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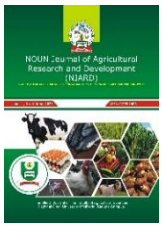

Original Article

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Evaluation of Poultry and Brown Bat Manure on The Growth and Marketable Yield of Two Amaranth Varieties in Mokwa, Southern Guinea Savannah, Nigeria

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ABSTRACT

A field experiment was conducted during the 2023 dry season at the College of Agriculture, Mokwa, Niger State, Nigeria, to evaluate the effects of poultry and brown bat manures on the growth and marketable yield of two amaranth (Amaranthus) varieties. The experimental site lies within the Southern Guinea Savannah agroecological zone at latitude 09°18'N and longitude 05°04'E. The study employed a factorial arrangement in a Randomized Complete Block Design (RCBD) with three replicates. Treatments included two amaranth varieties—Amaranthus cruentus and A. caudatus—and four application rates (0, 2, 4, and 6 t ha^{-1}) of each manure type. Data were collected on growth parameters and marketable yield and analyzed using the Least Significant Difference (LSD) test at a 5% probability level. Results indicated that A. cruentus produced significantly higher marketable yields (2659.6 kg ha^{-1}) compared to A. caudatus (2252.2 kg ha^{-1}). Among the manure treatments, brown bat manure applied at 4 t ha^{-1} yielded the highest output (3561.7 kg ha^{-1}), while the control treatment (no manure) recorded the lowest (693.0 kg ha^{-1}). The interaction between manure type and variety also influenced yield outcomes. Based on these findings, it is recommended that farmers in Mokwa and similar agroecological zones adopt A. cruentus variety and apply brown bat manure at 4 t ha^{-1} to optimize amaranth productivity and market returns.

***Keywords*:** *Spinach, variety, poultry manure, brown bat manure, crop*

1.0 INTRODUCTION

Amaranth is a leafy vegetable crop, belonging to the family Amaranthaceae. Its originated from South America and widely grown throughout most tropical regions, where it is used as a protein grain, leafy vegetable and a forage crop (Grubben and Van Slotten, 1981). Species grown for vegetables are represented mainly by *Amaranthus tricolor*, *A. dubius*, *A.lividus*, *A. cruentus*, *A. caudatus* and *A. hybridus*. Three principal species considered for grain include; *A. hypochondriacus*, *A. cruentus* and *A. caudatus* (Mlakar *et al.*, 2010). Olasupo *et al*, (2018) noted that the nutritional value of the amaranths varies with species.

Nutritionally, the amaranth spinach contains a significant source of vitamins and minerals (Kibar,2022). Its leaves are more superior than lettuce as its contain high levels of carotene and micronutrients such as sodium, Copper, Magnessium, and Chlorine (Schippers, 2000, Mnkeni 2005),

Medically, Martiorosyan and Miroshnichen, (2007), observed that people with hypertension and

cardiovascular disease can use the leaves as an effective alternative to drug therapy. The antioxidant properties of vegetable amaranth has been implicated in the prevention of aging related diseases such as cancer, arteriosclerosis, diabetes and in the management of HIV/AIDS. Increase in the consumption of the vegetable helps to preserve bones and fight bone thinning diseases called osteoporosis (Hertog *et al.*, 1992).

The use of inorganic fertilizers in crop production system, have played an important role in increasing agricultural production and improving world food security (Bayu, 2020). Over time, increased use of inorganic fertilizer under crop production systems results in soil degradation in the form of soil acidification, heavy metal accumulation, loss of organic matter, deterioration of the soil structure, and reductions in biological activities and fertility which leads to a reduction in crop yield, (Zhong and Cai, 2007., Khan *et al*, 2018). A decrease in the concentration of soil organic matter (SOM) worsens the retention capacity, aggregation, structure, mechanical strength and compaction of the soil while also lowering fertility which directly affects agricultural productivity (Eden *et al.*, 2017).

Organic manures that have been known for centuries can be an effective solution to these problems. The long-term application of organic manure helps to intensify the sequestration of carbon in the soil and increase food safety (Parmar *et al*, 2016). Thus, improving soil fertility, increasing the availability of nutrients and water for plants, limiting soil drying, maintaining high microbiological activity in the soil, and increasing the uptake of nutrients by plants (De Oliveira, 2018; Xu *et al.*, 2015). Nevertheless, the effect of organic manure on soil and crop productivity varies with its quality. The slow-release of organic manure maintains low-moderate nitrate concentrations in leaves during spinach growth (Ciesielczuk, 2017). High levels of leaf nitrate concentrations are harmful to human health (Fontes *et al.*, 2017).

The gradual release of nutrients by organic manure made it a sustainable source of enhancing crop productivity and improving soil health. Organic manure contains both macro nutrients such as; nitrogen, phosphorus, potassium, calcium, carbon e. t. c and micro nutrients such as; iron, boron, molybdenum, manganese, copper e. t. c. This will consequently improve both the physical and chemical properties of the soil. In addition, application of organic manure to soil enhances the concentration of water-soluble salts in the soil. Plants absorb plant nutrients in the form of soluble salts, but excessive accumulation of these salts suppresses plant growth. Therefore, application rates of fertilizers; organic or inorganic are very important for different types of soils. If applied correctly, organic manure can act as a good soil amendment and/or fertilizer and can also increase the soil productivity and uptake of major nutrients by plants (Duncan, 2005). It is along this backdrop that this research was carried out to investigate the appropriate manure type and rates, and amaranth species adaptable for production in the study area.

2.0 MATERIALS AND METHODS

A trial was conducted at the Teaching and Research Orchard, Niger State College of Agriculture, Mokwa, during the 2022 dry season. The site is located at latitude 09^0 18' and longitude 05^0 4' E of the equator in the Southern Guinea Savannah zone of Nigeria. The average annual rainfall distribution of the area is 1,177 mm and temperature of 33.6^0C (Niger State College of Agriculture, Mokwa, metrological unit, 2022).

The nursery bed was prepared within the field by repeated tilling of the soil and uniformly mixed with the humus. Seeds were broadcasted on the prepared bed and lightly covered with soil and dried grasses to conserved moisture. The bed was immediately watered and regular watering continued in the morning and evening hours at interval of 2 days. At 21 days after sowing, the bed was thoroughly irrigated and seedlings transplanted to the field. This was achieved by gentle uprooting of the seedlings with the soil mass attached to the root and gently placement. This was aimed at minimizing shock to the root.

The seeds were sourced from Adalinchi Agro-Allied Entreprise, Mokwa, Niger State. Treatments consisted of two varieties of amaranth; *Amaranthus cruentus* and *A caudatus*., and three levels of Poultry Manure (PM) and Brown Bat Manure (BBM) each; 2 tha^{-1}, 4 tha^{-1} and 6 tha^{-1}. These were factorially combined and laid layout in a Randomize Complete Block Design (RCBD), with each treatment replicated three times. The manures were measured using mechanical weighing balance and recommended nutrient was calculated using Mitchell and Donald (2012), method. The manures were incorporated into the plots, mixed thoroughly and allowed for further decomposition for two weeks before planting. Each treatment was replicated three times. The plot size measured 2 x 4m and each replicate separated by a 1m pathway.

3.0 RESULTS

Table 1 shows the physical and chemical properties of the soil sample of the experimental area. The textural class of the soil is sandy loam with an acidic pH of 5.76 and medium organic content. The nitrogen content is low (1.23 g/kg), medium available phosphorus (64.90 m/kg), and a cation exchange capacity of 9.84 c mol/kg^{-1}).

Table 1: Physical and Chemical Properties of Soil at the site prior to the experiment

Physical Properties	Value
Sand g kg-^{1}	91.36
Silt g kg-^{1}	1.68
Clay g kg-^{1}	6.96
Textural Class	Sandy loam
Chemical Properties	
pH H_2O	5.76
Organic Carbon g kg-^{1}	8.58
Organic Matter	14.79
Total N g kg-^{1}	1.23
Available Phosphorus mg kg-^{1}	64.90
Exchangeable bases (c mol kg^{-1})	
Potassium	0.28
Magnesium	4.04
Calcium	2.04
Sodium	4.48
CEC	9.84

Source: National Cereals Research Institute, Badeggi, Niger State, 2022

The chemical properties of both poultry and brown bat manure are presented in Table 2. Both the PM and BBM were neutral at pH (7.0 and 6.9), but the BBM had higher electrical conductivity, nitrogen and available phosphorus values (1849 c mol/kg, 4.85 g/kg and 685.94 mg/kg) than PM (900 c mol/kg, 2.06 g/kg and 666.83 mg/kg).

Table 2: Chemical Composition of Poultry and Brown bat manure

Parameters	Value	
	Poultry	**Brown bat**
Moisture %	11.34	4.52
pH	7.02	6.9
Elec. Conductivity c mol/kg	900	1849
Ash %	11.94	6.96
Na c mol/kg	50.60	53.46
K c mol/kg	0.58	0.48
Ca c mol/kg	0.74	1.06
Mg c mol/kg	9.18	4.78
P mg/kg	666.83	685.94
N g/kg	2.06	4.85

Source: National Cereals Research Institute, Badeggi, Niger State, 2022

Table 3 presents the Influence of different rates of Poultry and Brown bat manure on number of branches per plant, number of leaves per plant and marketable yield of two *Amaranthus* varieties in Mokwa, 2022 wet season.

Amaranthus cruentus, had significantly produced more number of branches per plant (6.8), number of leaves per plant (27.8), and also recorded higher marketable yield (2659.6 kg/ha) compared to *A. caudatus* (5.3), (17.6) and (2252.2 kg/ha), respectively.

Application of 4 t ha^{-1} BBM, had significantly resulted to more number of branches per plant and marketable yield, but statistically similar to 6 t ha^{-1} BBM and 6 t ha^{-1} PM. BBM at 4 t ha^{-1} and 6 t ha^{-1} statistically produced number of leaves that were similar, but significantly higher than the control (no manure application). Similarly, application of 6 t ha^{-1} PM, 4 t ha^{-1} BBM and 6 t ha^{-1} had resulted to marketable yield that were statistically similar, but significantly higher in number of leaves per plant at 6 t ha^{-1} PM, while the control (no fertilizer application) recorded the lowest number of branches per plant, number of leaves per plant and marketable yield, respectively.

Table 3: Influence of Different rates of Poultry and Brown bat manure on number of branches, number of leaves per plant and marketable yield of two *Amaranthus* varieties in Mokwa, 2022 wet season

Treatment **Varieties (V)**	Number of branches/plant	Number of leaves/plant	Marketable yield (kg/ha)
Amaranthus cruentus	6.8a	27.8a	2659.6a
Amaranthus caudatus	5.3b	17.6b	2252.2b
LSD	0.56	0.73	109.60
Manure Source			
Control (No application)	4.4d	12.2f	693.0d
PM at 2 t/ha	5.1b	20.1c	1715.1c
PM at 4 t/ha	4.7c	17.2c	2226.1b
PM at 6 t/ha	7.1a	28.2b	3689.5a
BBM at 2 t/ha	4.4b	18.5d	1536.2c
BBM at 4 t/ha	8.2a	31.1a	3561.7a
BBM at 6 t/ha	7.9a	31.9a	3568.9a
LSD	1.05	1.37	205.19
Interaction	NS	NS	NS

Means followed by the same letter(s) in a column within treatment group are not significantly different from one another at 5% level of probability., NS = Not Significant

4.0 DISCUSSION

The better performance of *A. cruentus* in the number of branches per plant, number of leaves per plant and marketable yield compared to *A. caudatus* could be attributed to the inherent genetic traits and adaptability of *A. cruentus* to the application of manures compared to the control.

The long-term application of organic manure helps to intensify the sequestration of carbon in the soil and increase food safety.

The observed differences in values obtained in all the parameters assessed could be attributed to the differences in nutrients contained in the PM and BBM and their rate. The higher percentage of nitrogen (basis for amino acids), phosphorus and their mineralization in the BBM might have increased soil organic matter content, that energies the activities of soil organism. This help to liberate the chemical nutrients needed by the crop plant and subsequently might have assisted in fast cell division and elongation and enhancement of chloroplast activities during photosynthesis. The present findings concur with the findings of Haque, (2023), who indicated that there was a positive trend for chicken manure application rate on the growth of spinach. He re-iterated that higher levels of chicken manure application had higher root and shoot dry matter yield regardless of soil types. According to Emede *et al*.,(2012) poultry manure positively influenced the plant growth and yield of *Amaranthus cruentus L*. Sistani *et al*. (2010) observed that dry-matter yield increased significantly with increasing rates. Lin *et al*.(2018), reported that crop yield increased with increasing poultry litter application rates. Also, Okoli and Nweke, (2015) affirmed that PM applied at the rate of 10tha^{-1}, 15tha^{-1} and 20tha^{-1} was found consistently to have affected the plant height, number of leaf area, fresh and dry weight of shoot and roots of amaranths,

5.0 CONCLUSION

From this finding, *Amaranthus cruentus* proved superior as against *A. caudatus,* and a rate of 4 t ha^{-1} BM, gave a better performance in the number of branches per plant, number of leaves per plant and marketable yield in the study area. This implies that, even at a higher dose of 6 tha^{-1} BBM, there was no statistically significant difference between BBM at 4 tha^{-1}in the performance of parameters tested.

However, it may not be under statement that, PM and BBM may contain toxic heavy metals and their application may have residual effect on plants as well. It is therefore suggested that, further research be carried out to know the level of toxicity of heavy metal contamination in PM and BBM and their potential bioavailabilty to plant. This will go a long way for establishing the optimum rate of the manure, its utilization and implication on food safety.

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