culm height make the grass a prime stock suitable for large scale pasture production in the dry savanna regions.

The effect of planting period on mean culm height (m) of established Gambagrass (*Andropogon gayanus*) at weeks 6, 8, 10 and 12 post planting (Table 3) indicated significant ($P < 0.05$) differences in culm height (m) across the treatments. At week 6, plants in treatment 1 through to 4 (early June, mid-June, late June and early July) were significantly ($P < 0.05$) taller relative to other planting periods. Similarly, at weeks 8 to 12 plants in treatments 3 and 4 (late June and early July) were significantly ($P < 0.05$) taller compared to other planting periods. Culm height at week 12 ranged from 2.08 to 2.93m. The results being reported here compares favourably with the value (2.79m) reported by Ibrahim *et al.* (2011) in similar study environment. Steve and Martin (2008) also reported that Gamba is a perennial grass that can grow up to 3m tall. Culm height increased consistently with increase in growth period in all the treatments evaluated. This observation corroborates with the reports of Steve and Martin (2008) and Ibrahim *et al.* (2011). Pressland and Watson (2008) reported that Gamba grass, a C4 plant (plant that cycles carbon dioxide into four carbon sugar compounds to enter into the Calvin cycle), has the ability to sustain higher rates of photosynthesis due to carbon dioxide enrichment. Furthermore, because the concentration of carbon dioxide relative to oxygen in bundle sheath cells is higher, rates of photorespiration in this type of plant is lower than in C3 plants and this makes it grow taller (Bogdan, 1977).

The effect of planting period on dry matter yield and chemical composition of established Gamba grass is shown in Table 4. There was significant ($P < 0.05$) difference in dry matter yield across the treatments. Early July planting proved superior ($P < 0.05$) to other planting periods. The values ranged from 4.09tDM/ha (in early June planting) to 10.20tDM/ha (in early July planting). The higher dry matter yield (10.20tDM/ha.) obtained in early July planting could be due to the establishment of effective rains, and is in agreement with the recommendations of Muhammad *et al.* (2004) and Muhammad and Abubakar (2004) that

planting should be done in early July in the Sudan savanna for obtaining higher forage dry matter yields. The authors further reported that rain fall is a critical factor in pasture establishment particularly in areas with unimodal rainfall pattern such as the semi arid zone, and the establishment of effective rains in the Sudan savanna ranges from mid June to early July. Gamba grass in this study was found to be high yielding and compares very well with other standard, conventional forage grasses such as *Panicum maximum* (Reilinget *al.*, 2001), *Pennisetumpurpleum*, *Brachiariadecumbens* and *Sorghum almum* (Muhammad *et al.*, 2004). Additionally, Steve and Martin (2008) reported that *Andropogon gayanus* is one of high-yielding grasses of west Africa, yielding up to 12tDM/ha.

There were no significant ($P > 0.05$) differences in chemical composition across treatments, even though the values were numerically different. The values for dry matter (DM) content ranged from 81.50 to 83.67%, ash from 5.66 to 6.42%, crude protein (CP) from 6.92 to 7.41 %, crude fibre (CF) from 28.17 to 30.57%, ether extract (EE) from 2.67 to 2.98%, nitrogen free extract (NFE) from 38.84 to 41.03%, acid detergent fibre (ADF) from 36.03 to 37.95%, while the range for neutral detergent fibre (NDF) was 62.24 to 64.97%. The range of values obtained in this study showed that the DM content (81.50 to 83.67%) was similar to the value (83.50%) reported by Duke (1997), for ash (5.66 to 6.09%) and CP (6.92 to 7.41 %) were similar to 6.90% and 7.48% reported by Cook *et al.* (2005) for ash and CP, respectively. The range of CF values (28.17 to 30.57%) was however, lower than the value (33.70%) reported by Vazquez and Smith (2000). The range of EE values (2.67 to 2.98%) was higher than the value (1.90%) reported by Toledo *et al.* (1990). Conversely, the range of NFE values (38.84 to 41.03%) was lower than the value (50.20%) reported by Nyako (2010). Similarly, the ranges of values for ADF (36.03 to 37.95%) and NDF (62.24 to 64.97%) were lower than 42.80% and 76.40% reported by Toledo *et al.* (1990) and Nyako (2010) for ADF and NDF, respectively. Ibrahim *et al.* (2011) also reported lower values for DM (76.65%), NFE (31.13%), ADF (33.95%) and NDF (56.40%) in Gamba grass.

The differences observed in the present study could be attributed to differences in management practices, location of the study or stage of harvest. The high DM range (81.50 to 83.67%) obtained in this study suggests a good source of energy and roughage that could enhance rumination and prevent digestive upset in the rumen as reported by McDonald *et al.* (1998). Higher EE in a feed indicates fat content which subsequently contributes to volatile fatty acids concentration and therefore energy value of the feed, suggesting that the grass has adequate energy required by grazing animals. The ADF is the fibrous component that represents the least digestible fiber portion of forage (McDonald *et al.*, 2010). This highly indigestible part of forage includes lignin, cellulose, silica and insoluble forms of nitrogen, but not hemicellulose. Forages with higher ADF are lower in digestible energy than forages with lower ADF. Thus, lower ADF value suggests higher digestible energy, implying that as the ADF levels increase, digestible energy levels decrease. NDF is the most common measure of fibre used for animal feed analysis, but it does not represent a unique class of chemical compounds. Furthermore, it has been established that NDF measures most of the structural components

in plant cells (i.e. lignin, hemicellulose and cellulose), but not pectin (Mondal, 2012). These structural components are not easily digestible. However, the level of NDF in the animal ration influences the animal's intake of dry matter and the time of rumination as reported by Vazquez and Smith (2000). The results of the present study showed that the CP content is below the recommended critical level (16%) to ensure optimum performance for animals on pasture (NRC, 1996). This suggests that animals raised on pure Gamba grass may respond positively to protein supplementation.

Conclusion

Based on the results of the present study, it was concluded that Gamba grass planted in early July establishes better and produces higher forage dry matter yield. It is therefore recommended that Gamba grass be established in early July in the semi-arid zone of Nigeria for higher fodder yield.

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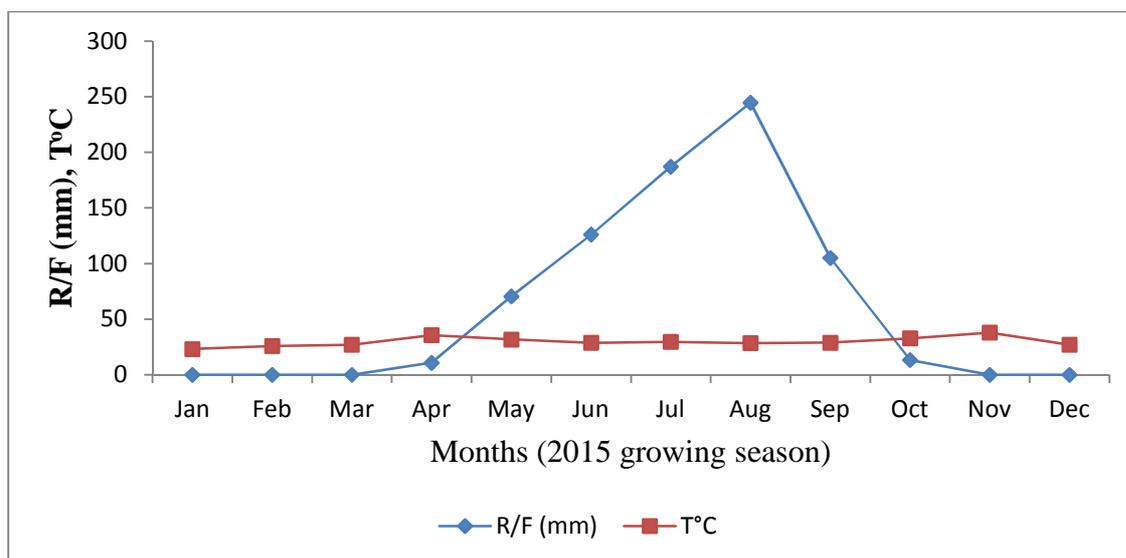


Fig. 1: Mean monthly rainfall (mm) and temperature (°C) for the 2015 growing season (Source: KUST Meteorological Station)

Table 1: Soil characteristics of the experimental site (KUST Teaching & Research Farm, Gaya)

Depth (cm)	pH	N (%)	OC (%)	CEC (meq/100g)	P (%)	Sand(%)	Silt (%)	Clay (%)	Textural Class
0-15	6.13	0.08	0.05	5.47	5.89	75.00	20.04	3.00	loamy sand
15-30	6.55	0.14	0.03	5.42	6.00	77.00	17.50	3.50	loamy sand

Table 2: Effect of planting period on mean tiller counts of established Gamba grass at weeks 6, 8, 10 and 12 post planting.

Planting period	Weeks post planting			
	6	8	10	12
Early June	14.67 ^c	21.58 ^c	27.37 ^c	37.87 ^c
Mid June	13.17 ^c	21.70 ^c	27.50 ^c	35.70 ^c
Late June	25.87 ^b	42.31 ^{ab}	51.83 ^b	64.60 ^b
Early July	38.00 ^a	49.23 ^a	64.50 ^a	81.00 ^a
Mid July	26.85 ^b	37.05 ^b	48.0 ^b	61.73 ^b
Late July	28.05 ^b	37.17 ^b	44.03 ^b	55.10 ^b
LSD	6.199	7.732	9.639	12.296

^{abc}: means within the same column with different superscripts differ significantly (P<0.05)

LSD= Least Significant Difference.

Table 3: Effect of planting period on mean culm height (m) of established Gamba grass at weeks 6, 8, 10 and 12 post planting.

Planting period	Weeks post planting			
	6	8	10	12
Early June	0.75 ^a	0.88 ^b	1.48 ^c	2.63 ^b
Mid June	0.76 ^a	0.88 ^b	1.55 ^b	2.60 ^b
Late June	0.75 ^a	0.93 ^a	2.05 ^a	2.93 ^a
Early July	0.75 ^a	0.93 ^a	2.05 ^a	2.93 ^a
Mid July	0.67 ^b	0.83 ^b	1.54 ^b	2.72 ^b
Late July	0.64 ^b	0.74 ^c	1.45 ^c	2.08 ^c
LSD	0.061	0.082	0.217	0.176

^{abc}: means within the same column with different superscripts differ significantly (P<0.05)

LSD= Least Significant Difference.

Table 4: Effect of planting period on dry matter yield (t/ha) and chemical composition (%) of established Gamba grass.

Planting period	DMY	DM	Ash	CP	Composition				
					CF	EE	NFE	ADF	NDF
Early June	4.09 ^d	82.00	5.66	7.12	28.17	2.98	41.03	37.95	63.21
Mid June	4.80 ^d	82.37	6.09	6.92	28.92	2.93	40.43	36.83	64.83
Late June	7.54 ^b	81.50	6.42	7.22	29.03	2.92	38.84	36.97	64.97
Early July	10.20 ^a	83.67	5.96	7.41	30.43	2.77	39.86	37.63	63.42
Mid July	6.30 ^{bc}	83.17	5.79	6.95	30.57	2.78	39.86	38.33	64.53
Late July	5.78 ^c	82.57	5.73	7.02	29.83	2.67	39.98	36.03	62.24
LSD	1.546	4.085	0.983	0.658	5.688	0.291	7.918	3.294	5.913

^{abcd}: means within the same column with different superscripts differ significantly (P<0.05); LSD= least significant difference; DMY= dry matter yield; DM= dry matter; CP= crude protein; CF= crude fibre; EE= ether extract; NFE= nitrogen free extract; ADF= acid detergent fiber; NDF= neutral detergent fiber.