

AGRONOMIC INDICES OF *Panicum maximum* AS AFFECTED BY BIOCHAR AND GOAT MANURE IN THE SUDAN SAVANNAH ZONE OF NIGERIA

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ABSTRACT

The study investigates the agronomic indices of *Panicum maximum* influenced by biochar and goat manure mixture across varying application rates and harvest stages in the Sudan savannah zone of Nigeria. The experiment was laid in a Randomized complete block design and replicated three times, three (3, 6 and 9t/ha) application rates alongside three harvest stages (6, 8 and 10) weeks after planting. Results indicated that the application of biochar and goat manure did not significantly affect Plant height, leaf length, leaf width, and number of leaves: however, tiller number was significantly higher at the 6t/ha combination. In contrast, the harvest stage exhibited a significant impact on all agronomic indices, with the 10-week post planting yielding the most favourable results, followed by 8- and 6- weeks after planting. These findings suggest that biochar/goat manure mixture influences tiller development, and the timing of harvest is crucial for optimizing the agronomic performance of *Panicum maximum* in this region. It is therefore recommended that farmers in this region use biochar/goat manure at 6t/ha for the cultivation of *Panicum maximum* and harvest at 10 weeks after planting for higher forage productivity to enhance sustainable livestock production.

Keywords: Biochar, Organic, Climate, Sustainable agriculture, Agronomic indices

INTRODUCTION

Climate change is a global phenomenon that spares no part of the world, including Nigeria as a whole and Sudan savannah zone of Nigeria in particular. Parts of the indices of climate change are; Greenhouse Gas emission, ozone layer depletion, change in seasonal pattern of rainfall, and prolonged dry season (Okon *et al.*, 2021), resulting in extinction of the native species of forage and reduction in the available feed for ruminant livestock. Soil in this agro-ecological zone is nutrient-depleted, resulting in the poor yield and quality of forages (Bello *et al.*, 2018). In order to ensure sustainable animal agriculture, there is an urgent need to develop a climate resilience mode of forage production through eco-friendly sources of soil nutrients and selection of forage species that are highly adaptable to diverse agro-ecological zones (Koura *et al.*, 2022).

Panicum maximum is particularly valued for its high nutritional quality and adaptability to diverse environmental conditions (Idowu, 2021). However, the productivity of *Panicum maximum* is often limited by nutrient deficiency and soil degradation, necessitating the exploration of sustainable soil management practices to enhance its agronomic performance. Recent research has highlighted the potential of organic amendments, such as biochar and goat manure to improve soil fertility and enhance the growth of forage crops. Biochar produced through the pyrolysis of organic materials, has been shown to improve soil structure, increase nutrient retention, water water-holding capacity, and increase microbial activities which can lead to better plant growth and yield (Idowu *et al.*, 2023).

Goat manure, rich in nutrients, is another organic amendment that can improve soil properties and provide essential nutrients for plant growth. Studies have shown that application of manure can enhance the chemical composition and yield of forage crops, including *Panicum maximum* by increasing the availability of Nitrogen and other essential nutrients (Idowu *et al.*, 2023). Harvesting at different stages also plays a crucial role in determining the agronomic indices of *Panicum maximum* (Jimoh *et al.*, 2019). The timing of harvest affects the plant's growth, nutrient content, and overall forage quality. Research indicates that harvesting at optimal stages can maximize the dry matter yield and improve the nutritional profile of the forage, which is essential for livestock production (Alalade *et al.*, 2013). This research seeks to look into the effect of biochar/goat manure mixture and harvest stages on the agronomic indices of *Panicum maximum* in the Sudan savannah zone of Nigeria.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at pasture unit of Prof. Lawal Abdu Saulawa Livestock Teaching and Research Farm, Department of Animal Science, Federal University Dutsin-Ma, Katsina state of Nigeria. Located along Kankara-Funtua Road in the Sahel savannah region of Nigeria. Ovimap (2015). The area is located in the Sudan Savanna ecological zone that lies between Latitude 12°27'18"N and Longitude 7°27'29"E. It is located at an elevation of 542.08 meters (1778.48 feet) above sea level, Dutsin-Ma has a subtropical steppe climate.

The district's yearly temperature is 33.2° (91.76°) and it is 3.74% higher than Nigeria's average. Dutsin ma

typically receives about 55.47 millimeters (2.18 inches) of precipitation and has 58.72 rainy days (16.09% of the time) annually (Weather and Climate, 2020).

Soil Samples of Experimental Site:

Soil samples were collected at four corners and center of the field at 15cm depth using a soil auger and analyzed for physical and chemical properties as described by A.E.S (1998). The analysis was done at the Department of Animal Science, Faculty of Agriculture, Federal University, Dutsin-Ma.

Collection and Preparation of Planting Materials and biochar

Seed of Guinea grass (*Panicum maximum*) used for the experiment was sourced from the Feeds and Nutrition Research Programme of National Animal Production Research Institute (NAPRI), Shika Zaria. Biochar was purchased from the commercial sellers at the Dutsin-Ma Wednesday market while the goat manure was obtained from the goat production unit of the Professor Lawal Abdu Saulawa Livestock Teaching and Research Farm, Department of Animal Science, Federal University Dutsin-Ma. The biochar and goat manure were ground to powder for easy mineralization and absorption before application.

Experimental Design

The experiment was laid out in a split-plot design using Randomized complete block design (RCBD) In a 3 x 3 factorial arrangement. The main plot factor is the levels of biochar/goat manure application (3, 6 and 9t/ha) in 1:1 (1.5:1.5, 3:3 and 4.5:4.5) of biochar replicated three times while the sub-plot factor is the stages of cutting (6, 8 and 10WAP).

Data Collection and Statistical Analysis

Plant Growth

Data on yield and crop phenology was measured weeks after sowing on primary growth which represent four (4) growth stages of the grass as vegetative, boot, milk and soft dough.

Yield Components

Four plants were selected randomly per plot and tagged for the measurements of various agronomic parameters using the standard parameters as reported by Tarawali *et al.* (1995).

Tiller numbers of *Panicum maximum*

The estimation of the tiller numbers was carried out by counting the number of tillers within the randomly selected Guinea grass stands at each harvesting period.

Plant heights

The plant heights were determined by measuring from the base of the plant to where the last leaf on the plant emerges with the aid of a tape rule on the randomly selected plants per plot.

Leaf Length

Leaf length was measured from the ligule to the tip of the leaves in the five randomly selected and tagged plants with the use of 30 cm ruler at 6, 8 and 10 WAP.

Leaf width

Leaf width where determined by measuring the length of leaf half way or mid-point of the leaf with the aid of 30 cm ruler on the 5 randomly selected plants per plot

RESULT AND DISCUSSION

Table 1: Effect of biochar/goat manure application rate and cutting stage on agronomic indices of *Panicum maximum*

BC/GM	PH	LL	LW	N L	TN
9	164.43	110.92	3.93	55.42	11.00 ^a
6	144.95	105.30	3.90	43.33	8.33 ^b
3	140.08	98.11 ^b	3.85	25.00	4.17 ^c
SEM	14.03	9.97	0.20	4.97	1.12
Cutting stages					
10	185.42 ^a	121.92 ^a	4.21 ^a	49.33 ^a	9.42 ^a
8	153.96 ^b	107.00 ^b	3.99 ^a	46.00 ^a	8.25 ^a
6	110.08 ^c	85.41 ^c	3.49 ^c	24.2 ^b	5.83 ^b
SEM	14.03	9.97	0.20	4.97	1.12

^{abc}Means with the same superscript along the columns are not significantly different, (P<0.05)., BC=biochar, PH= Plant height, LL= Leaf length, LW= Leaf width, NL= number of leaves, TN= Tiller number, BC/GM= biochar/Goat manure, SEM= standard error of the mean.

The result showed no significant effect (P>0.05) of biochar/goat manure application rates on the plant height, leaf length, leaf width and number of leaves while the tiller number increased (P<0.05) as the rate of manure application increased. The increase in tiller number could be as a result of nitrogen level in the soil which

stimulate sprouting of additional tillers and the higher the tiller number, the higher the biomass available for livestock grazing. All the values of agronomic indices here fell within the range reported by (Idowu, 2021; Jimoh *et al.*, 2019) on separate studies of agronomic indices involving *Panicum maximum* as affected by manure application in different ecological zones. All parameters measured were significantly affected ($P < 0.05$) by the stages of cutting. The plant height and leaf length increased significantly across the stages of growth while the LW, NOL and TN increased from 6 to 8WAP when additional growth was not significant thereafter. This increase in growth parameters as the stages of cutting increased could be attributed early light interception which increased the relative growth rate (RGR), increased utilization of photosynthetic assimilate, resulting in the overall increased rate of growth of *Panicum maximum* in this research. The results obtained is in line with what was reported by (Akinola, 2018; Dele *et al.*, 2018) in separate studies on *Panicum maximum* using manure and inorganic fertilizers.

CONCLUSION

From the results of this study, it is concluded that farmers and livestock owners cultivate *Panicum maximum* using biochar/goat manure mixture at 6t/ha and harvest at 10 weeks after planting for a higher agronomic indices and yield in the Sudan savannah zone of Nigeria.

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