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RESEARCH PAPER

GROWTH AND PERFORMANCE ANALYSIS OF *AMARANTHUS HYBRIDUS* L. ENRICHED WITH ORGANIC (SUGARCANE BAGASSE-BASED) FERTILIZER

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ABSTRACT

The study was carried out to determine the growth and performance analysis of *A. hybridus* enriched with organic and inorganic fertilizer in Odi, Bayelsa State, between February and March 2017. The study adopted a randomized complete block design (RCBD), with three replications. Data were obtained for plant height, number of leaf, stem girth, leaf width, leaf length and weight of plant on ten (10) plants that were randomly sampled. The results obtained 49 days after planting (DAP), showed significant differences ($p<0.05$) in plant height (80.07 cm), leaf length (33.94 cm), leaf width (12.43 cm), stem girth (7.20 cm) and mean number of leaves (38.80) respectively in treatment A (Organic). Similarly, plants in treatment A also recorded more weight than other treatments with weight of 5.5 kg. Based on the findings, sugarcane bagasse-based organic fertilizer may be recommended for maximum growth and returns of *A. hybridus* and other crops

Keywords: *Amaranthus hybridus*, Organic fertilizer, Inorganic fertilizer, Odi

INTRODUCTION

Amaranthus, collectively known as amaranth is a short-lived annual plants. It is an important vegetable in human diet as a source of nutrients such as vitamins, minerals, sugar, water, protein and fiber needed for healthy body growth and sustenance (Bailey, 1992). *Amaranthus hybridus* L. is an herbaceous plant that is common in waste places, cultivated fields and barnyards. In Nigeria, *A. hybridus* leaves combined with condiments are used to prepare soup, sauce for rice and yam (Oke, 1983; Mepha *et al*, 2007). *A. hybridus* has been shown to contain large amount of Squalene – a compound that has both health and industrial benefits (Rao and Newmark, 1998, Smith, 2000).

The 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 of Nigeria. However, yields increase are dependent on many factors ranging from water availability and distribution, spacing as well as nutrients supply, which is the major determinant of field addition or subtraction (Tindall, 1992).

Apart from the use of green manure, farmyard manure, inorganic fertilizers, crop residues and biofertilizers, organic manure has remain one of the most effective tools in improving the fertility status, tilt and soil productivity. Comparatively, organic manure outweighs inorganic fertilizers in terms of having a wide range of essential nutrients and organic matter needed by plants, since nutrients are held in organic form. It is therefore imperative to supplement nutrients to soil to boost plants growth and yield (Akanbi *et al*., 2003; Adeoye *et al*., 2015).

Some of the problems encountered by amaranth growers include decreasing soil fertility and quantity of manure required for optimum crop productivity (Lucas and Ojeifor, 1985; Adeyemi *et al*, 1987), inadequate supply of chemical fertilizer

and lack of capital to buy them (Olufolaji *et al*., 1999). However, to increase the availability of high quality amaranth throughout the year at reduction in its price, there is need to use organic manure since there is abundance of rains in the South-South region of Nigeria to encourage its decomposition. Hence, the aim of this study is to determine the growth and performance analysis of *A. hybridus* enriched with organic (sugarcane bagasse-based) and inorganic fertilizer (NPK) in Odi, Bayelsa State.

MATERIALS AND METHODS

Experimental site: A field experiment was conducted in Bioresources Development Centre Odi, Bayelsa State of Nigeria, during the early planting season of 2017, between February and March. Odi have its geographical coordinates of 5^0 34'0" North, 5^0 43'0" East, and is located in the ecological zone of southern Nigeria.

Experimental design: The experimental design was a completely randomized block design with three (3) replications. The experimental site was cleared, packed and tilled before the preparation of the seed bed. The beds marked and measured 10 m length and 50 cm width. Planting holes were dibbled with sharp pointed stick at 50 cm within row and the seedlings were firmly transplanted three (3) weeks after sowing in the nursery. At the time of transplanting, the seedlings were about 3-4 cm in height.

Soil sampling, preparation and analysis: Surface soil sampling was collected from the field, air dried for 7 days and sieved using 2 mm mesh sieve to remove debris and stones. The soil was analyzed and the result obtained as shown in table 1.

Planting material and organic manure preparation: *A. hybridus* seeds were gotten from the Advanced Bioresources Developmental Laboratory. The seeds were raised in a nursery and watered for three (3) weeks. Transplanting was done under cool morning weather after 14 days at a spacing of 50cm within row. Organic and inorganic fertilizer was introduced to the field at twenty one (21) days before transplanting, fourteen (14) days after transplanting and thirty five (35) days after transplanting and watered daily. The organic manure used for this research was prepared using sugarcane bagasse, poultry droppings and a well decomposed plant residues at a ratio of 3:2.5:1 respectively. The sugarcane bagasse was dried and carbonized. The manure was further subjected to analysis and result shown in table 2.

Growth and morphological data collection: Random sampling of ten (10) plants from each of the three treatments (replicates) – Treatment A (Organic), Treatment B (Inorganic) and Treatment C (Control) was done for data collection on plant height (cm), number of leaves, leave length (cm), leave width (cm) and stem girth (cm).

The data obtained in this study were further subjected to statistical analysis using Analysis of Variance (ANOVA). The significant means were separated using Fisher Least Significant Difference (FLSD) at 5% probability level. The data were obtained weekly for six (6) weeks after transplanting.

RESULTS

Characteristics of soil and organic (Sugarcane bagasse-based) fertilizer

The properties of the soil are shown in Table 1 which shows the need of the soil under study for organic amendment. The properties of the organic fertilizer used in this study are shown in Table 2, which contain nutrient elements that will be useful to the growth of the Amaranth plant.

Table 1: Characteristics of the experimental soil

S/N	PARAMETER (S)	VALUE
1	Total dissolved solids, TDS (mg/kg)	22
2	pH	6.20
3	Conductivity (µs/cm)	40
4	Chloride (mg/kg)	6.0
5	Salinity (mg/kg)	9.9
6	Phosphate (mg/kg)	0.20
7	Nitrate (mg/kg)	0.7
8	Temperature (^{0}C)	26.7
9	Magnesium, Mg (g/kg)	0.679
10	Calcium, Ca (g/kg)	0.429
11	Iron, Fe (g/kg)	5.521
12	Manganese, Mn (g/kg)	0.113

Table 2: Analysis of the organic fertilizer (Sugarcane bagasse-based)

S/N	PARAMETER (S)	VALUE
1	Total dissolved solids, TDS (mg/kg)	331.6
2	pH	8.93
3	Conductivity (µs/cm)	603
4	Chloride (mg/kg)	85
5	Salinity (mg/kg)	140.2
6	Phosphate (mg/kg)	1.11
7	Nitrate (mg/kg)	2.6
8	Temperature (^{0}C)	26.9
9	Magnesium, Mg (g/kg)	1.113
10	Calcium, Ca (g/kg)	4.901
11	Iron, Fe (g/kg)	3.058
12	Manganese, Mn (g/kg)	0.158

Effect of fertilizers on the growth and morphology of *Amaranthus*

The highest plant height was recorded for treatment A. The result reveals that organic fertilizer affected plant height significantly. The plants height in treatment A was 80.1 cm when the plant was 49 DAP, treatment B had 58.0 cm whilst treatment C had 48.8cm respectively. There was also a significant difference in the plant height in treatment A as there was no significant difference in plant height between treatment B and C.

The effect of organic fertilizer on the number of leaves was more significant at 42 and 49 DAP as the mean number of leaves was 25.4 and 38.8 respectively as shown in Table 4. However, there was a significant difference in the number of leaves of the *Amaranthus* in treatment A as shown in table 4 above. *Amaranthus* in treatment A and B did not show any significant difference in number of leaves at 28 and 35 DAP.

The treatment with the highest stem girth was treatment A at 49 DAP. The result also reveal that there was no significant difference in the mean stem girth of plants in treatment B and C, whilst significant difference was recorded in treatment A as shown in table 7.

The largest mean leaf lengths was (33.9), at 49 DAP and was recorded from plants grown in treatment A, and shortest leaf was (27.2), at 49 DAP, was measured from plants grown in treatment C as shown in table 5. The result further reveals that there was a significant difference between the leaf length in treatment A and the two other treatments at 28, 35, 42 and 49 DAP.

The widest mean leaf width at 49 DAP was 12.4 cm, and was measured from plants in treatment A. The narrowest mean leaf width was (9.5 cm), was recorded from plants grown in treatment C. Similarly, the highest weight (5.5 kg) was recorded in the application of organic fertilizer, followed by the inorganic acid with 3.6 kg as shown in Table 8.

Table 3: Summary of growth analysis of mean plant heights (cm) of the Amaranth at 49 days after planting (DAP)

Treatments	28(DAP)	35(DAP)	42(DAP)	49(DAP)
A (Organic)	10.27^{a}	21.89	50.67^{a}	80.07^{a}
B (Inorganic)	7.12^{b}	16.57	39.00^{b}	58.02^{b}
C (Control)	6.50^{b}	16.40	26.37^{c}	48.79^{b}
No. of Plant	30	30	30	30

I Values represent means of the plant height of 2017 planting season. II. Values within a column having different alphabet superscripts are statistically significant ($p<0.05$) according to Fisher Least Significant Difference (FLSD)

Table 4: Summary of growth analysis of mean number of leaves of the amaranth plant at 49 DAP

Treatment	28DAP	35DAP	42DAP	49DAP
A(Organic)	6.70	9.70	25.40^{a}	38.80^{a}
B(Inorganic)	6.80	9.60	17.70^{b}	28.80^{b}
C(Control)	5.60	9.30	14.50^{b}	24.20^{b}
No of Plant	30	30	30	30

I.Values represents means of the number of leaves of 2017 planting season. II. Values within a column having different alphabet superscripts are statistically significant ($p<0.05$) according to Fisher Least Significant Difference (FLSD)

Table 5: Summary of growth analysis of mean leave length (cm) of the amaranth at 49 DAP

Treatment	28DAP	35DAP	42DAP	49DAP
A(Organic)	7.06^{a}	17.31^{a}	27.47^{a}	33.94^{a}
B(Inorganic)	4.54^{b}	12.70b	22.02^{b}	31.89^{ab}
C(Control)	3.93^{b}	11.00^{b}	17.16^{b}	27.22^{b}
No of Plant	30	30	30	30

I.Values represents means of the plant leaf length of 2017 planting season. II. Values within a column having different alphabet superscripts are statistically significant ($p<0.05$) according to Fisher Least Significant Difference (FLSD)

Table 6: Summary of growth analysis of mean leaf width (cm) of the amaranth at 49 DAP

Treatment	28DAP	35DAP	42DAP	49DAP
A(Organic)	3.30[a]	6.15[a]	10.63[a]	12.43[a]
B(Inorganic)	1.59[b]	5.21[b]	8.45[b]	10.75[ab]
C(Control)	1.47[b]	4.20[ab]	7.09[b]	9.56[b]
No of Plant	30	30	30	30

I.Values represents means of the leaf width of 2017 planting season. II. Values within a column having different alphabet superscripts are statistically significant ($p<0.05$) according to Fisher Least Significant Difference (FLSD)

Table 7: Summary of growth analysis of mean stem girth (cm) of the amaranth at 49 DAP

Treatment	28DAP	35DAP	42DAP	49DAP
A(Organic)	2.62[a]	3.05[a]	5.21[a]	7.20[a]
B(Inorganic)	1.84[b]	2.18[b]	3.85[b]	5.66[b]
C(Control)	1.76[b]	2.01[b]	3.06[b]	5.08[b]
No of Plant	30	30	30	30

I.Values represents means of the stem girth of 2017 planting season. II. Values within a column having different alphabet superscripts are statistically significant ($p<0.05$) according to Fisher Least Significant Difference (FLSD)

Table 8: Mean performance and yield of amaranth after harvest at 49 DAP

Treatment	No of leaves	Plant height(cm)	Leave length (cm)	Leave width (cm)	Stem girth (cm)	Weight of plants sampled (kg)
Organic	38.80	80.07	33.94	12.43	7.20	5.5
Inorganic	28.80	58.02	31.89	10.75	5.66	3.6
Control	24.20	48.79	27.22	9.56	5.08	2.8

I.Values represents means of the performance and yield of amaranth of 2017 planting season. II. Values within a column having different alphabet superscripts are statistically significant ($p<0.05$) according to Fisher Least Significant Difference (FLSD)

DISCUSSION

Fertilizer is one of the most vital inputs contributing to crop production because it increases productivity and improves yield quantity and quality (Olaniyi *et al*., 2010). The general low ambient soil nutrient content made the soil suitable for study of responses to fertilizer. Application of organic fertilizer generally resulted in growth which compared favorably with NPK fertilizer.

Plant height is the major determinant of the plant's ability to compete for light. It determines the growth attained during the growing season. It increased with the amount of micro and macro nutrient supplied to the soil by the organic and inorganic fertilizers (Ndubuaku *et al*., 2015). Hence, the findings as shown in table 3, agrees with the report of Adeyemi *et al*, (1987), who observed that adequacy of organic manure increases plant height of *Amaranthus*.

The effect of organic fertilizer on the number of leaves indicates that the decomposition and availability of the organic fertilizer to the plants boost the number of leaves produced per plant. Tindall (1975) reported that *Amaranthus* require soils with high organic content and such soils favors the production of leaf number.

Stem girth determines the dimensional attainment of a plant during the growing period. It increases with the nutrient the soil gets. The treatment with the highest stem girth was treatment with organic fertilizer at 49 DAP which is in accordance with Ajari *et al*. (2003) who reported similar thing in okra.

The different treatment influenced the leaf length of the plant. The largest mean leaf lengths was recorded from plants grown in treatment A (organic fertilizer) which implies that organic manure favors the production of *Amaranthus hybridus* in the study area.

On the other hand, significant difference was also observed in the treatment A in the leaf width. However, significant variation of leaf width was found in treatment A due to the application of organic fertilizer. The application of the organic fertilizer similarly had a greater influence on the weight (kg) of the plant when harvested and recorded.

CONCLUSION

Amaranthus hybridus perform better when treated with organic fertilizer in the study area. Organic manure has proven to present a much viable agricultural and economic future for local farmers. At a time when cost of chemical fertilizer is skyrocketing and not affordable by farmers, sugarcane bagasse when incorporated with poultry droppings and decomposed plant residue will become a good source of nutrient and as a medium for raising sugarcane seedling, leguminous inoculants and other horticultural crops. Waste produce from sugarcane are organic in nature, and if augmented, it will improve the soil chemical, physical and biological properties as well as improve crop yield, quality, and also enhance nutrient availability to plants.

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AUTHORS'S CONTRIBUTIONS

Inyang JO, Abu T, Emmanuel AU, Friday JO, Bobai N, and Oise E were involved in several stages of this research, including the literature search, field experiment, manuscript drafting and draft revisions.