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EFFECT OF DIFFERENT CONCENTRATION OF POULTRY DROPPINGS ON THE GROWTH AND PROXIMATE COMPOSITION OF *Amaranthus cruentus* L.

ABDURRAHMAN ABUBAKAR[1], DAUDA EMMANUEL MBAYA[1] AND MOHAMMED ADAMU[2]

[1]Department of Biological Sciences, Faculty of Science, Federal University of Kashere, Gombe, Gombe State P.M.B. 0182, Nigeria
[2]Biology Education Department, School of Science, Adamawa State College of Education Hong, Adamawa state, Nigeria

Corresponding Author: abdulrahmanabubakar880@gmail.com

ABSTRACT

Amaranthus cruentus L. is a leafy vegetable commonly grown in Nigeria and other West African countries. Due to its high demand and abundance of poultry manure, farmers abuse the usage of poultry manure thereby causing soil nutrient imbalance and associated animal and human health risks, as well as surface water and groundwater contamination. This study investigated the growth performance, yields, and nutritional quality of *Amaranthus cruentus* under different concentration of poultry manure. Four different concentrations were used as treatments including 5, 10, 15, and 20 kg/plot, while plot without the application of poultry manure served as the control. It was observed that the growth parameters, such as plant height, stem girth, number of leaves and leaf area of plants have significantly affected by the increase in the concentration of the poultry manure. Optimum growth and significant improvement in the proximate composition such as ash and moisture content, fat, crude protein and fiber was achieved in poultry manure concentration of 15 kg/plot relative to the other treatments. Further increase of the poultry manure to the concentration of 20 kg/plot even though increase the growth performance, but lowered the available carbohydrate and total energy. Hence, the research recommended for farmers the use of 15 kg/plot of poultry manure for an enhanced/higher growth of *A. cruentus*.

Keywords: *Amaranthus cruentus*, growth performance, Nutritional composition, Poultry Droppings.

INTRODUCTION

Amaranth is one of the oldest food crops in the world, evidence of its cultivation dated back to as far as 6700 BC (Soriano-García and Aguirre-Díaz 2019). It is considered one of the most commonly cultivated and consumed indigenous vegetables on the African continent (Grubben and Denton 2004). According to (Adewole and Dedeke 2012), *Amaranthus cruentus* L. is a leafy vegetable commonly cultivated in Nigeria and other West African countries with an averagely growing period of 5 to 6 weeks thus making it an advantage for the rural and peri-urban farmers in Nigeria to keep cultivating it two or more times on the same piece of land in a year (Adewole and Igberaese 2011). Till now, the bulk of vegetables consumed in Nigeria are supplied by subsistence farmers. Apart from the usage of leaf part of *A. cruentus* uses as a vegetable, its grains can also be cooked as a cereal, popped like popcorn, toasted or

even grind into flour for baking (Patil and Jena 2020). It was observed that the fruits and vegetables of *A. cruentus* could alternatively play a major role in alleviating problems associated with malnutrition due to their ability to supply proteins, vitamins, calories and other nutrients needed in a balanced diet (Bvenura and Sivakumar 2017).

The leafy part amaranth has received significantly less research attention than grain amaranth. However, are very good sources of vitamins, protein and dietary minerals and has been rated considerably higher in minerals, such as calcium, iron, phosphorous, potassium, zinc, copper and manganese (Gebreil, Ali, and Mousa 2020). Since about 1980, Amaranth has been rediscovered as a promising food crop mainly due to its resistance to heat, drought, diseases and pests, and the high nutritional value of both seeds and leaves (Bhargava and Srivastava 2020). Thus, the improvement of amaranths through research and development could produce an easy and cost-effective way of eliminating malnutrition and promoting people health as well as achieving food security. Grain of amaranth has higher protein than other cereal grains and has significantly higher lysine content, more and higher quality protein than maize which is high in the amino acid lysine, which is the limiting one in cereals like maize, wheat and rice (Maurya and Arya 2018). The protein is also relatively rich in the sulphur containing amino acids, which are normally limited in the pulse crops. The "protein complement" of grain amaranth is very near to the levels recommended by FAO/WHO (Story *et al*. 2008). Amaranth grain consists of 6 to 10% of oil, which is higher than most other cereals with approximately 77% polyunsaturated fatty acids which are mostly within the germ (Maurya and Arya 2018).

Despite the huge advantages, the supply of these vegetables to major areas of high demand has remained low and seasonal as most of the subsistence farmers continue to rely on organic fertilizer and natural rainfall. This current high demand for vegetables in the cities and towns has stimulated the growth of market gardening along perennial rivers and streams in major towns and cities in Nigeria. Some farmers rely on irrigation water from streams, wells and boreholes to cultivate vegetables all year round. Organic production of vegetables became a good source of employment for young school leavers and also preferred in quality to conventional ones (Dipeolu *et al*. 2009). However, some of the problems encountered by amaranth growers in Nigeria are the low soil fertility and lack of capital to buy chemical fertilizers for optimum crop productivity (Inyang *et al*. 2018). Most African soils are inherently low in organic carbon, slightly acidic and relatively sandy. Studies revealed that the use of inorganic fertilizers has not been helpful in agriculture (Chen 2006). Scientists had previously advocated the use of properly amended organic manures to the resource-poor farmers for the cultivation of *A. caudatus,* another popular amaranth leafy vegetable in Nigeria (Adewole and Dedeke 2012). Moreover, the environmental impacts of waste by-products of poultry industries are of increasing importance worldwide and the disposal of these wastes is a major environmental problem. But the use of animal residues such as poultry can availably compensate for the export of soil nutrients because of their low cost and availability (Chiarelotto *et al*. 2021).

The use of poultry manure in crop husbandry must be done with sound soil fertility management practices to prevent soil nutrient imbalance and associated animal and human health risks, as well as surface water and groundwater contamination. Therefore, addition of poultry manures to soil for

enhanced fertility must be done with caution. Yet, the poultry manure quantity and quality depends on the type of bird and quality of feeds (Griffiths 2007). Presently in Nigeria, vegetable farmers always have heaps of poultry droppings around them that they need not to pay money for their collection and usage. This free access is therefore being abused. The repeated use of poultry manures as bio-fertilizers on the same piece of land, irrespective of the type and quality of the droppings for the cultivation of *A. cruentus* is on the increase. Currently, there is a dearth of information on the growth performance, yield and nutritional quality of *A. cruentus* under different concentration of poultry manures to soil. This study, therefore, sought to assess the biological and proximate composition of *A. cruentus* grown under different concentration of poultry manures.

MATERIALS AND METHODS

Sample Collection and Preparation

The seeds of *A. Cruentus* were obtained from local farmers from Kashere market and were identified in the Biological Sciences herbarium, Federal University of Kashere with voucher no NH84/452, while the poultry manure was obtained from the private farms in Kashere town of Akko L.G.A, Gombe State in a potable sack. In order to compost the poultry droppings, a pit of 1 m long by 50 cm wide and 1 m was prepared deep in a cool shady place and filled with poultry droppings, then ash was sprinkled just to cover the poultry dropping which contains calcium and potassium that help in regulating pH. Green grass was also added to the thickness of 20 cm and followed by sprinkling of topsoil of thickness of 2 cm and allowed for 3 days for it to decompose (Savala 2003).

Experimental Layout and Treatment Allocation

Three beds of land were designed with net plot sizes of 1m x 2m. The land was ploughed and harrowed after which the beds are been prepared and the different concentrations of composted poultry manure were applied to the soil and watered. The seeds were soared in rows at 20 cm inter-row and 40 cm extra row spacing and covered with soil and watered daily (Ayoola and Makinde 2007). Four different concentrations of poultry manure each having (3) replicate which were carried out in a complete randomized block design (CRD) layout. The treatments allocations were: 0, 5, 10, 15, and 20 kg/plot.

Analysis

Measurement of Growth Performance Indices

After germination of the *Amaranthus cruentus* L, the stem length, stem girth, and leaf length were measured in meter, leaf and branches number per plant was also measured in other to assess the growth performance of the plant, the measurements of these growth indices were taken periodically with an interval of one week for five consecutive weeks (1st, 2nd, 3rd, 4th, and 5th week after germination) using meter ruler and measuring tape (Tang *et al*. 2019).

Nutritional Quality Analysis

The leaves of the plants were collected for each treatment and replicate using clean knife and immediately transported to the laboratory. The fresh and healthy leaves were immediately washed under running tap water and excess water was dripped off. Edible portions of the vegetables were then cut into small pieces and grinded using laboratory pestle and mortar. The powdered samples were then used for analysis. However, some

leaves were transferred into an air-tight container and kept at -20^{0}C before further analysis. The macronutrient composition of each treatment was determined using the procedures described by A.O.A.C. (1999). The macronutrient compositions assessed were ash content, moisture content, crude protein, total fat, crude Fiber, available carbohydrate and total energy.The research was conducted in two phases; geological field studies with collection of soils samples and then laboratory analysis.

Statistical Analysis

The data obtained were subjected to Analysis of Variance using one way (ANOVA) and Duncan multiple range. The results were expressed as percentage differences, i.e. the differences between the mean values were determined at 95% confidence.

RESULTS

Effect of Different Concentration of Poultry Manure on Stem Length

The effects of different concentration of poultry manures on stem length of *A. cruentus* were measured at weekly intervals as represented in table 1 below. The results indicated that, there was significant difference among the treatment at (P<0.05). However, the stem length increases with the increase in concentration of poultry manure at 20 Kg>15 Kg>10 Kg>5 Kg>0 Kg for W1, W2, W3, W4 and W5 respectively.

Table 1: Stem Length measurement based on different conc. of poultry manure

Treatment (kg/plot)	W1	W2	W3	W4	W5
0	13.96±7.81	13.94±7.11	13.94±8.43	13.18±7.51	13.84±7.10
5	16.15±9.50	15.14±7.71	17.28±10.72	16.41±8.11	15.11±7.61
10	18.48±8.88	18.06±9.00	19.88±11.51	18.11±8.71	17.04±8.59
15	20.96±11.14	23.26±12.43	24.30±13.09	20.56±10.21	19.54±11.11
20	27.06±14.23	26.72±13.81	26.88±14.56	26.11±12.22	22.51±21.21

KEYS: W-Week. Values are mean ± standard deviation. Values down the column are the significant (P<0.05).

3.2 Effect of Different Concentration of Poultry Manure on Stem Girth

The effects of different concentration of poultry manure on the mean of stem girth of *A. cruentus* measured at weekly intervals are represented in table 2 below. The results indicated a significant changes at (P<0.05), therefore, the stem girth increase with the increase in concentration of poultry manure at 20 Kg>15 Kg>10 Kg>5 Kg>0 Kg in W1, W2, W3, W4 and W5 respectively.

Table 2: Stem Girth measurement based on different conc. of poultry manure

Treatment (kg/plot)	W1	W2	W3	W4	W5
0	1.10±0.75	1.08±0.72	1.52±1.07	1.11±0.76	1.09±0.78
5	1.70±1.41	1.40±0.88	1.72±1.34	1.61±1.12	1.40±0.88
10	2.28±1.78	1.90±1.27	2.06±1.38	2.11±1.61	1.90±1.27
15	2.72±1.81	2.30±1.53	2.66±1.84	2.61±1.91	2.20±1.43
20	3.02±2.15	3.10±2.28	3.72±2.56	3.11±2.17	3.10±2.29

Keys: W-Week. Values are mean ± standard deviation. Values down the column are the significant (P<0.05).

Effect of Different Concentration of Poultry Manure on Leaf Length

The effect of different concentrations of poultry manure, on the leaf length of *A. cruentus* measured at weekly intervals are represented in table 3 below. The studies revealed that there was significant difference (P<0.05) observed in the leaf sizes as the leaf length increases with the increase in concentration of poultry manure at 20 Kg>15 Kg>10 Kg>5 Kg>0 Kg in W1, W2, W3, W4 and W5 respectively.

Table 3: Leaf Length measurement based on different conc. of poultry manure

Treatment (kg/plot)	W1	W2	W3	W4	W58
0	8.60±5.22	9.40±6.35	10.00±5.79	8.60±5.22	10.00±5.81
5	11.60±5.03	11.40±6.27	10.40±7.02	11.60±5.03	11.41±6.27
10	13.00±8.09	12.40±8.08	12.60±10.24	13.00±8.09	12.40±8.08
15	15.20±9.98	14.20±9.04	14.60±10.24	15.20±9.98	14.60±10.24
20	16.00±11.83	15.80±11.09	16.40±12.09	16.00±11.83	15.80±11.09

KEYS: W-Week. Values are mean ± standard deviation. Values down the column are the significant (P<0.05).

3.4 Effect of Different Concentration of Poultry Manure on Leaves Number

The effects of different concentration of poultry manure on number of leaves of *A. cruentus* measured at weekly intervals and are represented in table 4 below. The result of the research shows a significant improvement on the average number of leaves per plant at (P<0.05). Hence, increase in the concentration of poultry manure is said to have increases the number of Leaves per plants 20 Kg>15 Kg>10 Kg>5 Kg>0 Kg in W1, W2, W3, W4 and W5 respectively.

Table 4: Number of Leaves measurement based on different conc. of poultry manure

Treatment (kg/plot)	W1	W2	W3	W4	W5
0	4	4	5	7	11
5	7	9	9	13	13
10	6	9	11	15	15
15	8	11	14	14	16
20	10	13	14	16	19

Effect of Different Concentration of Poultry Manure on Plant Branches

The effect of different concentration of poultry manure on the branches of plant of A. cruentus as measured on a weekly basis is represented in table 5 below. However, it is observed that there is significant difference at ($P<0.05$) among the different concentration of the poultry manure as the branches of plant increases with the increase in concentration at 20 Kg>15 Kg>10 Kg>5 Kg>0 Kg in W1, W2, W3, W4 and W5 respectively

Table 5: Branches of Plant measurement based on different conc. of poultry manure

Treatment (kg/plot)	W1	W2	W3	W4	W5
0	1	2	2	2	3
5	3	3	3	3	3
10	3	4	4	4	4
15	3	3	4	6	6
20	3	4	5	7	7

Nutritional Quality of *A. cruentus* Leaves

The effects of different concentration of poultry manure on the nutritional quality of *A. cruentus* Leaves after the 5th week are presented in the table 6 below. The results shows significant increment on the ash and moisture content, fat, crude protein and fiber across all the treatment except that it lowered the available carbohydrate and total energy as indicated in the below table

.

Table 6: Nutritional composition of Plant Leaves measurement based on different conc. of poultry manure

Treatment (kg/plot)	Ash Content (%)	Moisture Content (%)	Fat (%)	Crude Protein (%)	Crude Fibre (%)	Available Carbohydrate (%)	Total Energy (Kcal/g)
0	2.65±0.0	78.50±0.6	1.21±0.0	7.71±0.2	2.73±0.1	6.19±0.44	60.79±2.2
5	2.93±0.0	79.71±0.7	1.30±0.0	8.76±0.4	3.03±0.5	4.35±0.87	58.30±2.9
10	3.02±1.1	80.35±1.0	1.50±0.7	8.86±0.7	3.10±0.8	3.28±0.98	56.04±3.0
15	3.10±1.6	80.40±1.5	1.51±1.3	8.90±1.3	3.20±1.5	3.00±1.98	51.52±3.3
20	3.21±2.43	80.50±2.1	1.52±1.6	9.07±1.6	3.30±1.	2.60±2.54	46.21±3.4

KEYS: W-Week. Values are mean ± standard deviation. Values down the column are the significant ($P<0.05$).

DISCUSSION

From the result of the study, it is revealed that increase in concentration of poultry manure from 5 kg/plot had an incremental effect (growth) on the stem length, stem girth, number of leaves and branches of plant until it reaches 15 where further increase does not shows significant improvement on the growth and nutritional quality of *A cruentus*, but also shows a little decline in the carbohydrate and energy content. This implies the higher the concentration of poultry manure to certain level the higher the growth performance of *A. cruentus* which can be attributed to the increase in the amount of nutrients in higher concentration of poultry manure. Though,

some researcher reported zero statistical difference in all of the growth parameters of *A cruentus,* however, this research assessed only few growth indices the Amaranthus species such as stem length and girth (Jimoh, Afolayan, and Lewu 2020), the scenario can also be explained due to the short cropping period given less time for the mineralization of the nutrients that are there in the manure applied, However, the result of the growth parameters assessed in this current studies increases with an increasing concentration of poultry manure.

The observed differences in values obtained in all the parameters assessed could be attributed to the differences in nutrient composition and the rate of poultry manure applied. It was previously reported that higher organic manure concentration at 15 Kg and 20 Kg gave higher growth performance results than when manure was not applied or applied at lower concentration. More so, it is reported that Amaranthus requires soil with high organic content and as such, soils favoured the production of leaf number (Ma'shum *et al*. 2009), this was justified from the result obtained, because the number of leaves per plant increased with the application of poultry manure from zero level. The enhancement of the parameters studied by the application of poultry manure may as well be due to its rich in nitrogen and other plant nutrients. Also reported that poultry manure is rich in nitrogen and other plant nutrients and as a result it favours the growth and development of root system which reflects better growth, photosynthetic activity and dry matters accumulation (Mesallam *et al*. 2017).

For the nutritional components, the control recorded the highest available carbohydrate and total energy. Thus carbohydrate and total energy decrease with increase in concentration at 0 Kg>5 Kg>10 Kg>15 Kg>20 Kg of poultry manure, while ash content, moisture content, fat, crude protein and fibre increase with increase in concentration at 20 Kg>15 Kg>10 Kg>5 Kg>0 Kg of poultry manure. Similar findings were reported by (Mofunanya *et al*. 2021) that plant grown with organic fertilizer at different concentration gives high ash content, moisture content, fat, crude protein and fibre but lower the available carbohydrate and total energy.

CONCLUSION

From the result obtained in this study, it can be concluded that the effect of different concentration of poultry manure has significant influence on the growth of *A. cruentus* based on the growth performance indicators such as stem length, stem girth, leaf length, numbers of leaves and branches of plant in the order of 20 Kg>15 Kg>10kg>5 kg>0 kg. High concentration of poultry manure also have seen to favors the increase in the percentage of nutrition in ash, moisture, fat, crude protein crude fibers though an insignificant reduction was observed in the concentration of carbohydrate and energy as the concentration of the poultry manure increase in the order of 0 Kg>5 Kg> 10 Kg>15>20 Kg. Therefore, this research has recommended for farmers the use of 15 Kg per plot of poultry manure for an enhanced vegetative growth and nutritional quality of *A. cruentus*.

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