EFFECT OF NITROGEN FERTILIZER AND INTER ROW SPACING ON PROXIMATE 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 proximate 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 fifteen (15) treatments combinations, which were laid out in a RCBD replicated four times. 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 forage grass. Inter-row spacing of 70cm showed superiority among the treatments in the proximate compositions investigated compared to 50 and 30cm spacings.

Keywords: Centre of agricultural and pastoral research, crude protein, crude fibre, nitrogen free extract, ether extract, ~~rhodes grass~~2016 and 2017 rainy seasons.

1 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.

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^{l}N and longitude 5°25^{l}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. Crude protein (%CP), Crude fibre (% CF), Ether Extract, (%EE) and Ash (%Ash) by A.O.A.C procedure A.O.A.C 2002), while the Nitrogen free extract (NFE) was calculated as residual component of the feed dry matter using the equation below;

% NFE = 100% - (% MC +% CP + % EE +% CF + % Ash).

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The data were statistically analyzed by analysis of variance (ANOVA), using the GenStat 64-bit Release 17.1

3. RESULTS AND DISCUSSION

Proximate Composition

Crude Protein (C.P) contents

The mean C.P content of Rhodes grass herbage differ significantly (~~P<0~~P>0.05) with level of nitrogen fertilizer application in the year 2016, 2017 and the years combined results. ~~Application~~Fertilizer application of 160 kgNha^{-1} ~~generally~~ produced higher (~~P<0~~P>0.05) ~~CP~~C.P (10.73 – 10.74%) as compared to the rest of the treatments. ~~The inter~~ (0, 100, 120 and 140 kgNha^{-1}). Inter-row spacing also ~~had significant (P<005) effect on the~~significantly affect C.P contents of Rhodes grass ~~herbage~~ in the 2016, 2017 rainy seasons and the years combined (Table 1). The wider (70 cm) inter row spacing produced higher (P~~<~~>005) C.P values (9.19 – 9.23%) compared to the rest 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 ~~has effect~~play a vital role on light interception during photosynthesis, which ~~influences~~positively affects growth and nutrient ~~contents~~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 ~~(10. 73 – 10. 74%)~~ 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.

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 the Rhodes grass ~~herbage~~ 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.

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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 ~~years~~ combined ~~results. The~~analysis. C.F values generally ~~decreased significantly (P<005) from~~ decreases at 160 kgNha^{-1}. From 29.90 – 31.32% and increases to 41.44 – 43.00% at 0 kgNha^{-1} ~~to 29.90 – 31.32% at 160 kgNha^{-1}. The inter-row spacing generally had no significant (P>005) effect on the C.F contents of Rhodes grass herbage.~~

~~The significantly (P<~~. 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, ~~the result showed~~it is discovered that ~~crude fibre decreases with~~ increase in nitrogen fertilizer ~~application.~~ is accompanied by the decreases in crude fibre. This ~~result is similar to that reported by~~is also in line with the findings of Aderinola *et al*, (2011), Abbas (2003), Adam (2004), Gassim (2001) ~~whose results also showed that~~were they reported decrease in crude fibre ~~contents~~content of Rhodes grass ~~decreased~~ 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 during 3- 12WAS in the 2016, 2017 and the years combined ~~(Table 3). This is in line with the findings of Wiredu (1998) who reported that C.F is not significantly influenced by spacing. The significantly (P<0.05) higher C.F contents recorded from the Rhodes grass herbage produced on application of 0 KgNha^{-1} and 30cm inter row spacing during 3 and 12 WAS in the 2017 and the years combined may confirm~~, this signifies that Rhodes grass does not require application of nitrogen fertilizer and wide inter row spacing for C.F accumulation in the herbage up to 12 WAS in the study area (Wiredu, 1998).

Ash (Mineral matter)

~~Percent~~The Ash content (Mineral matter) of Rhodes grass herbage was found to be significantly (~~P<0~~P>0.05) influenced by nitrogen fertilizer during the 2016, 2017 rainy seasons and the years combined analysis. Application of 160 kgNha^{-1} 1n 2016 produced herbage with higher (~~P<0~~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%). 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~~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 ~~requires~~that high nitrogen fertilizer (160 kgNha^{-1} or more) is required to produce herbage with high Ash contents ~~in the study area.~~. The ~~result obtained for this study was a little lower than the 8.13% reported by Na-Allah (2015) for Rhodes grass in the study area. Meanwhile the~~ values for ash

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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 for Rhodes grass herbagein this research during 3 - 12WAS in the 2016, 2017 and the years combined results may indicate that syntheses and accumulation of Ash in the Rhodes grass herbage in the study area was unaffected by spacing (Table 4).

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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)

This result reveals that ~~application of~~ nitrogen fertilizer application significantly (~~P<0~~P>0.05) influenced the NFE content of Rhodes grass in the study area. Application of ~~–~~160 and 140 Kg N ha^{-1} produced Rhodes grass herbage with higher (~~P<0~~P>0.05) NFE contents in 2016 (~~32.90 –~~ 41.61~~) –~~ – 41.26) and the years combine (36.81~~ and 36.81~~) compared to ~~0, 100 and 120 kgNha^{-1}.~~ 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} during 3 – 12WAS in the 2016, 2017 and the years combined results (Table 5) 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 mean NFE value recorded by Rhodes grass herbage at 12 WAS in this study (36.81%) is lower than the 45.95 % reported by Na-Allah (2015) for Rhodes grass at 10 WAS in the study area and 48.03% reported by Irshadullah *et al.* (2012) for the same species in Ethiopia. The lower NFE contents recorded for the Rhodes grass herbage~~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 ~~a significant effect (P<0~~significantly (P>0.05) ~~on NFE~~influence 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 ~~NFE~~the soluble carbohydrate content of Rhodes grass. (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	36.62
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 ~~growth and herbage yield~~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 140 kgNha-^{1} and 70 cm spacing gave better (P~~<~~>0.05) nutrient quality of Rhodes grass in the study area.

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