Effects of Different Levels of Fertilizer Combinations on Quality and Yield of Rhodes Grass Cultivars in Meru County, Kenya

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Abstract

Production of forage plays an important role in development of livestock production systems. However, high quality and quantity of forage production is challenging to most livestock keepers due to inadequate knowledge on the effective fertilizer application and combinations for optimal production of improved grasses. The objective of this research was to determine the effect of different fertilizer combinations on yield and quality of two varieties of Rhodes grass. The treatments were; 0 Kg CAN/ha + 0 tons farmyard manure/ha, 75 kg CAN/ha + 5 tons farmyard manure/ha, 100 kg CAN/ha + 10 tons farmyard manure/ha, 125 kg CAN/ha + 15 tons farmyard manure/ha (L1, L2, L3 and L4) with two Rhodes grass varieties (Bhoma Rhodes and Katambora Rhodes grass). A randomized complete block design was used for establishment with three blocks of 2x1m separated by 1.0m pathway. Each block was subdivided into twelve subplots of 1x1m alienated by 0.5m pathways resulting into 36 plots. The data was collected on agronomic and qualitative parameters such as plant height and percentage dry matter. Analysis of variance (ANOVA) was conducted to determine any significant differences between treatment means at ($P<0.05$). Significant means were separated using Least Significant Difference (LSD) at 5% significant level. There was significant effect ($P <0.05$) after applying different rates of both CAN fertilizers and farm yard manure on the agronomic and qualitative parameters of Rhodes grass varieties except for metabolizable energy and percentage invitro dry matter digestibility. The study concluded that increase in plant attributes was achieved by application of 125 kg CAN/ha + 15 tons farmyard manure/ha and Bhoma Rhodes grass variety responded better in all treatments than Katambora Rhodes grass variety.

Key Words: *Biomass yields, Dry matter, Forage quality, Fertilizer, Yields*

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1.0 Introduction

In Kenya, livestock contributes over 12% to the Growth Domestic Product (GDP) and accounts for 47% of Agricultural GDP (Kabubo-Mariara, 2009). Sixty to seventy per cent of livestock production costs are due to feeds (Njenga et al.,2013). Feed production by small-scale farmers relies majorly on utilization of both locally and improved available feed resources to meet livestock requirements (Lukuyu, Franzel, Ongadi, and Duncan, 2011). Increased demand for animal products consumed both

locally and for export demands that farmers should have quality forage varieties that ensure consistent supply of feeds to their livestock. Reliance on long-term forage crops should ensure that animal feed is available all year round (Yossif & Ibrahim, 2013).

Rhodes grass (*Chloris gayana Kunth*) is a long-term grass of humid and sub-humid regions of Africa and is the only Carbon IV forage type in the regions. It is mostly located in high proportions in Savannah grasslands. It is from the sub-family Chloridoideae in the Poaceae and is common forage as pasture and hay (Osman, Aziz and Babiker, 2014). Due to local and international high demand of livestock products for consumption, production of forage crops is gaining greater importance. Expansions in the development of forage crops require diversification of the pattern of forage with new improved cultivars.

Fertilizer is the major chemical input contributing to fodder yield, growth and improvement of the quality of annual forage crops (Osman, Babiker, and Aziz, 2013). Due to lack of knowledge on the optimum dosage of farmyard manure in combinations with inorganic fertilizers for improved grasses, high quality and quantity forage production has been a challenge for most livestock farmers (Arshad, Ali, Khan and Bhayo, 2016). Therefore, this study aimed to assess biomass yield and nutrient composition of Rhodes grass herbage as influenced by organic and inorganic fertilizers.

2.0 Materials and Methods

The study used field trials which were conducted at the Kenya Methodist University Farm located at Kithoka in Meru County which is an ecological agro-coffee zone in Kenya's central highlands.

Description of the area of study

The region is situated on Mt Kenya to the eastern slopes with an altitude of 1500m asl. The average rainfall is 1200mm pa, for two seasons with long rains coming from mid-October to December at 650mm and short rains coming from mid-March to May at 550mm. Temperature averages from 25°C-14°C per month with 19.5^{o}C for long-term temperature per month. The type of soil found in the region is predominantly soft Nitisols with moderate to high inherent fertility (Food and Agriculture Organization & Intergovernmental Technical Panel on Soils, 2015).

Treatment description and experimental design

The treatment combinations entailed the combination of the eight fertilization levels of farm yard manure and CAN fertilizer; L1 = 0 Kg CAN/ha + 0 tons farmyard manure/ha, L2=75 kg CAN/ha + 5 tons farmyard manure/ha, L3=100 kg CAN/ha + 10 tons farmyard manure/ha, L4 = 125 kg CAN/ha + 15 tons farmyard manure/ha and the two Rhodes grass cultivars (Bhoma Rhodes grass and Katambora Rhodes grass). The experiment used a randomized complete block study design with three blocks measuring 2 by 1m with a pathway of 1.0m. Each block was subdivided into twelve sub-plots of 1 by 1m with a pathway of 0.5m resulting to a total of 36 plots. The four treatments were randomly distributed to the sub-plots with two varieties of viable Rhodes grass seeds.

Field establishment of Rhodes grass

In the preliminary step, the weeds were cleared manually using sickles. The land was ploughed by tractor and levelled by grading all raised areas to obtain uniformly flat plots. In order to break the big soil in to

small fine particles, hoes and forked *jembes* were used to ensure effective germination. The sowing rate of Rhodes grass seeds was 4 kg/acre and was sown in a well prepared farm applied with farmyard manure at a rate of 0 tons/ha, 5 tons/ha, 10 tons/ha and 15 tons/ha with two varieties of Rhodes grass. After two weeks of emergence, CAN fertilizer was applied at the rate of 0 kg/ha, 75 kg/ha, 100 kg/ha and 125 kg/ha. Both manual and chemical weeding was done. Manual weeding was done on the 15th day and 30th day after germination. Chemical weeding was done on the 45th day.

Data collection

Determination of leaf to stem ratio

Five plants were randomly cut per plot with leaves being stripped off from the stem. The leaves and stems were dried in the sun and their weights were recorded for dry matter determination. The leaf to stem ratio was attained by expressing the dry weight of leaves on the dry weight of stems. This measurement was done after 90 days from sowing (maturity stage).

Determination of number of leaf per plant

The leaf number was calculated on three labelled plants in every plot. The mean number of leaves for each plant was then obtained. This measurement was done after every 30 days, three times from the time of sowing.

Determination of leaf area

Five leaves from the three tagged plants were randomly selected from each plot to calculate leaf area by multiplying the length and maximum width which were then multiplied by a correction factor of 0.75 according to Watson, (1947). The means of leaf area per plant were then obtained for each plot.

Determination of green and dry matter

At 50% flowering, a fresh sample was harvested for each variety by randomly cutting five plants per row 5cm above the ground in each plot and their weights were recorded. The harvested fresh materials were sealed in polythene bags and were taken to the nutrition laboratory in the department of Animal Production, University of Nairobi for oven drying at 60^{o}C. The other plants within each plot were harvested by cutting at 5cm above the ground. They were placed into gunny bags and weighed using a hanging round scale to the nearest 1000g to obtain the fresh biomass yield per plot. After drying the 1kg fresh samples in an oven of 60^{o}C to stable weight, weight loss was taken and they were ground using a Wiley mill standard model No.3 with a sieve of 0.5mm. The dry matter content for each sample was determined by drying at 105^{o}C in an oven for five hours. Subsequently, the biomass yield (dry matter) per ha was estimated.

Determination of proximate composition

Dried milled samples were analysed for proximate composition following the Association of Official Analytical Chemist, (1995) procedure. Digestibility of two levels of invitro dry matter was determined following the Tilley & Terry, (1963) protocol.

Data analysis

The data on yield components and proximate composition for the two Rhodes grass varieties were subjected to Analysis of variance (ANOVA) to test whether variation for the two varieties and treatments was significant. Significant means were

separated using LSD statistical test at a significant level of 5%.

3.0 Results and Discussion

Treatments significantly influenced (P<0.05) all agronomic and qualitative parameters except metabolizable energy and percentage invitro dry matter digestibility of both varieties of Rhodes grass. Between varieties, the following agronomic parameters varied significantly: plant height, leaf number, leaf to stem ratio, green weight and dry matter except tiller number, number of nodes and leaf area. The following qualitative parameters; % DM, % Ash, % EE, % CF and % NFE, also varied significantly between the two varieties except crude protein and metabolizable energy.

Effects of fertilizer combinations on number of leaves for Rhodes grasses

Table 1

ANOVA Summary on Leaf Number

Source	Sum of Squares	Df	Mean Square	F	Sig.
Treatments	41213.944	3	13737.981	13.141	.000
Blocks	12587.556	1	12587.556	12.041	.001
Varieties	23225.194	2	11612.597	11.108	.000
Error	67950.583	65	1045.394		
Total	144977.278	71			

a. R Squared = .524 (Adjusted R Squared = .480)

The ANOVA showed that there was significant influence (P<0.05) on number of leaves at different levels of fertilizer combination.

Table 2

LSD Summary of Post-hoc Test for Number of Leaves

	L1	L2	L3	L4
L1		-9.00	-33.78*	-61.56*
L2			-24.78*	-52.56*
L3				-27.78*
L4				

*. The mean difference is significant at the 0.05 level

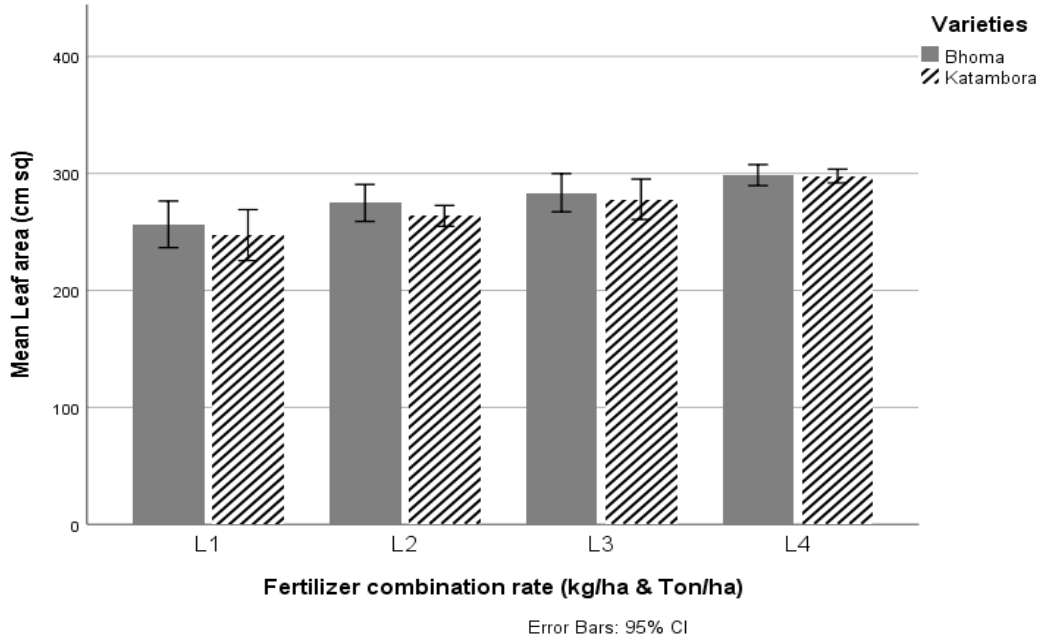
Key L1=0kg CAN + 0 T FYM, L3 = 75 kg CAN + 5 T FYM, L2 =100 kg CAN + 10 T FYM L4 =125 kg CAN + 15 T FYM

From the post hoc results, it was found that there was a significant influence (P<0.05) between control (L1) and L3, control (L1) and L4 while L1 and L2 did not have a significant difference (P>0.05).

The results on the number of leaves obtained in this research concurred with that of Ali, Imtiaz, Qamar, Ali, Arshad and Igbal (2001). From their discussion, the researchers asserted that, a higher leaf quantity is anticipated quality in fodder crops because their high nutritive content that makes them more digestible and hence increasing dry matter consumed by the animals. The process of photosynthesis at high level occurs due to adequate sunlight trapped by the high leaf number (Arshad et al., 2016; Yossif and Ibrahim, 2013). Other studies have reported increased yield of different types of fodder plant reported with application of manure in forage significantly (Heseen et al., 2017).

Figure 1

Effects of Fertilizer Combinations on Leaf Area for Rhodes Grass Varieties



The ANOVA indicated that treatments had significant influence ($P<0.05$) on the leaf area for the two varieties of Rhodes grass.

For the leaf area, results in this experiment conformed to those of Arshad et al., (2016), and Yossif and Ibrahim, (2013). A report by Mirza, Arid, Muhammad and Qamar (2002) showed different results from the current study findings. The disparity in the leaf area of Rhodes grass with different rates of fertilizer applications in this study may be due to the genetic variation of Rhodes grass or different dosages of fertilizers and fertilizer types used at establishment level

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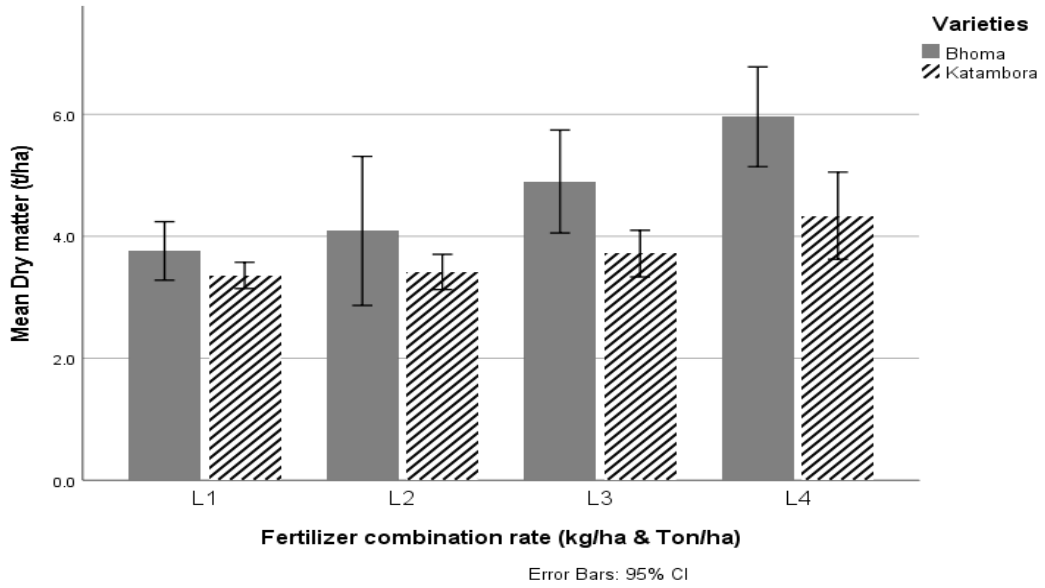
Effects of fertilizer combinations on biomass yields of two varieties of Rhodes grass

Figure 2

Effects of Fertilizer Combinations on Dry Matter Yields for Rhodes Grass Varieties



Key L1=0kg CAN + 0 T FYM, L3 = 75 kg CAN + 5 T FYM, L2 =100 kg CAN + 10 T FYM L4 =125 kg CAN + 15 T FYM

Table 3

ANOVA Summary for Dry Matter (t/ha)

Source	Sum of Squares	df	Mean Square	F	Sig.
Treatments	27.410	3	9.137	10.841	.000
Varieties	16.927	1	16.927	20.084	.000
Blocks	1.856	2	.928	1.101	.339
Total	54.782	65	.843		
Total	100.974	71			

a. R Squared = .457 (Adjusted R Squared = .407)

The analysis of variance indicated that treatments significantly influenced (P<0.05) dry matter yields of both varieties of grass while the two varieties varied significantly between themselves in their dry matter content. The dry matter yields in this work conform to other studies where the yields of the varieties under study increased significantly. This was thought to be due to the fact that animal manure produces a lot of oil and a relatively small percentage of plant food during the decomposition of farm yard

manure. In a study by Yossif and Ibrahim (2013), the maximum plant population and dry matter yield were achieved by application of chicken manure but the minimum fresh yield was attained by farm yard and chicken manure Similarly, findings by Kunene, Wahome and Oseni (2019) indicated that chicken manure-treated plants attained the highest growth rate and yield of dry matter.

Effect of fertilizer combinations on percentage invitro dry matter digestibility

High invitro dry matter digestibility was recorded with Bhoma Rhodes grass (41.1 g/100g) compared with Katambora Rhodes grass (36.9 g/100g) respectively.

Table 4

ANOVA Summary for % Invitro Dry matter Digestibility

Source	Sum of Squares	Df	Mean Square	F	Sig.
Treatments	3.310	3	1.103	.131	.940
Varieties	171.735	1	171.735	20.468	.000
Block	732.111	2	366.055	43.628	.000
Error	142.637	17	8.390		
Total	1049.793	23			

a. R Squared = .864 (Adjusted R Squared = .816)

The analysis of variance ((ANOVA) showed that the two varieties varied significantly ($P<0.05$) on percentage IVDMD but the different levels of fertilization did not have any significant effect.

Effect of fertilizer combinations on percentage crude fibre and percentage crude protein content for Rhodes grasses

Crude protein in animal feed refers to the quantity of protein in it and it depends on the nitrogen level of the food proteins. Crude fibre components include cellulose, hemi cellulose and lignin. An increase in the levels of lignin reduces the digestibility of fodder (Depeters and Heguy, 2013)

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Figure 3

Effects of Fertilizer Combinations on Percentage Crude Protein for Rhodes Grass Varieties

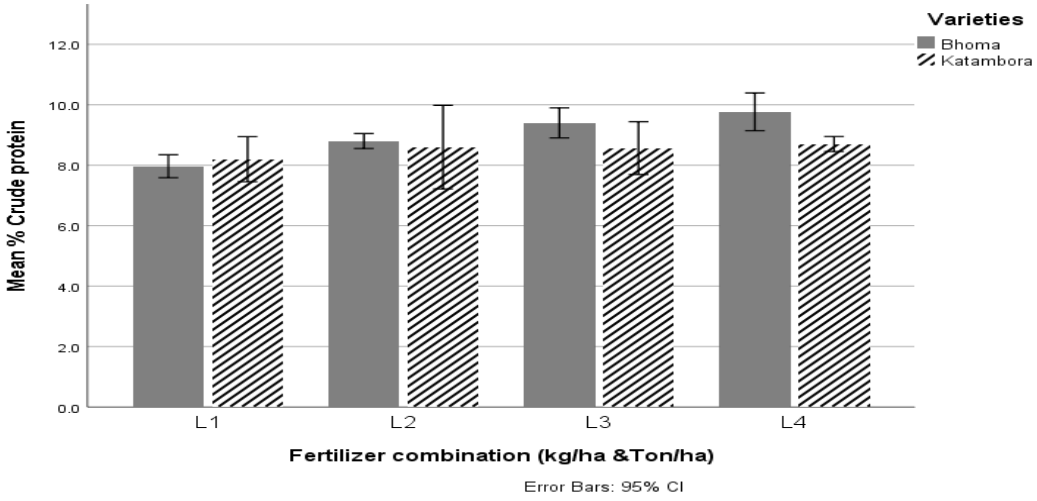

Figure 3 above indicates that the percentage crude protein was high for Bhoma Rhodes than Katambora variety in all the fertilizer combinations except in the first combination where the Katambora variety had higher levels of crude protein.

Table 5

ANOVA Summary for Percentage Crude Fibre

Source	Sum of Squares	Df	Mean Square	F	Sig.
Treatments	14.445	3	4.815	84.059	.000
Block	.961	2	.480	8.387	.003
Varieties	8.760	1	8.760	152.942	.000
Error	.974	17	.057		
Total	25.140	23			

a. R Squared = .961 (Adjusted R Squared = .948)

The ANOVA indicated that treatments significantly influenced (P<0.05) crude protein and crude fibre content of both varieties of Rhodes grass. The results of this study were similar to those reported by Arshad (2015) who found that crude protein content in forage plants varies with plant age and with the nitrogen content of the plant Application of farm yard manure to different forage plants has been noted to improve the soil mineral composition and uptake by plants especially with early harvest (Ansah, Osafo and Hansen, 2010).

4.0 Conclusion

From the research findings, all the agronomic parameters were significantly influenced by variation of fertilizers. The

plant attributes increased linearly with level of combined manure and fertilizer. The chemical components of the two varieties were significantly influenced by change in fertilizer combination except metabolizable energy and percentage invitro dry matter digestibility. The combination of 125 kg CAN/ha and 15 tons of farmyard manure/ha led to better response in the agronomic and qualitative parameters. These factors contributed towards increased yields of green fodder, dry matter and quality of both varieties. Bhoma Rhodes grass variety responded better on the treatments than Katambora Rhodes grass variety and it's therefore best suited to be grown in Kithoka climatic conditions.

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