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Research Article

Growth and Herbage Yield of Gamba (*Andropogon Gayanus, Kunth*) and Kyasuwa (*Pennisetum Pedicellatum, Tan*) Grasses in Sokoto Semi-Arid Zone of Nigeria

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Abstract

This paper reports on the growth and herbage yield of *Andropogon gayanus* and *Pennisetum pedicellatum* in the Sokoto Semi-arid zone of Nigeria, with a view to identifying most productive among the species for forage feed production in the study area. Field experiment was conducted during the 2010 rainy season at the Dabagi teaching and research farm of Usmanu Danfodiyo University, Sokoto, Nigeria. Parameters evaluated include plant height, number of leaves, leaf length, leaf width, number of tillers per plant and herbage dry matter yield at 10 WAS. The data generated was analyzed using the Statistical Analysis System in a Randomized Complete Block Design. Fisher's Least Significance Difference ($LSD_{t<0.05}$) test was used for mean separation. Results showed that, *P. pedicellatum* produced significantly ($P<0.05$) taller plants (110.01cm versus 77.25cm), higher ($P<0.05$) number of leaves per plant (6.39 versus 4.00) and higher ($P<0.05$) herbage dry matter yield (3.518 t DM ha^{-1} versus 2.037 t DM ha^{-1}) compared to the *A. gayanus. A. gayanus* recorded longer ($P<0.05$) leaves (46.83cm versus 27.90cm) and higher ($P<0.05$) number of tillers per plant (70.61 versus 28.67). Leaf width for the two grass species were statistically ($P>0.05$) similar (1.75cm versus 1.42cm) at 10 WAS. Merit analysis showed that *P. pedicellatum* recorded a higher score of 9 points and was ranked 1st while A. gayanus scored 8 points and was ranked 2nd. It may be concluded that both the *P. pedicellatum* and *A. gayanus* showed potentials for high productivity, thus; both species are recommended for production in the study area.

Keywords: *Andropogon Gayanus*; *Kunth*; *Pennisetum Pedicellatum*; Growth Parameters; Herbage Yield; Semi-Arid Zone

Introduction

Nigeria is blessed with numerous livestock resources among which are 16 million cattle, 33 million sheep and 52.5 million goats (FAO, 2009). However, provision of adequate feeding, has over the years, constituted a major challenge to the improved productivity of the animals [1-4]. This was attributed largely to inadequate supply and poor quality of feeds during the dry season, especially in the Savanna zones, where long dry season persist in the country [5-9] reported that over 90% of the cattle and 70% of the sheep and goats in Nigeria are being produced in the savanna zones of the country while Semi-arid zone of the Nigerian Savanna accounts for about 49, 47 and 37% of the cattle, sheep and goats, respectively, in the country. In the semi-arid savanna, the ruminant animals usually gain weight during the short (3-5 months) rainy season and loose much of it during the dry season due to inadequate and poor quality of the feeds [3,10].

Production and use of pasture species (both grasses and legumes) that produce high yield of good quality herbage has been reported as the cheapest and long term means of providing year - round adequate feeding to the ruminant animals in the Nigerian Savanna [11-16], and there is need to identify the most productive species that are suitable for production in the various ecological areas of the country [12]. The present research was carried out to

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evaluate some growth parameters and herbage dry matter yield of Gamba grass (*Andropogon gayanus*) and Kyasuwa grass (*Pennisetum pedicellatum*) and compare same in the Sokoto semi-arid zone of Nigeria. No similar research work has been reported on the two grass species in the study area; hence the need to carry out this research. Gamba grass (*Andropogon gayanus Kunth*), commonly called African gamba (West Africa), Rhodesian blue grass (Southern Africa) or Sadabahar (India), is native to the tropical Africa, and is adapted to a wide range of soil types [17,18]. It requires rainfall regime of 400-1400mm per annum [17]. Main attributes of the forage Gamba include excellent growth, exceptionally tolerant to drought stress, low P and N fertilizer requirements and high herbage dry matter production. It also has an acceptable nutritional quality and high palatability that result to high animal production due to high intake by animals [18].

Kyasuwa grass (*Pennisetum pedicellatum* Tan), commonly called annual kyasuwa (Nigeria), bare grass (West Africa) or deenanath grass (India); is native to the North tropical Africa and India [19]. Kyasuwa is normally cultivated on fertile loamy soils; but can grow on rich sandy soil [20]. It is normally cultivated as rain fed forage crop under optimum temperature of 30-35 °C. The usual rainfall is 500-650mm per annum but has been grown and produced seeds under very low rainfall (127mm) in India. Main attributes of the *P. pedicellatum* include good tolerance drought, high tillering, early flowering and high palatability [19].

Materials and Methods

Description of study area

Field experiment was conducted during the 2010 rainy seasons at the Dabagi teaching and research farm (Latitudes 12° 45' N and Longitude 5° 25' E) of Usmanu Danfodiyo University Sokoto, Nigeria. The Dabagi farm (study site) is located at about 40km south east of Sokoto metropolis, along the Sokoto–Gusau road. Sokoto falls within the Sudan savanna vegetation zone and lies on about 300m altitude. Sokoto state enjoys a semi-arid climatic condition; characterized by alternating wet (rainy) and dry seasons [21]. Mean monthly temperatures vary from 14 °C in December/January to 40 °C in April. Relative humidity varies from 51-79% during the rainy season and from 10-25% during the dry season [22]. The monthly rainfall at the study site, during the 2010 rainy season is shown in Figure 1. Topsoil (0-20cm) at the study site belongs to sandy loam textural class and with low fertility status. I was described as moderately acidic (pH (H_2O)=5.41; pH ($CaCl_2$)=5.40) and has low contents of organic matter (2.24gkg^{-1}), Organic carbon (0.80g kg^{-1}), total nitrogen (0.32gkg^{-1}), available phosphorous (1.14mgkg^{-1}), CEC (5.64cmolkg^{-1}) and base saturation (40.60%). The exchangeable cations were also low in the soil (Ca=1.73, Mg=0.23, K=0.12 and Na=0.21cmol kg^{-1}) [23].

Methodology

Treatments, experimental design, and field layout

The treatments for this experiment consisted of the two indigenous forage grass species replicated six times (2x6=12); carried out together with a similar experiment involving another two introduced forage grass species also replicated six times (2x6=12). The 2x2x6 treatment combinations were laid out in a Randomized Complete Block Design (RCBD) described by [24]. The field layout consists of six blocks of four plots each. Each plot measured 3.5x3.5m; with a gross area of 12.25m^2 and net area of 9.0m^2. Plots within each block were separated with 0.5m wide borders while 1.0m wide pathways separated blocks.

Cultural practices

Land preparation: A 50mx50m land at the Dabagi teaching and research farm of the Usmanu Danfodiyo University, Sokoto, was cleared off the shrubs and then mechanically ploughed using Tractor. Sunken type seed beds were measured and demarcated according to the field layout. The seed beds were then labeled using hand hoes and shovels.

Seed procurement and sowing: Seeds of the selected forage grass species were procured from the National Animal Production Research Institute (NAPRI), Shika-Zaria, Nigeria. The seeds were then surface-dressed, prior to sowing, using Apron Star (42WS) powder (contains 20%w/w thiamethoxam 20%w/w methalaxil-M and 2%w/w difenoconazole) at the rate of 2.5gkg^{-1} of seed to protect the seeds against fungal and insects' attacks on the field. The treated seeds were sown manually, using drilling method (50cm between drills) at 1.0-1.5cm below the soil surface. Sowing was carried out in July (03/07/2010), 2010; when the rains became established.

Fertilizer application: The experimental plots were applied Nitrogen (N), Phosphorous (P) and Potassium (K) fertilizers at the rate of 150, 30 and 30kg ha^{-1}, respectively [10]. Total doses of P and K were applied at sowing, using NPK 15:15:15, while N was applied in three equal splits of 50kgha^{-1} each; at sowing, at 2 and 6 weeks after sowing (WAS), using NPK 15:15:15 and Urea (46%).

Weeds control: Manual weeding was employed to control weeds on the experimental plots. First weeding was carried out at 2WAS, using hand hoes, while subsequent weeding was carried out as and when necessary.

Harvesting and weighing: Harvesting of the herbage was conducted manually using hand Sickle, at 10WAS in the month of September (12/09/10), 2010. The plants were caught at about 5cm above the ground level using hand Sickle. In each plot, plants within the net plot area of 9m^2 were harvested, packed together, tied and then weighed, using a Dial Spring Scale. The herbage weight reading from each plot was then recorded as Fresh Herbage Yield (FHY) per

net plot area (9m^2) and Dry Matter Yield (DMY) was estimated by drying a known weight of the fresh herbage in an Oven set at 65 °C to constant weight and reweighed. The percent DMYs for the various replicate plots was used to calculate the mean DMYs for the respective treatments and were converted to tones per hectare.

Data Collection and Analysis

Data collection includes measurement of plant height (cm), leaf length (cm) and leaf width (cm) by using meter ruler and number of leaves per plant and number of tillers per plant by counting; from three randomly selected plants from each plot at 10WAS when the herbage was harvested. Herbage Dry Matter Yield (DMY) for each species (treatment) was estimated fresh herbage and recorded. The data generated from the 2009 and 2010 trials was subjected to Analysis of variance (ANOVA) in a Randomized Complete Block Design (RCBD) using the General Linear Model (GLM) of the Statistical Analysis System [25]. Fisher's Least Significance Difference (LSD) test was used, at 5% level of significance for mean separation. Merit analysis was also conducted to measure the overall merit of each of the selected species and compare between the treatments.

Results and Discussion

Mean values for plant height, Number of leaves per plant, leaf length, leaf width and number of tillers per plant evaluated for the two indigenous forage grass species, at 4, 6, 8 and 10WAS and herbage dry matter yield at 10WAS, are presented in Table 1. The results showed that the two forage grass species differed significantly ($P<0.05$) in all the parameters measured, except plant height and number of leaves per plant at 2WAS.

Plant height

The significantly ($P<0.05$) taller plants recorded from the *P. pedicellatum* compared to *A. gayanus* at 6 and 8WAS may be explained by the plenty of rain received at the study site during the period Figure 1 which provided enough moisture that supported growth of all the plants. This, however, was not sustained by the *P. pedicellatum* to 10WAS when the rainfall received at the study site became reduced, and the *A. gayanus* plants measured taller ($P<0.05$) than the *P. pedicellatum* plants Table 1. This may suggest better adaptation to low moisture regime by the *A. gayanus* and higher vigor for better productivity than *P. pedicellatum* in Sokoto the semi-arid zone of Nigeria. The mean plant height recorded from A. gayanus at harvesting (10WAS), in this study (77.25cm), is greater than the range of 40.5-48.0cm reported as plant height for the species in the humid zone of Nigeria [26]. The taller *A. gayanus* plants recorded in this study may indicate better adaptation of the species to the dry Savanna than in the humid environment [18]. The mean plant height recorded for *P. pedicellatum*, at 10WAS in this study (110cm), is slightly higher than the 1.0m (or 100cm) height reported for the species in Bihar, India [19]. The *P. pedicellatum* was reported as rapid grower that persists well in northern Nigeria [27].

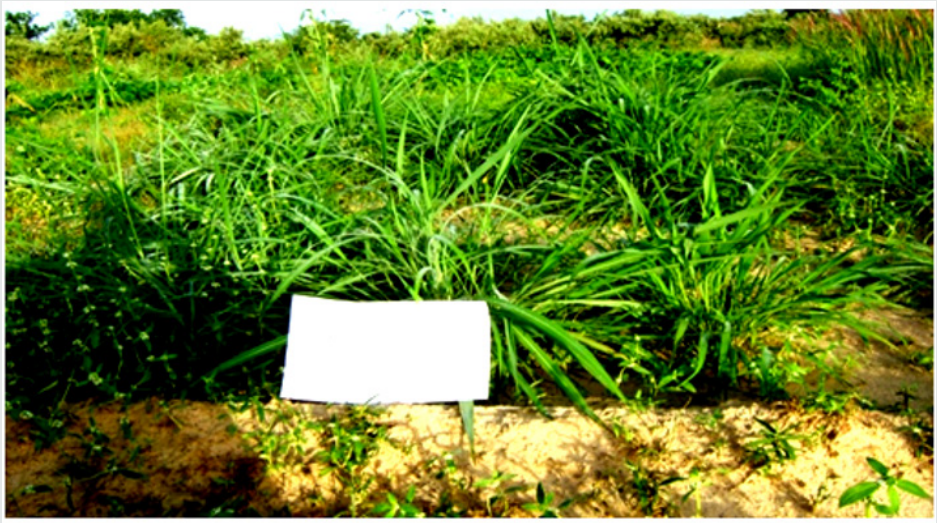

Figure 1: Plate 1: Gamba grass (Andropogon gayanus) at 10 WAS in Sokoto during 2010 trial.

Number of leaves per plant

The significantly ($P<0.05$) higher number of leaves per plant recorded from *P. pedicellatum* at 6, 8 and 10WAS compared to the *A. gayanus* Table 1, may suggest greater potential to utilize sunlight for photosynthesis, which may translate to better productivity by the species in the study area. [19] also reported high leaf to stem ratio from *P. pedicellatum* plants, which might have resulted from high number of leaves per plant. According to [28], under light mutual shading, high number of leaves per plant is required to achieve maximum absorption of solar radiation for photosynthesis by the leaves and other green parts of the plant.

Table 1: Growth parameters and herbage dry matter yield of Gamba (A. gayanus) and Kyasuwa (P. pedicellatum) grasses in Sokoto semi-arid zone of Nigeria.

Species	Age of plant (week)			
	4WAS	6WAS	8WAS	10WAS
Plant height (cm)				
A. gayanus	23.26	37.02[b]	58.38[b]	77.25[b]
P. pedicellatum	25.24	46.72[a]	71.39[a]	110.01[a]
LSD (P<0.05)	3.25	5.22	6.89	7.86
Number of leaves per plant				
A. gayanus	2.83	3.33[b]	3.56[b]	4.00[b]
P. pedicellatum	3	4.22[a]	5.61[a]	6.39[a]
LSD (P<0.05)	0.96	1.02	1.16	1.22
Leaf length (cm)				
A. gayanus	15.40[b]	27.06[b]	34.13[a]	46.83[a]
P. pedicellatum	18.82[a]	30.69[a]	29.25[b]	27.90[b]
LSD (P<0.05)	2.27	3.09	3.14	3.38
Leaf width (cm)				
A. gayanus	0.51[b]	1.01[b]	1.32[b]	1.76[a]
P. pedicellatum	1.34[a]	2.03[a]	1.61[a]	1.42[b]
LSD (P<0.05)	0.26	0.31	0.38	0.41
Number of tillers per plant				
A. gayanus	6.67[a]	28.67[a]	55.95[a]	70.61[a]
P. pedicellatum	3.50[b]	16.94[b]	25.06[b]	38.67[b]
LSD (P<0.05)	3.34	6.63	12.17	14.41
Herbage yield (t DM ha^{-1})				
A. gayanus	-	-	-	2.037[b]
P. pedicellatum	-	-	-	3.519[a]
LSD (P<0.05)	-	-	-	0.393

Means in the same column for same parameter carrying different superscript differed significantly (P<0.05).

Leaf length

The significantly (P<0.05) longer leaves recoded from the *P. pedicellatum* plants at 4 and 6WAS compared to the *A. gayanus* may be explained by the plenty of rain received at that period at the study site Figure 1 which provided enough moisture that supported growth of all the plants. This, however, was not sustained by the species at 8 and 10WAS when the *A. gayanus* leaves measured longer (P<0.05) than the leaves from the *P. pedicellatum* Table 1. This was probably due to the reduction in the amount rainfall received at the study site and the moisture available in the soil became reduced. This may suggest the better adaptation by the *A. gayanus* to low moisture regime [18]. Leaf length is a component of Leaf Area Index (LAI), and high LAI is required to achieve maximum absorption of solar radiation for photosynthesis by the leaves for better growth and high herbage yield [28]. The mean leaf length recorded from *A. gayanus*, at 10WAS in this study (46.83cm), is greater than the 30.0cm long indicated for the species [18]. The longer leaves recorded for *A. gayanus* plants may indicate better growth of the species in the study area; probably due to its adaptation to low fertility soils and low annual rainfall [18]. The mean leaf length recorded from *P. pedicellatum*, at 10WAS in this study (27.90cm), is greater than the 15.0-25.0cm leaf length indicated for the species by [19]. The longer leaves recorded for *P. pedicellatum* plants may indicate better growth by the species in the study area, probably due to its adaptation to low rainfall (Semi-arid) climatic environments [19].

Leaf width

The significantly (P<0.05) broader leaves recoded from *A. gayanus* at 4, 6 and 8WAS compared to the *P. pedicellatum* may be explained by the plenty of rain received at that period at the study site Figure 1 which provided enough moisture that supported growth of all the plants. This, however, was not sustained by the species at 8 and 10WAS when the *A. gayanus* leaves were broader (P<0.05) than the leaves from the *P. pedicellatum* Table 1. This may suggest the better adaptation by the *A. gayanus* to low moisture regime [18]. Leaf length is a component of Leaf Area Index (LAI), and high LAI is required to achieve maximum absorption of solar radiation for photosynthesis by the leaves for better growth and high

herbage yield [28]. The mean leaf width recorded from *A. gayanus*, at 10WAS in this study (1.76cm), is greater than 1.6cm leaf width indicated for the species [18]. The broader leaves recorded for *A. gayanus* plants at harvesting, in this study, may suggest potential of the species for better growth in the study area; probably due to its adaptation to dry (Semi-arid) climatic environments [18]. The mean leaf width recorded from *P. pedicellatum*, at 10WAS in this study (1.42cm), is greater than the 0.4 1.0cm leaf width indicated for the species [19]. The broader leaves recorded for *P. pedicellatum* plants, in this study, may suggest potential of the species for better growth in the study area, probably due to its adaptation to Semi-arid climatic environments [18].

Number of tillers per plant

The significantly (P<0.05) high number of tillers per plant recorded from the *A. gayanus*, from 4 to 10WAS compared to the *P. pedicellatum* Table 1, may indicate potentiality for higher productivity for the species. *A. gayanus* was described as tussock plant that produces many flowering branches (tillers) [17]. The species is also very resistant to drought and prefer long dry season of up to 7 months [18]. The mean number of tillers per plant recorded from *A. gayanus*, at 10WAS in this study (70.61), is greater than the range of 15.4-49.8 reported as number of tillers per plant for the species in Makurdi, in the humid zone of Nigeria [26]. The high number of tillers per plant recorded for the species, in this study, may be attributed to the species' adaptation to low rainfall in the Semi-arid zone than in the wetter humid environments [18]. There was no literature to compare the finding of this study on number of tillers per plant recorded for the *P. pedicellatum* at 10WAS in this study (28.67). However, this value is within the range of 15.4-49.8 reported as number of tillers per plant for the *A. gayanus* species in the humid zone of Nigeria [26].

Herbage dry matter yield

The significantly (P<0.05) higher herbage dry matter yield recorded from the *P. pedicellatum* compared to the *A. gayanus*, at 10WAS Table 1, may be explained by the species' production of plants that were significantly (P<0.05) taller, with higher number of leaves and number of tillers per plant compared to the *A. gayanus*, especially at harvesting. Sen C [29] reported high order positive correlation from the plant height and number of leaves per plant (and may include number of tillers per plant) with grain and herbage yield. *P. pedicellatum* was also reported to persist well in the dry northern Nigeria [19,20]. The herbage dry matter yield obtained for *A. gayanus*, in this study (2.037 t DM ha^{-1}), is within the range of 1.14-3.20 t DM ha^{-1} reported for the same species in the northern guinea Savanna zone of Nigeria [10], and also the range of 0.470-4.10 t DM ha^{-1} reported for the same species in the southern guinea savanna zone of Nigeria [26]. The value is, however, lower than 2.4-4.6 t DM ha^{-1} and 11.4 t DM ha^{-1} recorded for the same species by Yakubu AI, Kallah MS [30,31] respectively in the dry Sudan Savanna zone of Nigeria. The herbage dry matter yield for *P. pedicellatum*, obtained in this study (3.519 t DM ha^{-1}), is lower than range of 10.0-25.0 t DM ha^{-1} reported for the same species under varying seeding rates (10-40kg ha^{-1}) in the dry Sudan savanna zone of Nigeria [30] and 8-12 t DM ha^{-1} recorded by Ademosun AA [32] under low fertility conditions in the south west humid forest zone of Nigeria. The comparatively lower herbage yield obtained for *P. pedicellatum*, in this study, could be attributed to the low rainfall Figure 1 and poor soil conditions [23] in the study area.

Merit Analysis

Table 2 shows the merit scores and ranking of the two selected forage grass species (treatments) evaluated for growth and herbage yield [33]. The quantitative merit scores were derived from the qualitative rankings of the mean values for the evaluated parameters following separation of the group means at harvesting see Table 1. Muhammad IR [34] Results from Table 2 showed that *P. pedicellatum* recorded a higher total merit score of 9 points; Figure 2 and was ranked 1st while the *A. gayanus* scored total of 8 points and was ranked 2nd in terms of growth and herbage dry matter yield in the Sokoto Semi-arid zone of Nigeria.

Table 2: Merit scores and ranking of the selected forage grass species on growth parameters and herbage dry matter yield in the Sokoto Semi-arid zone of Nigeria.

Treatments	Merit score						Total	Rank
	PH	NL	LL	LW	NT	DMY		
A. gayanus	1	1	2	1	2	1	8	2nd
P. pedicellatum	2	2	1	1	1	2	9	1st

Note: PH=plant height; NL=number of leaves; LL=leaf length; LW=leaf width; NT=number of tillers and DMY=herbage dry matter yield.

Figure 2: Plate 2: Kyasuwa grass (*Pennisetum pedicellatum*) at 10 WAS in Sokoto during 2010 trial.

Conclusions and Recommendations

Based on the results obtained from this study, although *P. pedicellatum* recorded higher total merit score and was ranked 1st, both the *P. pedicellatum* and *A. gayanus* recorded good growth and herbage dry matter yield in the Sokoto Semi-arid zone of Nigeria. Thus, both the *P. pedicellatum* and *A. gayanus* species are recommended for forage production and further research exploitations in the Semi-arid zone of Nigeria.

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