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EFFECT OF NITROGEN FERTILIZER AND INTER ROW SPACING ON HERBAGE YIELD AND MINERAL COMPOSITION OF RHODES GRASS (*Chloris gayana* TAN) IN SEMI-ARID ZONE OF YOBE STATE, NIGERIA

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Abstract

Field experiment was conducted in the field area of the Chad basin development (Laba) in Bursari local government area of Yobe State Nigeria, during the 2021 and 2022 dry season to study and evaluate the effect of nitrogen fertilizer and inter-row spacing on herbage yield and nutrient quality of Rhodes grass (Chloris gayana Tan) for maximum yield and nutrient quality of herbage. Different levels of nitrogen fertilizer and inter-raw spacing were used for the assessment. A factorial combination of five fertilizer levels (0, 100, 120, 140 and 160KgNha^{-1}) and three inter row spacing (30, 50 and 70cm) laid out in a Randomized Complete Block Design (RCBD) with four (4) replications was used. At the end of the experiment (12 weeks after sowing) it was discovered that 60KgNha^{-1} significantly ($P < 0.005$) produces higher herbage yield as compared to the rest of the treatments. Similarly, 140KgNha^{-1} and 160KgNha^{-1} produces higher ($P < 0.005$) Sodium, phosphorus, Calcium, Magnesium and Potassium contents as compared to the rest of the treatments. From the result, it was also revealed that increase in nitrogen fertilizer is accompanied by increase in herbage dry matter yield (DMY) and mineral constituents of the forage grass proportionately. This results suggest that, 160KgNha^{-} and 50cm spacing produce the highest yield per hectare and highest mineral constituent of the plant nutrients. More so, optimum fertilizer level for higher and good quality forage in the study area was also observed in the range of 140 to 160kg N ha^{-1} and between 30 and 50cm spacing. Vigorous production can be maximized with the addition of more than 160kg N ha^{-1}

Keywords: Forage, Nitrogen, Fertilizer, spacing Mineral, and Yield

INTRODUCTION

Nigeria is one of the four leading livestock producers in sub Saharan Africa (Rim 1990). Amongst all the livestock in Nigeria, ruminant animals comprising of sheep, goat and cattle constitute the most important farm animals' species in the country's agricultural system. According to FAO, (2009), Nigeria has a population of 52.5 million goats, 33 million sheep and 16.2 million cattle. These animals contribute significantly to satisfying various human needs; such as provision of animal protein foods (Meat and Milk) for body and mental development, hides and skins for leather and tanning industries, manure for soil fertility improvement and for bio-fuel production, draft power and transportation etc. These are in addition to their value as a source of capital, social security and as insurance for food security, to mention but just a few (Tarawili et al., 2000; Olson et al., 2004, Peden et al., 2005).

However, the ruminant animals production in Nigeria is still dominated by extensive system (nomadism, transhumance and village herding), where extensive area for grazing and feed availability are the severe limiting factors, especially in the savanna zone where about 90% of the cattle and 70% of the Sheep and goats in the country are found (Muhammad and Abubakar 2004). 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 (Umunna and Iji, 1993; Adamu and Odion, 2002). Aregheore, (2009). Therefore, there is need to increase the forage production to accommodate the feed requirements of the livestock in the savanna region of the country. This requires evaluation and production of pasture species with potential to improve herbage productivity in the different sub regions of the savanna.

The present study aimed at evaluating the performance of the improved Rhodes grass (Chloris gayana Tan) in the semi-arid zone of Bursari Yobe State, Nigeria, as affected by nitrogen fertilizer levels and inter-raw spacing. The study will provide the optimum level of nitrogen and inter raw spacing for improved Rhodes grass production in the semi-arid zone of Bursari Yobe State Nigeria. 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 semi-arid 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 (Umunna and Iji, 1993; Adegbola 2004; Babayemi and Bamikole, 2006, Ogunbosoye and Babayemi, 2010). However, with the present trend of competitive land use, increasing forage production through expansion of land area of natural pastures is hardly feasible as a result of demographic changes. Improvement of forage feed availability for livestock therefore requires the development of sown pastures that make use of improved forage species; and to be cost effective, must be sustained under intensive system of management.

The improved pastures, therefore, must prove their superiority in terms of bulk productivity, palatability, nutrient composition and availability, among other things, under different climatic conditions (Muhammad and Abubakar 2004). The present research aim at evaluating the growth, herbage yield and quality of Rhodes (Chloris gayana Tan) under varying nitrogen fertilizer levels and inter-raw spacing in the semi-arid zone of Bursari Yobe State, Nigeria. This is to provide the optimum levels of nitrogen

fertilizer and inter-row spacing for maximum growth, herbage yield and nutrient quality of Rhodes grass in the study area.
According to Muhammad and Abubakar (2004), sown pasture when properly managed have potential to improve herbage quality and increase herbage yields several folds over that of natural grassland, and could lead to marked increased in animal productivity. The productivity and nutritive value of grasses and legumes, found in Nigeria, vary greatly with types of species, nature and fertility of the soil, fertilizer application, water relations; seasons of the year, disease control and stage of growth at which the grasses are harvested or grazed (Aregheore, 1996). Fertilizer is commonly used for growing all type of crops with application rates varying with soil fertility, type of crop and species. Inter-raw spacing is also an important cultural practice that affects crop productivity. The close spacing produces thin, slow growing and weaker plants. The wide spacing, on the other hand produces crop with lose canopy resulting to poor absorption of solar radiation, leading to low photosynthesis rate resulting to poor productivity of the crop. Wide spacing also expose crop to high weed infestation and production of low quality herbage. 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 stand that mean that close spacing produces thin, slow growth and weaker sword (Mannetja and Kersten, 1992). The present research study, aimed at evaluating the herbage yield and mineral quality of Rhodes (*Chloris gayana* Tan) under varying nitrogen fertilizer levels and inter-raw spacing, to provide the optimum levels of nitrogen fertilizer and inter-row spacing for maximum herbage yield and nutrient quality of herbage in the semi-arid zone of Bursari Yobe State, Nigeria, therefore sound justifiable.

MATERIALS AND METHOD

DESCRIPTION OF THE STUDY AREA

The experiment was carried out at the Chad Basin dry season farm (Laba) located at Bursari local government area, Yobe State, Nigeria. Yobe State is located within the Sahelian semi-arid region of Africa on longitude 10^0 05"N 13^0. 45"N and 10^0. 05˝N 13^0. 40"N while the longitude are 11^0. 30˝E – 14^0. 20˝E and 9^0. 20"E - $12^{0.}$ 04"E, respectively (NEAZDP 1999). The climate of the region characterized by long dry seasons punctuated by cold and dusty wind. The dry season begins from October to May. The annual rainfall in this area ranges between 500 – 650 mm per annum. The relative humidity may reach up to 45% during wet season. The dry hot season has a temperature ranges of 39.8 – 40,7^0C, while during the wet season, the temperature can fall to as low as 31.0^0C, (NEAZD 1999).

EXPIREMENTAL DESIGN AND TREATMENT COMBINATION

The treatments consisted of five (5) Nitrogen fertilizer levels (0, 100, 120, 140, and 160Kg/ha) and three (3) inter raw spacings (30, 50, and 70cm). The fifteen (15) the treatments were combine factorially and laid out in a randomized complete block design (RCBD) replicated four times. The treatments were randomly allocated to the plots using randomization technique. All plots were given the same agronomic practices.

EXPEREMENTAL PLOTS LAYOUT

Land area of about 500m² (0.5 ha) was cleared, ploughed and harrowed to soften the soil for ease of planting and seed germination. The area was divided into four main blocks comprising of 15 plots each. Each plot measure 3m x 2m (6m²) separated by 0.5m width borders and each block will be separated by 1m leeway.

SOIL SAMPLING AND EVALUATION

Soil sample was taken at the onset of the experiment at the depth of 0-15cm from nine randomly selected points at the experimental site, using Auger. The samples were bulked air dried and sieved. The bulk sample used for evaluation of physico-chemical properties; such as Soil pH, organic carbon, particle size, texture, total nitrogen, available P, K, and Na, as well as the Cation exchange capacity. Soil pH determination was determined using photometry method, Organic carbon was determine using Walky and black method, Particle size analysis was conducted using hydrometer method, (Boyoucous, 1951). Textural classes were determined by using soil textural triangle. Total nitrogen was determined by using regular Macro Kjeldhal digestion technique (Jackson 1964). While available phosphorus was determined by the Bray no 1 method (Bray and Kurtz, 1945). Potassium and Sodium were determined using flame photometer method while magnesium and calcium were determined by EDTA titration method. Cation exchange capacity (CEC) will be calculated using ammonium acetate method (Bray and Katz, 1945).

SEED PROCUREMENT AND TREATMENT

Rhodes grass seeds were obtained from the National Veterinary Research Institute (Vom), Jos Plateau State, Nigeria. The seeds were treated using Cardinal powder dust (20% w/w thiamethoxam; 20% w/w methalaxil-M and 2% w/w difenoconazole) sat 1g per 400g of seeds. (FAO, 2009).

SEED SOWING

The seeds were sown by drilling as per the treatment at 30, 50, and 70cm between drills sowing of seeds was done during the dry season of 2021 and 2022 rainy season.

DATA COLLECTION

Data was collected on herbage yield at 12 weeks when the plants are physiologically matured and plant samples which the mineral content was determine from, were collected from each treatment.

Herbage yield determination

At the end of 12 weeks post planting, a $0.25m^2$ (0.5m x 0.5m) area was harvested using a metallic frame (Quadrat). The herbage was harvested at 5cm above ground level using hand Sickle from the three plots from each treatment. The samples collected was air dried for the estimation of dry matter yield.

Nutrient composition determination

Herbage samples collected from each plot were bulked for each treatment and prepared for the determination of nutrient (mineral) composition. The sample for each treatment was analyzed for mineral composition using A.O.A.C to determine the mineral constituent (Crowder and Chheda 1982).

STATISTICAL ANALYSIS

The data obtained were subjected to analysis of variance (ANOVA), using the Statistical analysis system SAS, Version (Statistix 10.0) package. Treatment means that showed significant difference were separated using; Duncan Multiple Range test.

RESULTS AND DISCUSSION

Physico-chemical Properties of the Soil at the Experimental Site

The result of the physical and chemical properties of the soil at the experimental site indicated that the top soil (0-5cm) had at a strongly acidic property having low amounts of the exchangeable bases (organic carbon, calcium, sodium and phosphorus,) and Cation exchange capacity, moderate magnesium and high total nitrogen (Table 1). These implies 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 (FDALR, 1990). The top soil, having its particle size distribution (928 gkg^{-1} sand, 60gkg^{-1}silt and 14 gkg^{-1}clay), the soil was classified to be sandy loam (Table 1) as described by Soil Survey Staff of America (SSSA, 2010), Adeoye and Agbola (1985), Sobulo and Osiname (1981). This signifies that the soil requires only a light tillage to prepare the land for plant cultivation (SSSA, 2010; Adeoye and Agbola, 1985; Sobulo and Osiname, 1981).

Table 1: Physical and Chemical Properties of the Soil at the Experimental site

Soil properties	2021	2022	Mean
Chemical properties			
pH (in water)	5.4	5.6	5.5
Organic carbon (%)	8.6	8.2	8.4
Total nitrogen (%)	0.86	0.84	0.85
Available P (gkg^{-1})	0.97	0.96	0.97
Exchangeable bases			
Calcium Ca^{2+} ($cmolkg^{-1}$)	0.66	0.65	0.66

Magnessium Mg^{2+} Mg ($cmolkg^{-1}$)	0.41	0.43	0.42
Phosphorus K^{+}(cmolkg-1)	0.90	0.92	0.91
Sodium $^{Na+}$ (cmolkg-1)	0.30	0.29	0.30
Cation exchange capacity CEC (cmolkg-1)	5.7	5.7	5.7
Physical properties			
Sand (gkg^{-1})	928	927	928
Silt (gkg^{-1})	60	60	60
Clay (gkg^{-1})	14	14	14
Textural class	Loamy sand	Loamy sand	Loamy sand

Herbage dry matter yield (DMY) of Rhodes Grass (*Chloris gayana Tan*)

Good pasture required improved soil conditions for the better dry matter (D.M) yields which leads to increased animal output and this is usually achieved through fertilizer application. Once applied, the fertilizer increases the quality/quantity of the deficient element (John.2006). Results on herbage dry matter yield as influenced by nitrogen fertilizer application and inter row spacing during 2021, 2022 and the years combined is presented in Table 3. Significant ($P<0.05$) effect of nitrogen fertilizer application on the dry matter yield of Rhodes grass was observed in 2022 and the years combined. Application of 160 $kgNha^{-1}$ and 140 $kgNha^{-1}$generally produced higher ($P<0.05$) dry matter yields compared to the rest of the treatments. Inter row spacing had no significant ($P>0.05$) on the herbage DMY ha^{-1} of Rhodes grass in both 2021, 2022 and the years combined however there was generally no significant ($P>0.05$) interaction between nitrogen fertilizer application and inter row spacing. The herbage yield of the forage increased with increasing N doses, because this nutrient increased tissue flow mainly in areas of intense cell division. The use of N fertilization increases the availability of N in the soil, forage yield, and dry matter production Moir *et al*; (2013). Better yield results probably translate into an increase in animal stocking rates Vasques *et al;* (2019) The significantly ($P<0.05$) higher DMY produced by Rhodes grass from application of 160 $kgNha^{-1}$at 12 WAS in the 2021, 2022 and the years combined results (Table 3) shows that Rhodes grass requires higher dose of at least 160 $kgha^{-1}$ of nitrogen fertilizer for high herbage dry matter yield in the study area. This is in line with the findings by Aderinola *et al*., (2009), Abdelrahman (2007), Muhammad *et al*., (2005), Muhammad and Abubakar (2004) Yakubu and Magaji (2004), Burhan and Hago (2000), Rasmussen *et al*., (1996) and Akinola and Olorunju (1990) where they reported significant increase in herbage dry matter yield of Rhodes grass with increase in nitrogen fertilizer levels. Similarly, the significantly ($P<0.05$) higher mean herbage yield produced from application of 140 and 160$kgNha^{-1}$ (7.7867, 7.8296 and 7.8082 tones/ha^{-}) and (7.0571, 7.0892 and 7.0732 tones/ha^{-}) could be due to more availability and uptake of nitrogen by crop which resulted in more vegetative growth and higher biomass production (Olanite, 2010; Ishaiku *et al*. 2016). The higher herbage yield obtained from the higher nitrogen levels was attributed mainly to improved growth of the yield parameters viz., plant height, leaf length, leaf width, number of leaves, number of tillers, plant population per meter, etc which resulted in increased meristematic activity and photosynthetic area, thus more production and accumulation of photosynthates, yielding higher green fodder and dry matter (Mane and Singh 2017).

Significantly (P<0.05) higher values were observed for the inter row spacing of 30cm and this agrees with the findings of Duke (1978) that Rhodes grass has ability to withstand competition and suppress weeds under both close and wide row spacings. The non-significant (P>0.05) effect of inter row spacing (30, 50 and 70 cm) during 3 – 12WAS in the 2012, 2022 and the years combined results (Table 2) is contrary to the report by Department of Agricultural Office for Fogera Woreda (DAOFW, 1999) where they reported that growth and development of crops are determined by row spacing and nitrogen fertilizer levels. This may be due to the ability of Rhodes grass to withstand competition and suppresses weeds, (Duke 1978). There is significant interaction between Nitrogen fertilizer and Inter row spacing in the 2021, 2022 and the years combined as shown in Table 3 below

Table 2: Herbage dry matter yield in kg $ha^{-1}$of Rhodes grass (*Chloris gayana Tan*) as influenced by nitrogen fertilizer and inter row spacing, during the 2021/2022 rainy season and the years combined in the semi-arid zone of Yobe State, Nigeria

Treatment	DWY 1 (2021) Tones/ha	DWY 2 (2022) Tones/ha	Years Combined
Fertilizer (F) (kgNha^{-1})			
0(F0)	3.5458c	3.7417b	3.6446b
100(F1)	5.9508ab	6.2185a	6.0855a
120(F2)	6.0433a	6.4471a	6.2310a
140(F3)	7.7867a	7.8296a	7.8082a
160(F4)	7.0571a	7.0892a	7.0732a
SEM	0.8707	0.8375	0.8541
Significance	NS	**	**
Spacing (S) (cm)			
30(S1)	7.0172a	7.1298a	7,0735a
50(S2)	5.2847a	5.3947a	5.3471a
70(S3)	5.9283a	6.2710a	6.0997a
SEM	0.6745	0.6487	0.7160
Significance	NS	NS	NS
Interaction			
F * S	*	*	*

Means within a column for factor followed by the same letters are not statistically different using Duncan Range Multiple Test (DRMT) 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..

Table 3: Interaction between Nitrogen Fertilizer and inter Row Spacing on The Herbage yield on Rhodes Grass (Chloris gayana Tan) in the Semi-arid Zone of Sokoto, Nigeria

Interactions (F * S)	2021	2022	Years Combined
F0S1	2.817^{f}	2.988^{g}	2,9230^{fg}
F0S2	4.570^{def}	4.750^{efg}	4;670^{efg}
F0S3	3.250^{f}	3.487^{g}	3.378^{f}
F1S1	7.439^{bcd}	7.780^{bcd}	7.610^{bcd}
F1S2	5.607^{cdef}	5.725^{defg}	5.710^{defg}
F1S3	4.806^{def}	5.150^{defg}	4,980^{fg}
F2S1	9.218^{ab}	9.112^{ab}	9.251^{ab}
F2S2	4.337^{ef}	4.441^{fg}	4.410^{fg}
F2S3	4.575^{def}	5.787^{cdefg}	5.271^{cdef}
F3S1	7.102^{ecde}	7.151^{bcdef}	7.135^{cde}
F3S2	4.645^{def}	4.700^{efg}	4.731^{fg}
F3S3	11.612^{a}	11.638^{a}	11.710^{a}
F4S1	8.510^{bc}	8.618^{bc}	8.654^{c}
F4S2	7.264^{bcde}	7.358^{bcde}	7.311^{bcde}
F4S3	5.397^{def}	5.292^{defg}	5.345^{defg}
SEM	1.0479	1.0079	1.0380

Means within a column for factor followed by the same letters are not statistically different using Duncan Range Multiple Test (DRMT) 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.

Significantly higher yield ($P<0.05$) yield were produced with the interaction between 120KgN-, and 30cm spacing and140KgN- and 70cm and (160KgN- and 30cm spacing, in 2021, 2022 and the years combined as compared to the rest of the treatment. This agrees with the findings of Duke (1978) where he reported that Rhodes grass has ability to withstand competition and suppress weeds under both close and wide row spacings. The supply of growth factors such as light, water and nutrients to plants is affected by the interaction between plants and thus, increases the efficiency of the use of the limiting resources (Martin and Snaydon, 1982).

Sodium (Na)

The significantly ($P<0.05$) higher Na contents recorded for Rhodes grass on 140 kg N ha^{-1} and 160 kg N ha^{-1}at 12 WAS during 2021, 2022 trials (2.086, 0.774)), (2.292, 0.903gmg-

[1]D) and the years combined (1.415 and 1.599 $gmg^{-1}D$) (Table 4) indicated that Rhodes grass requires the application of higher dose of nitrogen fertilizer to produce herbage with high **Na** contents. This finding is in agreement with the work of Joelma *et al*; 2000, who reported a significant Increase in the DM, OM, MM, and CP with the increase in the nitrogen content. The increase in Na content confirms the ability of grasses such as Rhodes grass to respond well to N fertilization, which is due to the high number of leaves in the botanical composition of the harvested fractions that can retain high levels of N in their structure Pandey *et al'*; 2011. However, the figures obtained were lower than those obtained by Na-Allah 2015 on Rhodes grass in the dry sub-humid zone of Sokoto, Nigeria and this may be due differences rainfall pattern, nature of the soil and age at harvest.
The significantly ($P<0.05$) higher Na contents recorded for Rhodes grass herbage at 12WAS from the wider inter row spacing of 70 cm in the 2021, 2022 and the years combined results (Table 5.) indicated that Rhodes grass requires the wider inter row spacing to produce herbage with higher ($P<0.05$) Na contents in the study area. The high Na value (1.639, 0.6673 and 1.153 $gmg^{-1}D$) in 2021, 2022 and the years combine, recorded for Rhodes grass herbage in the study area may explain the good quality attribute of the species grown in the Semi-arid zone of Yobe State, Nigeria. Rhodes grass requires wider inter row spacing to produce herbage with higher ($P<0.05$) Na contents in the study area. Obi (1991) reported that plant spacing has effect on light interception during photosynthesis, which influences growth and nutrient contents of plants. The high Na value recorded for Rhodes grass herbage in this study (1.599gmg^{1}) may explain the good quality attribute of this forage species grown in the Semi-arid zone of Nigeria.

Table 4: Sodium Content of Rhodes grass *(Chloris gayana Tan*) as influenced by Nitrogen Fertilizer and Inter Row Spacing during 2021, 2022 rainy season and the years combined in the Semi-arid Zone of Yobe State, Nigeria

Treatment	First trial	Second trial	Years combined
Fertilizer(Kg/ha)			
0(F0)	0.120^{e}	0.120^{c}	0.120^{d}
100(F1)	1.757^{d}	0.701^{b}	1.229^{c}
120(F2)	1.940^{c}	0.744^{b}	1.357^{b}
140(F3)	2.086^{b}	0.774^{b}	1.415^{b}
160(F4)	2.292^{a}	0.903^{a}	1.599^{a}
SEM	0.0114	0.0396	0.0204
Significance	**	**	**
Spacing (cm)			
30(S1)	1.637^{a}	0.6627^{a}	1.149^{a}
50(S2)	1.641^{a}	0.6160^{a}	1.128^{a}
70(S3)	1.641^{a}	0.6673^{a}	1.153^{a}
SEM	8.838	0.0306	0.016

Significance	NS	NS	NS
Interaction			
F *S	NS	NS	**

Means within a column for factor followed by the same letters are not statistically different using Duncan Range Multiple Test (DRMT) 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.

Phosphorus (K)

Result on the phosphorus (K) contents of Rhodes grass herbage as influenced by nitrogen fertilizer application and inter row spacing during 2021, 2022 and the years combined is presented in Table 5. The mean K content of Rhodes grass herbage differ significantly ($P<0.05$) with level of nitrogen fertilizer application in the 2021, 2022 and the years combined results Application of 160 kgNha^{-1} in 2021, 2022 and the years combined generally produced higher ($P<0.05$) K values (0.858, 0.861 and 0.859 gmg-^{1}D) as compared to the rest of the treatments (Table 6). Walton (1983) described that fertilizers are normally used to increase forage yield and quality, but since plant tissue reflects the mineral constituents of the soil in which the plants are grown, quality is also greatly influenced as a result of the increasing nitrogen content of the soil. Increasing NPK fertilizer led to slight increase in phosphorus percentage. This result emphasizes that nitrogen plays a great role in the synthesis of mineral.

The inter-row spacing also had no significant (P>005) effect on the K contents of Rhodes grass herbage in the 2021, 2022 and the years combined. This shows that Rhodes grass has the ability to thrive under varying competitive environment to produce herbage with higher ($P<0.05$) K contents in the study area. Obi (1991) reported that plant spacing has effect on light interception during photosynthesis, which influences growth and nutrient quality of plants. The high K value recorded for Rhodes grass herbage in this study (0.859 gmg-^{1}D) may explain the good quality attribute of this forage species grown in the Semi-arid zone of Nigeria.

Table 5: Phosphorus (K) Content of Rhodes grass (Chloris gayana Tan) as influenced by Nitrogen Fertilizer and Inter Row Spacing during 2021, 2022 rainy season and the years combined in the Semi-arid Zone of Yobe State, Nigeria

Treatment	First trial	Second trial	Years combined
Fertilizer(Kg/ha)			
0(F0)	0.379e	0.448d	0.413e
100(F1)	0.577d	0.580c	0.578d
120(F2)	0.616	0.616c	0.616c
140(F3)	0.686	0.686b	0.686b
160(F4)	0.858a	0.861a	0.859a

SEM	4.535	0.0207	0.0204
Significance	**	**	**
Spacing (cm)			
30(S1)	0.627[a]	0.649[a]	1.149[a]
50(S2)	0.621[a]	0.642[a]	1.128[a]
70(S3)	0.621[a]	0.623[a]	1.153[a]
SEM	3.513	0.0160	0.0158
Significance	NS	NS	NS
Interaction			
F *S	NS	NS	NS

Means within a column for factor followed by the same letters are not statistically different using Duncan Range Multiple Test (DRMT) 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.

Calcium (Ca)

Result on calcium (Ca) contents of Rhodes grass herbage as influenced by nitrogen fertilizer application and inter row spacing during 2021, 2022 and the years combined is presented in Table 6. The mean Ca content of Rhodes grass herbage differ significantly (P<0.05) with level of nitrogen fertilizer application in the 2021, 2022 and the years combined results. Application of 140 and 160kgNha^{-1} generally produced herbage with higher (P<0.05) Ca values (0.678, 0.691 and 1.018 g/mg^{-1}) and (0.689, 0.694 and 1.033 g/mg^{-1}) for the 2021, 2022 and the years combined, as compared to the rest of the treatments. The higher (P<0.05) Ca values obtained from the higher nitrogen levels was attributed mainly to improved growth of the yield parameters viz., plant height, leaf length, leaf width, number of leaves, number of tillers, plant population per meter, etc which resulted in increased meristematic activity and photosynthetic area, hence more production and accumulation of photosynthates, yielding higher green fodder, dry matter yield and mineral matter (Mane and Singh 2017). The inter-row spacing also had no significant (P>005) effect on the Ca contents of Rhodes grass herbage in the 2021, 2022 but significant in the years combined result.

Table 6: Calcium Content of Rhodes grass (*Chloris gayana* Tan) as influenced by Nitrogen Fertilizer and Inter Row Spacing during 2021, 2022 rainy season and the years combined in the Semi-arid Zone of Yobe State, Nigeria

Treatment	First trial	Second trial	Years combined
Fertilizer(Kg/ha)			
0(F0)	0.428[c]	0.422[c]	0.636[c]
100(F1)	0.561[b]	0.569[b]	0.842[b]
120(F2)	0.578[b]	0.602[b]	0.867[b]

140(F3)	0.678^{a}	0.691^{a}	1.018^{a}
160(F4)	0.689^{a}	0.694^{a}	1.033^{a}
SEM	0.0284	0.0247	0.0116
Significance	**	**	**
Spacing (cm)			
30(S1)	0.543^{a}	0.556^{a}	0.817^{b}
50(S2)	0.610^{a}	0.622^{a}	0.909^{a}
70(S3)	0.607^{a}	0.609^{a}	0.911^{a}
SEM	0.0490	0.0509	0.0499
Significance	NS	NS	**
Interaction			
F *S	NS	NS	NS

Means within a column for factor followed by the same letters are not statistically different using Duncan Range Multiple Test (DRMT) 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.

Magnessium

Result on calcium (Mg) contents of Rhodes grass herbage as influenced by nitrogen fertilizer application and inter row spacing during 2021, 2022 and the years combined is presented in Table 7. Significantly ($P<0.05$) higher magnesium contents is produced with the application of 160 kgN^{-1} in 2021, 2022 and the years combined as compared to the rest of the treatments. Herbage with higher mg mineral concentration of (0.556, 0.564^{a} and 1.522mgm^{-1}) was recorded from the application of 160 kgN^{-1} in both 2021, 2022 and the years combined Table 8. This is because; Nitrogen fertilization develops stronger cells for photosynthesis (M. Bob, 2011)). Nitrogen fertilization benefits grasses by the decay of root nodules or mineralization of shed leaves and increases forage dry matter yield, forage quality in terms of crude, protein content, mineral matter, voluntary feed intake and digestibility (Aderinola 2007). Nitrogen fertilizer application is responsible for changes in nutritive value of Chloris gayana (Cop *et al*; 2009). Tropical grasses have ability for high yield and the nutrients are simultaneously enhanced when treated which organic/inorganic fertilizer or established with nitrogen fixing shrubs or tree legume Aderinola *et al*. (2011)**.** Inter row spacing has no significant effect on the magnesium content of Rhodes grass herbage in both 2021, 2022 but significant in the years combined.

Table 7: Magnesium (mg) Content of Rhodes grass (*Chloris gayana* Tan) as influenced by Nitrogen Fertilizer and Inter Row Spacing during 2021, 2022 rainy season and the years combined in the Semi-arid Zone of Yobe State, Nigeria

Treatment	First trial	Second trial	Years combined
Fertilizer(Kg/ha)			
0(F0)	0.306^{b}	0.309^{c}	0.875^{e}
100(F1)	0.328^{b}	0.330^{bc}	1.053^{d}
120(F2)	0.361^{b}	0.382^{bc}	1.119^{c}

140(F3)	0.433[ab]	0.459[ab]	1.328[b]
160(F4)	0.556[a]	0.564[a]	1.522[a]
SEM	0.0489	0.0433	0.0139
Significance	NS	NS	**
Spacing (cm)			
30(S1)	0.457[a]	0.469[a]	1.225[a]
50(S2)	0.377[a]	0.386[a]	1.175[b]
70(S3)	0.357[a]	0.372[a]	1.138[c]
SEM	0.0527	0.0516	0.0107
Significance	NS	NS	**
Interaction			
F *S	NS	NS	**

Means within a column for factor followed by the same letters are not statistically different using Duncan Range Multiple Test (DRMT) 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.

Potassium

The significantly higher ($P<0.05$) P values recorded for Rhodes grass at 12WAS from application of 160 $kgNha^{-1}$during 2021 and 2022 trials and the years combined (Table 8) Application of $60KgN^{-1}$, significantly ($P<0.05$) produced higher potassium content in 2021, 2022 (5.566, 5.587) and the years combined (3.009 gmg^{-1}) as compared to the rest of the treatment. This may indicate that the Rhodes grass plant require higher dose of nitrogen fertilizer to produce herbage with higher potassium content. The result obtain was in agreement with the findings of Na-Allah (2015) in the dry sub-humid zone of Sokoto, Nigeria and that of Aderinola *et al*, (2011) in Abeokuta, humid zone of Nigeria. The P content recorded for this study (5.566, 5.587 and 5.577gmg^{-1}), was however higher than the average range of 2.33 – 3.04% P reported from the herbage dry matter of this species across the Sub-humid zone of Nigeria (Na-Allah 2015). Adam (2004) observed that nitrogen improved forage quality by increasing crude protein and mineral matter of Teff grass.

The non-significant($P>0.05$) effect of inter row spacing recorded for Rhodes grass during 3 - 12WAS in the 2021, 2022 and the years combined (Table 8) may indicate that syntheses and accumulation of P in the Rhodes grass herbage in the study area was unaffected by spacing.

Table 8: Potassium (P) Content of Rhodes grass (*Chloris gayana* Tan) as influenced by Nitrogen Fertilizer and Inter Row Spacing during 2021, 2022 rainy season and the years combined in the Semi-arid Zone of Yobe State, Nigeria

Treatment	First trial	Second trial	Years combined
Fertilizer(Kg/ha)			
0(F0)	5.142[d]	5.156[ab]	5.50[e]
100(F1)	5.200[d]	4.881[b]	5.041[d]

120(F2)	5.279[c]	5.292[ab]	5.286[c]
140(F3)	5.392[b]	5.395[a]	5.391[b]
160(F4)	5.566[a]	5.587[a]	5.577[a]
SEM	0.0489	0.1468	3.809
Significance	**	NS	**
Spacing (cm)			
30(S1)	5.308[a]	5.319[a]	2.868[b]
50(S2)	5.334[a]	5.145[a]	2.883[a]
70(S3)	5.305[a]	5.323[a]	2.868[b]
SEM	0.0768	0.1519	2.951
Significance	NS	NS	**
Interaction			
F *S	NS	NS	NS

Means within a column for factor followed by the same letters are not statistically different using Duncan Range Multiple Test (DRMT) 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 AND RECOMMENDATION

It could be concluded from the findings of this study that, nitrogen fertilizer and inter row spacing had significant influence on the growth and herbage productivity of Rhodes grass (*Chloris gayana Tan*) in the study area. Mineral elements composition of the forage grass specie evaluated in this study compares favorably well with most of the values reported in the literature, more especially those from the same geographical region and climatic environment with the study area. The forage grass species generally contained adequate mineral elements of Na, K, Mn and P required by the ruminant livestock for maintenance and production purposes, adequate of the Na, P, Mg and K and less adequate of the Ca minerals for maintenance by the ruminant livestock in the study area. Due to the fact that, nitrogen fertilizer and inter row spacing had significant influence on the growth and herbage productivity of Rhodes grass with forage grass specie evaluation containing adequate mineral elements, the production of Rhodes grass in the study area (*Laba)* is recommended.

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