EFFECT OF NITROGEN FERTILIZATION AND SPACING ON CHEMICAL COMPOSITION OF RHODES GRASS (*Chloris gayana* Tan) IN THE DRY SUB HUMID ZONE OF SOKOTO NIGERIA

ABSTRACT

A field experiment was conducted during the 2016 and 2017 rainy seasons at Centre for Agriculture and Pastoral Research (CAPAR) of the Usmanu Danfodiyo University Sokoto, Nigeria to study the effect of nitrogen fertilizer and inter-row spacing on chemical compositions of Rhodes grass. A factorial combination of five fertilizer levels (0, 100, 120, 140 and 160 kgNha^{-1}) and three inter row spacing (30, 50 and 70cm) were used, making (15) treatments combinations, which were laid out in a RCBD replicated four times. The data obtained was subjected to analysis of variance (ANOVA), using CRD with two repetitions, Least Significant difference (LSD was used for the separation of means. The sample for each treatment was analyzed for chemical composition using A.O.A.C procedure (CP) was determined by Kjeldahl method, Ash was determined by burning the herbage sample in a furnace at 550-650°C for 3 hours. Ether extract (EE) was estimated by using Sohlex extraction method, crude fibre (CF) was determined by sequential acid and alkali extractions from the residue obtained after fat extraction. Nitrogen free extract (NFE) was calculated as residual component of the feed dry matter; the result revealed that, application of 160 kgNha^{-1} consistently recorded higher values (P<005) for CP, NFE and EE and lower values for the CF and Ash contents of the samples. 70cm Spacing showed superiority among the treatments in the chemical compositions investigated compared to 50 and 30cm spacings. It may be concluded that application of 160 kgNha-^{1} and 70 cm spacing gave better (P<0.05) nutrient quality of Rhodes grass in the study area.

Keywords: Centre of agricultural and pastoral research, crude protein, crude fibre, nitrogen free extract, ether extract, 2016 and 2017 rainy seasons, weeks after sowing.

INTRODUCTION

Ruminant livestock in Nigeria which includes 52.5 million Cattle, 33 million Sheep and 16.2 million Goat, in Nigeria account for about 85% of the domestically produced meat in the country (FAO 2009). These animals form an important part of the nation's agricultural production system there by providing income to the farmer and foreign exchange to the nation. In addition to providing manure for arable farming, hides and skins, for leather and tanning industries social security and as insurance for food security, to mention but just a few (Tarowili *et al.,* 2000; Olson *et al.*, 2004, Peden *et al.*, 2005).

In order to meet the feed requirements of the ruminants animals in Nigeria; there is need to increase the forage production in the savanna region of the country. This requires production of improved pasture species with potential to high herbage production and nutritive value in the different sub regions of the savanna. Hassan (2004) reported that higher rate of nitrogen significantly increased HCN content, nutritive value and yield as compared to control. Adam (2002) observed that Nitrogen improved forage quality by increasing crude protein of teft grass. Similar results were also obtained by Etelib (2004), Gasim (2001) and Soliman (2005). Moreover, Abbas (2013) and Gasim (2001) found that crude protein increased with increased phosphorus application. Gasim (2001) started that increased in nitrogen level reduced fibre content of maize. Abbas (2013) showed that crude fibre decreased with addition of phosphorus. Kaftasa (1990) reported that nitrogen fertilizer increased the crude protein of Rhodes grass by 15% at the early stage of growth during the research on the Effects of developmental stages and nitrogen application on yield and nutritional value of Rhodes grass (Chloris gayana Kunth) in Ethiopia.

2. Materials and Methods

Experimental Site

This study was conducted at the Center for Agriculture and Pastoral Research (CAPAR), formally Dabagi Farm, of Usmanu Danfodiyo University Sokoto, during the 2016 and 2017 raining season. The farm is geographically located on latitude12°45'N and longitude 5°25'E and on 350m altitude. The farm is situated at 33 kilometers away from Sokoto metropolis, along the Sokoto-Gusau road, in Dange shuni local government area of Sokoto State, Nigeria. The farm has a total land area of about 512 ha, (CAPAR 2010). Dabagi farm falls within the Sudan-Savanna vegetation zone. Isah and Shinkafi (2000), the climate is characterized by alternating wet and dry seasons. The rainy season starts normally in June/July and ends in September with approximate annual rainfall of 500 - 900 mm with wide inter annual variations. (SERC, 2010). The total annual rainfall during the 2016 and 2017 were 663.42 mm and 606.18 mm respectively. The soil texture was sandy loam; with sand, silt and clay represented at 92.7%, 5.9% and 1.4% respectively.

The treatments for this research consisted of five Nitrogen fertilizer levels (0, 100, 120, 140, and 160Kg/ha) and three inter row spacings (30, 50, and 70cm), which were combined factorially and laid out in a randomized complete block design (RCBD) replicated four times. The forage was sown on 15th and 8th of July 2016 and 2017 respectively. The fertilizer treatments were applied at three (3) weeks after sowing. Dry weight was completely determined by Oven drying. The herbage sample from each plot was bulked for each treatment to form a representative sample. The representative sample for each treatment prepared was ground using mortar and pestle and sieved. The fine particles obtained were used for chemical analyses. The sample for each treatment was analyzed for proximate composition using A.O.A.C procedure. Crude protein (CP) was determined by Kjeldahl method. Ash was determined by burning the herbage sample in a furnace at 55°C for 3 hours. Crude fat by Sohlex extraction, crude fibre was determined by sequential acid and alkali extractions to dissolve all the carbohydrates contained in the residue after fat extraction. The extraction was carried out for a period of 8 hours. Nitrogen free extract (NFE) was calculated as residual component of the feed dry matter using the equation; %NFE= 100%- (%CP + %EE +%C.F + % Ash), (Crowder and Chheda 1982).

The data were statistically analyzed by analysis of variance (ANOVA), using the software GenStat 64-bit Release 17.1, CRD was adopted for the analysis, two repetitions was used in running the analyses and Least Significant difference (LSD) was used for the separation of means.

3. RESULTS AND DISCUSSION

Proximate Composition

Crude Protein (C.P) contents

The mean C.P content of Rhodes grass herbage differ significantly (P>0.05) with level of nitrogen fertilizer application in the year 2016, 2017 and the years combined results. Application of 160 kgNha^{-1} generally produced higher (P<0.05) CP (10.74 – 10.73%) compared to the rest (0, 100, 120 and 140) of the treatments. Inter-row spacing also had significant (P<005) effect on C.P contents of Rhodes grass in the 2016, 2017 rainy seasons and the years combined (Table 1). The wider (70 cm) inter row spacing produced higher C.P values (9.19 – 9.23%) compared to the rest (30 and 50 cm)of the treatments.

The significantly (P<0.05) higher C.P contents recorded for Rhodes grass on 160 kg N ha^{-1} at 12 WAS during 2016 and 2017 trials and the years combined (Table 1) indicated that Rhodes grass requires the higher dose of nitrogen fertilizer to produce herbage with high C.P contents. This could be as a result of the role played by nitrogen in the synthesis of protein. Similar results were also reported by Keftasa (1990) and Na-Allah (2015) for Rhodes grass in the dry sub humid zone of Nigeria and Aderinola *et al*. (2011) for Guinea grass in sub humid zone of Nigeria. The significantly (P<0.05) higher C.P contents recorded for Rhodes grass herbage at 12WAS from the wider inter row spacing of 70 cm in the 2016, 2017 and the years combined results (Table 1) indicated that Rhodes grass requires the wider inter row spacing to produce herbage with higher (P<0.05) C.P contents in the study area. Obi (1991) reported that plant spacing play a vital role on light interception during photosynthesis, which positively affects growth and nutrient constituents of plants. Balakarishman (2001), reported that C.P below 6 – 7% depresses the microbial activity in ruminants due to less availability of nitrogen in the rumen, and thus, the C.P produced is therefore adequate for the maximum ruminant animals production in the study area. Bhati (1998) reported that crude protein content of forage herbage is essentially a manifestation of nitrogen content, probably from nitrogen fertilizer application and wider plant spacing.

Inter row spacing had significant (P<0.05) effect on C.P contents of Rhodes grass during the 2016, 2017 rainy season and the years combined. The significantly higher (P<005) C.P content produced was as a result of adequate spacing which is attributed light interception during photosynthesis and less competition between plants, which positively affects growth and chemical constituents of plants, this is in agreement with the report of Obi (1991) where he found out that plant spacing play a vital role on light interception during photosynthesis, which positively affects growth and nutrient constituents of plants.

Table 1: Crude Protein (%) of Rhodes grass as influenced by nitrogen fertilizer and Inter row spacing, during the 2016/2017 rainy season and the years combined in the dry sub humid zone of Sokoto, Nigeria

Treatment	**2016**	**2017**	**Combined**
Fertilizer (F) (kgNha^{-1})			
0 (F0)	5.75^{e}	5.65^{e}	5.70^{e}
100 (F1)	8.57^{d}	8.59^{d}	8.58^{d}
120 (F2)	9.14^{c}	9.11^{c}	9.13^{c}
140 (F3)	9.94^{b}	10.01^{b}	9.98^{b}
160 (F4)	10.73^{a}	10.74^{a}	10.74^{a}
LSD	0.1035	0.108	1.522
Significance	*	*	*
Spacing (S) (cm)			
30 (S1)	8.48^{c}	8.44^{c}	8.46^{c}
50 (S2)	8.81^{b}	8.79^{b}	8.80^{b}
70 (S3)	9.19^{a}	9.23^{a}	9.21^{a}
LSD	0.0802	1.084	1.179
Significance	*	*	*
Interaction			
F*S	N	N	N

a,b,c, Means within a column for factor followed by the same letters are not statistically different using Least Significant Difference (LSD) at 5% level of probability. *=Significant at 5% probability level, NS = not significant at 5% level of probability.
F= Fertilizer, S = Spacing, F * S = Interaction between fertilizer and spacing, WAS = Weeks after Sowing.

Ether extract (EE)
The result showed that EE values did not differ significantly (P>0.05) with nitrogen fertilizer application, except in 2016. In 2016, higher EE value (4.89%) was obtained from application of 160 kgNha^{-1} compared to the rest of the treatments (2.45 – 3.01%). Inter row spacing generally had no significant (P>0.05) effect on EE contents of the Rhodes grass herbage, (Table 2). The significantly higher (P<0.05) EE contents recorded for Rhodes grass at12WAS from application of 120 kgNha^{-1} during 2016 and 2017 trials and the years combined may indicate that the Rhodes grass plant require the moderate dose of nitrogen fertilizer to produce herbage with higher EE contents. The result obtained was in agreement with the findings of Na-Allah (2015) in the same study area and that of Aderinola *et al*, (2011) in Abeokuta, humid zone of Nigeria. The EE contents recorded for this study (5.92 %) was however higher than the

average range of 1.5 – 3.5% EE reported from fresh herbage of this species across the Sahel zone of Africa (Heuzé and Tran (2012).

The non-significant (P>0.05) effect of inter row spacing recorded for Rhodes grass during 3 - 12WAS in the 2016, 2017 and the years combined (Table 2) may indicate that syntheses and accumulation of EE in Rhodes grass in the study area was unaffected by spacing.

Table 2: Ether extract content of Rhodes grass as influenced by nitrogen fertilizer and inter row spacing during the 2016, 2017 rainy season and the years combined in the dry sub humid zone of Sokoto, Nigeria

Treatment	2016	2017	Combined
Fertilizer (F) (kgNha^{-1})			
0 (F0)	2.45^{d}	2.65	2.55
100 (F1)	2.75^{c}	5.59	4.17
120 (F2)	2.62^{c}	5.11	3.87
140 (F3)	3.01^{b}	6.01	4.51
160 (F4)	4.89^{a}	6.74	5.92
LSD	0.672	4.703	2.300
Significance	*	NS	NS
Spacing (S) (cm)			
30 (S1)	2.94	2.96	2.95
50 (S2)	2.96	3.00	2.97
70 (S3)	3.02	3.05	3.02
LSD	0.207	3.643	1.782
Significance	NS	NS	NS
Interaction			
F*S	NS	NS	NS

a,b,c, Means within a column for factor followed by the same letters are not statistically different using Least Significant Difference (LSD) at 5% level of probability. *=Significant at 5% probability level, NS = not significant at 5% level of probability. F= Fertilizer, S = Spacing, F * S = Interaction between fertilizer and spacing, WAS = Weeks after Sowing.

Crude fibre (C.F)

The results showed that the mean C.F content of Rhodes grass herbage differ significantly (P>0.05) with level of nitrogen fertilizer application in the 2016, 2017 and in the combined analysis. C.F values generally decreases at 160 kgNha^{-1}. From 29.90 – 31.32% and increases to 41.44 – 43.00% at 0 kgNha^{-1}. The significantly (P<0.05) higher C.F contents recorded by 0 kg Nha^{-1} from Rhodes grass at 12WAS during 2016 and 2017 trials and the years combined indicated that C.F accumulation in the Rhodes grass herbage dose not required nitrogen fertilizer in the study area. Indeed, it is discovered that increase in nitrogen fertilizer is accompanied by the decreases in crude fibre from 29.90–31.32% at 160 kgNha^{-1}, to 41.44–43.00% at 0 kgNha^{-1}, and this is because nutritive value of grasses varies greatly with species fertilizer application and stage of growth at which the grasses are harvested or grazed (Aregheore, 1996). Increases in fertilizer level, reduced fibre content of Maize forage Gassim (2001). This is also in line with the findings of Aderinola *et al*, (2011), Abbas (2003), Adam (2004) were they reported decrease in crude fibre content of Rhodes grass with increase in the addition of nitrogen fertilizer.

Table 3: Crude fibre contents of Rhodes grass as influenced by nitrogen fertilizer and inter row spacing, during 2016 and 2017 rainy season and the years combined in the dry sub humid zone of Sokoto, Nigeria

Treatments	2016	2017	Combined
Fertilizer (F) ($kgNha^{-1}$)			
0 (F0)	41.44[a]	43.00[a]	42.22[a]
100 (F1)	33.78[b]	33.56[b]	30.78[c]
120 (F2)	32.00[bc]	31.89[c]	33.44[b]
140 (F3)	30.00[c]	31.01[c]	30.05[c]
160 (F4)	29.90[c]	30.00[c]	31.32[c]
LSD	2.336	2.111	1.522
Significance	*	*	*
Spacing (S) (cm)			
30 (S1)	33.18	36.00	34.59
50 (S2)	33.27	36.00	34.63
70 (S3)	34.27	35.98	35.10
LSD	1.809	1.635	1.179
Significance	NS	NS	NS
Interaction			
F*S	NS	NS	NS

a,b,c, Means within a column for a factor followed by the same letters are statistically not significant at 5% probability level, using least significant difference
(LSD) * = Significant at 5% and NS = not significant at 5%. F = Fertilizer S = Spacing WAS = Weeks after Sowing.

Inter row spacing had no significant (P>0.05) effect on the C.F content of Rhodes grass herbage in the 2016, 2017 and the years combined, this signifies that Rhodes grass does not require a wide inter row spacing for C.F accumulation in the herbage, Sunran, et al; (2009). The C.P decreases as the plant matures while percent C.F increases as the plant increases in height and Sunran, et al; (2009), this is in line with the findings of (Wiredu, 1998), who reported that at advanced stage of growth C.F is not significantly influenced by spacing. Obi (1991) reported that plant spacing play a vital role on light interception during photosynthesis, which positively affects growth and nutrient constituents of plants

Ash (Mineral matter)

The Ash content (Mineral matter) of Rhodes grass herbage significantly (P<0.05) influenced by nitrogen fertilization during the 2016, 2017 rainy seasons and the years combined result. Application of 160 $kgNha^{-1}$ 1n 2016 produced herbage with higher (P<0.05) ash contents (6.36%), which is similar to (P<0.05) to 120 and 140 $kgNha^{-1}$ (6.23 and 5.91%), compared to 0 and 100 $kgNha^{-1}$ (4.59 and 5.81%). The ash and OM contents in forages vary with stage of plant maturity, soil fertility and fertilizer application (Crowder and Chheda, 1982) Ash contents of forages have been reported to vary as 3 – 12% (Bogdan, 1977), 8 - 12% (Gillespie, 1998) and 0.7 – 16% (Jagdish and Neeraj, 2008)..In 2017, application of 160 and 100 $kgNha^{-1}$ produced Rhodes grass herbage with higher (P<0.05) ash contents (4.53 and 4.17%) compared to those on 0, 120 and 140 $kgNha^{-1}$ (3.73, 3.30 and 3.49 %), while in the years combined, application of 160 $kgNha^{-1}$ produced herbage with higher (P<0.05) ash contents (5.45%), which were similar (P<0.05) to 120 $kgNha^{-1}$ (4.77%), compared to those on 0, 100 and 140 $kgNha^{-1}$.
The significantly (P<0.05) higher Ash contents (5.45%) recorded from the Rhodes grass herbage produced on application of 160 $kgNha^{-1}$ during 2016 and 2017 trials and the years combined (Table 4) may indicate that Rhodes grass that high nitrogen fertilizer (160 $kgNha^{-1}$ or more) is required to produce herbage with high Ash contents. The values for ash content recorded for the species in this study was

within the average range of 0.6 – 16% ash reported for tropical forages (Gillespie 1998; Jagdish and Neeraj 2008.

The non-significant (P>0.05) effect of inter row spacing on Ash contents recorded in this research 12WAS in the 2016, 2017 and the years combined results may indicate that syntheses and accumulation of Ash was unaffected by spacing (Table 4).

Table 4: Percent (%) Ash contents of Rhodes grass as influenced by nitrogen fertilizer and inter row spacing, during 2016, 2017 rainy season and years combined in the dry sub humid zone of Sokoto, Nigeria

Treatment	2016	2017	Combined
Fertilizer (F) (kgNha^{-1})			
0 (F0)	4.59^{c}	3.73^{b}	4.16^{c}
100 (F1)	5.18^{b}	4.17^{a}	4.65^{b}
120 (F2)	6.23^{a}	3.30^{b}	4.77^{ab}
140 (F3)	5.91^{ab}	3.49^{b}	4.70^{b}
160 (F4)	6.36^{a}	4.53^{a}	5.45^{a}
LSD	0.469	0.482	0.393
Significance	*	*	*
Spacing (S) (cm)			
30 (S1)	5.61	4.26	4.94
50 (S2)	5.62	4.13	4.89
70 (S3)	5.74	4.34	5.04
LSD	0.363	0.296	0.227
Significance	NS	NS	NS
Interaction			
F *S	NS	NS	NS

a,b,c, Means within a column for factor followed by the same letters are not statistically different using Least Significant Difference (LSD) at 5% level of probability. *=Significant at 5% probability level, NS = not significant at 5% level of probability, F= Fertilizer, S = Spacing, F * S = Interaction between fertilizer and spacing, WAS = Weeks after Sowing.

Nitrogen free extract (NFE)

Application of nitrogen fertilizer significantly (P<0.05) influenced the NFE content of Rhodes grass in the study area, 160 and 140 Kg N ha^{-1} produced Rhodes grass herbage with higher (P<0.05) NFE contents in 2016, (41.61 – 41.26), (32.35 and 32.00) in 2017 and (36.81 and 36.81) in the years combine compared to the rest of the treatments. The significantly (P<0.05) higher NFE contents recorded from the Rhodes grass plants on application of 160 kg N ha^{-1} at 12WAS in the 2016, 2017 and the years combined results (Table 5). This is due to the accumulation of photosynthate during photosynthesis. In addition the high result recorded is as a result adequate rainfall received during the years which attributes to the accumulation of useful nutrients. And also may be an indication that higher dose of nitrogenous fertilizer was required to produce high amounts of soluble carbohydrate (NFE) contents in the study area. The lower NFE contents recorded for Rhodes grass (herbage) in this study may be due to older age of the plant at harvesting (12 WAS) and yearly differences of rainfall in the study area and probably in the Ethiopia. This is because older plants at younger age accumulate more of the structural materials represented by the crude fibre leading to reduction in the crude protein (CP) and soluble carbohydrate (NFE).

Inter row spacing had significant (P<0.05) effect on the soluble carbohydrate contents of Rhodes grass during the 2016 rainy season, while in the 2017 and the years combined inter row spacing had generally no significant (P>0.05) effect on the soluble carbohydrate content of Rhodes grass at 12WAS. 30cm spacing produces herbage with higher NFE content in 2016, 2017 and the combined result as compared the rest of the treatments. The accumulation of useful nutrients may be an indication that Rhodes grass does not require wider inter row spacing for the accumulation of soluble carbohydrate content in the specie. (Table 5).

Table 5: Percent Nitrogen free extract content of Rhodes grass as influenced by nitrogen fertilizer and inter row spacing, during 2016, 2017 rainy season and years combined in the dry sub humid zone of Sokoto, Nigeria

Treatment	**2016**	**2017**	**Combined**
Fertilizer (F) (kgNha^{-1})			
0 (F0)	32.90^{b}	30.57^{c}	31.76^{c}
100 (F1)	32.23^{b}	33.01^{a}	32.62^{b}
120 (F2)	34.49^{b}	33.26^{a}	33.88^{b}
140 (F3)	41.26^{a}	32.35^{b}	36.81^{a}
160 (F4)	41.61^{a}	32.00^{b}	36.81^{a}
LSD	3.067	0.621	0.732
Significance	*	*	*
Spacing (S) (cm)			
30 (S1)	36.40^{a}	36.34	36.37
50 (S2)	34.87^{a}	35.58	35.34
70 (S3)	32.80^{b}	34.44	33.62
LSD	1.621	2.001	0.668
Significance	*	NS	NS
Interaction			
F*S	NS	NS	NS

a,b,c, Means within a column for factor followed by the same letters are not statistically different using Least Significant Difference (LSD) at 5% level of probability. *=Significant at 5% probability level, NS = not significant at 5% level of probability. F= Fertilizer, S = Spacing, F * S = Interaction between fertilizer and spacing.

Conclusion

From the results of this research, Rhodes grass has showed appreciable adaptation and herbage productivity in the study area. Application of nitrogen fertilizer consistently increased the nutrient composition of Rhodes grass in the study area. The higher Nitrogen fertilizer level of 160 KgNha^{-1} produced higher values for CP and NFE; CF and EE were also low. The wider inter row spacing also produced higher (P<0.05) CP and NFE values. It can be concluded that application of 160 kgNha-^{1} and 70 cm spacing gave better (P<0.05) nutrient quality of Rhodes grass in the study area.

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