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Effect of Nitrogen and Variety on Quality Performance of Rhodes Grass (*Chloris gayana* kunth) in the Sudan

Hussein H. A. M^α, Dagash Y. M. I^σ & Maarouf I. Mohammed^ρ

Abstract- An experiment was conducted in Shambat (2016-2017) in the demonstration farm of the College of Agricultural Studies, Sudan University of Science and Technology to study the effect of variety and nitrogen fertilization on the quality performance of Rhodes grass. Two Rhodess grass varieties (Fine Cut and Reclaimer) and three nitrogen levels (60kgN/ha, 120kg N/ha and Control= 0.0kgN/ha) were investigated across seven cuts. The treatments were studied as factorial arrangement in Completely Randomized Design. Proximate analysis for Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Crude Protein(CP) was carried out.

Differences between varieties were not significant for Neutral Detergent Fiber (NDF) Acid Detergent Fiber (ADF) and Crude protein (CP). Nitrogen dose and cutting age have a significant effect on NDF and ADF. Crude protein was significantly affected by cutting age but not nitrogen dose. The interaction effect of nitrogen dose and cutting age was significant for NDF and ADF. The dose 60kgN/ha gave desirable ADF percentage compared to 120kgN/ha whereas the opposite is true for NDF. Cutting age at 182 and 268 days resulted in desirable ADF percentage compared to 75 day whereas the opposite is true for NDF. Crude protein was better at cutting age of 75 day than 182 day. It was concluded that cutting age and nitrogen fertilization have significant impact on Rhodes grass digestibility and intake potential. More research is needed to study the impact of nitrogen fertilization on crude protein of Rhodes grass.

Keywords: NDF, ADF, CP, cutting age.

I. INTRODUCTION

Rhodes grass (*Chloris gayana* Kunth) has become one of the major forage crops throughout the tropical and sub-tropical World. It is a perennial C4 grass originated in Africa where it was first cultivated in 1985 (Loch *et al.*, 2004; Ubei *et al.*, 2001). It can be grazed, cut for hay or used as deferred feed, with moderate to high feed quality (Cook *et al.*, 2005). Many Rhodes grass cultivars have been developed to suit different cultivation conditions or end-uses: for example cultivars with varying flowering duration, prostrate cultivars suitable for grazing or erect ones for hay

production (FAO, 2014; Quattrocchi, 2006; NSW DPI, 2004; Duke, 1983; Göhl, 1982). Rhodes grass flourish in areas with annual rainfall of 600-1600 mm. The crop is grown in a wide range of soils; from clays to sandy loam. It responds well to irrigation and moderately tolerant to flooding. The crop is palatable to animals with good nutritive value in early growth stages (Loch *et al.*, 2004).

Sudan owns one of the huge animal wealth in Africa. The national herd is greatly dependent on the natural vegetation that supports maintenance and reproduction requirements with very little contribution to animal's performance. One of the possible solutions is to encourage irrigated fodder production to support the natural pastures. Although the earliest attempt to introduce Rhodes grass to Sudan dated back to 1970s (Zaroug, 2002), its commercial cultivation is relatively new. According to the record of the National Seed Administration of Sudan, importation of Rhodes grass seed increased steadily since 2012 through 2016 pointing to the growing importance of Rhodes grass in the Sudan. Based on total seed imported up to 2017 the area cropped to Rhodes grass in Sudan could be estimated around 32000 ha.

High quality forage is a prerequisite for improved animal performance, however, the traditional system for forage production in the Sudan favors high yields at the expense of high feeding value (Mohammed and Zakaria, 2014). Research works on Rhodes grass in the Sudan, specially those dealing with forage quality, are not coping with its growing importance in the country. Some works on husbandry practices (Abuswar, 2005; Abdelrahman, 2007; Elnazier, 2010) and variety performance (Maarouf, 2008) have been made. The objectives of this study were to investigate the effect of variety, nitrogen fertilization, cutting age and their interaction on the quality performance of irrigated Rhodes grass in the Sudan.

II. MATERIALS AND METHODS

The experimental site: The experiment was conducted at Shambat during 2016-2017 in the demonstration farm of the College of Agricultural Studies, Sudan University of Science and Technology, latitude 15°39'N, Longitude 32°31'E, 280 meter above sea level. The location is in

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the semi-arid tropical region with very hot summer and a short rainy season between July and September (Appendix I). The soil of the site is moderately clay, non-saline, non-sodic, with pH of 7.8 (Appendices II and III).

Management and Cultural practices: The seeds of Rhodes grass were sown in 28- August, 2016. The plot size was two ridge 7m long spaced at 0.75m. The seeds were drilled manually in furrows opened in one side of the ridge at seed rate of 20 kg/ha. TSP fertilizer was added before sowing at a rate of 50 Kg P₂O₅/ha. The first irrigation was given immediately after sowing; irrigation water was applied after that at intervals of 7-10 days. Weeds were kept at minimum using hand tools. The experiment was affected by shortage of irrigation water and termite infestation. The zero cut (cut of the seed-crop) commenced after 65 days from sowing, a time at which all entries in each plot were in 25% to 50% bloom. Thereafter, succeeding cuttings were approximately maintained at intervals of 35 to 40 days or when 10%-25% of plants in each plot have flowered. Forage cuttings were continued to be taken up to the 9th cut after which the experiment was terminated. However, the data of cut 8 and cut 9 will not be reported due to sever termite infestation.

Treatments: Two Rhodes grass (*Chloris gayana* Kunth) and 3 levels of nitrogen fertilizer were investigated. The seeds of the cultivars: Fine cut and Reclaimer were received from Selected Seed Co. of Australia via their local agent in the Sudan. The levels of the nitrogen fertilizer (in a form of urea) were: 60kg N /ha, 120kg N /ha and 0.0kg N /ha (Control).

Data collection: Proximate analysis for the following forage quality traits was carried out on dry matter basis based on the standard procedure of A.O.A.C. (1984):

- Percentage of Neutral Detergent Fiber (NDF %),
- Percentage of Acid Detergent Fiber (ADF %),
- Percentage of Crude Protein (CP %),

The traits were studied across the two Rhodes grass varieties and the three fertilizer levels using two replicate samples taken from three cuts spread over the seven cuts, namely: cut 2, cut 5 and cut 7 which coincide with the cutting age of 75 day, 182 day and 268 day, respectively. The chemical analysis was carried out in the Laboratory of the Faculty of Animal Production, University of Khartoum, Shambat.

Experimental design and statistical analysis: The treatments were originally replicated four times in RCB design. However, due to budget limitation the treatments were studied as factorial arrangement in Completely Randomized Design. The data collected were subjected to the analysis of variance (ANOVA) procedure (Cochran and Cox, 1957). The Least Significant Difference (LSD) procedure was used to

separate the means. The statistical package Gen Stat (2009) was used to run the analysis.

III. RESULTS

Table 1 shows mean squares for neutral (NDF), acid (ADF) detergent fibers and crude protein (CP). The effects of nitrogen and cutting age were significant for NDF and ADF whereas the effect of variety for both traits was not significant. For crude protein, significant effect was only detected among cutting ages. The effect of nitrogen dose x cutting age was significant for NDF and ADF whereas the effect of dose x variety was significant only for ADF. The interaction of dose x cutting age x variety was significant for NDF and CP.

a) Main effects

The effect of nitrogen dose on nutritive value of Rhodes grass is shown in Table 2. The ADF value (42.7%) shown by the dose 60kgN/ha was the lowest (desirable) and that obtained by 120kgN/ha (46.6%) was the highest. In contrast, the NDF value (63.3%) shown by 120kgN/ha was lower (desirable) than 60kgN/ha (66.8%) and the control (68.4%). Crude protein obtained by 120kgN/ha was 8.5% and that of the other doses was 8.1%.

Table 3 shows the effect of variety on nutritive value of Rhodes grass which reflects no significant differences between cultivars. The ADF, NDF and CP averaged 44.5%, 66.7% and 8.0%, respectively.

Table 4 shows the effect of cutting age on nutritive value of Rhodes grass. Cutting at 182 and 268 day resulted in lower ADF percentage than cutting at 75 day with respective values of 41.7%, 42.9% and 48.5%. For NDF, cutting at 268 day gave the lowest value (60.8%) compared to 75 day (70.3%) and 182 day (68.7%). Crude protein was best (9.9%) when cutting was done at 75 day than 182 day (6.6%).

b) Interaction effects

Nitrogen dose x cutting age: Table 5 shows the effect of nitrogen dose x cutting age interaction on nutritive value of Rhodes grass. The nitrogen dose 60kgN/ha with cutting age 182 day gave the lowest ADF value (37%) whereas the same dose with cutting age 75 day gave the highest ADF value (50%). Similar trend was noticed when using the same cutting ages with control. Cutting at 268 day with nitrogen dose 120kgN/ha gave higher ADF value (49.3%) than with other cutting ages. For NDF, the nitrogen dose 120kgN/ha with cutting age 268 day gave the lowest value (54%) compared to other cutting ages (> 65%). Similar trend was noticed for the same cutting age with other nitrogen doses. For crude protein, the nitrogen dose 120kgN/ha with cutting age 75 day gave the highest value (11.1%) compared to other interactions. Similar trend was noticed for the same cutting age by other doses in contrast to respective interactions.

Variety x nitrogen dose interaction: Table 6 shows the effect of nitrogen x variety interaction on nutritive value of Rhodes grass. The nitrogen dose 60kgN/ha with Fine cut gave the lowest ADF value (41.5%) followed by control with Reclaimer (43.4%). The highest ADF value (48.6%) was noticed for the dose 120KgN/ha with variety Reclaimer.

Variety x cutting age interaction: The effect of cutting age x variety interaction on nutritive value of Rhodes grass was not significant. The data are presented in Table 7.

Nitrogen x cutting age x variety interaction: The effect of nitrogen dose x cutting age x variety interaction on CP and NDF of Rhodes grass are presented in Tables 8 and 9, respectively. For crude protein, the nitrogen dose 120KgN/ha at cutting age 75 day in both varieties gave the higher CP (10.9%-11.3%) than other respective interactions. For NDF (Table 9), the nitrogen dose 120KgN/ha at cutting age 268 day gave the lowest NDF in both varieties (48.7% for Reclaimer, 59.3% for Fine cut) in contrast to control at cutting age 75 day that gave the highest NDF with respective values of 71% and 74%.

IV. DISCUSSION

Lack of significant differences between Rhodes grass varieties for quality traits could be attributed to the narrow genetic base as both varieties have been developed from one variety (Katambora population). Therefore, most of the variability observed could be attributed to the effect of nitrogen fertilization and cutting age. The effect of cutting age on NDF, ADF and protein content has been reported by Keftasa (1990).

The ADF measures digestibility. The lower the ADF value the better the digestibility and energy value of the fodder. NDF predicts intake potential; the higher the NDF, the lower the intake (Steve and Marble, 1997). There was a general trend that nitrogen application will improve digestibility, however, this was not evident at the low nitrogen dose (60KgN/ha). The intake potential was found to be improved by nitrogen in this study. These findings agree with those reported by Keftasa (1990) who found that both NDF and ADF were lower in nitrogen fertilized Rhodes grass if cut early, however, he noted that higher NDF and ADF values have been obtained if cutting was done at advanced maturity stage.

The present study showed that the crude protein (CP) was not significantly increased by nitrogen fertilizer where only slight increase in CP was obtained by applying the highest dose of nitrogen (120kgN/ha). Disagreeing results were reported by Keftasa (1990) and Loch, *et al.*, (2004). However, the former stated that nitrogen fertilization at the later stages of growth decreased CP content.

The study showed that cutting age has significant effect on quality traits. CP was significantly

higher at earlier growth stage than the later ones. Similar results were obtained by Mbwire and Uden (1997). The NDF and ADF values were decreased at increased age of cutting indicating improved digestibility and potential intake. These results disagree with those reported by Mbwire and Uden (1997).

Based on the most significant factors affecting quality traits in this study (nitrogen dose x cutting age interaction) the results obtained for crude protein (6.3%-11.1%) and ADF (37.0%-50.0%) were within the range of those reported in the literature for Rhodes grass (Heuze *et al.*, 2016). The range obtained for NDF (48.7%-74%) was however, lower than that reported by Heuze *et al.*, (2016). In Sudan, Babiker, (2010) reported NDF values ranging 68.5%-70.3%, ADF 42.4%-45% and CP 10.6%-11.4%.

a) Conclusion

Nitrogen fertilization and cutting age have significant impact on Rhodes grass digestibility and intake potential. More research is needed to explain why nitrogen fertilization did not positively impacted crude protein of Rhodes grass.

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Table 1: Mean squares from ANOVA for neutral (NDF), acid (ADF) detergent fibers and crude protein (CP) of 2 Rhodes grass cultivars evaluated across 7 cuts (2016-2017)

Source of variation	Mean Squares			
	D.F.	NDF (%)	ADF (%)	CP (%)
Nitrogen dose(D)	2	543.76 **	252.51**	3.946 ns
Cutting age (C)	2	2180.52**	1160.35**	234.739 **
Variety (V).	1	239.70ns	30.91ns	21.048 ns
D x C	4	270.28*	460.43**	14.363 ns
D x V	2	135.51ns	222.12**	4.142 ns
C x V	2	33.82ns	15.47ns	1.121ns
D x C x V	4	250.11 *	55.89ns	26.210 *
Residual	237	76.49	46.50	9.129

*. **: Significant at 5% and 1% probability level, respectively.

ns: Not significant at 5% probability level.

Table 2: Effect of nitrogen dose on nutritive value of Rhodes grass

	ADF (%)	NDF (%)	CP (%)
60kgN/ha	42.7	66.8	8.1
120kgN/ha	46.6	63.3	8.5
Control	44.3	68.4	8.1
Mean	44.5	66.7	8.2
SE±	0.85	1.09	0.38
LSD (5%)	2.06	2.65	0.91
CV%	15.3	13.1	36.8

Table 3: Effect of variety on nutritive value of Rhodes grass

	ADF (%)	NDF (%)	CP (%)
Reclimaier	44.9	65.7	7.9
Fine cut	44.2	67.6	8.5
Mean	44.5	66.7	8.2
SE±	0.6	0.78	0.27
CV%	15.3	13.1	36.8

Table 4: Effect of cutting age on nutritive value of Rhodes grass

Cutting age*	ADF (%)	NDF (%)	CP (%)
75 day	48.5	70.3	9.9
182day	41.7	68.7	6.6
268 day	42.9	60.8	8
Mean	44.5	66.7	8.2
SE±	0.75	0.97	0.33
LSD (5%)	2.05	2.63	0.93
CV%	15.3	13.1	36.8

*: Number of days from zero cut

Table 5: Effect of nitrogen dose x cutting age interaction on nutritive value of Rhodes grass

Cutting age*	ADF (%)			NDF (%)			CP (%)		
	75 day	182 day	268 day	75 day	182 day	268 day	75 day	182 day	268 day
60kgN/ha	50	37	40.7	69.5	66.1	64.6	9.4	6.8	8.1
120kgN/ha	45.1	45.4	49.3	66.8	69.3	54	11.1	6.7	7.5
Control	49.6	42.2	40.6	72.5	69.6	62.4	9.4	6.3	8.3
Mean	44.5			66.7			8.2		
SE±	1.49			1.91			0.66		
LSD (5%)	3.55			4.55			1.57		
CV%	15.3			13.1			36.8		

*: Number of days from zero cut

Table 6: Effect of nitrogen x variety interaction on nutritive value of Rhodes grass

Variety Dose	ADF(%)		NDF(%)		CP(%)	
	Reclaimer	Fine cut	Reclaimer	Fine cut	Reclaimer	Fine cut
60kg N/ha	43.9	41.5	67.7	66.1	7.6	8.6
120kg N/ha	48.6	44.6	61.4	65.2	8.1	8.9
N0(Control)	43.4	45.3	67	69.7	8	8.2
Grand Mean	44.5		66.7		8.2	
SE±	1.22		1.57		0.54	
LSD (5%)	2.92		3.78		1.31	
CV%	15.3		13.1		36.8	

Table 7: Effect of cutting age x variety interaction on nutritive value of Rhodes grass

Variety Cutting age*	ADF (%)		NDF (%)		CP (%)	
	Reclaimer	Fine cut	Reclaimer	Fine cut	Reclaimer	Fine cut
75 days	48.4	48.6	68.6	71.9	9.5	10.3
182 days	42.3	41.2	67.9	69.4	6.4	6.7
268 days	43.6	42.3	60.4	61.2	7.8	8.3
Mean	44.5		66.7		8.2	
SE±	1.08		1.38		0.48	
LSD (5%)	2.92		3.74		1.29	
CV%	15.3		13.1		36.8	

*: Number of days from zero cut

Table 8: Effect of nitrogen dose x cutting age x variety interaction on crude protein(CP%) of Rhodes grass

Variety Cutting age	Reclaimer			Fine cut		
	75 day	182 day	268 day	75 day	182 day	268 day
60kg N/ha	7.4	7.8	7.8	11.4	6.0	8.4
120kg N/ha	10.9	6.2	6.9	11.3	7.2	8.0
N0(Control)	9.7	5.8	8.3	9.2	6.9	8.4
Grand Mean	8.2					
SE±	0.96					
LSD(5%)	2.25					
CV%	36.8					

Table 9: Effect of nitrogen dose x cutting age x variety interaction on neutral detergent fiber (NDF%) of Rhodes grass

Variety Cutting age	Reclaimer			Fine cut		
	75 day	182 day	268 day	75 day	182 day	268 day
60kgN/ha	68.4	66.9	67.6	70.6	65.5	62
120kgN/ha	64.5	71.7	48.7	69.3	67.2	59.3
Control	71	66.5	63	74	72.7	61.8
Grand Mean	66.7					
SE±	2.77					
LSD(5%)	6.53					
CV%	13.1					

Appendix I: Monthly average temperature of meteorological data for the experimental period at Shambat.

Month	2016				2017			
	Max Temp. (°C)	Min Temp. (°C)	Rain Fall (mm)	Relative Humidity (%)	Max Temp. (°C)	Min Temp. (°C)	Rain Fall (mm)	Relative Humidity (%)
Jan	-	-	-	-	16.8	34.2	-	30
Feb	-	-	-	-	14.9	31.6	-	23
Mar	-	-	-	-	17.8	36.3	-	19
Apr	-	-	-	-	24	40.9	-	17
May	-	-	-	-	26.3	41.6	5.3	29
Jun	-	-	-	-	26.4	42.4	1.5	30
Jul	-	-	-	-	26.7	39.9	40.4	42
Aug	25.2	36.1	69.5	55	24.8	36.6	15	52
Sep	25.4	39.2	23	63	26.5	39.3	2.5	43
Oct	24.6	40.2	-	32	24.3	39.4	-	27
Nov	21.4	37	-	31	20.8	34.8	-	30
Dec	17.5	33.4	-	34	18.3	33.6	-	38

Source: Ministry of Environment, Natural Resources and Physical Development Metrological Authority.

Appendix II: Chemical and physical soil properties of the experimental site

Depth (cm)	pH	ECe (dm/m)	Ca+Mg (mmol+L)	Na (mmol+l)	SAR	CaCO ₃	Clay (%)	Silt (%)	Sand (%)
0-15	7.79	1.4	9.0	5.1	2.4	5.10	42.1	15.9	42.0
15-35	7.88	1.0	6.0	4.3	2.5	4.88	39.6	15.8	44.6
35-51	7.87	1.2	5.0	7.1	4.5	4.99	44.1	16.4	39.5
51-75	7.91	2.0	8.0	12.5	6.3	4.88	51.4	16.6	32.0
75-90	7.71	2.2	6.0	16.0	9.2	5.20	50.0	16.6	33.4

Appendix III: Soil analysis for Nitrogen (N), Phosphorus (P) and potassium (K)

Depth (cm)	N%	P (meg/kg)	K (meq/l)
0-20	0.084	0.53	0.195
0-20	0.140	0.79	0.096
0-20	0.140	0.46	0.070
Mean	0.121	0.59	0.120
20-40	0.112	0.54	0.079
20-40	0.098	0.54	0.066
20-40	0.098	0.51	0.084
Mean	0.103	0.53	0.076



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