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Full Length Research Paper

Evaluation of growth and herbage yield of Rhodes grass (*Chloris gayana* Kunth) as affected by nitrogen fertilizer and inter-row spacing in Sokoto, Nigeria

***[1]Y. Na-Allah, [2]A. Bello, and [1]M. H. Adeshina**

[1]Department of Animal Science, Usmanu Danfodiyo University, Sokoto, Sokoto State, Nigeria.
[2]Department of Veterinary Anatomy, Usmanu Danfodiyo University, Sokoto, Sokoto State, Nigeria.
*Corresponding Author E-mail: yakubunallah@gmail.com

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This study evaluated the growth and herbage yield of Rhodes grass (*Chloris gayana* Kunth) as affected by nitrogen fertilizer and inter-row spacing at Dabagi Farm of Usmanu Danfodiyo University, Sokoto during 2017 rainy season. The experiment consisted of five Nitrogen fertilizer levels (0,100,120,140 and 160 Kgha^{-1}) and three inter-row spacing (30, 50 and 70 cm) laid in a Randomized Complete Block Design (RCBD). Data were collected on growth parameters (plant height, leaf length, leaf width, number of leaves and number of tillers), fresh and dry matter yields. Results obtained show no significant effect (P>0.05) of spacing on growth parameters and herbage yields across the week intervals but Significant effect (P<0.05) existed with nitrogen fertilizer levels at 9 and 12WAS and on fresh and dry herbage yield after harvest. Significant effect (P<0.05) also occurred on growth parameters due to interaction between the factors at 9 and 12 WAS. Interaction between factors also yielded a significant effect (P<0.05) on the fresh and dry matter yields with 120 KgNha^{-1} ×30 cm having the highest mean herbage yield. It was concluded that the combination of 120 KgNha^{-1} ×30 cm is optimum for Rhodes grass production in the study area.

Keywords: *Chloris gayana* kunth, growth yield, herbage yield, Dabagi farm, rainy season

INTRODUCTION

Ruminant livestock production in many arid and semi-arid areas of the world (Nigeria inclusive) is based on forages as the major feed resource. Forage refers to herbaceous materials including grasses, legumes and browse plants (trees and shrubs) and byproducts. The main limitations to animal production in these areas (arid and semi arid) are lack of green feed for more than half of the year (6-7 months) and low nutritive quality of the forages during most of the period of active pasture growth (Jones and Wilson, 1987). In Nigeria, feed deficits and low quality of the available feed are major constraints for optimum livestock production in the savanna region particularly during the dry season when grassland productivity is low (Oloyo and Ilelaboye, 2002).

The low nutritive quality of the forage during the growth period is mainly due to environmental stresses such as high temperatures (Van Soest, 1988), infertile soils (Roberts, 1987) and poor management (Dev, 2001). In recent years, there has been several attempts to improve the nutritive quality of the forage resources through propagation of improved species with high nutritive value (Dzowela, 1988) which requires establishment of suitable sown pasture and feed lots to meet the higher nutritional needs of more productive animals (Bamikole and Babayemi, 2004).

Rhodes grass (*Chloris gayana* Kunth) being one of the improved pasture species in Nigeria has been increasingly cultivated over the last few years in the country due to its high dry matter yield, favourable economics of cultivation, and superiority over other perennial forage grasses (Prakash, 1989). In order to improve the availability of good quality pasture feed, a fast growing, high yielding and qualitative forage species are required for the development of sown pastures (via pasture agronomy) that are to be sustained under intensive systems of management. Intensive pasture production make use of forage species that prove their superiority in terms of bulk productivity (dry matter yield per unit area), palatability, chemical composition, nutrient availability, persistence under defoliation regimes and inclement climatic conditions, competition and compatibility with other forages in the pasture ecosystem (Muhammad and Abubakar, 2004). Therefore there is need to evaluate the growth and herbage yield of the newly introduced pasture species such as Rhode grass (*Chloris gayana* Kunth) while subjecting it to some management practices for optimum growth, yield and nutritive value to increase the availability of good quality feed for improved livestock production.

According to Muhammad and Abubakar, (2004), increments in pasture feed production can be achieved by expansion of land areas under natural pastures or by increasing yields per unit land area through intensive production of improved pasture species. With the present trend of competitive land use in Nigeria, increasing pasture feed production through expansion of land area under natural pasture is hardly feasible as a result of the demographic changes. The only viable option therefore remains the production of improved species of grasses and legumes for intensive livestock production due to their high forage yield and nutritive value (De Leeuw and Brinckman, 1974; Olubajo, 1974).

More so, pasture management techniques such as fertilization and spacing are utilized in order to secure a desirable balance for high productivity (Rhodes and Stern, 1978; Keftasa, 1996). Therefore, evaluation of growth and herbage yield of Rhodes grass (*Chloris gayana* Kunth) as affected by nitrogen fertilizer and inter-row spacing in Sokoto sound justifiable. The aim of this study is to evaluate the optimum fertilizer level and inter-row spacing for high growth and herbage yield of Rhode grass (*Chloris gayana* Kunth) in the study area (Sokoto). This aim will be achieved through the following objectives;

(i) To evaluate the effect of nitrogen fertilizer on the growth and herbage yield of Rhodes grass (*Chloris gayana* Kunth) in the study area (Sokoto).
(ii) To evaluate the effect of inter-row spacing on the growth and herbage yield of Rhodes grass (*Chloris gayana* Kunth) in the study area (Sokoto).
(iii) To evaluate the interaction effect of nitrogen fertilizer and inter-row spacing on Rhodes grass (*Chloris gayana* Kunth) in the study area (Sokoto).

MATERIALS AND METHODS

Study area description

Field experiment was conducted during the 2017 rainy season at the Dabagi Farm of Usmanu Danfodiyo University, Sokoto. The farm is located at kilometer 33 along Sokoto-Gusau road. The farm is located within latitude 13°1′ N and longitude 5°15′ E in the Dry Sudan Savannah of the north-west agro-ecological zone of Nigeria (Malami and Sama'ila, 2011). Sokoto has an average annual rainfall ranging between 550 and 750 mm. The mean annual temperature is 32°C with the maximum of 41°C obtained mostly in April and minimum of 13°C obtained mostly in January (Mamman *et al.,* 2000). It is characterized by a long dry season of about 8 months (October - June) and a short rainy season (June/July -September/October) with the peak in August. The highest humidity (76 – 80%) is recorded during the rainy season and the lowest (10 – 30%) is recorded in the dry season. The soil type in Sokoto state was generally described as ferruginous (i.e. fine sandy loam, friable and relatively easy to cultivate) (Yayock and Owonubi, 1986; Umunna and Iji, 1993; Aregheore, 2009). The soil of Dabagi farm was described as *Typic Dystrusteps* unit of the order Inceptisol under the USDA Soil Taxonomy System (Sakaba, 2011). Muhammad *et al.,* (2010) reported that the physico-chemical properties of the top soil (0-30cm) at Dabagi Farm was texturally sandy loam, strongly acidic (pH in water = 5.41, pH in $CaCl_2$ = 5.12), low total organic matter (OM = 2.24 gkg^{-1}), organic carbon (OC = 1.3 gkg^{-1}), total nitrogen (N= 0.22 gkg^{-1}), available phosphorus (P = 2.71 $mgkg^{-1}$), exchangeable cation such as Calcium (Ca = 1.74 $Cmolkg^{-1}$), Magnesium (Mg = 0.23 $Cmolkg^{-1}$), Potassium (K = 0.12 $Cmolkg^{-1}$) and Sodium (Na = 0.19 $Cmolkg^{-1}$). It was also revealed that the top soil possesses low values of Cation Exchange Capacity (CEC) and percentage base saturation of 2.42 $Cmolkg^{-1}$ and 43% respectively.

Treatments and experimental design

The treatments for this experiment were composed of five (5) levels of nitrogen (N) fertilizer (0,100,120,140 and 160 $kgha^{-1}$) and three (3) inter-row spacing (30, 50 and 70 cm). The nitrogen (N) fertilizer levels were denoted by F_0, F_1, F_2, F_3, and F_4 respectively while the inter-row spacing were denoted by S_1, S_2, and S_3 respectively. The treatment combinations were laid out in a Randomized Complete Block Design (RCBD) and replicated three (3) times as shown below:

Field layout

The experimental field layout was made up of three (3) blocks, each consisting of fifteen experimental units

$F_0 \times S_1$	$F_0 \times S_2$	$F_0 \times S_3$
$F_1 \times S_1$	$F_1 \times S_2$	$F_1 \times S_3$
$F_2 \times S_1$	$F_2 \times S_2$	$F_2 \times S_3$
$F_3 \times S_1$	$F_3 \times S_2$	$F_3 \times S_3$
$F_4 \times S_1$	$F_4 \times S_2$	$F_4 \times S_3$

(plots). Each plot measured (4 × 3) m giving a gross plot area of 12 m^2. A distance of 0.5 m was left to separate plots within the block while a leeway of 1 m was left between blocks. The allocation of treatments to each experimental unit was conducted randomly through balloting.

Pre-planting and post-planting operations

Land preparation

This involved the removal of shrubs and debris from the experimental site and was shortly followed by ploughing and leveling using hoe then the experimental plots were prepared following the outlined field layout.

Seed procurement and treatment

Improved Rhodes grass seed was procured at the National Animal production Research Institute (NAPRI) Shika in Zaria, Kaduna state, Nigeria. The seeds were dressed with Apron star (42 WS) powder at the rate of 2.5gkg^{-1} of seed to protect it from fungal and insect attack on the field.

Seed viability testing

The seeds procured were subjected to seed germination testing in order to determine the viability of the seeds prior to sowing. This process was carried out at the Crop Science laboratory of Usmanu Danfodiyo University, Sokoto. The percentage viability of the seeds was determined using the formula below;

$$\text{Percentage Viability} = \frac{\text{number of seeds germinated}}{\text{number of seeds used/sown}} \times 100$$

Sowing

The seeds were sown upon the establishment of rain using drilling method at the prescribed spacing of 30, 50 and 70 cm respectively between drills and at 1.0 – 1.5 cm soil depth.

Fertilizer application

Nitrogen (N) fertilizer was applied to the experimental plots according to the prescribed treatments of 0, 100, 120, 140 and 160 kgha^{-1} and a basal application of 30kgha^{-1} of Phosphorus (P) and potassium (K). The Nitrogen (N) fertilizer was applied in two splits at the 2 and 6 weeks after sowing (2 and 6 WAS) using NPK 15:15:15 at recommended rate while Urea (46%N) fertilizer was used to balance for nitrogen (N) requirement in the first and second splits of fertilizer applications.

Weed and pest controls

First and second weeding were conducted manually by hoe at the 2 and 6 weeks after sowing (2 and 6 WAS). This was carried out in order to control weed while regular visit was made to the experimental field to assess the occurrence of pest and disease and take the appropriate measure to control them.

Harvesting

The herbage produced were harvested at physiological maturity during 12 weeks after sowing (12 WAS). Herbage within the net plot area of the experimental plot was harvested manually at 5cm above the ground level with the aid of sickle. They were then packed, tied up and subjected to weighing using a weighing balance. The readings of the scale obtained give the fresh herbage yield (FHY) from the replicated plot. Also, sub-samples were taken from each replicate in order to obtain the herbage dry matter yield (HDMY) of the respective treatments.

Data collection

Data were collected on growth parameters which include number of tillers per plant, plant height, and number of leaves per plant, leaf length, and leaf width. Three representative plants were selected at random from each plot and were tagged using a black polythene bag. Measurement was taken at 4, 6, 8, 10 and 12 weeks after sowing (WAS).

Number of tillers per plant (NT)

The extra shoot arising from the parent shoot of the selected plants per plot were counted and recorded during each periods of measurement. The average was taken to determined number of tillers per plant from each plot.

Plant height (PH)

The heights of the selected plants from each plot were determined and recorded during each periods of measurement. This was done by measuring the height from the plant base (ground level) to its leaf apex using a meter rule graduated in centimeter (cm).

Number of leaves per plant (NL)

The number of leaves per plot of the selected plants was determined during each periods of measurement by counting the numbers of life leaves. It was then recorded and the average was taken.

Leaf length (LL)

Leaf length of the selected plant in each plot was determined by measuring the leaf from its apex to its base using a meter rule. The values were recorded in centimetre (cm) and the average was taken to determine the leaf length of the plant from each plot.

Leaf width (LW)

Leaf width of the selected plant in each plot was determined by measuring the leaf's widest portion across the midrib with the aid of a meter rule. The values obtained were recorded in centimetre (cm) and the average was taken.

Herbage yields (HYs)

The herbage yield of the varying treatments was determined by obtaining both fresh herbage yield (FHY) and herbage dry matter yields (HDMY). The fresh herbage yield for each treatment was determined by taking the mean of fresh herbage yield of all the replicates in the treatment. The values obtained were extrapolated to kilogram per hectare ($kgha^{-1}$) and was recorded. The herbage dry matter yields (HDMYs) of the experimental units was determined by obtaining a sub-sample from the initially air-dried fresh herbage. Sub-samples were then taken to laboratory for oven drying at the temperature of 100°C until a constant weight was achieved. The formula below was used to obtain the percentage dry matter (%DM):

$$\%\ DM = \frac{W1-W2}{W1} \times 100$$

Where, W_1 = weight of fresh sample
W_2 = weight of dried sample

The percentage dry matter (%DM) obtained from these sub-samples will be used to estimate the herbage dry matter yield (HDMY) of the Rhodes grass using the formula below:

$$HDMYs\ (kgha^{-1}) = \left[FHY\ (kgha^{-1}) \times (\%DM/100)\right]$$

Data analysis

The data obtained from the growth parameters and herbage yield was subjected to the analysis of variance (ANOVA) via IBM SPSS Statistics and where there is significance difference between the treatment mean, Least Significant Difference (LSD) tests at 5% level of significance was used to separate the mean.

RESULTS AND DISCUSSION

Growth performance of Rhodes grass (*Chloris gayana* Kunth.)

Plant height

Mean plant height (cm) of Rhodes grass (*Chloris gayana*) as affected by nitrogen fertilizer (kg) and inter-row spacing during 2017 rainy season at Dabagi Farm, Sokoto, Nigeria is presented in (Table 1). The result showed a significant ($P<0.05$) effect of nitrogen fertilizer on plant height at 9 and 12 WAS while plant height at 3 and 6 WAS showed no significant ($P>0.05$) effect. Application of (100, 120, 140 and 160 $KgNha^{-1}$) of nitrogen fertilizer produced taller ($P<0.05$) plants than control (0 $KgNha^{-1}$). The result also showed significant ($P<0.05$) effect of inter-row spacing on plant height at 3WAS, but there was no significant ($P>0.05$) effect at 6, 9 and 12WAS. 50 cm spacing produced the taller plants (3.13 cm) at 3WAS than 70 cm spacing. The effect of interaction between nitrogen fertilizer levels and the inter-row spacing was also significant ($P<0.05$) at 3, 9 and 12WAS. The result agrees with the findings of Yesihak, (2008) who reported plant heights of 100.7-121.0 cm for the same species in the savannah zones of Ethiopia. Duke, (1997) also added that Rhodes plant measured with foliage reach height of 0.5m-1.2m (50cm-120cm). However, the non-significant ($P<0.05$) effect of plant height as affected by fertilizer at 3 and 6WAS could be due to leaching and competition of Nitrogen by plant with microorganism.

Leaf length

Mean leaf length (cm) of Rhodes grass (*Chloris gayana*) as affected by nitrogen fertilizer (kg) and inter-row spacing during 2017 rainy season at Dabagi Farm, Sokoto, Nigeria is presented in (Table 2). The result showed a significant ($P<0.05$) effect of nitrogen fertilizer on leaf length at 9 and 12WAS while at 3 and 6WAS showed no significant ($P>0.05$) effect. The 120$KgNha^{-1}$ of nitrogen fertilizer had longer leaves (33.99 cm) compared

Table 1. Plant height (PH).

Plant height (cm)				
Treatments	**3WAS**	**6WAS**	**9WAS**	**12WAS**
(A) Fertilizer levels (Kgha^{-1})				
0	2.97	9.39	15.10^{b}	56.79^{b}
100	2.68	8.65	23.29^{ab}	107.34^{a}
120	2.76	9.34	26.42^{a}	116.57^{a}
140	2.97	9.35	28.07^{a}	111.90^{a}
160	2.92	9.41	26.80^{a}	117.17^{a}
S.E	0.17	0.53	3.27	4.54
(B) Spacing (cm)				
30	2.87^{ab}	9.31	24.45	103.28
50	3.13^{a}	8.93	21.93	101.20
70	2.58^{b}	9.44	25.43	101.39
S.E	0.13	0.41	2.53	3.52
Interaction				
A×B	*	NS	*	*

WAS= Weeks after sowing, NS= Not significant at P > 0.05, * = Significant at P < 0.05.

Table 2. Leaf length (LL).

Leaf Length (cm)				
Treatments	**3WAS**	**6WAS**	**9WAS**	**12WAS**
(A) Fertilizer levels (Kgha^{-1})				
0	8.26	22.27	31.21^{c}	26.50^{b}
100	7.00	20.30	32.54^{bc}	31.08^{ab}
120	7.77	21.45	33.85^{abc}	33.99^{a}
140	8.11	21.69	37.69^{ab}	32.15^{ab}
160	7.92	22.93	39.30^{a}	31.31^{ab}
S.E	0.59	1.29	2.03	1.97
(B) Spacing (cm)				
30	7.75	21.33	34.72	31.80
50	7.96	21.43	34.83	31.69
70	7.73	22.43	35.21	29.53
S.E	0.46	1.00	1.57	1.53
Interaction				
A×B	NS	NS	*	*

WAS= Weeks after sowing, NS= Not significant at P > 0.05, * = Significant at P < 0.05.

to other levels (0, 100, 140 and 160KgNha^{-1}) with 0KgNha^{-1} producing the least leaf length (26.50 cm) at 12WAS. Spacing however did not show any significant (P>0.05) effect on leaf length. The effect of interaction between nitrogen fertilizer levels and inter row spacing was also significant (P<0.05) at 9 and 12WAS. This result is in agreement with Yesihak, (2008) who reported leaf length (36.0-41.0cm long). It is in contrast with the findings of Na-Allah, (2015) who reported the longest leaf length (10.87cm) at 10WAS i.e. shorter leaf length.

Leaf width

Mean Leaf width (cm) of Rhodes grass (*Chloris gayana*) as affected by nitrogen fertilizer (kg) and inter-row spacing during 2017 rainy season at Dabagi Farm, Sokoto, Nigeria is presented in (Table 3). The result showed a significant (P<0.05) effect of nitrogen fertilizer on leaf width at 9 and 12WAS while at 3 and 6WAS showed no significant (P>0.05) effect. The fertilizer level of 160KgNha^{-1} at 12WAS produced wider leaves (1.04 cm) which were similar (P>0.05) to (100,120 and 140KgNha^{-1}). 0KgNha^{-1} yielded the least leaf width (0.72cm). Spacing on the other hand had no significant (P>0.05) effect on leaf width across the treatments (30, 50 and 70 cm). The effect of interaction between nitrogen fertilizer levels and inter-row spacing showed a significant (P<0.05) effect on leaf width at 6, 9 and 12WAS. The result obtained here is in line with the report by Yossif and Ibrahim, (2013) that leaf area and leaf to stem ratio

Table 3. Leaf width (LW).

Leaf width (cm)				
Treatments	**3WAS**	**6WAS**	**9WAS**	**12WAS**
(A) Fertilizer levels ($Kgha^{-1}$)				
0	0.46	0.76	0.95^{b}	0.72^{b}
100	0.44	0.65	1.19^{ab}	0.99^{a}
120	0.45	0.74	1.11^{b}	0.99^{a}
140	0.50	0.81	1.26^{ab}	0.92^{a}
160	0.45	0.88	1.44^{a}	1.04^{a}
S.E	0.49	0.73	0.10	0.53
(B) Spacing (cm)				
30	0.47	0.77	1.20	0.96
50	0.48	0.76	1.20	0.88
70	0.43	0.77	1.17	0.96
S.E	0.04	0.06	0.08	0.04
Interaction				
A×B	NS	*	*	*

WAS= Weeks after sowing, NS= Not significant at P > 0.05, * = Significant at P < 0.05.

of Rhodes grass increases by increase in fertilizer. Onyeonagu, (2005) also reported that high crop responses in term of growth, tiller production and tissue concentration of elements and yield have been associated with application of nitrogen fertilizer. The result also agrees with the findings of Na-Allah, (2015) who recorded leaf width of 1.23 cm for Rhodes grass at 10WAS.

Number of leaves

Mean number of leaves of Rhodes grass (*Chloris gayana*) as affected by Nitrogen fertilizer (kg) and inter-row spacing (cm) during 2017 rainy season at Dabagi Farm, Sokoto, Nigeria is presented in table 4.4. The result showed a significant (P<0.05) effect of nitrogen fertilizer on number of leaves at 12WAS while at 3, 6 and 9WAS showed a non significant (P>0.05) effect. Fertilizer levels of 100, 120, 140 and 160 $KgNha^{-1}$ produced higher (P<0.05) number of leaves (7 leaves) compared to $0KgNha^{-1}$ (6 leaves). Spacing shows no significant (P>0.05) effect on mean number of leaves across treatments (30, 50 and 70 cm). The effect of interaction between nitrogen fertilizer levels and inter-row spacing shows a significant (P<0.05) effect on mean number of leaves at 6, 9 and 12 WAS. The result (Table 4) is higher than the findings of Na-Allah, (2015) who reported the mean number of leaves of for Chloris gayana as 6 leaves per plant at 10 WAS. Yesihak, (2008) also reported 10-13 leaves for Rhodes grass grown sole in the savannah region of Ethiopia at 8WAS.

Number of tillers

Mean number of tillers of Rhodes grass (*Chloris gayana*) as affected by nitrogen fertilizer (kg) and inter-row spacing (cm) during 2017 rainy season at Dabagi Farm, Sokoto, Nigeria is presented in (Table 5). The result showed a significant (P<0.05) effect of nitrogen fertilizer on number of tillers per plant at 9 and 12WAS and no significant (P>0.05) effects were observed at the 3 and 6WAS. 120 and $160KgNha^{-1}$ produced higher number of tillers (36 tillers) than $0KgNha^{-1}$. Spacing on the other hand show no significant (P>0.05) effect on mean number of tillers across the treatments at 3, 6, 9 and 12WAS. The effect of interaction between nitrogen fertilizer levels and inter-row spacing shows a significant (P<0.05) effect on mean number of tillers at 9 and 12 WAS. This result differs from the findings of Yesihak, (2008) who recorded the number of tillers per plant for Rhodes grass grown sole in the savannah region of Ethiopia as 81 tillers. The result also was however higher than the findings of Tewodros *et al.* (2012) who recorded 4-16 tillers from Rhodes grass in southern region of Ethiopia. Also, the result agrees with the findings of Atif *et al.* (2012) who recorded 14-30 tillers from Rhodes plant in the Shambut region of Sudan. The mean number of tiller recorded in this research is lower than the findings of Na-Allah, (2015) who recorded 79 tillers from *Chloris gayana* sown at Sokoto semi arid region of Nigeria. Variations in the number of tillers may be as a result of type of cultivar, age of plant and other environmental factors (Duke, 1997 and FAO, 2009).

Herbage Yields of Rhodes grass (*Chloris gayana* Kunth)

Mean herbage yield of Rhodes grass (*Chloris gayana*) as affected by nitrogen fertilizer (Kg) and inter-row spacing (cm) during 2017 rainy season at Dabagi Farm, Sokoto, Nigeria is presented in (Table 6). The result showed a significant (P<0.05) effect of nitrogen fertilizer on

Table 4. Number of leaf (NL).

Number of leaves				
Treatments	**3WAS**	**6WAS**	**9WAS**	**12WAS**
(A) Fertilizer levels ($Kgha^{-1}$)				
0	4	6	7	6^{b}
100	4	6	8	7^{a}
120	4	6	8	7^{a}
140	4	6	8	7^{a}
160	4	6	7	7^{a}
S.E	0.22	0.25	0.47	0.22
(B) Spacing (cm)				
30	4	6	8	7
50	5	6	8	7
70	4	6	8	7
S.E	0.17	0.19	0.37	0.17
Interaction				
A×B	NS	*	*	*

WAS= Weeks after sowing, NS= Not significant at P> 0.05, * = Significant at P < 0.05.

Table 5. Number of tillers (NT).

Number of Tillers				
Treatments	**3WAS**	**6WAS**	**9WAS**	**12WAS**
(A) Fertilizer levels ($Kgha^{-1}$)				
0	0	3	9^{b}	16^{b}
100	0	2	18^{a}	28^{ab}
120	0	3	19^{a}	36^{a}
140	0	3	20^{a}	30^{ab}
160	0	3	20^{a}	35^{a}
S.E	0.00	0.58	1.46	4.84
(B) Spacing (cm)				
30	0	3	16	31
50	0	3	18	25
70	0	3	18	30
S.E	0.00	0.45	1.13	3.75
Interaction				
A×B	NS	NS	*	*

WAS= Weeks after sowing, NS= Not significant at P > 0.05, * = Significant at P < 0.05.

Table 6. Herbage yield.

Herbage yield (tha^{-1})		
Treatments	**Fresh herbage yield**	**Dry herbage yield**
(A) Fertilizer levels ($Kgha^{-1}$)		
0	41.7^{c}	36.8^{c}
100	96.7^{b}	89.9^{b}
120	133.3^{a}	120.6^{a}
140	111.3^{b}	101.6^{b}
160	98.3^{b}	90.0^{b}
S.E		
(B) Spacing		
30	91.4	82.6
50	100.2	92.1
70	97.2	88.6
S.E	5509.6	5047.6
Interaction		
A×B	*	*

WAS= Weeks after sowing, NS= Not significant at P> 0.05, * = Significant at P < 0.05.

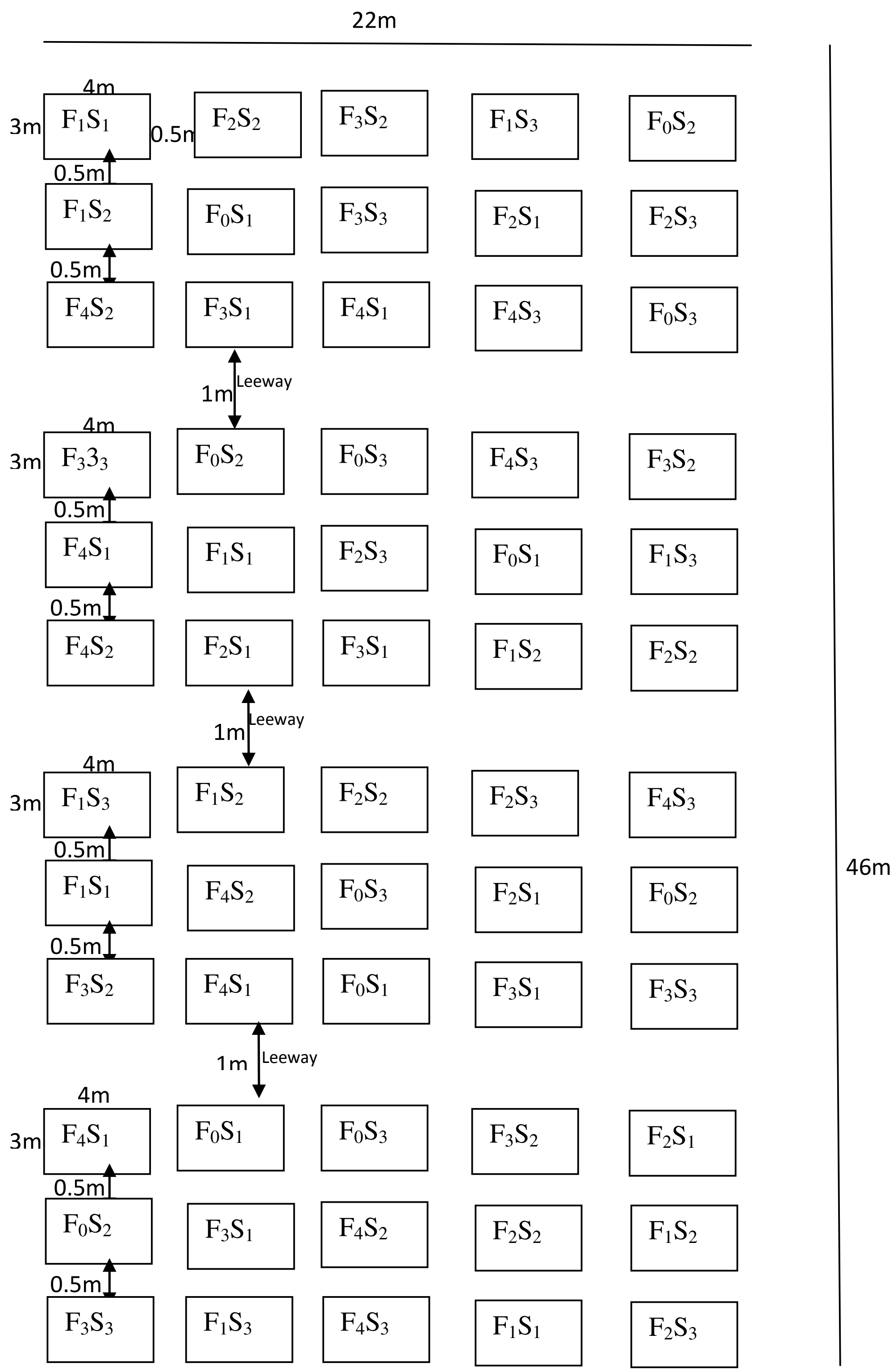

Figure 1. Field layout

herbage yield of *Chloris gayana* both fresh and dry. 120 $KgNha^{-1}$ produced higher ($P<0.05$) fresh and dry herbage yields (133.3 tha^{-1} and 120.6tha^{-1}). Least fresh and dry herbage yields (41.7 and 36.8tha^{-1}) were recorded from the control (0Kgha^{-1}). No significant effect (P>0.05) of spacing was observed on herbage yield (fresh and dry matter). The effect of interaction between the two factors (nitrogen fertilizer levels and inter-row spacing) yielded a significant (P<0.05) effect on both fresh and dry herbage yields. The result of this research on herbage yield (Table 6) is higher compared to the findings of Na-Allah, (2015) who recorded 3.018 tha^{-1} (3018 Kgha^{-1}) on dry matter yield of Rhodes grass sown at Sokoto semi arid region of Nigeria. It is also higher from the results obtained by Yakubu and Magaji, (2004) who recorded 4,100 – 10,000 KgDMha^{-1} for Rhodes grass sown at Zamfara reserve of dry Sudan savannah of Nigeria. Mohammed, (2009); Yossif and Ibrahim, (2013) reported that fertilizer treatment levels had a very significant effect on fodder yield both fresh and dry.

Conclusion

Based on the study conducted, levels of spacing had no significant effect on growth parameters as well as herbage yield. Effects of nitrogen fertilizer levels were observed at 9 and 12WAS including herbage yields both fresh and dry matter. The interaction between nitrogen fertilizer levels and levels of inter-row spacing brought about a significant effect on growth parameters at 9 and 12WAS with little variation of significant effect at 6WAS while at 3WAS, no significant effect existed. Therefore, it can be concluded that “Nitrogen fertilizer level of 120 Kgha^{-1} and 30cm spacing is optimum for the production of Rhodes grass (*Chloris gayana*) which gives a better growth and herbage yield and it will also enable pasture agronomist to minimize cost of production and effective usage of land.

Recommendation

Based on the result obtained from this study, it is recommended that Rhodes grass should be cultivated with 120 kgNha^{1} and 30 cm inter-row spacing in the study area.

Authors’ declaration

We declared that this study is an original research by our research team and we agree to publish it in the journal.

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