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Effect of Nitrogen Fertilizer and Inter Row Spacing on Herbage Yield and Some Yield Components (Number of Leaves and Number of Tillers per Plant) of Rhodes Grass (*Chloris gayana* Tan) in the Dry Sub Humid Zone of Sokoto Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author MMI designed the study, conducted the field trial and data taking and wrote the protocol. Author JI wrote the first draft of the manuscript and performed the statistical analysis and author SUB managed the literature searches and effect corrections regarding the missing references in the text. All authors read and approved the final manuscript.

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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 herbage yield and some yield parameters 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 70 cm) were used, making fifteen treatments combinations, which were laid out in a RCBD replicated four times. Determination of herbage dry matter yield at the end of 12 weeks post planting was carried out using a 0.25 m^2 (0.5 m x 0.5 m) area metallic frame (Quadrat). The herbage was harvested at 5 cm above ground level using hand

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Sickle from the four plots for each treatment. The samples collected ware oven dried for the determination of dry matter yield, while determination of number of leaves and number of tillers per plant was done by counting the numbers of individual leave and tillers of each of the representative plant sample. The result revealed that, Application of 160 KgNha^{-1} generally produced higher ($P < 0.05$) dry matter yield, number of leaves and number of tillers compared to the rest of the treatment, There was no significant ($P > 0.05$) effect of inter row spacing in both 2016, 2017 and the years combined on herbage dry matter yield, however significant ($P < 0.05$) effect of spacing was observed in 2016, 2017 and the years combine on the numbers of leaves and numbers of tiller. Inter-row spacing of 70cm showed superiority among the treatments in the herbage yield compositions investigated compared to 50 and 30cm spacings.

Keywords: Centre of agricultural and pastoral research; herbage yield; nitrogen fertilizer; inter row spacing and Rhodes grass.

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 [1]. 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 [2,3,4].

Land which was previously used for grazing is gradually brought into cultivation to satisfy the food needs of the increasing human population. Livestock are forced to graze on marginal land and use crop residues which are often low in both quantity and quality, which results in poor livestock performance [5].

The major problem facing the livestock producers in the savanna zones of Nigeria is provision of adequate feeding to the animals during the dry season. This challenge is most severe in the dry sub humid zone of the Savanna, where the dry season is longer (from October-may/June) and crops and pasture productivity are also low due to lower annual rainfall and poorer soils [6,7,8,9]. During dry season the decreased quantity and quality of the natural pasture and crop residue makes it impossible for the animal to meet their nutritional requirements. Supplementary feed stuffs such, as Cotton Seed Cake, Groundnut Cake etc are also very expensive during this period. This problem results to loss of body, high rate of reproductive failures, incidences of diseases and mortality of young animals amongst other things [10]. Therefore there is need to increase the forage production to meet the feed requirements of livestock in the Savanna region of the country.

However about 90% of Cattle and 70% of the Sheep and Goat in Nigeria are under extensive system of production. Over 80% of these animals are found in the savannah zones of the country where extensive area for growing and or forage feed availability are the severe limiting factors of production [11,12].

According to [11,6,13,14,12] the bulk of the feed resources used for the ruminant livestock production in Nigeria include; natural pasture in the native range lands, crop residue and agricultural by-products. The increasing demand for animal and animal related products can be met through the use of improved pasture species supplementation to satisfy animal's dietary requirements. It is therefore more economical to use grassland as a source of meat and milk because grass herbage cannot be used directly by man but can be used indirectly through animals that convert it to edible products. Ruminant livestock in Nigeria depends largely on natural grasslands that are nutritionally poor. The savanna zone characterised by low annual rainfall of shorter duration, lighter sandy soils and longer dry season, has low potential for natural forage production [6,15]. Therefore, 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.

Nuru [16] reported that with the current increase in crop production through massive land clearing, coupled with population growth and hence the development of more and larger towns and cities, the land use patterns is changing and less land is available for extensive livestock production. These has led to the introduction of improve pasture production which yields more dry matter of high nutritive value, leading to greater animal productivity than do native pastures as part of the technologies to improve animal husbandry/production [16].

Excess fertilizer application, on the other hand, can be detrimental as 'fertilizer burn' may occur when too much fertilizer is applied resulting to drying out of leaves and damage or even death of the plant [17]. Therefore determination of Optimum fertilization level is important for better crop production. [18], Khair [19] noted that Rhodes grass responded well to nitrogen fertilizer when applied in separate doses.

Inter-raw spacing is also an important cultural practice that affects crop productivity. Optimum spacing is therefore necessary for effective growth, yield and quality of crops. If seedlings are widely scattered (spaced) Rhodes grass can quickly produce a dense stands that means that close spacing produces thin, slow growth and weaker sword [20].

2. MATERIALS AND METHODS

2.1 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°45ˡN and longitude 5°25ˡE 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, [21]. Dabagi farm falls within the Sudan-Savanna vegetation zone. Isah and Shinkafi [22], 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 [23]. 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 160 Kg/ha) and three inter row spacings (30, 50 and 70 cm), 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, while determination of number of leaves and number of tillers per plant was done by counting the numbers of individual leave and tillers of each of the representative plant sample.

The data were statistically analyzed by analysis of variance (ANOVA), using the GenStat 64-bit Release 17.1 [24].

3. RESULTS AND DISCUSSION

3.1 Physical and Chemical Properties of the Soil at the Experimental Site

Results of physical and chemical properties of the soil at the experimental site are presented in Table 5. The result showed that the soil had a strongly acidic properties (pH in water) = 5.1 - 5.6). The soil had low organic carbon (0.89 gkg^{-1}), while the total nitrogen was extremely high (0.84 – 0.85 cmolkg^{-1}). However, the available P (0.96gkg^{-1}), calcium (0.65 cmolkg^{-1}), organic carbon, (8.4 gkg^{-1}) and Cation exchange capacity CEC (5.6 cmolkg^{-1}) were all low. The soil also had moderate magnesium content (0.40 cmolkg^{-1}), high in sodium (0.39cmolkg^{-1}) and extremely high in potassium (0.92 cmolkg^{-1}). The soil texture was sandy loam; with sand, silt and clay represented at 92.7%, 5.9% and 1.4% respectively. These indicate that there is need for additional supply of nutrients to the soil, especially nitrogen and phosphorus that are required by plants as recommended by the Federal Department of Agriculture and Livestock Resources [25]. The top soil, owing to its particle size distribution (927 gkg^{-1} sand, 59 gkg^{-1} silt and 14 gkg^{-1} clay) was sandy loam (Table 1) as described by Soil Survey Staff of America [26,27,28]. This indicates that the soil requires only a light tillage to prepare the land for plant cultivation [26, 27,28].

3.2 Herbage Dry Matter Yield (DMY)

Results on herbage dry matter yield as influenced by nitrogen fertilizer application and inter row spacing during 2016, 2017 and the years combined is presented in Table 2. Significant (P < 0.05) effect of nitrogen fertilizer application on the dry matter yield of Rhodes grass was observed in 2016, 2017 and the years combined. Application of 160KgNha^{-1} generally produced higher (P < 0.05) dry matter yields compared to the rest of the treatments. Inter row spacing had no significant (P > 0.05) effect on the herbage DMY ha^{-1} of Rhodes grass in both 2016, 2017 and the years combined. The significantly (P < 0.05) higher DMY of Rhodes grass recorded from application of 160 kgNha^{-1} at 12 WAS in the 2016, 2017 and the years combined results (Table 2) indicated that Rhodes grass requires at least 160 kg ha^{-1} of nitrogen fertilizer to produce high herbage dry matter yield in the study area. This could be due to the increase in leaf: stem ratio with increasing levels of nitrogen which was mainly due to rapid expansion of dark green foliage which could intercept and utilize the incident solar radiation in the production of photosynthates and eventually resulting in higher meristematic activity and increased leaf: stem ratio of the crop (fodder). This might be also due to favorable influence of nitrogen on cell division and cell elongation, which could have produced more functional leaves for a longer period of time. Singh and Gill [29], this may be explained by the abundance of nitrogen in the soil which is required by the plants for higher merismatic activities leading to more production and accumulation of more photosynthates or dry matter in the plant herbage[30]. The production of several leaves by the Rhodes plant due to increased fertilizer level may attribute to its superiority in larger leaf area that could have led to increased assimilate production and consequently increased its yield and yield attributes.

This result is similar to the findings by [31,32,33,34,35,36,37,38,39,40,41], who also reported significant increase in herbage dry matter yield of Rhodes grass with increase in nitrogen fertilizer levels.

The DM content recorded for *Chloris gayana* in this study (16.01%) was lower than the 29.02% DM reported for Rhodes grass at 10 WAS by Na-Allah (2015) in the same study area and 47.0% DM by Iyeghe-Erakpotobor and Muhammad [42] in Zaria, northern guinea Savannah zone of Nigeria. The lower DM contents recorded in this study may be due to yearly differences of rainfall in the study area or the lower rainfall and poorer soil conditions than in the northern guinea Savannah zone of Nigeria. The non-significant (P > 0.05) effect of inter row spacing recorded from the varying inter row spacing (30, 50 and 70 cm) during 3 – 12 WAS in the 2016, 2017 and the years combined results (Table 1) may be explained by the Rhodes grass ability to withstand competition and suppress weeds under both close and wide row spacings [43]. The increase in herbage yield with increased in plant spacing observed in this investigation is in line with the findings of different researchers on different crops. [44], reported that plant spacing has effect on light

Table 1. Physical and chemical properties of the soil at the experimental site

Soil properties	2016	2017	Mean
Chemical properties			
pH (in water)	5.5	5.6	5.6
Organic carbon (%)	8.4	8.3	8.4
Total nitrogen (%)	0.84	0.85	0.85
Available P (gkg$^{-1)}$	0.96	0.95	0.96
Exchangeable bases			
Calcium Ca^{2+} (cmolkg^{-1})	0.65	0.65	0.65
Magnessium Mg^{2+} Mg (cmolkg^{-1})	0.40	0.41	0.41
Phosphorus K^{+}(cmolkg-1)	0.92	0.93	0.93
Sodium $^{Na+}$ (cmolkg-1)	0.29	0.28	0.29
Cation exchange capacity CEC (cmolkg-1)	5.6	5.7	5.7
Physical properties			
Sand (gkg^{-1})	927	926	927
Silt (gkg^{-1})	59	60	59
Clay (gkg^{-1})	14	14	14
Textural class	Loamy sand	Loamy sand	Loamy sand

Table 2. Herbage dry matter yield of Rhodes grass as influenced by nitrogen fertilizer and inter row spacing, during the 2016/2017 rainy season and the years combined in Sokoto Nigeria

Treatment	2016	2017	Combined
Fertilizer (Kg/ha^{-})			
0 (F0)	5500^{d}	4877^{e}	5189^{e}
100 (F1)	9060^{c}	7173^{d}	8123^{d}
120 (F2)	9683^{c}	8333^{c}	9018^{c}
140 (F3)	10660^{b}	9780^{b}	10221^{b}
160 (F4)	11322^{a}	11100^{a}	11215^{a}
LSD	866.4.	957.67	422.91
Significance	*	*	*
Spacing (cm)			
30 (S1)	9703	8836	48948
50 (S2)	9600	8090	50603
70 (S3)	9600	770.50	51779
LSD	583.59	788.90	4670.53
Significance	NS	NS	NS

*Means within a column for a factor followed by the same letters are statistically not significant at 5% level probability, LSD $_{(t < 0.05)}$ Least Significant Difference at 5% probability level. *= Significant at 5%, NS = not significant at 5%, of probability level, F = Fertilizer, S = Spacing, WAS = Weeks after Sowing*

interception during photosynthesis, which influences growth and nutrient contents of plants. El-Na'im and Jabereldar [45] reported that closer spacing reduced the number of pods per plant of groundnut; this may be due to competition between plants and between different parts of the individual plant under high planting population. El-Na'im et al. [46] found that seed yield per plant substantially decreased with decrease in plant spacing. Growth and development of crops is determined by row spacing and nitrogen levels [47].

Crop competitive ability can be enhanced by choosing a density and arrangement for the crops or combination of crops rather than weeds. Raw spacing has a direct effect on plant population. It plays a distinct role in the amount of solar radiation intercepted and density, hence crop canopy development which in turn affects photosynthesis and ultimately dry matter produced by the plant. Weed biomass was highest at widest spacing because wider raw spaces provide adequate space for less competition for nutrients and light among weed species [48].

Plant spacing is invariably link with yield; Wider planting eventually caught up or out-grew closely spaced plants, [49].

3.3 Number of Leaves per Plant (NL)

Results on the mean number of leaves as influenced by fertilizer level and inter row spacing during, 2016, 2017 rainy season and the years combined is presented in Table 3. The result showed that number of leaves increased linearly, it also revealed that nitrogen fertilizer levels was found to be significantly affected (P<005) in all the growth stages 3, 6, 9 and 12WAS in the 2016, 2017 cropping season and the years combined Table 3. At 3WAS 120 and 140 KgN ha^{-1} produces higher number of leaves in 2016 which is similar to 120, 140 and 160 KgN ha^{-1} in 2017 and the years combined as compared to the rest of the treatments. At 6WAS, 160 KgN ha^{-1} produces higher number of leaves in 2016 which was similar to; 160 KgN ha^{-1} in 2017 and the years combined as compared to the rest of the treatments. At 9WAS 160 KgN ha^{-1} in 2016 produces higher number of leaves which is similar to that of; 160 KgN ha^{-1} in 2017 and the years combined as compared to the rest of the treatments. At 12WAS 160 KgN ha^{-1}, also produces higher numbers of leaves which is similar to 160; KgN ha^{-1} in 2017 and the years combined analysis as compared to the rest of the treatments.

Result on inter row spacing showed significant effect (P<005) in all the spacings levels studied for the 2016, 2017 rainy seasons and the years combined. At 3, 6 9 and12WAS 70cm spacing in 2016 produces higher number of leaves which is similar to the inter row spacing of 70cm in 2017 and the years combined as compared to the rest of the treatments in all the growing stages.

The result showed that number of leaves increased linearly, it also revealed that nitrogen fertilizer had been significantly (P<005) influenced, in the 2016, 2017 rainy season and the years combined in all the growth stages studied. This may be attributed to the fact that increased in yield due to fertilizer application leads to the increase in both leaf production, increased number of tillers and photosynthesis [50]. Brima [51] stated that mean number of leaves per plant of Rhodes grass was significantly affected by NPK The number of leaves reported was however higher than what [52] reported, where he recorded 10 - 13 leaves, in the Savanna region of Ethiopia and this may be due to varietal differences, rainfall variabilities and also differences in the environment. Results on the number of leaves was found to be significantly (P<005) influenced by Inter row spacing at 3, 6 9 and 12WAS, during the 2016, 2017 rainy season and the years combined. Spacing in plants plays a distinct role in the amount of solar radiation intercepted and density, hence crop canopy development which in turn affects photosynthesis and ultimately the number of leaves produced by the plant, 70 cm spacing produced higher numbers of leaves as compared to the rest of the combinations and this is due to the fact that Weed biomass was highest at widest spacing because wider raw spaces provide adequate space for less competition for nutrients and light among weed species [41].

Rhodes grass has the ability to withstand competition and suppress weeds under both close and wide row spacings [43].

3.4 Number of Tillers per Plant (NT)

Result on mean number of tillers (NT) as influenced by nitrogen fertilizer levels and inter row spacing is presented in Table 4. The result showed that number of tillers increased linearly, significant effect (P<005) of nitrogen fertilizer was observed at 6, 9 and 12WAS in 2016, 2017 and in the years combined. At 6WAS application of 160 KgN ha^{-1} in 2016 produces higher number of tillers which were similar to the application of 160, KgN ha^{-1} in 2017 and the years combined analysis, as compared to the rest of the treatments. At 9WAS application of 160 KgN ha^{-1}produces higher number of tillers in 2016 which is similar to the application of 160, KgN ha^{-1} in 2017, 140 Kg N ha^{-1} and 160 KgN ha^{-1} in the years combined analysis. At12 WAS application of 160, KgN ha^{-1} produces higher number of tillers in 2016 which were similar to the application of 140 and 160, KgN ha^{-1} in 2017 and 160, KgN ha^{-1} in the years combined analysis.

Inter row spacing was not significantly affected at 3WAS in 2016, 2017 and the years combined analysis, 6WAS in 2017 and 9WAS in 2017 however significant effect was observed at 6WAS in 2016, 9WAS in 2016 and 12WAS in 2016, 2017 and the years combined analysis. At 6WAS application 160, KgN ha^{-1} produces higher number of tillers which were similar to the application of 160, KgN ha^{-1} in the years combined analysis. At 9WAS application of 160, KgN ha^{-1} produces higher number of tillers which were similar to the application of 140 and 160 KgN ha^{-1} in the years combined analysis. At 12WAS application of 160, KgN ha^{-1} in 2016 produces higher number of tillers which were similar to the application of 160, KgN ha^{-1} in 2017 and the years combined analysis.

The result showed that number of tillers increased linearly from, 6-12WAS, nitrogen fertilizer had significant (P<005) at 6, 9 and 12 WAS in 2016, 2017 and the years combined, however nitrogen fertilizer had no significant (P>005) on number of tillers 3WAS in both 2016, 2017 and the years combined analysis.

The significant different could be due to the application of Sodehinde et al. [53] observed that nitrogen fertilizer influenced positively the number of tillers produced per stand in an experiment on the effect of nitrogen on dry matter yield of Pannicum maximum. The increased yield due to fertilizer application could be attributed to increase in both leave production increased number of tillers and photosynthesis, [50]. The number of tillers recorded was in agreement with what was reported in the literature by Yisehak [52] and this is because of the variation in age and the fertilizer levels used, but is in agreement with the finding of Atif et al. [54], who reported 14 – 30 tillers for the species in the Shambut region of Sudan. However, higher than 4 – 16 tillers was reported in the Southern region of Ethiopia [55].

Results on inter row spacing had a significant (P<005) effect at 6WAS in 2016 and the years combined, 9WAS in 2016 and the years combined and 12WAS in 2016, 2017 and the years combined. The significantly higher (P<0.05) number of tillers per plant recorded for Rhodes grass during 3 - 12 WAS from 70 cm inter row spacing in this study (Table 3) may indicates that the Rhodes grass plants requires wider inter row spacing to produce plants with higher number of tillers per plant in the study area. Kutu and Asiwe [48] explained that plant

Table 3. Number of leaf of Rhodes grass at 3, 6, 9 and 12WAS as affected by Nitrogen Fertilizer levels and inter row spacing during 2016 and 2017 rainy seasons and the years combined in Sokoto, Nigeria

	3WAS			6WAS			9WAS			12WAS		
Treatment	**2016**	**2017**	**Combined**	**2016**	**2017**	**Combined**	**2016**	**2017**	**Combined**	**2016**	**2017**	**Combined**
Fertilizer(Kg/ha)												
0(F0)	4^{e}	3^{d}	3^{e}	7^{e}	6^{d}	7^{e}	9^{e}	9^{d}	9^{e}	10^{e}	10^{d}	10^{e}
100(F1)	5^{d}	4^{c}	4^{d}	11^{d}	10^{c}	10^{d}	13^{d}	17^{c}	15^{d}	14^{d}	13^{c}	14^{d}
120(F2)	6^{b}	5^{b}	6^{c}	14^{c}	15^{b}	14^{c}	15^{c}	18^{c}	16^{c}	16^{c}	16^{b}	16^{c}
140(F3)	6^{a}	6^{a}	6^{a}	17^{b}	17^{b}	17^{b}	18^{b}	21^{b}	19^{b}	20^{b}	20^{b}	20^{b}
160(F4)	5^{c}	6^{a}	6^{b}	19^{a}	22^{a}	21^{a}	20^{a}	24^{a}	22^{a}	22^{a}	22^{a}	22^{a}
LSD	0.350	0.655	0.380	0.220	1.117	2.885	1.394	1.528	1.567	1.243	2.080	1.203
Significance	*	*	*	*	*	*	*	*	*	*	*	*
Spacing (cm)												
30(S1)	5^{b}	5	5^{b}	12^{b}	13^{b}	13^{b}	14^{b}	16^{b}	15^{b}	14^{b}	16	16^{b}
50(S2)	5^{c}	5	5^{c}	13^{b}	13^{b}	13^{b}	14^{b}	18^{a}	16^{b}	14^{b}	15	15^{b}
70(S3)	5^{a}	5	5^{a}	16^{a}	17^{a}	17^{a}	17^{a}	19^{a}	18^{a}	17^{a}	18	18^{a}
LSD	0.369	0.298	0.380	0.865	2.506	1.290	1.080	1.184	0.701	1.394	2.080	1.203
Significance	*	*	*	*	*	*	*	*	*	*	*	*

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

Table 4. Number of tillers of Rhodes grass at 3, 6, 9 and 12WAS as affected by Nitrogen fertilizer and inter row Spacing during 2016 and 2017 rainy seasons and the years combined in Sokoto, Nigeria

	3WAS			6WAS			9WAS			12WA		
Treatment	**2016**	**2017**	**Combined**	**2016**	**2017**	**Combined**	**2016**	**2017**	**Combined**	**2016**	**2017**	**Combined**
Fertilizer(Kg/ha)												
0 (F0)	0	0	0	4.^{e}	4^{d}	4	8^{d}	9^{d}	8^{d}	12_{d}	18^{c}	15^{d}
100(F1)	0	0	0	7^{d}	4^{d}	6^{d}	12^{c}	16^{c}	14^{c}	16_{c}	29^{b}	23^{c}
120(F2)	0	0	0	9^{c}	9c	9^{c}	15^{b}	20^{b}	18^{b}	17_{c}	34^{ab}	26^{c}
140(F3)	0	0	0	13^{b}	14^{b}	14^{b}	22^{a}	22^{ab}	22^{a}	25^{b}	38^{a}	32^{b}
160(F4)	0	0	0	14^{a}	17^{a}	16^{a}	22^{a}	24^{a}	23^{a}	41^{a}	37^{a}	39^{a}
LSD	0.00	0.00	0.00	0.351	1.815	0.914	0.767	2.911	1.467	1.699	2.023	1.071
Significance	NS	NS	NS	*	*	*	*	*	*	*	*	*
Spacing (cm)												
30(S1)	0	0	0	9^{c}	9	9^{c}	14^{c}	17	16^{b}	20.59^{c}	31^{ab}	26^{ab}
50(S2)	0	0	0	10^{b}	10	10^{b}	16^{b}	18	17^{a}	22.43^{b}	27^{b}	25^{b}
70(S3)	0	0	0	11^{a}	10	11^{a}	18^{a}	19	18^{a}	24.16^{a}	35^{a}	29^{a}
LSD	0.00	0.00	0.00	0.272	1.406	0.708	0.594	2.255	1.134	1.317	1.567	3.0095
Significance	NS	NS	NS	*	NS	*	*	NS	*	*	*	*

a,b,c Means within a column for factor followed by the same letters are statistically not significant at 5% level of probability, using Least significant difference.
F= Fertilizer, S = Spacing, WAS = Weeks after Sowing

spacing is an important agronomic attribute which affects light interception by plant during which photosynthesis takes place. It also enables the plants to utilize more effectively the soil moisture and nutrient and avoid excessive competition among the plants [44]. This is in agreement with the findings of Alam et al. [56] who reported that number of plants in given area, which is controlled by plant spacing, influences soil radiation interception, nutrient uptake, rate of photosynthesis, and other physiological phenomena ultimately affects the growth and development of crops as well as the nutrients and this could result in the increases in the number of tillers per plant. [57,58,59] also reported a pronounced effect of spacing on number of effective tillers per plants, which might be due to more space and nutrient available for the individual plant under wider spacing. However significant effect of inter row spacing had not been recorded at 3WAS in 2016 and 2017, 6WAS and 9WAS in 2017 more so 70 cm inter row spacing produces higher numbers of tillers as compared to the rest of the treatments.

4. 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 of Rhodes grass in the study area. The higher fertilizer level of 160 $KgNha^{-1}$ produced higher values for plant height, leaf length, number of leaves per plant, number of tillers per plant as well as the herbage dry matter yield compared to other treatments.

The inter row spacing also had significant (P<0.05) effect on herbage yield and some yield parameters (number of leaves and number of tillers per plant), Optimum herbage dry matter yield and growth parameters (number of leaves and number of tillers per plant) were produced by the wider inter row spacing (70 cm) during the growing stage, especially from 6 – 12 WAS. It can be concluded that application of 160 $kgNha\text{-}^{1}$ and 70 cm spacing gave better (P<0.05) growth, herbage dry matter yield and some growth parameters (number of leaves and number of tillers per plant) of Rhodes grass in the study area.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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