Sahel Journal of Life Sciences FUDMA (SAJOLS)
September 2024 Vol. 2(3): 170-176
ISSN: 3027-0456 (Print)
ISSN: 1595-5915(Online)
DOI: https://doi.org/10.33003/sajols-2024-0203-22

Research Article

Early Growth of Soursop *(Annona muricata)* as Affected by Different Levels of Powerplant Liquid Organic Fertilizer in Abraka, Delta State, Nigeria

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ABSTRACT
This study was conducted in 2022 and repeated in 2023 to assess the effects of Liquid Organic Fertilizer (LOF) on the early growth of soursop *(Annona muricata)* in Abraka, Delta State, Nigeria. Five different rates of fertilizer in litres per hectare were applied to the soil-filled poly pots where the seeds were planted according to the treatments – 0, 5, 10, 15 and 20 lha^{-1}. The experiment was carried out in a randomized complete block design with three replications. Six parameters were investigated to achieve the objectives of the study, including initial soil physicochemical properties, germination percentage (%), plant height, number of leaves/plant, leaf area and collar diameter of *Annona muricata*. The results of the study showed that plants that received 20 lha^{-1} of LOF were outstanding in all the parameters tested. Based on the findings of the study, it was therefore recommended that farmers adopt LOF application rate of 20 lha^{-1} for increased growth of *Annona muricata*in Abraka, Delta State, Nigeria.

Keywords: Early growth; Soursop; Rates; Organic fertilizer; Abraka; Nigeria

Citation: Enujeke, E.C. & Anwuli-Okoh, L.A. (2024). Early Growth of Soursop *(Annona muricata)* as Affected by Different Levels of Powerplant Liquid Organic Fertilizer in Abraka, Delta State, Nigeria. *Sahel Journal of Life Sciences FUDMA,* 2(3): 170-176. DOI: https://doi.org/10.33003/sajols-2024-0203-22

INTRODUCTION

Soursop (*Annona muricata*) originated from the warm and tropical regions of America (Moghadamtousi *et al.*, 2015). It belongs to the Annonaceae family, it requires well-drained soil with a pH of 6.1 to 6.5, spacing of 4m x 4m to 7m x 7m. The fruits, which grow on trees, are large and oval-shaped. The green exterior, which has spines on it, covers a white, fibrous flesh (Lotha, 2008). They grow up to 20cm and can weigh up to 4.5kg grams (Worrell *et al.*, 1994). Soursop's flavour can be described as a cross between a mango and pineapple, and has many uses to treat a wide range of health conditions and ailments. With its strong nutrient profile, it provides a variety of health benefits. It has a high content of Vitamin C, an antioxidant known to boost immune health (Oweh, 2018). The vitamin strengthens the immune system and improves its ability to defend itself against pathogens. It also promotes the destruction of free radicals, which can help to protect your skin and cells from environmental oxidative damage (Zamudio-Cuevas *et al*., 2014). One whole soursop contains 215% of your recommended daily allowance of Vitamin C. The leaves and fruits contain many antioxidants such as phytosterols, vitamins and flavonoids which play vital roles in protecting against a variety of health conditions. Other health benefits of soursop include enhancement of healthy digestion since whole fruit contain about 83% of the recommended daily allowance of fibre, which is a vital nutrient for your digestive health. Fibre helps to promote regularity and prevents such issues as constipation. Soursop helps to fight and prevent cancer of the breast by reducing its size by killing the tumours and cancer cells (Najmuddin *et al*., 2016). It could stop the formation of leukaemia cells (Pieme *et al*., 2014). The antioxidants contained in soursop help to reduce inflammation in the body (Chan *et al*., 2010; Hunter, 2012; Ishola *et al*., 2014). High blood pressure which leads to heart disease and heart attack due to the presence of sodium and potassium can be reduced or stopped by eating a whole fruit of soursop

(Manson *et al*., 1993). Soursop provides antibacterial effects that kill many strains of bacteria that cause gum disease and cavities (Viera *et al*., 2010: Pai *et al*., 2016). Besides vitamin C, soursop also contains vitamins B_1, B_2 and B_3 as well as folate, calcium, iron, potassium, magnesium, phosphorus and zinc. It contains 105 grams of carbohydrates, 21 grams of Fibre, 85 grams of sugar. Regular consumption of soursop prevents problems of Parkinson's disease and diabetes (Champy *et al*., 2005; Adeyemi *et al*., 2008; Ngueguim *et al*., 2014).

The enormous potentials of soursop and its health benefits notwithstanding, the reduction in soil fertility caused by continuous cropping and annual bush burning which exposes the soil to leaching of essential nutrient elements limits the production of crops including soursop in many agro-ecological systems (Enujeke, 2013). Inorganic fertilizers are costly and inaccessible to resource-poor farmers and leave long hazardous effects on soils and crop productivity. Conversely, liquid organic fertilizers are environmentally friendly, mineralized quickly and are easily absorbed through the leaves and roots of benefiting plants. (Enujeke *et al.*, 2013; Emuh *et al.*, 2015; & Ehigie *et al.*, 2023). The present study was therefore carried out to assess the effects of different rates of liquid organic fertilizers on the early growth of soursop to determine the most appropriate level required for enhancing its production in Abraka, Delta State, Nigeria.

MATERIALS AND METHODS

Site Description

The work was carried out at the experimental site of the Faculty of Agriculture, Delta State University, Abraka in 2022 and repeated in 2023. The site lies between Latitude 60°4'E and Latitude 5°4'N where the rainy season commences in April and ends in October, while the dry season is from November to March. The temperature of the site ranges from 25° to 31°c while rainfall is between 2000mm and 3000mm (Efe & Aruegodore, 2003).

Pre-planting Soil Analysis

The soil samples collected from the polypots were air-dried at room temperature (27°C) for three days, after which crushing and filtration using a 2mm sieve were done. Particle size distribution was obtained using the hydrometer method recommended by Gee and Bauder (1986). A pH meter (PyeUnican Model MK^2) was used to indicate the pH in a 1:2:5 soil/water suspension ratio, while the Walkley-Black wet oxidation method suggested by Nelson and Sommers (1982) was used to know the organic carbon. As recommended by Bremmer and Mulvaney (1982), the micro-Kjedahl distillation technique was used to determine total nitrogen, while the bray No. 1 method recommended by IITA (1979) was used to assess the available phosphorus. A flame photometer was used to know the exchangeable potassium, while the *ammonium acetate* saturation method suggested by Roades (1982) was used to indicate the cation exchange capacity (CEC).

Seed Procurement and Planting

Matured fruits of *Annona muricata* were purchased from the Abraka market and the seeds were extracted from the pulp. Healthy seeds were selected using the floatation method recommended by Oroka and Ureigho (2019). Fifteen polypots measuring 45cm x 50cm with perforation at their bottom which were filled with soil constituted a treatment three seeds of *Annona muricata* were sown in each polypot but were later thinned to one healthy plant. The experiment was laid out in a randomized complete block design with three replicates.

Dilution Rate of Liquid Organic Fertilizer and its Application

The liquid organic fertilizer was diluted at the ratio of 60ml of fertilizer to 15 litres of water as recommended by Danbara and Green Planet International (2003). The fertilizer was applied to the topsoil according to the treatment hand sprayer.

Weeding

The polypots were kept weed-free throughout the period of the experiment.

Data Collection

Data collected at forthright intervals starting from 6^{th} week after planting were percentage (%) emergence of *Annona muricata,* plant height (cm), number of leaves/plant, leaf area (cm^2), number of branches/plant, collar diameter (cm) at 3cm above soil level.

Seedling emergence or germination percentage (%) of the treatments was obtained by counting the number of seedlings that emerged on the 28^{th} day after planting, dividing by the number of seeds planted per treatment and multiplying by 100 following the procedures of Agbogidi *et al.* (2007) and Enujeke (2013). Plant height was measured from the top of the soil to the terminal bud using a measuring tape. Number of leaves and branches/plant was obtained by counting each parameter. In contrast, leaf area was determined by multiplying the length and breadth of the leaf and multiplying by a correction factor of 0.75 as suggested

by Agbogidi *et al.* (2007). Using a veneer caliper, collar diameter at 3cm above soil level was determined.

Data Analysis

Data collected were subjected to analysis of variance and significant means were separated using Duncan Multiple Range Test (DMRT) using SAS (2000).

RESULTS AND DISCUSSIONS

Particle Size Distribution

The particle size distribution (Table 1) indicates that the soils were sandy loam with low fertility status as shown by the low organic matter content (14.5gkg^{-1}), and total nitrogen of 0.85gkg^{-1}. Soil pH was strongly acidic with value of 5.1. The available phosphorus (P) and water-soluble potassium (K) with values of 5.10mgkg^{-1} and 0.41Cmokkg^{-1}, respectively were low with respect to the FMANR (1996) rating for that ecological zone. The low fertility status of the soil could be traced to the effect of heavy rainfall, erosion and leaching associated with ultisols of humid environment that are strongly weathered of low activity clay minerals resulting in high acidity.

Germination Percentage (%) of *A. muricata*

The germination percentage of *A. muricata* as affected by five different levels of goat manure is shown in Table 2. Liquid organic fertilizer significantly influenced the germination percentage of the crop. Plants that received 20 lha^{-1} of the fertilizer had the highest germination percentage of 95% in 2022 and 97% in 2023 followed by plants that received 15 lha^{-1} which had 81% in 2022 and 83% in 2023 Plants that did not receive LOF (control) had the lowest germination percentage of 58% in 2022 and 62% in 2023. The superiority of plants that received LOF against their control counterparts to higher germination % could be attributed to more supply of additional nutrients to the soil by the applied fertilizer. This is similar to the findings of Enujeke *et al.* (2013) who reported that the applied LOF added nutrients in a faster-acting form to benefiting crops than their control counterparts which did not receive L.O.F. It is also consistent with the report of Microsoft-Corporation (2003) which indicated that L.O.F acts as the substrate for micro-organisms help in biological stimulation of germination, growth, vitality and plant vigour improvement, and decrease in crop maturity period.

Table 1: Initial Physico-Chemical Properties of Soil used for the Study

Parameters measured	Values obtained
Particle Sixe Fractions (%)	
Sand	86.4
Silt	9.5
Clay	4.1
Textural class	Sandy loam
pH (H_2O)	6.1
Organic matter (gkg^{-1})	14.5
Total nitrogen (gkg^{-1})	0.83
Available P (mgkg^{-1})	5.10
Exchangeable K (cmolkg^{-1})	0.14
CEC (cmolkg^{-1})	10.15

Table 2: Effects of Five Different Levels of Liquid Organic Fertilizer (L.O.F) on Germination Percentage (%) of *A. muricata* of 28 days after Planting.

Rate of L.O.F	Germination (%)		
	2022	2023	Mean
0	58_d	62_d	60
5	64_d	68_d	66
10	67_d	71_c	69
15	81_b	83_b	82
20	95_a	97_a	96

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

Effects of L.O.F on Plant Height, Number of Leaves/Plant, Leaf Area and Collar Diameter of *A. muricata*

The effects of L.O.F on plant height, number of leaves/plant, leaf area and collar diameter of *A. muricata* is shown in Tables 3 – 6. Significant differences were observed in the growth parameters of *A. muricata* at 6, 9 and 12 weeks after planting as a result of the added fertilizer.

Plant height (Table 3). All the plants in the polypots that received liquid organic fertilizer application rates of 5, 10, 15 and 20 lha^{-1} performed better than their control counterparts which did not receive fertilizer (0 lha^{-1}) and the growth performance of the parameter investigated increased correspondingly with increased rate of L.O.F applied. For instance, at 6 weeks after planting, plants that received 20 lha^{-1} of L.O.F had the highest heights of 14cm in 2022 and 16.0cm in 2023, followed by plants that received 15 lha^{-1} of fertilizer of 12.5cm in 2022 and 13.5cm in 2023 Plants in the control plot which did not receive fertilizer had the lowest height of 4.8cm in 2022 and 5.2cm in 2023.

During the 9th week, plants that received 20lha^{-1} of fertilizer were also superior in height with values of 31.8cm in 2022 and 32.2cm in 2023, followed by plants that received 15 lha^{-1} of L.O.F which had heights of 25.2cm in 2022 and 25.8cm in 2023. Also, plants in the control plot (0 lha^{-1}) had the lowest height of 10.8cm in 2022 and 11.6cm in 2023.

At 12 weeks after planting, height of plants that received fertilizer application rate of 20 lha^{-1} also had outstanding heights of 78.0cm in 2022 and 78.4cm in 2023, followed by plants that received 15 lha^{-1} of fertilizer which had height of 60.2cm in 2022 and 60.8cm in 2023 Plants that had 0 lha^{-1} of L.O.F also had the lowest height of 26.0cm in 2022 and 26.6cm in 2023. The order of superiority in height with respect to level of L.O.F received in lha^{-1} was 20 > 15 > 10 > 5 > 0.

Other Growth Parameters

Similar trend was observed in the performance of other growth parameters evaluated, including number of leaves/plant, leaf area and collar diameter of *A. muricata* (Table 4 – 6).

The outstanding performance of plants that received L.O.F application rate of 20 lha^{-1} suggests that it was the most appropriate level which contained the quantity of nutrient needed to satisfy the soil requirements for increased growth and yield of *A. muricata* in the study area. This is consistent with the findings of Enujeke (2014) who reported that highest fertilizer rate released higher carbon content which enhanced the activities of beneficial micro-organisms that promoted growth and yield enhanced in cucumber. It is also synonymous to the findings of Mehedi *et al*. (2011) which reported that the highest rate of applied manure gave a corresponding highest growth parameters and seed yield of tomato.

Table 3: Effects of Five Different Levels of Liquid Organic Fertilizer on Plant Height (cm) of *A. muricata*

	Weeks After Planting			←			→		
	6			**9**			**12**		
	2022	**2023**	**Mean**	**2022**	**2023**	**Mean**	**2022**	**2023**	**Mean**
Rate of L.O.F (1/ha^{-1})									
0	4.8$_e$	5.2$_e$	5.0	10.8$_e$	11.6$_e$	11.2	26.0$_e$	26.6$_e$	26.3
5	7.6$_d$	8.0$_d$	7.8	16.2$_d$	16.8$_d$	16.5	37.6$_d$	38.4$_d$	38.0
10	9.5$_c$	10.5$_c$	10.0	21.6$_c$	22.0$_c$	21.8	51.2$_c$	51.6$_c$	51.4
15	12.5$_b$	13.5$_b$	13.0	25.2$_b$	25.8$_b$	25.5	60.2$_b$	60.8$_b$	60.5
20	14.0$_a$	16.0$_a$	15.0	31.8$_a$	22.2$_a$	32.0	78.0$_a$	78.4$_a$	78.2
Mean	9.7	10.6	10.2	21.1	21.7	21.4	50.6	51.2	

Means with the same letters under the same column are not significantly (P ≤ 0.05) different using Duncan Multiple Range Test (DMRT)

Table 4: Effects of Five Different Levels of Liquid Organic Fertilizer on Number of Leaves/Plant of *A. muricata*

	Weeks After Planting								
	6			9			12		
	2022	2023	Mean	2022	2023	Mean	2022	2023	Mean
Rate of L.O.F ($1/ha^{-1}$)									
0	2.6_e	3.0_e	2.8	4.7_e	5.5_e	5.1	7.6_d	8.4_e	8.0
5	4.7_d	5.1_d	4.9	6.6_d	7.2_{cd}	6.9	9.8_{cd}	10.6_{cd}	10.2
10	7.2_c	7.6_c	7.4	8.1_c	8.5_c	8.3	11.4_b	12.0_c	11.7
15	8.6_b	9.2_b	8.9	10.6_b	11.0_b	10.8	13.7_b	14.5_b	14.1
20	10.6_a	11.4_a	11.0	12.7_a	13.5_a	13.1	16.4_a	17.0_a	16.7
Mean	6.7	7.3	7.0	8.5	9.1	8.8	11.8	12.5	

Means with the same letters under the same column are not significantly (P ≤ 0.05) different using Duncan Multiple Range Test (DMRT)

Table 5: Effects of Five Different Levels of Liquid Organic Fertilizer on Leaf Area (cm^2) of *A. muricata*

	Weeks After Planting								
	6			9			12		
	2022	2023	Mean	2022	2023	Mean	2022	2023	Mean
Rate of L.O.F ($1/ha^{-1}$)									
0	21.6_e	22.4_e	22.0	41.6_e	42.2_e	41.9	59.4_e	60.2_e	59.8
5	25.6_d	26.2_d	25.9	45.4_d	46.4_d	45.9	63.6_{cd}	64.6_d	64.1
10	29.0_c	29.6_c	29.3	49.6_c	50.2_c	49.9	68.2_b	68.6_c	68.4
15	33.0_b	33.8_b	33.4	54.4_b	55.0_b	54.7	71.6_b	72.4_b	72.0
20	36.6_a	37.4_a	37.0	58.6_a	59.2_a	58.9	78.0_a	78.8_a	78.4
Mean	29.2	29.9	29.5	49.9	50.6	50.3	68.2	68.9	

Means with the same letters under the same column are not significantly (P ≤ 0.05) different using Duncan Multiple Range Test (DMRT)

Table 6: Effects of Five Different Levels of Liquid Organic Fertilizer on Collar Diameter of *A. muricata*

	Weeks After Planting								
	6			9			12		
	2022	2023	Mean	2022	2023	Mean	2022	2023	Mean
Rate of L.O.F ($1/ha^{-1}$)									
0	1.0_a	1.2_a	1.1	1.0_a	1.4_a	1.2	1.4_a	1.8_a	1.6
5	1.2_a	1.6_a	1.4	1.2_a	1.8_a	1.5	1.6_a	2.2_a	1.9
10	1.6_a	2.0_a	1.8	2.0_a	2.4_a	2.2	2.2_a	2.6_a	2.4
15	1.8_a	2.2a	2.0	2.2_a	2.6_a	2.4	1.6_a	3.0_a	2.8
20	2.2_a	3.8_a	2.5	2.4_a	3.4_a	2.9	3.2_a	3.6_a	3.4
Mean	1.56	1.96	1.76	1.76	2.32	2.04	2.20	2.64	

Means with the same letters under the same column are not significantly (P ≤ 0.05) different using Duncan Multiple Range Test (DMRT)

CONCLUSIONS

The study has confirmed that application of liquid organic fertilizer significantly affects the germination and seedling growth of *Annona muricata*. It also established that 20 lha^{-1} of LOF is most appropriate rate for the soil of the area. It is therefore recommended that farmers in the study area apply 20 lha^{-1} of power plant liquid organic fertilizer for increased germination and seedling growth of soursop.

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