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Full Length Research Paper

The Influence of Fertilizer Sources and Planting Pattern on the Growth of Two Rangeland Grasses in Sokoto, Sudan Savanna Ecological Zone, Nigeria

Waziri, A. F.*, and Aliero, B. L.

Department of Biological Sciences, Usmanu Danfodiyo University, Sokoto, Sokoto State, Nigeria.
*Corresponding Author E-mail: altine.waziri@gmail.com

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ABSTRACT: The research on effects fertilizer sources and planting pattern on the growth of the two grass species was conducted at Janzomo farm, Shagari LGA, Sokoto State. Sokoto lies on Latitude 12.00^0 and 13.60^0N, Longitude 4.80^0 and 6.50^0E and 350m above sea level. . It involved sole planting of *A. gayanus*, *P. pedicellatum* and combination of the two grasses. The seeds were drilled and broadcasted in fertilizer treated and untreated plots of 2.5m x 2.5m under rain fed conditions.NPK treated plants produced tallest stems in comparison with NPFY and FYM while both fertilizer sources produced plants that had significantly ($p \geq 0.05$) taller stems than CTR. This meant that these grass species responded positively to the application of fertilizers, particularly NPK. The increase in plant height with application of nitrogenous fertilizer could be attributed to its role in protein synthesis and a key component of plant chlorophyll, therefore, a necessary ingredient for overall growth and development of all plants. Broadcasted plants produced significantly ($p \geq 0.05$) taller stems and longer leaves that respectively reached 102.6cm and 43cm. On the other hand, drilled plants produced 72 leaves and 17 tillers. This showed that significant difference ($p \geq 0.05$) existed between the planting patterns in which broadcasted plants had taller stems, longer and wider leaves whereas drilled plants possessed more leaves and tillers for the two seasons. This indicated that broadcasted plants had significantly ($p \geq 0.05$) taller stems, longer and wider leaves than drilled plants which were attributed to relatively even space in the broadcasted plots. Drilled plants produced significantly ($p \geq 0.05$) large number of tillers than broadcasted plants. This was probably due to competition for space in which plants maximized space to occupy and survive.

Keywords: - Fertilizer, Sudan Savannah, Sokoto, NPK, Ecological Zone, Rangeland

INTRODUCTION

Tropical grasses grow vegetatively or from seed in pastures/grazing reserves and rangelands. When planting vegetatively, the tops of the grass should be cut off because splits with uncut stems and leaves will almost always die due to water loss through the leaves. Long roots should also be cut short because the plants will develop new ones and live on them as the old ones die. When the purity and uniformity of grass or hybrid clones must be maintained, vegetative propagation may be simpler or less expensive. Planting is typically done in rows, with the distance between rows varying according to plant size and local custom; the distance between plants in rows is less important except in experiment plots (Bogdan, 1977). Establishment from seed is typically more difficult in the tropics than in colder climates. Seeds are often scarce in the tropics, they are mostly small, and drought can kill small weak seedlings, though this can also occur in drier temperature climates (Bogdan, 1977; Hopkins. 1997). *A. gayanus* belongs to the tribe Andropogoneae. It is commonly called Gamba grass

(Bodgan, 1977; Grof, 1981; Pagot, 1993; Purse glove, 1979). It is indigenous and widely distributed throughout the savanna zone in Nigeria and the rest of tropical Africa. It is a tall, perennial grass with erect, tufted/tussock stems that reach 2 to 4 meters in height. It has vigorous tillers and dense foliage, particularly during the rainy season (Bogdan, 1977; Purseglove, 1979; Chlleda and Crowder, 1982, Pagot, 1993). The leaf sheath encircles the cylindrical, jointed, smooth stem. Leaves are carried on sheaths that form at nodes. They are glabrous, up to 45 cm long and 5-15 mm wide, and have a prominent white midrib. The inflorescence has a large spathate panicle with up to 6 groups of 2 - 8 cm long primary branches terminating in a pair of racemes. The spatheles that support the rays have somewhat infiltrated sheaths that are reduced or absent on at least one side, each with 10 - 14 joints that are 4 -5 mm long, infiltrated, usually hairy on the sides, and each bearing a pair of spikelets. The sessile spikelet of pair 7-9 mm long, bisexual flowers with kneels and spirally petals from which the seeds develop. The flowers are unappealing. Seeds have hooks or barbs that cling to animal hair or human clothing and allow them to travel a long distance. Humans and animals almost always spread seeds unintentionally (Akobundu, 1987; Pagot, 1993). Several varieties are recognised: var. g*ayanussquamulatus*, *argyophoeus*, *bisquamulatus*, and *tridentatus*. Var. *gayanus* tolerates drought, fire, high pH, low pH, heavy soil, poor soil and water logging.

It is native to Africa and widely distributed in tropical Africa, north and south of Equator and was introduced to other tropical areas, Brazil, India, and Western Australia.. Gamba grass is reported to tolerate annual precipitation of 80 to 270 cm, annual temperature of 15 to 32^{0}C and pH of 4.3 to 8.3. It is found in grasslands, damp places and edge of thickets; often forming large areas. It also thrives in areas with a long dry season, which can last up to 7 months. It can grow in a variety of soil types, from sandy to heavy black cracking clays. It is drought and fire resistant. *P. pesicellatum* Trin, belongs to the tribe Paniceae. It is commonly known annual kyasuwa grass. It is also indigenous and occurs naturally in tropical and subtropical Africa but practically absent in tropical East Africa (Bogdan, 1977).

It has many lateral branches, is a leafy annual grass, and the stems range in height from 40 to 150 cm, or more in some cases, and can have up to 10 nodes. The leaf sheath encircles the smooth, cylindrical, jointed stem. The leaves are carried on sheaths that emerge from the nodes. They are flat and up to 40 cm long, with a width of 4 - 16 mm. Inflorescence a moderately dense spike 5 - 15cm long and 8 -16 mm wide (excluding bristles), green, pale or purplish, with clusters of up to 5 spikelets or solitary spikelets surrounded by numerous fine bristles. The bristles are up to 12 mm long, with one bristle being longer than the others and measuring 16-28 mm in length. Solitary spikelets have predicels that are 1 to 2 mm long. One of the grouped spikelets is sessile, while the others are predicelled. Spikelets 4 - 5 mm long, with two florets, one male and one bisexual, fertile, 25 - 3 mm long, smooth slimy (Bogdan, 1977). It thrives in areas that are either relatively dry or moderately humid. It requires a 4 – 6 month rainy season with an average annual rain fall of 500 – 1000 mm, as well as well-moisturized soil during the active growth period. It grows in poor soils but produces much more in fertile, well-drained loams. It reproduces by seed and reseeds itself. The initial growth is rapid, and the grass can be used approximately 3.5 months after sowing. Large land areas in Nigeria could be better utilized for raising cattle. In the savanna region are most of the grazing reserves and rangelands. Sadly, it appears that there wasn't much information available on rangelands in Nigeria. The 1965 grazing reserve law allows for the conservation of new lands expressly for grazing and for pastoralist settlement. However, while the Federal Government, international organizations, and some state governments have made some progress in this area, it must be noted that progress is still slow and insufficient to meet the need (Calderbank, 1991). The Federal Land Tenure Decree had placed all of Nigeria's land in the hands of the Federal Government, with states and Local Government Councils exercising control (Abdulslahi, 1985).

MATERIALS AND METHODS

The study was conducted at Janzomo Farm in Shagari Local Government Area of Sokoto state. The farm is located along Sokoto-Jega road, about 55 km south-west of Sokoto town, Sokoto state Nigeria. Sokoto is located on latitude 12.00^0 and 13.60^{0}N and Longitude 4.08^0 and 6.50^{0}E. It also lies at an altitude of 350m above the sea level (Kowal and Knabe, 2002). The study area is shown in (Figure 1). Sokoto state falls within the Sudan Savanna and is found in the Northwest geopolitical zone of Nigeria. It is characterized by distinct wet and dry seasons that may vary in their duration and intensity from year to year. The wet season lasts from May/June to September/October with an average annual rainfall of 500-700mm. Plant growth essentially takes place during this period. The remaining part of the year consists of long dry season that can be distinguished by cool hamattan winds from November to February followed by hot and dry period from March to May. The mean monthly temperature ranges between 15^{0}C in December and 40^{0}C in April. The mean annual temperature averaged 27^{0}C (Mamman *et al.*, 2000). It follows that the coolest months are November to January while the hottest months are March to May. The vegetation of the area,

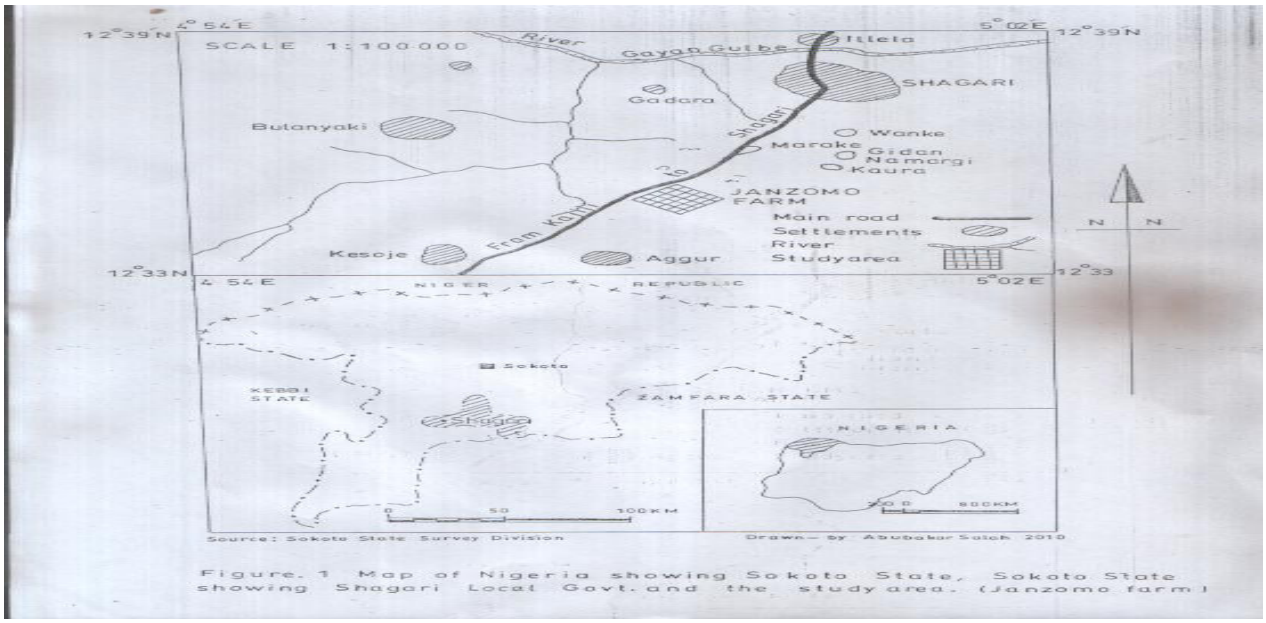


Figure 1 Map of Nigeria showing Sokoto State, Sokoto State showing Shagari Local Govt. and the study area. (Janzomo farm)

Figure 1: Layout of experimental site.

being Sudan Savanna type is composed of scattered trees, many shrubby plants with dominant grasses and herbs.

There were twenty four (24) study sub plots which consisted of treatments of *A. gayanus* Kunth, *P. pedicellatum* Trin and the mixture of the two species. Each was drilled, broadcasted and replicated three times. The experiments were laid out in a Randomised Complete Block Design RCBD) as outlined by Gumez and Gumez (1984).The randomization method used was that of Random numbers from the Random Number Table. The study plots were subjected to application of both farm yard manure (FYM) sourced at Janzomo farm, Shagari and inorganic compound fertilizer (NPK 15:15:15) and Urea from Sokoto Agricultural and Rural Development Authority. Farm yard manure was applied to the selected drilled and broadcasted study plots at the rate of 15,000 kg/ha. (1.5kg/m^2 = 9.38kg/6.25m^2) Similarly, inorganic compound fertilizer, Nitrogen, phosphorus and potassium (NPK) was applied to other selected plots (drilled and broadcasted) at the ratio of 125:30:30 kg/ha (Urea 20.65g/m^2 = 129g/6.25m^2 and NPK 20g/m^2 = 125g /6.25m^2) respectively.

Furthermore, half rate of both FYM and NPK were also determined by dividing the total rate into 2. Therefore, FYM was 7500kg/ha (750g/m^2 = 4.69kg/6.25m^2) and NPK at the ratio of 62.5-15-15kg/ha (Urea 10.33g/m2 = 64.56kg/6.25m^2 and NPK 10g/m^2 = 62.5g/6.25m^2) and applied to selected plots. The fertilizer (NPK) was applied before sowing at the ratio of 30:30:30 and the remaining were applied after four weeks. There was control in which no any form of fertiliser (organic and inorganic) was applied (Muhammad and Abubakar, 2004) Seeds of the two grass species were sown by drilling and broadcasting in the respective study plots. The seeds were drilled in rows (50cm apart) at the depth of 3 – 5 cm and covered with soil. The seeds were also broadcasted evenly and thinly covered with soil. The seed rate was as recommended by Pagot (1993) and Kallah (1999) In each selected area, a sample of individuals were identified and noted for measurement of shoot height, leaf number, leaf length, leaf diameter (width) and tillers. Growth measurements started sixth week after planting and repeated at two weeks interval to the end of the growing period (16 weeks).The data was collected during 2011/12 and 2012/13 seasons cm (Abduallhi and Aliero, 2005).

RESULTS AND DISCUSSION

The first growing season results in (Table 1) showed that plants treated with NPK had significantly (p≥0.05) taller stems and wider leaves which were 109.1cm and 1.8cm respectively. On the other hand, NPK/FYM treated plants produced significantly (p≥0.05) large number of leaves (81) and 19 tillers then followed by FYM treated plots. It was observed that CTR plants were least in all the growth parameters investigated compared with other fertilizer sources. The result of the second growing season also indicated that NPK treated plants had significantly taller stems that reached 111.2cm with leaves 1.8cm wide.

Table 1: Effect of fertilizer source on the growth parameters irrespective of species and planting pattern during first and second growing seasons.

Growth Parameters First season					
Fertilizer Source	Stem Height	Leaf Number	Leaf length	Leaf cm	Tillers
NPK	109.1 [a]	57 [c]	44.4 [a]	1.8	15[b]
FYM	101.8[b]	74 [b]	40.1 [b]	1.7	16[b]
NPK/FYM	101.6[b]	81 [a]	44.6 [a]	1.7	19[a]
Control	77.5cm [c]	54 [c]	36.7 [c]	1.	14[b]
SE±	2.93	5.37	1.18	0.07	0.86
LSD	4.83	6.53	3.06	0.75	2.61
Sign	*	*	*	*	*
Second Season					
NPK	111.2[a]	57[b]	46[a]	1.8	15[b]
FYM	99.1[c]	77[a]	42[b]	1.5	17
NPK/FYM	104[b]	79[a]	46[a]	1.6	18[a]
Control	79[d]	54[b]	39.2[b]	1.4	15[b]
SE±	2.98	5.37	1.18	0.26	1.24
LSD	4.87	6.54	3.06	1.44	2.50
Sign	*	*	*	*	*

Means in a column followed by same letter(s) are not significantly different (<0.05) at 5% level using LSD. SE=Standard Error.
*= Significant. Ns=Not significant.

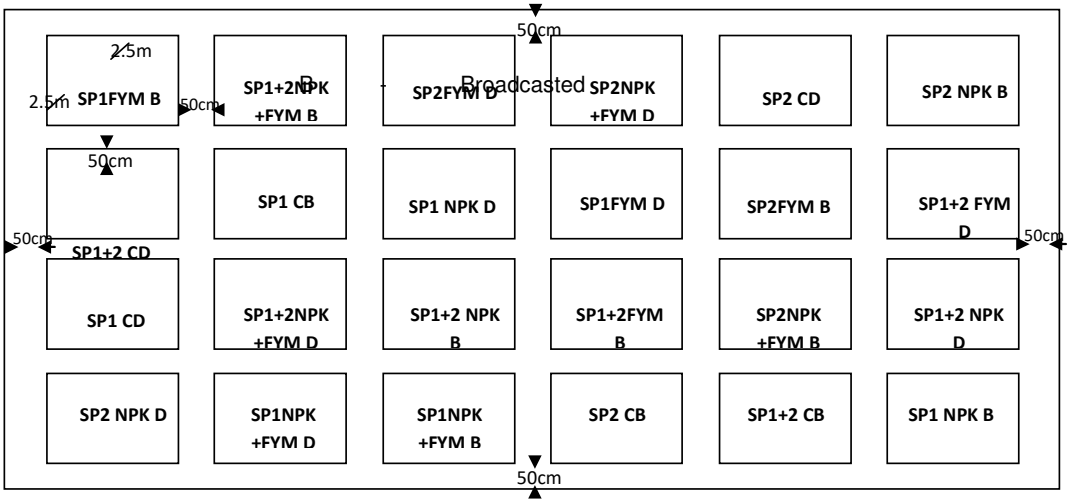
Furthermore, NPK/FYM applied plants had 79 mean numbers of leaves and 18 tillers. It was also closely followed by FYM in all the growth parameters studied while CTR had least performance. Comparatively, first growing season plants were generally taller with longer and wider leaves whereas in the second growing season, plants produced large number of leaves and tillers. Significant difference (p≥0.05) existed where NPK treated plants produced tallest stems in comparison with NPFY and FYM while both fertilizer sources produced plants that had significantly (p≥0.05) taller stems than CTR. This meant that these grass species responded positively to the application of fertilizers, particularly NPK. Muhammad and Abubakar (2004) also reported that application of compound fertilizers (NPK) is necessary for grasses, increase their vegetative growth and yield especially in areas with low soil nutrients.

Similar findings were also reported by Raemaekers (2001) and Katung (1998) who stated that application of fertilizer in a form of NPK produced tallest plants. The increase in plant height with application of nitrogenous fertilizer could be attributed to its role in protein synthesis and a key component of plant chlorophyll, therefore, a necessary ingredient for overall growth and development of all plants (FAO,2000 and Yusuf *et al,*2011). Similarly, Isitekale and Osenwota (2010) and Akanbi *et al*. (2001) wrote that application of organic manure (as in NPFY) improves nutrient holding capacity of soil and meets the nutrient requirement of crops with resultant increase in their productivity.

The result also showed that NPFY and FYM treated plants produced large number of leaves than NPK and CTR treated plants. Sharifai *et al* (2012) also reported that combined application of organic and inorganic manure is essential for crop growth. Similar observations were made by Yusuf *et al* (2011) and FAO (2000) who reported that application of NPK fertilizer enhances the production of leaves. Ogbenna *et al* (2011) and Mounde *et al* (2012) also opined that plants treated with FYM did better than control. Akoriaraj and Kanvapan (1994) stated that organic manure increases cation exchange capacity (CEC), infiltration and retention of water, release plants nutrients into the soil upon decomposition which might include N, P, K, Ca, and Mg.

The result also revealed that NPK and NPFY treated plants had significantly (p≥0.05) longer leaves than FYM and CTR. This was an indication that application of manures, particularly the inorganic manure N.P.K encouraged leaf length significantly. Similar observations were made by Bala *et al* (2012) and Enwezor *et a*l (1989) who reported that these grass species responded well to the application of nitrogenous fertilizers. Also, NPK treated plots produced plants with significantly (p≥0.05) wider leaf diameter followed by NPFY then FYM while CTR had the least (Figure 2). This indicated that application of NPK enhanced the leaf diameter of grasses as corroborated by FAO (2000) and Yusuf *et al* (2011) who stated that fertilizers influence vegetative growth of grasses.

Furthermore, NPFY and FYM treated plants produced significantly (p≥0.05) large number of tillers than other sources. This was an indication that application of NPK



Key:
SP1 – Species 1(A. gayanus)
SP2 – Species 2(P. Pedicellatum)
NPK – Nitrogen Phosphorus and Potassium (Compound fertilizer)
FYM – Farm yard manure
C – Control (No any form of fertilizer)
D – Drilled

Table 2: Effect of planting pattern on the growth parameters of the two grass species during first and second growing seasons

Growth parameter (cm)					
First season					
P/Pattern	**Stem height**	**Leaf number**	**Leaf lcm**	**L/dmcm**	**Tillers**
Drilling	85.8 [b]	70 [a]	39.7 [b]	1.6	18 [a]
Broadcasting	105.1 [a]	63 [b]	44.4 [a]	1.7	15 [b]
SE±	2.48	4.36	0.94	0.05	0.57
LSD	4.39	5.86	2.72	0.63	2.12
Significance	*	*	*	ns	*
Second season					
Drilling	87.4[b]	72 [a]	38[b]	1.6	17 [a]
Broadcasting	102.6[a]	61[b]	43 [a]	1.7	14[b]
SE±	2.53	2.92	1.04	0.05	0.55
LSD	4.50	4.83	2.88	0.63	2.10
Significance	*	*	*	ns	*

Means in a column followed by same letter(s) are not significantly different (<0.05) at 5% level using LSD. SE=Standard Error. s= Significant. Ns=Not significant. P/Pattern = Planting pattern

and FYM favoured tiller production of these grasses. Muhammad and Abubakar (2004) also reported that appropriate fertilizer formulation is recommended for enhanced tiller production of pasture grasses. Ogbenna *et al* (2011) opined that synergistic relationship between the two sources of fertilizers might have accounted for their performance which was also corroborated by Kekong *et al*. (2010). Thus, NPFY applied plants performed better than others possibly due to synergy and availability of mineral elements from both FYM and NPK than sole application of either of the sources (Sharifai *et al*, 2012 and Boateng et al, 2006). The results on effect of planting pattern on the growth of the two grass species for the first season are shown in (Table 2). It showed that broadcasted plants had significantly (p≥0.05) taller stems (105.1cm) and longer leaves which were 44.4cm. On their part, drilled plants had 70 leaves and 18 tillers which were significantly higher than broadcasted plants. The second season result also revealed that broadcasted plants produced significantly (p≥0.05) taller stems and

longer leaves that respectively reached 102.6cm and 43cm. On the other hand, drilled plants produced 72 leaves and 17 tillers. This showed that significant difference (p≥0.05) existed between the planting patterns in which broadcasted plants had taller stems, longer and wider leaves whereas drilled plants possessed more leaves and tillers for the two seasons. This indicated that broadcasted plants had significantly (p≥0.05) taller stems, longer and wider leaves than drilled plants which were attributed to relatively even space in the broadcasted plots. Kilgori (2011) stated that plants require adequate space for enhanced growth. On the other hand, drilled plants had significantly (p≥0.05) large number of leaves than the broadcasted plants. This was attributed to competition for space and resources which led to production of more leaves for enhanced photosynthetic activities (Dugje, 2004). This finding was in contrast with Kilgori (2011) who reported that plants need more space to expand and produce large number of leaves compared with closer spacing of more interplant competition. Furthermore, drilled plants produced significantly (p≥0.05) large number of tillers than broadcasted plants. This was probably due to competition for space in which plants maximized space to occupy and survive. Similar observation were made by Ojo *et a*l (2011) and Leach *et al* (1976) who stated that rapid production of tillers especially soon after establishment is desirable characteristic for competition and weed control.

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