

**Effects of Applying Different Combinations of
Fertilizers on Growth Performance of
Cynodon nlemfuensis**

Selemani I.S. and Shani G.J.

*Department of Animal, Aquaculture and Range Sciences,
Sokoine University of Agriculture (SUA). P. O. Box 3004,
Morogoro, Tanzania. Correspondence:*

suma02seleman@yahoo.co.uk

Abstract

Scarcity of livestock feeds during dry season in Tanzania raises the concern for maximizing grass production during wet season and conserve for critical dry season feeding. However, poor soil fertility and unpredictable rainfalls are the major limiting factors for maximum grass production. To achieve this, a study was conducted at Magadu dairy farm to assess the effect of different combination levels of fertilizers on growth and yield performance of native stargras (Cynodon nlemfuensis). The four combination levels of farmyard (FYM) manure and NPK were applied randomly to different plots of stargras using the Complete Randomized Design (CRD). The results indicated that, the best performance in terms of tiller number, tiller length and above-ground biomass production were obtained in treatment received 75:25 ratio of NPK and FYM respectively. It was noted that, the above ground biomass yield was significantly low to those treatments received less than 50% NPK. Therefore, anintegration of NPK and FYM at 75:25 and 50:50 ratios which yielded 3.5 and 4

t/ha respectively, are recommended for maximum and profitable production of C. nlemfuensis.

Keywords: *Farmyard manure, NPK, Integration, Biomass, tillers*

Introduction

Livestock production in semi-arid rangelands of Tanzania is limited with scarcity of feed especially during dry seasons. Approximately 70 % of cattle population is kept in arid and semi-arid areas of the country (Mwilawa *et al.*, 2008). Despite the high population of livestock in Tanzania (where about 30.5 million are cattle, 18.8 million are goats and 5.3 million are sheep) the production per animal is low and characterized by seasonal fluctuations as animals are relatively fed well during short period of rainy season and subjected under-nutrition during prolonged dry season (Kanuya *et al.*, 2006; MLF, 2018). Low livestock productivity in Tanzania is not only associated with scarcity of feed but also attributed to poor nutritive values of available forages and lack of proper feeding plans especially during period of feed scarcity. In dry season most of agro-pastoralists (in addition to natural pasture) depend on crop residues which are characterized with low

crude protein (CP) and high fiber contents. According to Mtengeti *et al.* (2008), CP level of most crop residues in Tanzania is ranging from 3 to 4 %, which is below maintenance requirement of most ruminants. Therefore, seasonal fluctuation in quality and availability of feed results into weight gain and weight losses of ruminant livestock at rainy and dry season respectively. This seasonal loss of weight tend to prolong the period to attain maturity and market weight which subsequently resulted in great financial loss to livestock owners (Timpong-Jones *et al.*,2015).

To overcome the problem of feed shortage during dry season, Timpong-Jones *et al.* (2015), recommended maximizing production of grass during wet season and conserve in order to provide feed at reasonable quality during months of critical shortage. To maximize forage production in semi-arid areas where there is high climatic variation and poor edaphic factor, selection of suitable grass species and appropriate levels of fertilizers application is required. Stargrasses are indigenous to tropical Africa including Tanzania, with large leaves and

stems that spread aggressively (Sollenberger, 2008) and thus are potential source of livestock feed especially during dry season if well conserved. This forage species is C4 grass that is metabolically efficiency than temperate grasses (Johnson *et al.*, 2011). In semi-arid ecosystem, where microbialmediated breakdown of dead organic tissues is limited, nutrients needed for grass growth are provided by fertilizers and livestock excreta. However, information relating to fertilization on growth performance and productivity of stagrass is limited. The current study investigated the appropriate combination level of NPK and FYM on growth performance and above-ground biomass production of stargrass.

Material and methods

Study site description

The on-station experiment was carried out at Magadu Dairy Farm located at Sokoine University of Agriculture (SUA); about 5 km south west of Morogoro Municipality. Morogoro region lies between the central highlands and the coastal region. It is geographically located at 37°39'E and 06° 05'S (Mwatawala, 2006). Currently, the study area

has experienced climate variability and changes with mean annual rainfall of 600 mm per annum and the annual average temperature in the region is 18°C (Paavola, 2004). The farm is characterized with wooded grassland dominated by herbaceous grasses and few scattered trees. The dominant grass species includes *Cynodon nlemfuensis*, *Cenchrus ciliaris*, *Panicum maximum* and *Bothriocloa species*.

Study design and sampling procedure

The study involved application of Nitrogen fertilizer in the form of NPK in combination with farmyard manure. The hypothesis of this study was that, combined application of organic and inorganic fertilizer would increase growth performance and yield of stargrass. The farmyard manure was collected from Magadu Farm and the chemical compositions were analyzed at the laboratory of the Animal, Aquaculture and Range Sciences, SUA prior to application. The experiment was conducted during rainy season, from December 2014 to February 2015. The experimental was laid out by using the CRD with three replicates as appeared in Table 1.

Table 1: Experimental layout for six combination levels of NPK:FYM (in %) replicated randomly at different plots

Replicates	Treatments					
	1	2	3	4	5	6
1	T1 =	T3	T5	T2	T6	T4
	0:0	=75:25	=25:75	=100:0	=0:100	50:50
2	T4 =	T6	T1	T3	T2	T1
	50:50	=0:100	=0:0	=75:25	=100:0	=0:0
3	T6 =	T5	T2	T4	T5	T3
	0:100	25:75	100:0	=50:50	25:75	75:25

Field preparation was done by ploughing, followed by raking and leveling using wooded plank. Thereafter, individual plots of equal size (2x2 m) were prepared. Organic manure and inorganic fertilizers were uniformly applied and incorporated at 15 cm depth to each plot as per treatment. After the application fertilizers the cultivar of stargrasses were transplanted at a spacing of 15x15 cm. the management practices were similar in all treatments including weeding by hands at 20 days intervals. There were no serious incidences of pest and diseases, and therefore neither insecticides nor fungicides were applied.

Data collection and analysis

Data on tiller number and tiller length were collected from each treatment level after every two weeks. This was done by randomly selecting few individual plants from each treatment, measured the tiller length and recording the number of tiller per sward. At maturity stage, the above ground biomass was estimated by harvesting and weighing the selected samples. A quadrant of 0.25 x 0.25 m was used to sample randomly from each plots. The samples were oven-dry for 48 hours at the laboratory for estimation of dry matter. All the data were statistically analyzed by one-way analysis of variance technique using the Statistical Analysis Software (SAS, 2004). Wherever treatment differences were found significant at 5% level of probability, the means were separated using Fisher's least significant difference (LSD) as suggested by Montgomery (2003).

Results and discussion

Integration of inorganic and organic fertilizers found to improve growth performance and yield of *C. nlemfuensis*. Application of combined ratio of NPK and FYM

significantly improve tiller number as indicated in Figure 1. The significant highest numbers of tillers were observed at the ratio of 75:25 and 50:50 with respect to NPK:FYM. When compared to untreated plots, the numbers of tillers were increased by 52.6 % and 21% at 75:25 and 50:50 ratio respectively. The rapid growth of *C. nlemfuensis* following fertilization is associated with improved soil physical and chemical properties. Xia (2004), reported that herbaceous plant especially grasses have characteristics of rapid stabilization to soil and therefore tend to grow faster in response to fertilization when compared to woody species. Cruz and Boval (2000) pointed out that, fertilization especially application of N fertilizer does increase proportional number of potential sites for tiller development in stoloniferous plants. Poor tiller development in most of tropical grasses could be due to lack of N fertilizer. Garay *et al.* (2004) pointed out that, N is the most limiting nutrient in the tropical and sub-tropical grassland ecosystem. This has been evidenced from this study, where tillering and yield of *C. nlemfuensis* were relatively low when the percentage of N fertilizer was below 50 %. According to Cruz and Boval (2000), few

axillary buds induce tiller development in limited N nutrient conditions.

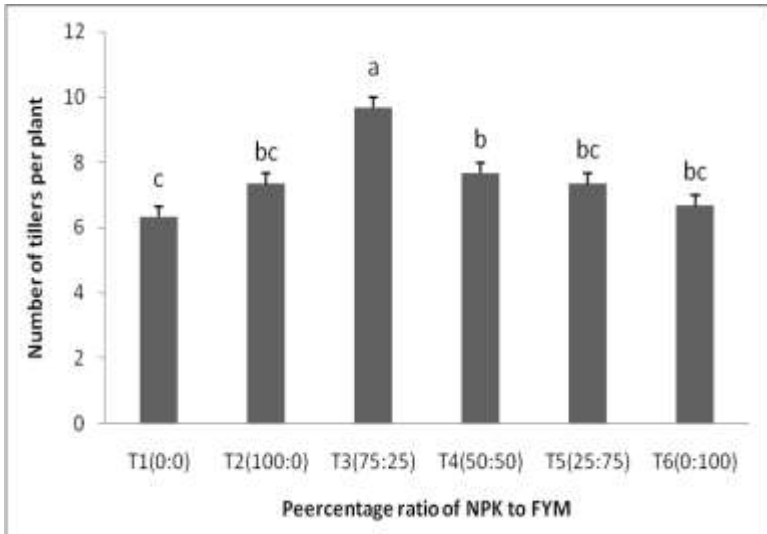


Figure 1: Influence of NPK and FYM on tiller number of *C. nlemfuensis*

In addition to increased number of tiller following fertilization, the length of tiller were also found to be significantly higher at 75:25 and 50:50 combination ratio of NPK and FYM respectively (Figure 2). Increased in average tillers' lengths of *C. nlemfuensis* at these combination ratios were probably due to an appropriate combination of inorganic and organic fertilizer.

While inorganic fertilizer provide important N nutrients required for plant growth, farmyard manure provide energy source for microbes during nitrification process (Meng *et al.*, 2005). Therefore integration of inorganic and organic fertilizer at appropriate level provides an ideal condition for nitrification which is important for plant growth.

The use of inorganic fertilizer is essential for maximizing pasture productivity. However, socio-economically, organic fertilizer has got considerable attention due to increase in prices of inorganic fertilizers and environmental concern. Ibrahim *et al.* (2008) emphasized the use of organic fertilizers because they are economically and environmentally friend. Results from this study suggest that, integration of farmyard manure alongside with inorganic fertilizers can be effective for increasing pasture productivity while reducing the cost of production. Different researches on integration of inorganic and organic manure have been done on crop production and found to have considerable positive effects on productivity (Palm *et al.* 1996; Amujoyegbe *et al.*, 2007). For example, Satyanarayana *et al.* (2002) found optimal yield of rice as a

result of combined application of farmyard manure and NPK. The authors associate the higher yield with increased nutrient availability and uptake enhance by these integration. Bokhita and Sakurai (2005) reported that, application of farmyard manure in combination with chemical fertilizers increased absorption of N, P and K in plant tissues.

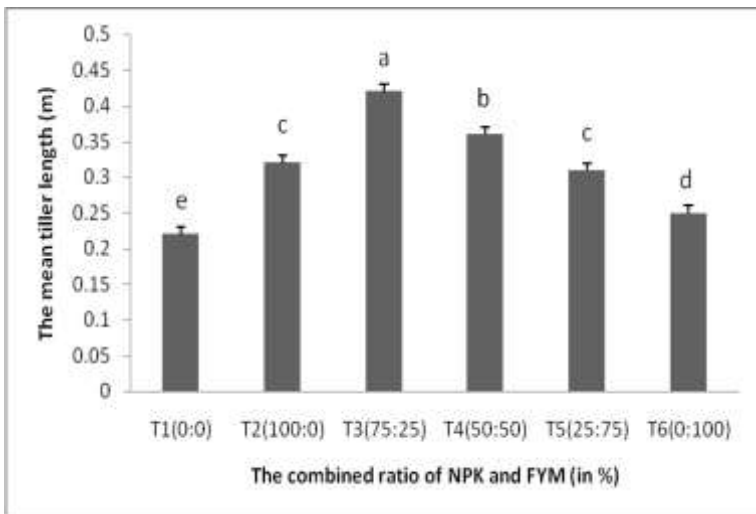


Figure 2: Effect of integration of NPK and FYM on tiller length of *C. nlemfuensis*

There was significant higher above-ground biomass of *C. nlemfuensis* at 75:25 ratios of NPK and FYM (Figure 3). When compared to control plots, the optimal yield increased by 93 %. Improved in productivity of *C. nlemfuensis* in terms of about-ground biomass in response to application of combined inorganic and an organic fertilizer has economic and environmental implications. Although forage quality in tropical grasses is generally low (Garay *et al.*, 2004), high dry matter yield of *C. nlemfuensis* due to application of integrated fertilizers is a potential source of animal feed during dry season when forage decline. Maximizing production of grasses during wet seasons can reduce problem of feed scarcity in dry season and subsequently improve animal performance. This could reduce reliance on supplemental feeds such as concentrate which are costly and in most cases are not available.

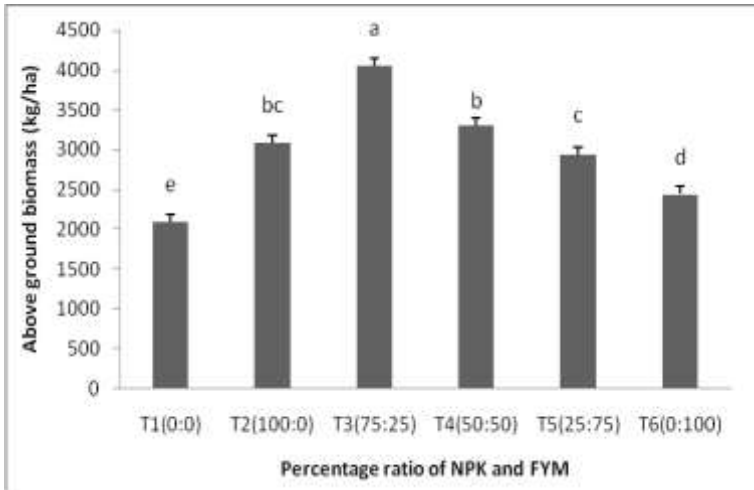


Figure 3: The above-ground biomass in response to different levels of fertilization

In the current study, application of NPK rates below 50 % found to have poor yield in terms of above-ground biomass (Figure 3). These findings were in agreement with Kering *et al.* (2013) who found that, total annual biomass of tropical grasses increased linearly with N fertilization. In order to reduce shortage of forage in dry season, it is therefore, recommended to maximize biomass production using appropriate combination level of inorganic and organic fertilizers during rainy season and conserve them in the form of hay to be utilized during dry season. Mislevy and

Martin (2006) have demonstrated that stargrass has high potential for hay making, because of its high biomass yield if managed well.

Although, the current study focused only on forage quantity, Johnson *et al.* (2011) reported that, N fertilization has positive effect on both forage mass and quality of stargrass. The authors found that, stargrass exhibit large N concentration at higher fertilization rate. This implies that, the Nitrogen pool available for microbial rumen activities in ruminant livestock can be enhanced by fertilization of tropical grasses. Low rate of N fertilization has found to reduce the rate of protein rumen degradation (Sollenberger, 2008), and thus potentially limiting performance of ruminants with high crude protein requirements.

Conclusion

This study demonstrated that stargrass has great potential source of feed during dry season because of its excellence growth performance and high biomass production under fertilization. The optimal yields were observed when combined inorganic and organic fertilizers applied at 75:25

and 50:50 ratios of NPK and FYM respectively. The rapid growth rate in terms of tiller number and tiller length following fertilization implies that, stargrass respond quickly on integrated application of inorganic and organic fertilizer. This integration can have some economic implication by reducing reliance solely on chemical fertilizers which are costly and sometimes unavailable especially to smallholder farmers. Moreover, maximizing production of stargrass during rainy season and be conserved in the form of hay to be utilized during dry season could reduce the cost for buying supplemental feeds. To reduce shortage of feed resources during dry season it is recommended to maximize biomass production using appropriate combination level of inorganic and organic fertilizers during rainy season. This will reduce the possibility of weight loss and increase the performance and productivity of ruminant livestock.

Acknowledgments

Special thanks go to the late Mr. Protas Mihalu from the Department of Animal, Aquaculture and Range Sciences, SUA, for technical advice and assistance in data collection.

References

- Amujoyegbe, B.J., Opabode J.T. and Olayinka, A. (2007). Effect of organic and inorganic fertilizer on yield and chlorophyll content of maize (*Zea mays* L.) and sorghum *Sorghumbicolour* (L.) Moench. *African Journal of Biotechnology*, 6 (16):1869-1873.
- Cruz, P. and Boval, M. (2000). Effect of Nitrogen on some morphogenetic traits of temperate and tropical perennial forage grasses. In: Lemaire G; Hodgson J; de Moraes A; Nabinger C; de Carvalho PCF, eds. *Grassland Ecophysiology and Grazing Ecology*. Pp151-168.
- Garay, A. H., Sollenberger, L. E., McDonald, D. C., Ruegsegger, G. J., Kalmbacher, R. S. and Mislevy, P. (2004). Nitrogen fertilization and stocking rate affect stargrass pasture and cattle performance. *Crop science*, 44(4): 1348-1354.
- Ibrahim, M., Hassan, A., Iqbal, M., &Valeem, E. E. (2008). Response of wheat growth and yield to various levels of compost and organic manure. *Pakistan Journal of Biotechnology*, 40(5): 2135-2141.

- Kanuya, N. L., Matiko, M. K., Nkya, R., Bittegeko, S. B. P., Mgasa, M. N., Reksen, O. and Ropstad, E. (2006). Seasonal changes in nutritional status and reproductive performance of Zebu cows kept under a traditional agro-pastoral system in Tanzania. *Tropical animal health and production*, 38(6): 511-519.
- Kering, M. K., Guretzky, J. A., Interrante, S. M., Butler, T. J., Biermacher, J. T. and Mosali, J. (2013). Harvest timing affects switchgrass production, forage nutritive value, and nutrient removal. *Crop Science*, 53(4): 1809-1817.
- Ministry of Livestock and Fishery (MLF) (2018). Budget Speech 2018/2018. Viewed at <http://www.mifugouvuvuvi.go.tz/publications/40>
- Mislevy P. and Martin F.G. (2006). Biomass yield and forage nutritive value of Cynodon grasses harvested monthly. *Soil and Crop Science Society of Florida Proceedings*, 65:9-14.
- Montgomery D.C. (2013). *Design and Analysis of Experiments*. 5th Edn. John Wiley & Sons, New York.

- Mtengeti, E. J., Phiri, E. C. J. H., Urrio, N. A., Mhando, D. G., Mvena, Z., Ryoba, R., and LØrken, T. (2008). Forage availability and its quality in the dry season on smallholder dairy farms in Tanzania. *Acta Agriculturae Scandinavica Section-A*, 58(4): 196-204.
- Mwilawa, A. J., Komwihangilo, D. M. and Kusekwa, M. L. (2008). Conservation of forage resources for increasing livestock production in traditional forage reserves in Tanzania. *African Journal of Ecology*, 46: 85-89.
- Paavola J. (2004). *Livelihoods, vulnerability and adaptation to climate change in the Morogoro region, Tanzania*. The Open Access Publication Server of the ZBW. CSERGE Working Paper EDM, No. 04-12, viewed at <http://hdl.handle.net/10419/80286>
- Palm C.A., Robert,J;., Myers, K. and Nandwa, S.M. (1996). Combined use of organic and inorganic nutrient sources for soil fertility maintenance and replenishment. In: Roland J; Buresh P; Sanchez A; Calhoun F, eds. *Replenishing Soil Fertility in Africa*. Proceedings of an international symposium of the American Society of Agronomy and the Soil Science Society of America, Indianapolis, Indiana, 6 November 1996. p. 193-218.

Statistical Analysis Software (SAS).(2004). *Statistical Analysis Software/Stat. User's guide*. SAS Institute Inc., Cary, NC.

Satyanarayana, V., Vara Prasad, P. V., Murthy, V. R. K. and Boote, K. J. (2002). Influence of integrated use of farmyard manure and inorganic fertilizers on yield and yield components of irrigated lowland rice. *Journal of plant nutrition*, 25(10): 2081-2090.

Sollenberger, L. E. (2008). Sustainable production systems for *Cynodon* species in the subtropics and tropics. *Revista Brasileira de Zootecnia*, 37: 85-100.

Timpong-Jones, E. C., Adjorlolo, L. K. and Ayizanga, R. A. (2015). The Impact of Harvest Frequency on Herbage Yield and Quality of *Cynodon nlemfuensis*. *West African Journal of Applied Ecology*, 23(2): 7-15.