Micro mineral concentrations of Congo grass as affected by Shading and Harvesting age

Dele P. A., Akinyode, J. I., Eesuola, A.A., Akinyemi, B.T., Enwete, F.E., Anotaenwere, C.C., Awoola, O.I. and Aiyesa, O.L.
Department of Pasture and Range Management, Federal University of Agriculture, Abeokuta, Nigeria

Keywords: artificial; Brachiaria; cutback; fertilized; split-plot.

Abstract. This study investigated the effect of levels of artificial shading and harvesting age on four micro mineral concentrations (iron, manganese, copper and zinc) of Congo grass (*Brachiaria ruzizinensis* Germain & Evrard). The experiment was a 3 x 3 factorial arrangement in a split plot design with four replicates, which is three levels of artificial shading (0, 30 and 60% shading) as the main plot and three harvesting age (3, 6 and 9 weeks after cutback). The grass was established in May 2017 and grazed in 2018 and 2019, but a cutback was done in May 2020 for this study and was fertilized with NPK 20:10:10 at the rate of 200kgN/ha. The results showed that the micro minerals were affected ($P<0.05$) by the shading and harvesting age. The iron concentration and manganese concentration increased as the level of the shading increased whereas the copper concentration decreased with the increase in the level of shading. The zinc increased with the 30% level of shading but at 60% shading, the concentration was lesser than the concentration of the 0% shading. The effect of harvesting age showed decrease in the micro minerals with advance in harvest age. The interaction effect of shading level x harvesting age had significant ($P<0.05$) on the micro mineral concentrations of the grass. The grass shaded at 60% and harvested at 3WAC had the highest Fe and Mn concentration whereas the unshaded grass harvested at 3WAC had the highest Cu and Zn concentrations. It could be concluded that harvesting the grass at advanced age reduced micro mineral concentration and that shading as well affect the mineral concentration.

Introduction

Ruminant production in the tropics have been noted to be limited by the low productivity of forages (Annison and Bryden, 1998). Dele *et al.* (2021) reported that minerals are germane to the productivity of ruminants in the tropics. Forages are a major feed resource for minerals in the diet of this class of livestock either as natural or sown pastures. Previous studies (Cruz, 1997; de Castro *et al.,* 2001) reported on the effect of shading as it tends to increase nutritive quality of forages. Congo grass, a tropical forage is gaining attention in recent times among the ruminant livestock stakeholders in Nigeria (Ojo *et al.,* 2018; Sani *et al.,* 2019). The aim of this study was to investigate the level of shading and harvesting age on the micro mineral concentration of *B. ruzizinensis* in Southwest Nigeria.

Methods and Study Site

The study was carried out at the Cattle Production Venture and the laboratory of the Department of Pasture and Range Management, Federal University of Agriculture, Abeokuta (FUNAAB), Ogun State Nigeria. FUNAAB is situated in the derived savanna zone of the south western Nigeria on latitude 7º26'11.98"N (Google Earth, 2020). Total land area measuring 448 m^2 was mapped out for the experiment. The *B. ruziziensis* plot was established in May 2017 at the rate of 7kg/ha using broadcast method and was grazed from October 2017 to 2019 and it was cut back to 5cm above ground level to maintain uniformity in May 2020. At the onset of this study, a compound fertilizer (NPK 20:10:10) was applied after a cutback at 5cm above ground level at the rate of 200 kgN/ha across all the plots using broadcasting method. The experiment was a 3 × 3 factorial in a split-plot design. This consist of 3 different shading levels [control-unshaded (0%), single layered (30%) and double layered (60%) shade] as the main plot and 3 harvesting age [3, 6 and 9 weeks after cutback (WAC)] as the sub plot, the subplot is a 4 x 5 m^2. Polypropylene shading of various shade levels (unshaded, single and double shades) was used in accomplishing the shading levels, fixed on brace. The screening was extended above the plots 2.0 m

above the ground level, to permit ventilation passage and simple entry below. The direction towards west and east was slanted down at a 45° point to 1.2 m above the ground level, to shade the plants from morning and evening sun. At each harvesting age, the grass was cut at 3, 6 and 9 weeks after cut back using a 0.5 × 0.5 m quadrat. The harvested samples were oven dried at 105 ^{o}C to constant weight and milled to pass through a 1 mm sieve screen. The samples were analysed for mineral analysis. The sample was dried in an oven at 105 ^{o}C for 24 hours, followed by wet ash using nitric acid and hydrochloric acid in ratio 3:1. After wet ashing on the samples in nitric and hydrochloric acids. The concentrations of Iron, Manganese, Copper and Zinc was determined with atomic absorption spectrophotometry following procedures described by Fritz and Schenk (1979). The unit of the measured elements was in mg/kg. Data collected were analyzed using the General Linear Model Procedure of SAS (1999) computer package.

Statistical model

Y_{ijk} : $\mu + F_i + G_j + (FG)_{ij} + \varepsilon_{ijk}$

Where;

Y_{ijk}	:	Observed value of the dependent variables
μ	:	Population mean
S_i	:	Shading levels
H_j	:	Harvesting age
$(SH)_{ij}$	:	Interaction effect of Shading levels and Harvesting age
ε_{ijk}	:	Random residual error

Results and Discussion

The interaction effect of shading levels and harvesting age on the micro mineral concentrations of *B. ruzizinensis* is as presented in Table 2. The Fe concentration ranged from 256.2 to 718.2 mg/kg DM with the grass with 60% shade level harvested at 3WAC having the highest value. The grass shaded at 60% and harvested at 3WAC was also observed to have the highest Mn (74.7 mg/kg DM) concentration and the least value was recorded for the unshaded grass harvested at 9WAC. The Cu and Zn concentration of the unshaded grass harvested at 3WAC were the highest.

The result obtained in this study showed that the *B. ruzizinensis* grass shaded (30 and 60% shaded) had higher Fe and Mn concentration than the unshaded. The Fe concentration are found to be in excess of the requirement for ruminants (Spears, 1994) and are lower than the maximum tolerable limit of 500 mg/kg DM (NRC, 2016) except for the concentration of Fe for the grass at 60% shade and harvested at 3WAC, which might be as a result of probably contamination with soil during harvest. The Fe concentration showed that the grass was above the 50 mg/kg DM recommended for all classes of ruminants (NRC, 2016; Arthington and Ranches, 2021). The increase in the Mn concentration also attested to the fact that as the intensity of sun is interfered with by the artificial shade imposed the Mn increased. The Cu concentration as influenced by the shade was in a decreasing order as the intensity of the sun is interfered with in this order 0% shade > 30% shade > 60% shaded whereas the Zn concentration had no definite pattern as the 30% shaded grass had the highest Zn concentration, which implied that Zn concentration is suppressed when Congo grass is grown under direct sunlight and when the shading effect is beyond 30% shading. The decrease as observed in the micro minerals with advanced maturity in this study is in line with the report of Dele *et al.* (2021). Fleming (1973) reported that with increase in dry matter concentration as a plant advanced in maturity the minerals tend to decrease. The lower Cu concentration (2.68-4.14 mg/kg DM) of Congo grass as observed in this study affirmed the report of Arthington and Ranches (2021) that Cu deficiency are generally high in grazing cattle if forage is the sole source of dietary Cu. This is lower than the range (8-10 mg/kg DM) recommended by NRC (1984) and NRC (2016) and 14-16 mg/kg DM by NRC (2001) for beef and dairy cattle, respectively. The implication of which is that grazing these classes of cattle on Congo grass as in this study will require Cu supplementation. Zinc recommendation by NRC (2016) for beef cattle is 30 mg/kg DM but the Zn concentration in this study is below this either for the shaded and unshaded suggesting that there will be the need to supplement Zn for the cattle. It was also observed that maturity affect the Cu and Zn concentration of Congo grass as the grass gets older, the concentration reduces.

Table 1: Interaction effect of shading and harvesting age on micro mineral concentrations (mg/kg DM) of *B. ruzizinensis*

Shading levels (%)	Harvesting age (WAC)	Iron	Manganese	Copper	Zinc
0	3	481.9^{b}	69.2^{b}	4.1^{a}	22.5^{a}
	6	442.3^{bc}	55.7^{e}	3.2^{bc}	19.2^{c}
	9	256.2^{e}	36.1^{h}	2.7^{d}	14.2^{d}
30	3	408.0^{cd}	64.7^{c}	3.6^{b}	22.2^{a}
	6	438.0^{c}	60.1^{d}	3.00^{c}	20.3^{b}
	9	391.2^{d}	39.4^{h}	2.8^{c}	13.7^{e}
60	3	718.2^{a}	74.7^{a}	2.8^{c}	20.7^{b}
	6	370.1^{d}	55.6^{e}	3.00^{c}	19.5^{c}
	9	256.6^{e}	49.4^{f}	2.9^{c}	14.0^{d}
SEM		33.22	1.49	0.07	0.45
P-value		0.03	0.01	0.01	0.01

SEM; Standard error of means; WAC: Weeks after cutback

Conclusion

The concentration of micro-minerals did differ with the shading levels and harvesting age. It could be concluded that with or without shading, as the grasses mature the micro mineral concentrations decline. Shading at 60% increased the Fe and Mn concentration of the grass and Cu concentration is suppressed by shading. Shading can be concluded as a valuable management tool to improve the Fe and Mn concentration of Congo grass and as a consequence potentially increase animal production.

References

Annison, E. F. and Bryden, W. L. 1998. Perspectives on ruminant nutrition and metabolism. I. metabolism in the rumen. *Nutrition Research Review*. 11: 173-198.

Arthington, J.D. and Ranches, J. 2021. Trace Mineral Nutrition of Grazing Beef Cattle. *Animals* 11: 2767. https://doi.org/10.3390/ani11102767

Cruz, P. 1997. Effect of shade on the growth and mineral nutrition of a C4 perennial grass under field conditions. *Plant and Soil* 188: 227–237

de Castro, C. R. T., Garcia, R., Carvalho, M. M. and Freitas, V. D. 2001. Effects of shading in the mineral composition of tropical forage grasses. *Revista Brasileira de Zootecnia* 30 (6):1959-1968. https://doi.org/10.1590/S1516-35982001000800001

Dele, P., Akinyemi, B., Oyeleke, O., Anotaenwere, C., Salawu, F. and Onifade O.S. 2021. Mineral profile of Panicum maximum var. Ntchisi as influenced by organic nitrogen rate and age at harvest. The XXIV International Grassland Congress / XI International Rangeland Congress (Sustainable Use of Grassland and Rangeland Resources for Improved Livelihoods) takes place virtually from October 25 through October 29, 2021. Proceedings edited by the National Organizing Committee of 2021 IGC/IRC Congress. This document is available at https://uknowledge.uky.edu/igc/24/2-2/42

Fleming, G.A. 1973. Mineral composition of herbage. p. 529-566. In G.W. Butler and RW. Bailey (ed.) Chemistry and biochemistry of herbage. Academic Press, New York.

Fritz, J.S. and Schenk, G.H. 1979. Quantitative Analytical Chemistry. 4th Ed., Allyn and Bacon, Inc., Boston, Massachusetts

NRC (National Research Council). 2016. National Academies of Sciences, Engineering, and Medicine. Nutrient Requirements of Beef Cattle, 8th ed.; The National Academies Press: Washington, DC, USA, 2016

NRC (National Research Council). 2001. Nutrient Requirements of Dairy Cattle. 7th rev. ed. National Academies Press, Washington, DC, USA

Ojo, V. O. A. Adeyemi, T. A. Adewuyi, A. I. Akinyemi, T. R. Akinade, G. A. and Amodu J. T. 2018. Response of two Brachiaria species to swine manure application rates: effect on biomass yield, nutritive quality and acceptability by WAD sheep. *Nigerian Journal of Animal Production* 45(5):158-168

Sani, I., Ahmad, S. S., Muhammed, A., Nuratu, A. and Nuhu, S. H. 2019. Rumen dry matter degradability of Yankasa rams fed *Brachiaria ruziziensis* (Congo grass) hay with different supplements. *Nigerian Journal of Animal Production* 46(4): 264-272

SAS 1999. Statistical Analysis System Institute Inc., SAS/ 24. STAT Programme, Carry, NC: SAS Institute Inc.

Spears, J. W. 1994. Minerals in forages. Pages 281–317 in Forage Quality, Evaluation, and Utilization. G. C. Fahey, ed. Am. Soc. Agron., Crop Sci. Soc. Am., Soil Sci. Soc. Am., Madison, WI. http:// doi.wiley.com/10.2134/1994.foragequality.c7.