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Growth and Yield of Amaranth (*Amaranthus cruentus*) as Influenced by Poultry Manure Rates and Variety in Sudan Savanna, Nigeria

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Abstract: *Amaranth is a general-purpose plant whose leaves and grains are tasty and of high nutritional value. It is a vegetable plant grown in Nigeria with huge benefits, mostly for its vegetative parts used in soup making, stew, salad porridge and for garnishing. Low fertility of native soils is hindering its production in Nigeria. The use of chemical fertilizer to increase yield is effective only within a few years, demanding consistent use on a long term basis. The negative health and environmental impacts made inorganic fertilizers not only detrimental but also financially ineffective and beyond the reach of the poor farmers who still dominate the Nigerian agricultural sector, theses have necessitated the use of organic manure, a readily available alternative, which proves more environmentally friendly. A factorial pot experiment was conducted at the Teaching and Research Farm of Faculty of Agriculture, Bayero University Kano to study the effect of variety and different levels of poultry manure on the growth and yield of Amaranthus cruentus. The treatments consisted of 3 varieties (Hemera, White Amaranth and Black Amaranth) and 4 levels of poultry manure rates (0, 10, 20 and 30 t ha^{-1}), the treatments were arranged in Complete Randomised Design (CRD) and replicated three times. The parameters studied were plant height, the number of leaves, stem girth and leaf area/plant. The result showed that Black Amaranth variety performed better than other varieties, while poultry manure rates do not affect growth and yield of Amaranth varieties.*

Key words: *Amaranthus, poultry manure, varieties, hemera, Sudan Savanna*

INTRODUCTION

Amaranth is the unified name for the domesticated species of the genus Amaranthus (family *Amaranthaceae*). It is among the first generation of food crops in the world (Gigliola & Vera, 2012), and one of the most promising plant genera, and it consists of approximately

70 species of which 40 originated from the Americans, 17 are mainly vegetable species, three are grain while others are weedy (Andreas *et al.,* 2011). Amaranth is a multipurpose crop whose leaves and grains are tasty and of high nutritional value, additionally, it can be cultivated as an ornamental plant (Venskutonis & Kraujalis, 2013). The genus Amaranthus has received considerable attention in many countries because of the high nutritional value of some species that are essential sources of food, either as vegetable or grain (Srivastava, 2001).

Amaranthus (*Amaranthus cruentus*) is a staple vegetable plant grown in Nigeria, for its leafy material used in Nigerian dishes such as soup, stew, salad porridge and as garnish (Abdullahi *et al.,* 2019). It is a long-stemmed annual plant with a short life cycle of two to three months and is widespread in different climatic zones of the savanna. Its cultivation and consumption is becoming increasingly popular and more than 60 species are under cultivated in Asia, Australia, North and South America, Europe and Africa (Spetter and Thompson, 2007).

The use of chemical fertilizer to increase yield is effective only within a few years, demanding consistent use on a long term basis. The environmental hazards and high cost of these fertilizers make them undesirable, uneconomical and beyond the reach of the poor farmers make the population of Nigerian agricultural sector, this warrants for the use of organic manure, a readily available alternative, which proves more environmentally friendly (Adzemi *et al.,* 2017). Chemical fertilizers are frequently used to rejuvenate and maintain soil fertility to boost farm productivity but long term reliance on synthetic fertilizers jeopardizes the environment leading to unsustainable crop production. Also the extent to which chemical farming can be depended on to increase farm output is constrained by high cost and untimely availability of the right type of inorganic fertilizers as well as lack of technical skills and limited financial capacity of traditional farmers who dominate crop agriculture in Nigeria for their livelihood to purchase the fertilizers (Haruna et al., 2018).

Similarly, organic wastes are also being advocated for by different environmental organisations worldwide to preserve the sustainability of agricultural systems. Furthermore, poultry manure is preferred among other animal wastes because of its high concentration of macro-nutrients (Haruna et al., 2019). Adeniyan & Ojeniyi (2005) indicated that fresh poultry manure dropping contains 70% water, 1.4% N, 1.1% P_2O_5 and 0.5% K_2O. Among the different source of organic manure used in crop production, chicken dropping was found to be among those with high concentration of nutrients (Lombin *et al.,* 1992). Kostchi et al. (1989) reported that application of chicken manure increased the availability of some soil minerals, and especially the transfer of nutrients from rangeland to the plant. Izunobi (2002) reported that poultry manure, especially those produced in a deep litter and/or battery cage house, is the best known farmyard manure supplying more considerable amounts of absorbable plant nutrient. Fabiye & Ogunfowore (1992) noted that poultry dropping plays significant roles in enhancing the yield of crops. Amujoyegbe et al. (2007) deduced that poultry manure increased the leaf area, total chlorophyll content and grain yield of maize and sorghum. Ibeawuchi *et al.* (2007) reported that 8t/ha of poultry manure resulted in significantly higher grain yield, dry matter and an increased leaf of maize. Fagimi & Odebode (2007) reported that poultry droppings applied at the rate of 10 t/ha and 20 t/ha influenced the plant height, number of leaves and fruit yield of pepper while the severity of pepper veinal mottle virus (PVMV) was reduced.

MATERIALS AND METHODS

A pot experiment was conducted at the Teaching and Research Farm of Faculty of Agriculture, Bayero University, Kano (11^0 59'N; 8^0 25'E) in the Sudan Savannah ecological zone of Nigeria, during the raining season of 2018. The research was carried out to study the effect of variety and poultry manure rates on the growth and yield of amaranths (*Amaranthus cruentus*). The treatments consist of three (3) different varieties of Amaranth (Hemera, white amaranth and black amaranth) and four (4) different rates of chicken manure (0, 10, 20, and 30 t/ha). This gives a total of twelve (12) treatments replicated 3 times to give a total of 36 pots of 7.6 kg each. The experimental design for this study was a completely randomised design (CRD).

Two weeks after the incorporation of the manure according to respective treatment, three seeds were sown in each pot and thinned to 1 stand per pot after establishment.

Parameters studied: The following parameters were observed during the study periods:

Plant height (cm):- The plant height per plant was measured by the use of a meter rule and average height was taken at 3, 5 and 7 WAS.

Number leaves - The number of leaves of the tagged plants per plot were calculated and means computed at 3, 5 and 7 WAS.

Leaf area per plant – also at 3, 5 and 7 WAS. Data for this study were analysed using analysis of variance (ANOVA) with GEMSTAT (Gemstat, 2011) and means separated using Student-Newman Keuls Test (SNK)

RESULTS AND DISCUSSION

Plant height (cm)

The effect of poultry manure and Amaranth varieties on plant height per plant at 3, 5 and 7 WAS are shown in Table 1. The result shows that the varieties have a significant effect on plant height at 3 WAS and Black amaranth recorded significantly taller plant while White amaranth recorded the shortest. Also, the effect of poultry manure on plant height was not significant at all sampling periods at 3 WAS. Table 2 shows the interaction of poultry manure and varieties at 3 WAS. The result indicated that varieties Hemera that received zero application of poultry manure recorded the shortest plant, while the remaining varieties under the various level of poultry manure were at par recorded significantly taller plants.

This position was already reported by Egharevba & Ogbe (2002), the highest plant exhibited by plants treated with poultry manure at the rate of 12 t ha^{-1} might have been due to presence of primary nutrients (N, P and K) plus calcium and magnesium found in organic manure, confirmed by FAO, (2007).

Number of leaves

The effect of poultry manure and Amaranth varieties on the number of leaves per plant at 3, 5 and 7 WAS was shown in Table 2. The result shows that the varieties had a significant effect on the number of leaves at 3 WAS, with Hemera recording significantly higher number of leaves at while Black amaranth recorded the least number of leaves. Also, poultry manure rate of 10t, 20t and 30t/ ha were at par and recorded a significantly higher number of leaves at 3 WAS. At 7 WAS, application of 30 t/ha was at par with an application of 10 and 20t/ha and recorded significantly higher number of leaves per plant, while zero application recorded the least. The interaction between varieties and poultry manure was

significant at 7 WAS. Variety Hemera with no application of poultry manure recorded the significantly lowest number of leaves than the other varieties under various application of organic manure. The more the number of leaves are the better the overall performance of amaranths as the leaves serve as the photosynthetic organ of the plant (Ayodele, 1983).

Stem girth

Table 1 shows the effect of varieties and poultry manure on stem diameter of amaranth plant. The result shows that poultry manure and amaranth varieties had no significant effect on stem diameter per plant at all sampling periods. Interaction between varieties and poultry manure rates were not significant at all the sampling periods. This finding was in harmony with the reports by Akanbi and Togun (2002) that the widest girth of amaranths stems was recorded at 12 t ha^{-1} at 4 WAS In both cropping seasons.

Leaf area/plant:

Table 3 shows the effect of poultry manure and amaranth varieties on leaf area per plant at 3, 5, and 7 WAS. The result showed that varieties had no significant effect on leaf area, and the effect of poultry manure on leaf area was not significant at all sampling periods. The interaction between the crop varieties and poultry manure is having no significant impact at all sampling periods. Akanbi & Togun (2002) reported having widest L.A when poultry manure was applied at the rate of 12 t ha^{-1} throughout the cropping seasons.

Table 1: Effect of poultry manure and amaranth varieties on plant height (cm), number of leaves and stem girth (mm)/plant at 3, 5 and 7 weeks after sowing (WAS)

Treatments	Plant Height (cm)			Num of Leaves/Plant			Stem Girth (mm)		
	3	5	7	3	5	7	3	5	7
Variety (V)									
Black A	29.81a	42.7	13.58	9.25c	14.36	6.59	4.06	5.02	3.89
Hemera	15.78c	20.7	5.57	10.92a	13.33	6.00	3.06	3.78	3.75
White A	25.01b	33.3	9.94	10.41b	10.95	6.99	3.65	4.07	3.64
SE±	1.46	2.19	0.77	0.59	1.10	0.40	0.33	0.382	0.25
PM Rates (t/ha)									
0	21.89	29.8	10.15	8.02b	10.65	5.99b	3.87	4.03	4.20
10	23.76	33.6	9.19	11.01a	13.35	6.18ab	3.29	4.79	3.07
20	23.98	34.1	10.14	10.74a	13.85	6.16ab	3.44	4.79	4.04
30	25.01	31.5	9.31	11.00a	13.67	7.78a	3.76	4.09	3.74
SE±	1.69	2.52	0.88	0.68	1.27	0.47	0.39	0.44	0.28
V x PM	*	NS	NS	NS	NS	*	NS	NS	NS

Means in the same column, having the same letter(s) are not significantly different at P ≤ 0.05 using Student Newsman-Keuls Test. PM= Poultry Manure; A= Amaranth; NS= not significant

Table 2: Effect of interaction of poultry manure rates and amaranth varieties on plant height (cm) and number of leaves at 3 and 7 WAS respectively

Treatments	Plant Height (cm)	Number of Leaves
BA0	21.66a	6.24ab
BA10	31.32a	5.65ab
BA20	29.27a	6.15ab
BA30	31.00a	8.33a
HE0	6.13b	3.67b
HE10	16.13a	6.67ab
HE20	20.17a	6.33ab
HE30	20.17a	7.33ab
WA0	30.37a	8.64a
WA10	23.83a	5.67ab
WA20	22.50a	6.00ab
WA30	23.33a	7.67ab

Means followed by the same letter (s) within a column of each treatment group are not significantly different at 5% level of probability using Newman-Keuls Test. BA= Black Amaranth; HE= Hemera; WA= White Amaranth

Table 3: Effect of poultry manure and amaranth varieties on leaf area (cm2) at 3, 5 and 7 WAS

	WAS		
Treatments	3	5	7
Variety (V)			
Black A	39.9	125.3a	53.4
Hemera	96.7	93.2a	54.5
White A	83.0	93.9b	49.3
SE±	3.76	9.67	3.78
PM Rates (t/ha)			
0	92.7	87.0	54.4
10	93.4	112.0	55.4
20	87.7	105.8	54.2
30	91.0	101.7	45.6
SE±	4.34	11.16	4.36
V x PM	NS	NS	NS

Means followed by the same letter (s) within a column of each treatment group are not significantly different at 5% level of probability using Newman-Keuls Test. BA= Black Amaranth; HE= Hemera; WA= White Amaranth; NS= not significant

CONCLUSION

From the findings of this study, Black Amaranth variety should be adopted for higher plant weight and Hemera for more number of leaves in the study area, while application of poultry manure, at any rate, is of no significant effect. Further field experiment within the research area is recommended.

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