Original Artical
ISSN (Online): 2350-0530
ISSN (Print): 2394-3629

International Journal of Research - GRANTHAALAYAH
May 2021 9(5), 145–156

GROWTH RESPONSE OF GONGRONEMA LATIFOLIUM (AMARANTH GLOBE) TO SOURCES AND RATES OF ORGANIC MANURES IN AN ACID SOIL ENVIRONMENT OF TROPICAL REGIONS

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ABSTRACT

A field potted experiment was carried out in Asaba area of Delta State, Nigeria to evaluate sources and rates of organic manures (poultry and farmyard) on growth responses of Gongronema latifolium in an acid soil environment. It was a factorial experiment laid out in a randomized complete block design replicated 3 times. Data on plant height, number of leaves/branches, leaf area and stem girth were collected at 3, 5, 7, 9, 11 and 13 Weeks after sowing (WAS) and subjected to analysis of variance. The results that the effects on growth parameters of the crop were not significant and that higher application rates significantly increased plant height, number of leaves/branches and stem girth of G. latifolium. Application rates of 15 and 20 t/ha of both poultry and farm yard manures increased plant height from 10.45 cm to 12.52 cm and 8.12 cm and 10.68 cm respectively. The overall result indicated that the higher rate of organic manure, the better the response of growth indices of G. latifolium, though interaction effect was not significant. Poultry manure produced higher values of growth indices than farm yard manure, hence was recommended for increased productivity of G.latifolium in the study area.

Keywords: Growth, G Latifolium, Sources and Rates, Organic Manures, Acid Soil Environment

Received 5 May 2021
Accepted 19 May 2021
Published 31 May 2021

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DOI 10.29121/granthaalayah.v9.i5.2021.3916

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

1. INTRODUCTION

Gongronema latifolium (common name Amaranth globe) is an endangered crop specie of ethno-medical value among the local populace of Nigeria. It is commonly known as 'utazi' and 'orokeke' among the indigenous people of south east and south west Nigeria respectively.

Gongronema latifolium (Benth) is one of the tropical rainforest endangered crop species of great medicinal value. It is a very popular crop in the south east of Nigeria where it is known as 'utazi' and south west as 'arokeke' among the Yoruba tribe of south west of Nigeria. It is a climbing shrub with a heart-shaped leaf that can be propagated by seed or stem cutting. The stem is usually soft with characteristics tiny hairs and bitter taste when it is eaten fresh. It generally belongs to the family of plant known as Asclepiadacea and mostly seen in the tropical rainforest region mostly during the rainy season of April to September. It is one of those herbs commonly used as spice for sauces, soup and garnish some local delicacies (African salad) (Anaso and Onochie, 1999) and vegetable. In traditional folk medicine, it is used for the treatment of digestive problems such as loss of appetite, dyspepsia, constipation, dysentery and stomach ache Ugochukwu et al. (2003). According to Morebise et al. (2002)) and Ogundipe et al.,(2003), the medicinal values of the crop ranged from anti-oxidant, anti-inflammatory, hypolipidermic, hypoglycemicic and anti-asthmatic.

In the traditional African setting, *G. latifolium* is used essentially as a stimulating tonic for digestive system when it is combined with bitter leaf and scent leaf. Most importantly, the plant is essentially eaten by women that just put to birth as it is known to cleanse the womb and reduce abdominal pains after birth. It is also used in solving fertility problems such as infertility among women, low sperm count among men and cure minor ailments such as bruises, cuts and inflammations Nwachukwu et al. (2010).

In recent years, there are increasing health challenges from known to unknown ailments. Some of these ailments have proven stubborn and resistant to chemically synthesized drugs which are expensive, unaffordable among local people and its increasing problems of counterfeit. It therefore becomes necessary to look inward for alternative sources. The African medicinal herbs remained very strongly to be exploited. Because of the immense medicinal benefits of G. latifolium and the increasing population of people using it in combination with other herbs to cure various ailments, it becomes essential that the cultivation of the crop should be expanded using cheap local sources of soil amendment.

The objective of the study therefore was to assess the effects of locally sourced organic manures on growth parameters of *G. latifolium* in an acid soil environment of rainforest zone.

2. MATERIALS AND METHODS

2.1 STUDY AREA AND FIELD WORK

A potted field experiment was carried out during the months of June to September 2019 in a botanical garden located at Asaba, Delta State, Nigeria. Rainfall received during the period of study ranged between 1,250 mm to 1,450 mm. relative humidity during same period was between 70 – 85%, while the temperature was 35^0C. Soil was collected from a nearby fallow land at a depth of 0 – 30 cm. The soil was dried, crushed and sieved through a sieve mesh of 2 mm in diameter. Some portions of the soil samples were used for routine soil analysis (Table 1). The initial soil properties analysed were particle size distribution, soil pH, organic matter, total nitrogen, available phosphorus, exchangeable cations and cation exchange capacity. The organic wastes were air-dried, grinded and sieved and subsequently analyzed for their chemical composition (Table 2).

The treatments consisted of 5 levels each of poultry and farm yard manures at (0, 5, 10, 15 and 20 t/ha). The poultry manure and farm yard manure were collected from a nearby poultry house within the experimental site. This factorial experiment was arranged in a randomized complete block design with three (3) replicates. Approximate weight of organic waste were taken an properly incorporated into the soil in the plastic pots and allowed to decompose and mineralize for two weeks.

G. latofolium seedlings were brought from a nearby local market. Four seedlings were sown directly into the pots and later thinned to two seedlings per pot at 2 weeks after sowing. The pots were regularly watered using water hose at 3 days intervals to enable the seedlings to establish properly.

Data on plant height, number of leaves, number of branches, stem girth per plant and leaf area were taken at 5, 7, 9, 11 and 13 weeks after sowing (WAS). The height of the plants in each pot was measured from the ground level to the apex of the last leaf using centimetre rule. The number of leaves and branches were taken by counting. Stem girth per plant was measured using viernier callipers and leaf area was measured using leaf area metre.

The organic manure rates were estimated by using furrow-slide method. In this method, the soil in each pot weighed 5 kg. Thus, the rates were calculated using the following formula:

$$R = \frac{Y \times W}{2{,}000{,}000}$$

Where R = weight of organic manure per pot

W = weight of soil in each pot

Y = manure rate on per hectare basis

2,000,000 = equivalent weight of soil from 1 hectare of land which is 10,000 m^2.

The crop was harvested at 13 (WAS).

2.2 STATISTICAL ANALYSIS

The data collected was subjected to statistical analysis of variance (ANOVA) to test for significance in effects of treatments as described by Snedecor and Cochran (1980). Main effects of treatments interactions were determined by all characters in accordance with Gomez and Gomez (1984).

3. RESULTS AND DISCUSSION

The results of soil properties and analysis of manures are shown in Tables 1 and 2 . The soil was sandy loam in texture, strongly acidic pH in water (5.5) and in $Cacl_2$

(4.7), low in organic carbon (5.46 gkg^{-1}), total nitrogen (0.65gkg^{-1}) and available phosphorus (3.86 $mgkg^{-1}$). Exchangeable bases and cation exchange capacity with these values; Ca (2.52 $cmolkg^{-1}$), Mg (0.64 $cmolkg^{-1}$), K (0.15 $cmolkg^{-1}$), Na (0.03 $cmolkg^{-1}$) and cation exchange capacity (6.38 $cmolkg^{-1}$) were generally low (Table 1).

Table 1 Properties of the soil used for the study

Soil characteristics	Values obtained
Soil pH (in water)	5.5
Soil pH (in $CaCl_2$)	4.7
Organic carbon (gkg^{-1})	5.46
Total nitrogen (gkg^{-1})	0.65
Available phosphorus ($mgkg^{-1}$)	3.86
Exchangeable bases ($cmolkg^{-1}$)	
Ca	2.52
Mg	0.64
K	0.15
Na	0.03
Cation exchange capacity ($cmolkg^{-1}$)	6.38
Particle size analysis (%)	
Sand	75.20
Silt	12.50
Clay	12.30
Textural class	Sandy loam

Table 2 Chemical properties of the organic sources (poultry and farm yard manures) used for the study

Parameters	Poultry manure	Farm yard manure
pH (H_2O)	7.8	8.25
Organic matter (gkg^{-1})	25.74	32.15
Total nitrogen (gkg^{-1})	3.45	2.75
Available phosphorus (gkg^{-1})	27.56	23.28
$Ca^{++\leftarrow}$	5.42	5.13
$Mg^{++}\leftarrow cmolkg^{-1}$	1.8	1.6
$K^{+\leftarrow}$	0.35	0.46

Table 2 presents the result of the chemical analysis of the Poultry manure and-Farm yard manures used for the study. The pH of the treatment sources showed slightly alkaline 7.8 and moderately alkaline 8.25 for poultry and farm yard manures respectively. The organic matter and total nitrogen contents with values 27.74 gkg^{-1} for poultry manure and 32.15 gkg^{-1} for farm yard manure were moderate to very high. Total nitrogen with value of 3.45 gkg^{-1} was higher in poultry manure than farm yard manure 2.75 gkg^{-1}. In the same vein, available phosphorus was quite high in poultry manure 27.56 $mgkg^{-1}$ compared to 23.28 $mgkg^{-1}$ in farm yard manure.

The farm yard manure had higher concentration of Potassium 0.46 cmolkg^{-1} than 0.35 cmolkg^{-1} obtained in poultry manure. The overall result of the chemical analysis of the organic sources showed that they were very rich in nutrient contents that are necessary for plant growth and development.

The low pH, organic matter content, total nitrogen, available phosphorus, exchangeable bases and cation exchange cation exchange associated with the soil type of the study area (oxisols) have been described as nutritionally deficient in major plant nutrients Agboola and Unamma (1991). The low nutrient capacity of the experimental soil is highly linked to the rainfall characteristics of the environment which is usually terrific at the time of the study. This causes enormous soil erosion, leaching of nutrients especially of basic cations from the top soil and high soil acidity. Also, the nature of the clay minerals which are dorminantly kaolinite with characteristics low content of activity clay contributed to the low fertility status of the soil. The result of the initial physical and chemical characteristics of the experimental site conformed with previous reports of soils of the environment Kennedy et al. (2018).

3.1 EFFECTS OF TREATMENT APPLICATIONS ON GROWTH PARAMETERS OF G LATIFOLIUM

Table 3 shows the effects of rates of poultry and farm yard manures on plant height of *G. latifolium*. At 3, 5 and 7 WAS, the different rates of treatment application had no significant effect on the plant height per plant of *G. latifolium*, although there was an increase on plant height as affected by treatment application at 11th and 13th WAS in both manure types. However, the increase was not statistically different in relation to treatment interaction. Observed effects at weeks 3, 5 and 7 WAS and at different rates of application were not statistically different.

The response of number of leaves per plant of G. latifolium at 3, 5, 7, 9, 11 and 13 WAS to different rates of poultry and farmyard manures is presented in Table 4 . There were no significant differences in the number of leaves per plant, though higher rates of application of poultry and farmyard manures resulted in higher number of leaves per plant of the crops, while plants in the control plot which did not receive manure had lower number of leaves.

Plants that did not receive poultry manure (0 t/ha) gradually increased in number of leaves from 3.42 at 3 WAS to 6.15 at 13 WAS, while plants that received poultry manure application rate of 20 t/ha) gradually increased from 5.25 at 3 WAS to 7.85 at 13 WAS.

Similarly, plants that received farmyard manure application rate of 0 t/ha gradually increased in number of leaves from 3.12 at 3 WAS to 6.10 at 13 WAS, while plants that received 20 t/ha of same manure gradually increased from 5.25 at 3 WAS to 8.05 at 13 WAS.

Indicates the effects of treatment on the number of branches per plant of *G. latifolium*. There was generally no observed effect at 3, 5 and 7 WAS as treatment application at different rates did not produce any branches. However branches emerged at

9, 11 and 13 WAS. The highest number of branches approximately 2 to 3 branches per plant were obtained at 15 and 20 t/ha of both poultry and farm yard manures application. The result reflected the slow growth of *G. latifolium* generally. The interaction effects between treatments was not significant.

Table 6 shows the effects of rates of manure types in stem girth of *G .latifolium* at 3, 5, 7, 9, 11 and 13 WAS. Plants in the control plot in treatments of both poultry and farmyard manure had lower stem girth per plant, while plants that received higher rates of manure had higher stem girth. These were no significant differences in the stem girth of *G .latifolium* due to the treatment applications.

Plants that received 0 t/ha of poultry manure graduallt increased from 0.15 cm at 3WAS to 0.30 cm at 13 WAS, while plants that received 20 t/ha of poultry manure gradually increased from 0.98 cm at 3 WAS to 2. 15 cm at 13 WAS.

Plants that received farmyard manure application rate of 0 t/ha gradually increased from 0.15 cm at 3 WAS to 0.30 cm at 13 WAS. Plants that received 20 t/ha of farmyard manure also gradually increased from 0.94 at 3 WAS to 1.05 cm at 13 WAS.

The application of poultry and farm yard manure at different rates and weeks after planting did not significantly have major effect on stem girth. Stem girth generally increased at the 13 WAS at application rates of 20t/ha. Stem girth increased from 0.98 to 2.15cm at 20 t/ha of poultry manure application and 0.94 cm to 1.95 cm at 20 t/ha of farm yard manure treatment application. The interaction effect was not significant.

The response of leaf area per plant at 3, 5, 7, 9, 11 and 13 WAS to different rates of poultry and farmyard manure is shown in Table 7 . Leaf area per plant of G. latifolium was not significantly influenced by treatment application at different rates and weeks after planting. At the 11^{th} and 13^{th} weeks after sowing and at 15and 20 t/ha of poultry manure, leaf area increased significantly to 2.88 cm and 3.20 cm and 3.15 to 3.42cm respectively.also, application rate of 15 t/ha of farmyard manure at 11 WAS had leaf area of 2.14cm and 3.18cm, respectively while 20 t/ha of same manure had leaf area of 2.86cm and 3.30cm at 13 WAS, respectively. However they were not statistically different but different at 0, (1.19 cm), 5 (1.19 cm) and 10 (1.21 cm) t/ha application of farm yard manure (Table 7).

Significant effect was not observed in the interaction.

Table 3 Effect of rates of poultry and farm yard manures on plant height of G. latifolium

Treatment	**Plant height (cm)**					
Weeks after sowing						
	3	5	7	9	11	13

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Table 3 continued

Poultry manure (t/ha)						
0	3.04^d	3.14^d	5.24^d	5.42^d	7.14^e	10.12^d
5	3.04^d	3,16^d	5.42^c	5.84^c	7.95^d	10.18^d
10	3.45^c	3.65^c	5.85^b	6.12^b	8.25^c	11.00^c
15	4.15^b	4.30^b	5.28^d	5.56^d	10.45^b	12.52^b
20	6.42^a	6.85^a	8.10^a	8.72^a	11.32^a	13.48^a
SE ±	1.42	1.54	1.21	1.36	1.93	1.49
Farm yard manure (t/ha)						
0	2.85^d	3.10^c	5.10^c	5.45^d	6.85^d	9.78^d
5	2.88^d	3.25^c	5.12^c	5.48^d	6.90^d	9.86^d
10	3.17^c	3.55^c	5.38^c	5.76^c	7.10^c	10.32^c
15	3.88^b	3.92^b	5.72^b	5.88^b	8.12^b	10.68^b
20	5.48^a	5.82^a	7.74^a	7.86^a	10.10^a	12.72^a
SE ±	1.10	1.10	1.12	1.01	1.38	1.20
Interaction						
PM × FYM	NS	NS	NS	*	*	*

Means in the same column with similar alphabets are not significantly different at P≤ 0.05 using Duncan Multiple Range Test (DMRT)
NS = Not significantly different * = Significantly different at p< 0.05

Table 4 Effects of rates of Poultry and farm yard manures on the number of leaves per plant of G. latifolium at 3, 5, 7, 9, 11 and 13 WAS

Treatment	**Number of leaves**					
Weeks after sowing						
	3	5	7	9	11	13
Poultry manure (t/ha)						
0	3.42^{c}c	3.52^d	4.15^c	4.35^d	5.14	6.^{15e}
5	3.48^b	3.75^c	4.20^c	4.40^d	6.15	6.52^d
10	4.15^b	5.10^b	5.25^b	5.72^c	5.85	6.82^c
15	5.72^a	5.82^a	6.13^a	6.70^b	6.85	7.10^b
20	5.75^a	5.90^a	6.35^a	6.84^a	7.15	7.85^a
SE ±	1.16	1.13	1.04	1.20	0.80	0.64
Farm yard manure (t/ha)						
0	3.12^c	3.30^c	4.10^c	4.15^d	5.24^e	6.10^d
5	3.15^c	3.35^c	4.21^c	4.28^d	5.56^d	5.98^d
10	4.00^b	4.15^b	5.12^b	5.18^c	6.34^c	6.51^c

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Table 4 continued

15	5.15^{a}	5.35^{a}	6.10^{a}	6.25^{b}	7.25^{b}	7.85^{b}
20	5.25^{a}	5.45^{a}	6.25^{a}	6.75^{a}	7.54^{a}	8.05^{a}
SE ±	1.04	1.04	1.01	1.16	1.01	0.98
Interaction						
PM × FYM	*	*	NS	NS	NS	NS

Means having the same letters in the same column are not significantly different at P≤ 0.05 using Duncan Multiple Range Test
NS = Not significantly different * = Significantly different at p< 0.05

Table 5 Effects of manure on the number of branches per plant of G .latifolium at 3, 5, 7, 9, 11 and 13 WAS

Treatment	**Number of branches**					
Weeks after sowing						
	3	5	7	9	11	13
Poultry manure (t/ha)						
0	0	0	0	1.52^{b}	1.85^{a}	2.12^{a}
5	0	0	0	1.52^{b}	2.10^{a}	2.56^{a}
10	0	0	0	1.85^{b}	2.18^{a}	2.75^{a}
15	0	0	0	2.12^{a}	2.18^{a}	3.07^{a}
20	0	0	0	2.45^{a}	2.75^{a}	3.10^{a}
SE ±	00	00	00	0.40	0.33	0.40
Farm yard manure (t/ha)						
0	0	0	0	1.15^{a}	1.80^{a}	2.05^{a}
5	0	0	0	1.15^{a}	1.85^{a}	2.05^{a}
10	0	0	0	1.60^{a}	1.90^{a}	2.65^{a}
15	0	0	0	2.20^{a}	2.25^{a}	3.00^{a}
20	0	0	0	2.25^{a}	2.34^{a}	3.14^{a}
SE ±	00	00	00	0.54	0.25	0.51
Interaction						
PM × FYM	NS	NS	NS	NS	NS	NS

Means with similar alphabets in the same column are not significantly different at P≤ 0.05 using Duncan Multiple Range Test
NS = Not significantly different

Table 6 Effects of rates of poultry and farmyard manures on stem girth per plant on G. latifolium at 3, 5, 7, 9, 11 and 13 WAS

Treatment	**Stem girth (cm)**					
Weeks after sowing						
	3	5	7	9	11	13
Poultry manure (t/ha)						
0	0.15[a]	0.15[a]	0.18[a]	0.20[a]	0.20[a]	0.30[b]
5	0.15[a]	0.15[a]	0.18[a]	0.20[a]	0.20[a]	0.30[b]
10	0.65[a]	0.65[a]	0.75a	0.75[a]	0.80[a]	0.82[b]
15	0.92[a]	0.92[a]	0.94[a]	0.98[a]	0.98[a]	2.00[a]
20	0.98[a]	0.98[a]	0.98[a]	0.98[a]	1.02[a]	2.15[a]
SE ±	0.40	0.40	0.40	0.40	0.41	0.90
Farm yard manure (t/ha)						
0	0.15[a]	0.15[a]	0.18[a]	0.20[a]	0.20[a]	0.30[a]
5	0.15[a]	0.15[a]	0.18[a]	0.20[a]	0.20[a]	0.30[a]
10	0.65[a]	0.65[a]	0.65[a]	0.65[a]	0.67[a]	0.75[a]
15	0.85[a]	0.85[a]	0.85[a]	0.85[a]	0.90[a]	1.35[a]
20	0.94[a]	0.94[a]	0.95[a]	0.95[a]	0.98[a]	1.95[a]
SE ±	0.38	0.38	0.37	0.35	0.37	0.46
Interaction						
PM × FYM	NS	NS	NS	NS	NS	*

Means in the same column with similar alphabets are not significantly different at P≤ 0.05 using Duncan Multiple Range Test (DMRT)

NS = Not significantly different * = Significantly different at p< 0.05

Table 7 Effects of rates of poultry and farmyard manures on leaf area per plant at 3, 5, 7, 9, 11 and 13 WAS

Treatment	**Leaf area (cm)**					
Weeks after sowing						
	3	5	7	9	11	13
Poultry manure (t/ha)						
0	1.21[a]	1.21[a]	1.23[a]	1.23[b]	2.25[a]	3.10[a]
5	1.21[a]	1.21[a]	1.23[a]	1.23[b]	2.25[a]	3.10[a]
10	1.25[a]	1.25[a]	1.25[a]	1.27[b]	2.85[a]	3.18[a]

Continued on next page

Table 7 continued

15	1.30^{a}	1.30^{a}	1.30^{a}	1.35^{b}	2.88^{a}	3.20^{a}
20	1.35^{a}	1.35^{a}	1.35^{a}	2.36^{a}	3.15^{a}	3.42^{a}
SE ±	0.06	0.06	0.05	0.49	0.41	0.13
Farm yard manure (t/ha)						
0	1.19^{a}	1.19^{a}	1.21^{a}	1.23^{a}	1.75^{b}	2.50^{a}
5	1.19^{a}	1.23^{a}	1.25^{a}	1.23^{a}	1.75^{b}	2.85^{a}
10	1.21^{a}	1.25^{a}	1.27^{a}	1.28^{a}	1.80^{b}	3.12^{a}
15	1.30^{a}	1.30^{a}	1.31^{a}	1.28^{a}	2.14^{b}	3.18^{a}
20	1.32^{a}	1.32^{a}	1.35^{a}	1.38^{a}	2.86^{a}	3.30^{a}
SE ±	0.06	0.05	0.06	0.06	0.48	0.32
Interaction						
PM × FYM	NS	NS	NS	*	NS	*

Means with similar letters under the same column are not significantly different at P≤ 0.05 using Duncan Multiple Range Test
NS = Not significantly different * = Significantly different at p< 0.05

The differences in growth response of G. latifolium to rates of applications at different WAS though statistically similar could be adduced to the variations in the mineral composition of the manures used as treatment. Poultry manure which had fairly higher concentrations of nitrogen and phosphorus regarded as chief minerals Kolay (2002) that are very important for crop growth and development showed higher performance in most of the G. latifolium growth performances evaluated than farm yard manure. In similar studies on the effects of organic manures on the performance of some African perennial crops, Aliyu and Kuchinda (2002); Obiora et al. (2015) reported the same trend of better performance than farm yard manure. Asiegbu and Oikeh (1995) opined that differences in response could be associated to the composition of the manures, types and health conditions of the birds, quality of feeds fed to the birds. Higher poultry manure and farm yard manure rates caused increased production of more leaves and by this, increasing the photosynthetic activities of *G. latifolium* which influenced positively taller plant height, number of leaves, leaf area and number of branches as seen in the study.

In some related studies on crop growth responses to different organic sources and rates of application. Adeniyan and Ojeniyi (2005) reported increased crop dry matter yield, plant height, leaf area and increased nutrient status of crops in response to poultry manure and farm yard manure at variable rates of application. Ojeniyi (2011) reported increase in soil organic matter, nitrogen, phosphorus, potassium, calcium and magnesium with the application of poultry and farm yard manure. The report further opined conclusively that poultry manure which invariably has higher nutrient content gave better growth and yield response than farm yard manure treatment. Dantata et al. (2011) also reported that poultry manure treated soil media gave higher number of branches, number of leaves and fruit yields of tomato that was comparatively treated with poultry manure and farm yard manure in a green house experiment.

The control plot (0 t/ha) and application rates of 5 t/ha in both treatments did not show appreciable response and performed less than higher rates. This implied that farmers should increase the rates of manure application to the cultivation of G. latifolium as recommended by Solowokere (2004) who indicated that organic manures improve soil quality, reduce soil acidity, improve soil chemical properties and increase yield of crops.

4. CONCLUSION AND RECOMMENDATIONS

The use of organic manure sources in the cultivation of *G. latifolium* is recommended in the tropics. It is relatively inexpensive source of both macro and micronutrients and serve as a good source for crop production. The present study showed that the application of higher rates of organic sources gave the highest yield of *G. latifolium* with respect to the growth parameters.

Poultry manure which performed best in all the growth parameters evaluated and is a cheap source of plant nutrient that can be locally sourced was recommended for increased yield of *G. latifolium* in the study area.

5. ACKNOWLEDGEMENT

The authors sincerely acknowledge the roles of staff of the laboratory in analysis. We also acknowledge the assistance of Mrs Azubuike Chinwe for typesetting and proof reading this work.

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