INFLUENCE OF UREA FERTILIZER APPLICATION RATE AND PLANT SPACING ON THE MICRO-MINERAL COMPOSITION OF F1 *PENNISETUM PURPUREUM*

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ABSTRACT

This study was conducted at the Pasture site of Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso, aiming to assess the micro-mineral composition of F1 Pennisetum purpureum under varying urea fertilizer rates and plant spacing. Employing a 2 x 2 factorial experiment design within a Randomized Complete Block Design (RCBD), the experiment utilized inter-plant spacing of 75 cm and 100 cm, along with urea fertilizer rates of 200 kg and 400 kg, with three replications each. The findings revealed significant variations in Zinc, Manganese, Iron, and Copper levels in F1 Pennisetum purpureum based on the combination of 75 cm plant spacing and 400 kg N/ha urea fertilizer application, resulting in elevated micro-mineral content. Furthermore, the study observed a direct correlation between increased urea fertilizer application rates and higher values of micro-mineral content. The implications of these results underscore the importance of carefully managing urea fertilizer rates and plant spacing to optimize the micro-mineral composition of F1 Pennisetum purpureum. Specifically, the identified favorable conditions for enhanced Zinc, Manganese, Iron, and Copper content highlight potential strategies for improving the nutritional quality of F1 Pennisetum purpureum. This research provides valuable insights for agricultural practitioners seeking to enhance the micro-mineral composition of forage crops, contributing to improved livestock nutrition and overall agricultural productivity. In conclusion, understanding the intricate relationship between urea fertilizer rates, plant spacing, and micro-mineral composition offers opportunities for targeted agricultural practices aimed at enhancing the nutritional value of forage crops, thereby benefiting livestock health and agricultural sustainability.

Keywords: *Pennisetum purpureum*, Micro-mineral composition, Urea fertilizer rates, Plant spacing and Agricultural productivity

INTRODUCTION

Elephant grass (*Pennisetum purpureum*) is a forage species most commonly grown and is often used as supplemented forage in dairy production (Leta, *et al*., 2013; Asmare, B. 2016). The plant originated in Africa and was introduced to Brazil in 1920; it becomes widely spread and predominantly cultivated in meadows (Asmare, B. 2016; FAO, 2015). Elephant grass is a high-quality, high-producing forage specie when cultivated under proper and good management (FAO, 2015). F1 *Pennisetum purpureum* (pearl millet x elephant grass) has resulted in higher annual herbage productivity after three weeks of establishment at spacing of 50 x 50 cm yielding forage for combating incessant feed challenge in ruminant production (Nyambate, *et al.,* 2010). Morphological parameters and nutrient contents can be significantly affected by the effects of fertilizer type and plant spacing (Mihret, *et al.,* 2018). Nitrogen fertilization is one of the most common practices, and it is also the major factor for increasing pasture yield and nutritive value (Ibeawuchi, *et al.,* 2008). Plant spacing is an important agronomic attribute as it has effects on light interception, which is the energy manufacturing medium of green parts of the plant, which could have an effect on its mineral production rate and availability (Ansah, *et al.,* 2010). Establishment at higher spacing is thus to be examined and to get its micro mineral profile so as to postulate feeding requirements for ruminant animals (Martel *et al.,* 1996). The objective of this study is to determine the micro mineral composition of F1 *Pennisetum purpureum* when planted at different spacing and urea fertilizer application rates (Martel *et al.,* 1996).

MATERIALS AND METHODS

Experimental Site

The experiment took place at the Teaching and Research Farm, Ladoke Akinola University of Technology, Ogbomoso, situated in the derived Savanna zone of Nigeria.

Land Preparation

A field measuring 37 x 15 m was curved and fenced. Twelve beds, each measuring 4 x 4 m with 1 m spacing between them, were prepared. Stem cuttings were planted with intensive daily wetting, and nine days post-planting, transplanted to respective beds based on treatment. Urea application was carried out two weeks after transplanting. There were four treatments with three replicates each. Manual weeding was performed as necessary to prevent weeds from competing with *P. purpureum* for nutrients. In addition, pruning of trees used as fencing was conducted to prevent shading on the treatment plots.

Soil Analysis and Rainfall Data

Soil samples were randomly collected using a soil auger from five different locations within each replicate at a depth of 0-15 cm. Soil analysis was conducted following the procedure outlined by AES (1998).

Procurement of Stem Cuttings

Stem cuttings of the grass (F1 *P. purpureum*) were sourced from the Pasture and Research Farm in Adamawa, Adamawa State.

Experimental Treatments and Design

The experiment consisted of the following treatments:

*Urea rate of 200 kg/ha and 75 cm plant spacing
*Urea rate of 200 kg/ha and 100 cm plant spacing
*Urea rate of 400 kg/ha and 75 cm plant spacing
*Urea rate of 400 kg/ha and 100 cm plant spacing

The experimental design employed a 2 x 2 factorial arrangement using Randomized Completely Block Design. (RCBD)

Data Collection

Data collection occurred 10 weeks post-planting. Quadrants measuring 1 x 1 m were sampled to determine the quantity of dry matter (biomass yield) based on urea fertilizer application rate and plant spacing. Samples were oven-dried at 60 degrees Celsius for 72 hours.

Chemical Analysis

Mineral digestion was performed using the method described by Sahrawi et al. (2002) for sample digestion.

Statistical Analysis

The data generated underwent General Linear Model Analysis using SPSS (2010). Significant means were separated using Duncan's Multiple Range Test (DMRT) within the same package.

RESULTS

The table below shows the plant spacing, urea fertilizer application, and the interaction effect of both. 75 cm plant spacing recorded higher Zinc (52.03), Iron (156.27), and Copper (14.16) levels with a significant difference ($P<0.05$). However, plant spacing had no significant effect on Manganese. Significant effects ($P<0.05$) were observed at urea fertilizer application rates, with 400 kg N/ha recorded higher micro-mineral levels across the table. The interaction effect of plant spacing and urea fertilizer application rate was highest at 75 cm plant spacing with 400 kg N/ha on ($P<0.05$) Zinc, Manganese, Iron and Copper However, 75 cm plant spacing with 200 kg N/ha, 75 cm plant spacing with 400 kg N/ha, and 100 cm plant spacing with 400 kg N/ha recorded the highest Copper levels with a significant difference ($P < 0.05$). The lowest value was observed at 100 cm at 700 kg N/ha across all the mineral content.

Table 4.1: Effect of plant spacing and urea fertilizer rate on mineral contents of F1 *Pennisetum purpureum* (mg/kg)

Spacing	Urea R	Zn	Mn	Fe	Cu
Effect of plant spacing					
75cm		52.03^a	28.83	156.27^a	14.16^a
100cm		49.87^b	27.37	148.98^b	12.11^b
SEM		1.10	0.77	2.01	0.24
Effect of Urea fertilizer rate					
	200 kgN/ha	47.28^b	25.88^b	147.74^b	12.96^b
	400 kgN/ha	54.63^a	30.32^a	157.51^a	13.31^a
	SEM	1.10	0.77	2.01	0.24
Interaction effect of plant spacing and urea fertilizer rate					
75cm	200 kgN/ha	47.90^c	26.35^c	149.77^c	14.83^a
	400 kgN/ha	56.17^a	31.31^a	162.77^a	13.49^a
100cm	200 kgN/ha	46.66^c	25.40^c	145.71^d	11.09^b
	400 kgN/ha	53.09^b	29.33^b	152.25^b	13.12^a
SEM		1.56	1.09	2.88	0.34

^{abc}= on the same column with different superscript differ significantly (P<0.05), Ca = Calcium, P = Phosphorus, K = Potassium, Mg = Magnesium, Zn = Zinc, Mn = Manganese, Fe = Iron, Cu = Copper, SEM = Standard Error Mean, cm = centimeter kgN/ ha= Kilogram of nitrogen fertilizer per hectare.

DISCUSSION

Zinc is crucial in stress management, immune response, enzyme systems, and protein synthesis. Limited research suggests that growing heifers have a greater Zn requirement for growth than bulls and steers (Coser, *et al.,* 2008). Manganese is a co-factor in several enzyme systems, required for normal reproduction, fetal, and udder development (Leta, *et al.,* 2013). High dietary Fe might increase Mn requirements (Leta, *et al.,* 2013). Iron is involved in thyroid hormones regulating the rate of metabolism (Asmare, et al., 2016). Copper is an important component of many enzyme systems essential for normal growth and development (FAO, 2015). The dietary requirement of ruminants for Cu ranges from 8 to 14 mg/kg (FAO, 2015).

Urea Fertilizer Influence

The positive correlation between urea fertilizer rates and micro-mineral content aligns with previous studies highlighting the role of nitrogen in micronutrient uptake (Ishii, et al., 2005). The observed increase in micro-mineral levels with higher urea application rates underscores the importance of precise fertilizer management.

Plant Spacing Effects

The significant impact of plant spacing on micro-mineral composition echoes findings emphasizing the role of spacing in optimizing nutrient absorption (Martel, *et al*., 1996). The superior performance at 75 cm spacing suggests enhanced access to light, nutrients, and reduced inter-plant competition.

Optimal Conditions for F1 *Pennisetum purpureum*

The study concludes that F1 *Pennisetum purpureum* planted at 75 cm spacing with 400 kg N/ha urea fertilizer attains optimal micro-mineral composition. These conditions specifically enhance Zinc, Manganese, Iron, and Copper levels, contributing to the nutritional quality of the forage grass.

Implications for Sustainable Forage Management

Understanding the nuanced effects of urea fertilizer rates and plant spacing on micro-mineral composition provides actionable insights for sustainable forage crop management. Farmers can utilize this knowledge to tailor their practices, optimizing both crop yield and nutritional quality.

In summary, this study elucidates the intricate relationships between urea fertilizer rates, plant spacing, and the micro-mineral composition of F1 *Pennisetum purpureum.* The findings contribute valuable insights to the field of forage crop management, offering practical implications for sustainable agricultural practices.

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