EFFECT OF ORGANIC FERTILIZERS ON GROWTH AND YIELD OF GARLIC (Allium Sativum L.) IN OBIO AKPA, AKWA IBOM STATE, NIGERIA.

ABSTRACT

The study was conducted at the Teaching and Research Farm of Akwa Ibom State University, Obio Akpa Campus, in May, 2022 to February, 2023 cropping seasons to examine the effect of organic fertilizers namely: Decomposed Fluted Pumpkin pod (DFPP), oil palm Bunch Ash (OPBA) and poultry Manure (PM) on the growth and yield performance of Garlic. The experiment was laid out in a Randomized complete Block Design with four treatments replicated three times.

The growth and yield Parameters were number of leaves, length of leaves, plant height, number of Cloves, weight of fresh bulb, bulb diameter and bulb length. Data obtained were subjected to analysis of variance. The results showed that the four treatment differed slightly in number of leaves across the growth period and their mean differences were not significant ($p<0.05$). DFPP produced the longest leaves (62.76cm) at 6 WAP, followed by OPBA (59.07cm), while control had the least value (57.97cm) and their differences was significant ($p<0.05$). The mean height of Garlic plant obtained from the Four treatments differed significantly ($p<0.05$) from the initial growth period with DEPP producing the tallest plant (58.27cm) at 4 WAP, while OPBA had the least (53.81cm). The yield parameters obtained, PM had the highest fresh weight of Garlic (19.94g) followed by DFPP (13.62g) and OPBA (13.32g), while the control had the least (8.28g) and their difference was significant. DFPP recorded the highest bulb diameter (3.14cm) significantly different ($p<0.05$) from PM, OPBA and control with 3.02cm, 2.76cm and 2.74cm respectively. PM recorded the highest number of cloves (5.33), while DFPP, OPBA and control recorded 5.00 and their difference were not significant ($p<0.05$). PM, also had the highest bulb length (3.88cm), while control had the least (3.51cm). Therefore, combined application of DFPP and PM is highly recommended to maintain high yield of crop in the study area.

Keywords: Garlic, Growth yield parameters, decomposed fluted pumpkin pod, oil palm bunch ash, poultry manure

INTRODUCTION

Soils are primary resources for agricultural production (Udoh *et al.,* 2021), decline in physical, chemical and biological properties of the soil affect agricultural productivity and environmental protection e.g. low water holding capacity, organic matter status among others leading to loss of soil quality. Low organic matter is responsible for low productivity and poor crop yield (Makincle *et al.*, 2011). Maintenance of soil fertility is essential by application of organic fertilizer for sustainable land management practice and conservation technique that improve soil quality in the tropical soils (Ayoola and Makincle, 2009) for production of Garlic.

Garlic (Allium sativum L.) belongs to the family Alliaceae and is the second most widely used Allium speces next to onion (Yadav *et al.,* 2017). It is one of the most important vegetable crops

Comment [TEI1]: Please follow the guidelines for authors strictly. You have to recast the abstract to meet the laid down standards for the journal.

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Comment [TEI5]: Replace next with after grown throughout the world. Garlic is mostly cultivated in temperature and tropical zones (FOA, 2004). FAOSTAT (2019) reported that the production volumes in 2019 for the top 3 countries were 23. 26 million metric tonnes for china, 2.91 million metric tonnes for India and 466. 39 thousand metric tonnes for Bangladesh. Garlic production is concentrated both internationally and domestically. Spain is the highest exporter of Garlic followed by china. In Africa, it is commercially grown in Egypt, Ethiopia, Algeria, Sudan, Morocco, Tunisia, Nigeria, Tanzania and Kenya. Egypt is the highest producer and exporter in Africa.

In Nigeria the production of Garlic is concentrated in the Northern Guinea and Suden Savanna ecological Zones, where it is mainly grown under irrigation in the dry season. Production in Nigeria is relatively low with the largest quantities beiny 2 cultivated in the Northern states like Kano, Kad, Kebbi, Sokoto, Jigawa, Bauchi, Katsina and Zafara states (Kudi *et al., 2008)*. Sokoto state takes a lead in Garlic production in Nigeria Garlic is an erect annual herb with a height of 75- 90 cm generally cultivated during dry and middle winter season in the western world (Etana, 2018). In Nigeria, it does well during the onset of the rains. The leaves of Garlic are flattened, it has a tall erect flowering stem (Adetunde *et al.,* 2014). With respect to its production and economic value, Garlic is one of the main Allium vegetable crops in the world and is used widely as flavoring in cooking. Garlic is used as spice for stews, soups, sauces, and other delicacy. It is use either fresh or as a dry powder or oil. It has been used throughout the ages for both culinary and medicinal purposes (KK *et al.,* 2008).

Garlic (Allium sativum L.) has shown the wide range of biological and Pharmacological activities including antioxidant, Cancer prevention liver protection, immune modulation and reduction of cardiovascular disease risk factors etc. (Butt *et al*. 2009 and Pittler and Ernst 2007). Udounang *et al.,* (2023) explained that there are some level of specification in crop adaptation to the type and quality of fertility for crop growth and potentials. Since there is scarcity, high coast and negative effect of inorganic fertilizer to humans and environment, the need to use organic fertilizer is inevitable. Garlic is one of the most relished spices and it is commonly used because of its nutritive, medicinal and health benefits. Not much research has been done on Garlic in Nigeria, especially in Akwa Ibom state.

Thus, this study effect of organic fertilizers on growth and yield of Garlic in Obio Akpa, Akwa Ibom State to curb or outsource Garlic from other locations, making it available amongst small holder farmers and efficient use of organic agricultural wastes to improve its production and availability.

Materials and Methods

Experimental site and cropping History. The research was carried out at the Teaching and Research Farm of Akwa Ibom State University, Obio Akpa Campus in Oruk Anam Local Governmental Area of Akwa Ibom State, Nigeria, in May 2022 to February 2023 cropping seasons. The area lies between latitude 4^0 30^1 N and 5^030^1 N and longitude 7^030^1 E and 8^000^1 E of the Greenwich Meridian (Slus-AK, 1989). it is in the humid tropical region Characterized by two seasons; (rainy and dry season). The dry season spans from November- March while the rainy season begins from April-October with a short dry spell in August called “August break”. The annual temperature from 2000-2500mm with annual temperature from 24^0C – 30^0C and relative humidity of 75-79% (SLUS – AK, 1989). The soil is formed from coastal plain sands parent materials and classified as an ultisols (USDA, 2004).

The vegetable of the area originally was tropical rainforest but is now predominantly secondary forest due to continuous cultivation of crops such as; Oil Palm (Elacis guineensis) and Cassava (Manihot esculenta).

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Comment [TEI7]: Add a reference

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Comment [TEI16]: Include the research done in the area so far with references. Saying that not much research has been done is not scientific.

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Field Method

Soil Samples were randomly collected from the site at depths of 0 – 15cm and 15 – 30cm using soil auger for physicochemical analysis. The samples were air- dried for the following analysis: - Particle size distribution has done using Bouyoucos Hydrometer method as described by Udo et al., (2009). After dispersing the soil particles with sodium hexameta-phosphate solution. The textural class of the soil was determined using the textural triangle.

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Soil pH was determined in KCL using a 1: 2. 5 soil to water suspension and the pH was read with a glass electrode pH meter. Organic matter was determined by Walkley and Black wet digestion method (Nelson and Sommers, 1996).

Organic matter was obtained by multiplying the result from organic carbon with the Van Bemmele factor of 1. 724. Total Nitrogen was determined using macro-Kjedahl digestion method (Bremner, 1996) cited in Umoh *et al.* (2021a) Available Phosphorus was determined by the Bray p-1 method. The phosphorus in the extraction was measured by the method of murphy and Riley (1962). Exchangeable Bases (Ca, Mg, Na, and K) were determined by extraction using ammonium acetate (in NH, OAC) solution (Thomas, 1982). The available K and Na were determined using Atomic Absorption Spectrophotometer.

Comment [TEI24]: recast to make sentence clearer.

Exchangeable Acidity was determined using KCL extraction method (Mclean, 1982) Electrical Conductivity was determined in 1:2. 5 soil/water ratio using conductivity bridge (Udo *et al.*, 2009

Base Saturation was calculated as follows;

% B sat = TEB × 100

Where

Bsat = Base saturation, TEB = Total exchangeable bases, ECEC = Effective cation exchange capacity.

Planting bag used for the Experiment

Polythene bag used for the experiment was medium size, having a length of 30.02cm and a circumference of 73.00cm, with an average weight of soil contained in bag of about 23.2kg.

Experimental plot and Treatment

The experiment was laid out in a Randomized complete block design with three replications and four treatments allocated to each replicate. Decomposed Fluted pumpkin pod (DFPP), oil palm Bunch Ash (OPBA) and poultry manure (PM) were used as treatments for specific plots as well as control (C), with a spacing of 0.5m in between plants and 1m in between treatments and replications. Each treatment group were allocated 10 bags each. The experiment was a pod experiment with a total number of 120 medium size poly bags replicated three Times.

Comment [TEI25]: Give in tons per hectar

Sources of planting/ Experimental materials

The Garlic (Allium Sativum L.) bulbs and bags, rich hums soil organic fertilizer, fluted pumpkin pod wast and oil palm empty fruit bunch were obtained at Akwa Ibom State University commercial Farms, cross River Basin Development commercial Authority in Abak, and oil mill Farm in Obio Akpa, respectively. The Fluted pumpkin pod waste was dried under shade for several weeks and then ground to an average particle size. The oil palm empty fruit bunch was sun dried and burnt into ash.

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Type of Garlic Variety planted: Variety cultivated was the soft neck variety

Agronomic Practices

The experimental field was slashed and weeded the poly bags were filled with rich hurts topsoil and arranged for planting.

Planting: - The Garlic was propagated using cloves. Healthy cloves free from diseases and injured were used for planting. All the cloves were planted except the long slender ones in the center of the bulb. The Cloves were planted vertically with the pointed end facing upward 2-3cm deep and the planting was done 1 clove of about 5.81_g per bag.

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Field Management

Weed: - Control of weeds was done by hand pulling the weeds at every 2 weeks interval during the period of the crop growth.

Fertilizer Application:- Fifty grams per organic manure (Poultry manure, oil palm Bunch Ash, and Decomposed Fluted Pumpkin pod) wea applied of the Garlic plant at 5 leaf stage .

Harvesting: - The harvest of Garlic started when the leaf tops begin to dry, discolour and bend towards the ground. The Garlic crop was harvested using a hand trowel at nine months after planting.

Data Collection: - Data were collected randomly on number of leaves per plant, length of leaves, height of plant, bulb diameter, number of cloves per bulb, length and Weight of fresh bulb (g)

Leaf length per plant: - The length of the leaf was measured using a meter rule of about 30 cm long for the first two weeks after planting and then Subsequently the leaf length was measured using a measuring tape.

Number of leaves per plant: - This was done through visual Counting at two weeks interval.

Height (cm): - The highest of the plant was measured from the soil surface to the top of the plant using a measuring tape.

Bulb diameter (cm): - The diameter of the bulb was measured using a measuring tape.

Number of Cloves per bulb: - The number of Cloves were counted from bulbs at random and then divided from the total number of bulbs.

Bulb length (cm): - The length of the bulb was measure from the same bulbs after taking the diameter of the bulb using a measuring tape.

Weight of Fresh bulb (g): - The Garlic harvested was weighted using Mettler sensitive weighing balance and the average weight was recorded:

Data Analysis

Data collected were analyzed using the one-way analysis of Variance in randomized complete block design, while means of significant parameters were separated using Duncan Multiple Range Test at 0.05 level of significance (Wahua, 1999).

Results and Discussion

Physicochemical properties of the experimental soil physicochemical properties of the experimental soil presented in Table 1, Showed that at 0-15 and 15-30 cm, the soil had high proportion of sand fractions of 844 and 818 gkg^{-1} with mean value of 831± 1.85, Silt had 34 and 37 gkg^{-1}, with mean value of 35 ± 0.27, while clay recorded 122 and 145 gkg^{-1} with mean value of 134 ± 1.58, respectively. The textural class in the 0-15 and 15-30 cm depth were sandy loam. This agrees with some results obtained by previous researchers in most soils of Akwa Ibom State (Essien *et al.*, 2022; Umoh *et al.*, 2021b; Simeon and Essien, 2023). Different textural fractions impart certain unique properties on the soil fertility Characteristics. For instance, the sand fraction has small specific surface because of their large size and therefore contribute very little to water and nutrient holding capacity of the soil. Clay fraction with its large specific surface is very essential in nutrient retention for crop production. It also influences the stability of the primary aggregates However the low clay fraction could suggest low fertility status of the experimental soil, Akwa Ibom State (Ogban and Essien, 2016).

Table 1: Physicochemical properties of the soil at the experimental site

Soil property	**0-15 cm**	**15-30 cm**	**Mean**	**Sd (±)**
Sand (gkg^{-1})	844	818	831	1. 85
Silt (gkg^{-1})	34	37	35	0.27
Clay (gkg^{-1})	122	145	134	1.58
Textural Class	sandy loam	sandy loam	Sandy loam	
pH (H_2o)	5.1	5.0	5.0	0.08
Organic matter (%)	2.11	1.63	1.87	0.34

Comment [TEI30]: Rephrase

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Comment [TEI32]: Replace wea with were

Comment [TEI33]: Extrapolate to amount in kg/ha.

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Comment [TEI37]: Check again

Comment [TEI38]: Include more references that in your materials and methods section

Comment [TEI39]: Check how tables are references from other papers in this journal.

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Total nitrogen (%)	0.22	0.18	0.2	0.03
Available phosphorus (mgkg^{-1})	20. 54	17.86	19.2	1.90
Electrical conductivity (dsm^{-1})	0.13	0.15	0.14	0.01
Ca (cmolkg^{-1})	1.23	1.18	1.21	0.04
Mg (cmolkg^{-1})	0.82	0.96	0.89	0.10
Na (cmolkg^{-1})	0.07	0.08	0.08	0.01
K (cmolkg^{-1})	0.15	0.16	0.16	0.01
Effect cation exchange capacity (cmolkg^{-1})	2.27	2.38	2.33	0.08
Exchangeable acidity (cmolkg^{-1})	0.89	1.1	0.99	0.15
Base Saturation (%)	60.79	53.78	57.28	4.96

Comment [TEI41]: Please concatenate the sd to the values, leave out the mean value, and perhaps and run an analysis of variance to make your work more robust.

Chemical properties of the experimental soil shown in Table 1 indicated that pH was 5.1 at 0 -15 cm and 5.0 at 15-30 cm with mean of 5.0 ± 0.08 classified as acidic. Organic matter was 2.11% at 0 – 15 cm and 1.63% at 15-30 cm with mean of 1.87 ± 0.34 %, which was low for crop production (FFD/ FMARD 2012). This Suggest that the soil may lack ability to supply essential nutrients for plant growth and development. Total nitrogen was 0.22% at 0 – 15 cm and 0.18% at 15-30 cm with mean of 0.20 ± 0.03% which is very low for v., crop production compared to 2% reported by Onofiok (2002) as a critical value for crop production. This implies that the experimental soil was deficient in Nitrogen. Available phosphorus was 20.54 mgkg^{-1} at 0-15cm and 17.86 cm at 15- 30 cm with mean of 19.20 ± 1.90 mgkg^{-1}, slighting higher than the 15 mgkg^{-1} reported by Enwezor *et al.* (2012) as the critical value for crop production.

Exchangeable Cations of the soil were generally low. Specifically, Ca was 123 cmolkg^{-1}at 0-15 cm and 1.18 cmolkg^{-1} at 15-30cm with mean of 1.21 ± 0.04 cmolkg^{-1} Mg recorded 0.82 cmolkg^{-1} at 0-15 cm and 0.96 cmolkg^{-1} at 15-30 cm with mean of 0.89 ± 0.10 cmolkg^{-1} ; Na recorded 0.07 cmolkg^{-1} at 0-5cm and 0.08 cmolkg^{-1} at 15-30 cm with mean value of 0.08 ± 0.01 cmolkg^{-1}, while K content was 0.15 cmolkg^{-1} at 0-15 cm 0.16 cmolkg^{-1} at 15-30 cm with mean of 0.16 ± 0.01 cmolkg^{-1}. The low exchangeable bases could be inferred that these soils may not support high crop production without amendment, and the low exchangeable bases obtained in these soils may be attributed to low pH of the soil.

Exchangeable acidity recorded 0.89 cmolkg^{-1} at 0-15cm and 1.1 cmolkg^{-1} at 15-30 cm with mean of 0.99 ± 0.15 cmolkg^{-1}. Base Saturation recorded 60.79 % at 0-15cm and 53.78 % at 15-30cm with mean of 57.28 ± 4.96 %.

Table 2 shows effect of different rates of organic fertilizer on number of leaves per plant of Garlic across the growth period. Generally, the means were not significantly different among the four treatments (p>0.05) across the growth periods (2,4,6,8,10,12,14,16 and 18 WAP). However, DFPP and OPBA had the highest number of leaves at initial growth stage (2 WAP) with 2.27 leaves, respectively, followed by PM with 2.67 leaves, while control had the least (2.56 leaves). DFPP had the highest number of leaves at 6 WAP (5.83 leaves) followed by control with 5.78 leaves to OPBA with 5.61 leaves, while PM had the least (5.44 leaves). The trend at 8 WAP showed that DFPP had the highest number of leaves (5.83), followed by PM and control with 5.67 leaves, respectively. While OPBA had the least (5.61 leaves). PM and OPBA had the highest number of leaves (6.50) leaves at 10 WAP, respectively while DFPP had the least (6.39). The result at 16 WAP showed that DFPP and the Control had the highest (7.67) leaves, respectively, followed by OPBA with 7.28 leaves, while PM had the least (7.17) leaves. At the end of the growth period (18 WAP), OPBA had the highest number of leaves (7.28), while DEPP had the least (6.89) leaves.

Table 2 : Number of leaves per plant of Garlic across the Growth period. Week After planting (WAP)

	Weeks After Planting								
Treatment	**2**	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**
PM	2.67	5.17	5.44	5.67	6.50	6.89	7.39	7.17	7.17
DFPP	2.72	5.22	5.83	5.83	6.39	6.61	7.33	7.67	6.89
OPBA	2.72	5.11	5.61	5.61	6.50	6.50	7.00	7.28	7.28

Control	2.56	5.33	5.78	5.67	6.67	6.67	7.44	7.67	7.22

Column are significantly different (p< 0.05) Length of leaves (cm) script along the same PM = Poultry manure, DFPP – Decompose fluted pumpkin pod, OPBA- Oil palm bunch Ash

Table 3 shows effect of treatments on length of leaves per plant of Garlic across the growth period. The result indicated that PM produced the longest leaves at 2 WAP with 23.06cm, followed by DFPP with 22. 61cm, while OPBA had the least (21.87 cm), and there was no significant difference (p> 0.05). At 6 WAP, DFPP had leaf length of 62. 76 cm significantly (p> 0.05) higher than OPBA with 59. 07cm, while control had the least (57.97 cm).At 8, 10 and 12 WAP, the control had the highest leaf lengths of 64.01, 62.57, and 60.91cm, respectively and there was no significant difference (p> 0.05) from the other treatments (PM, DFPP and OPBA). DEPP recorded the longest leaf of 56. 73 cm at 14 WAP, followed by control with 54. 9 cm, while PM had the least (53.44 c). At 16 WAP, the longest leaf was also recorded in DFPP with 52.58 cm followed by OPBA with 49.17cm, while PM had the least (48.32 cm). At the end of the growth period (18 WAP), DEPP still maintained the longest leaf of 45.71 cm followed by OPBA with 44.66cm, while the control had the shortest leaf (43.34 cm).

Table 3 : Length of Leaves (cm) per plant of Garlic Across the Growth Period

	Weeks After Planting								
Treatment	**2**	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**
PM	23.06	52.74	58.74^b	61.03	61.13	59.60	53.44	48.32	44.16
DFPP	22.61	55.05	62.76^a	61.45	61.17	57.83	56.73	52.58	45.71
OPBA	21.87	50.79	59.07^b	61.06	61.14	58.86	53.78	49.17	44.66
Control	22.00	53.38	57.97^b	64.01	62.57	60.91	54.90	49.04	43.34

Means with different superscript along the same column are significantly different (p <0.05) PM = Poultry Manure, DFPP = Decomposed Fluted Pumpkin Pod, OPBA = Oil Palm Bunch Ash.

The result of effect of treatments on the plan height of the Garlic across the growth period is shown in table 4, revealed that the treatments were slightly significant (p < 0.05) among the treatments with DFPP producing the highest plant height (58.27cm), while the least was recorded in OPBA (53.81cm). At 6 WAP, DFPP recorded the highest plant height (66.49cm), while the control had the least (61.47cm) plant height.

At 10 WAP and 14 WAP, the Control recorded the highest height of 69.56cm and 66.37cm, respectively. DFPP recorded the highest at 16 WAP and their differences was not significant from other treatments (p > 0.05). At the end of the growth period (18 WAP) DFPP also recorded the tallest plants (51.32cm), followed by OPBA (50.22cm), while the control had the least (49.16cm).

Table 4 : Plant Height (cm) of Garlic Across the Growth Period

	Weeks After Planting								
Treatment	**2**	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**
PM	41.31^{ab}	55.27^{ab}	62.07	66.31	67.68	66.36	63.93	54.72	50.09
DFPP	41.11^b	58.27^a	66.49	66.26	67.54	67.28	64.29	59.39	51.32
OPBA	44.69^a	53.81^b	62.54	66.17	67.66	65.89	64.20	55.45	50.22
Control	42.82^{ab}	55.77^{ab}	61.47	69.52	69.56	64.74	66.37	55.70	49.16

Means with different superscript along the same column are significantly different (p < 0.05) PM= Poultry Manure, DFPP = Decomposed Fluted Pumpkin Pod, OPBA = Oil Pam Bunch Ash

Comment [TEI42]: Run an analysis on this data such as time series or present the information in the form of graphs to bring out the variations.

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The fresh weight of Garlic bulb obtained from four treatment is shown in Table 5. From the result, PM had the highest fresh weight (19.94g), followed by DFPP (13.62g) and OPBA (13.32g), while the Control had the least (8.28g). The result showed that the fresh weight of the crop obtained from the four treatments was significantly different.

Table 5: Effect of organic fertilizer on the yield components of Garlic

Treatment	Fresh Weight of Garlic (g)	Number of Cloves per Bulb	Bulb Diameter (cm)	Bulb Length (cm)
PM	19.94[a]	5.33	3.20[ab]	3.88[a]
DFPP	13.62[a]	5.00	3.14[a]	3.81[ab]
OPBA	13.32[a]	5.00	2.76[b]	3.60[bc]
Control	8.28[b]	5.00	2.74[b]	3.51[c]

Mean with different superscript along the same column are significantly different ($p < 0.05$). PM = Poultry Manure, DFPP = Decomposed Fluted Pumpkin Pod, OPBA = Oil Palm Bunch Ash.

The result indicated that mean number of cloves obtained from respective treatment was also presented in Table 5. DFPP, OPBA and Control had the same number of cloves (5.00), except PM that had 5.33 cloves, there was no significant difference in number of cloves obtained from the four treatments. This implies that number of cloves obtained from Garlic plant is not a function of type of fertilizers applied. The bulb diameter shown in Table 5 indicated that DFPP had the highest bulb diameter (3.14cm), followed by PM (3.02cm) and OPBA (2.76cm), while the Control had the least value of 2.74cm, there was a significant difference ($p < 0.05$) in bulb diameter obtained from the four treatments. This is an indication that the type of fertilization is a significant determinant of the quality of Garlic bulb obtained in term of diameter of the bulb.

The bulb length of the Garlic crop is also presented in Table 5. The result showed that PM recorded the longest bulb with average length of 3.88cm, followed by DFPP with average bulb length of 3.81cm and OPBA with 3.60cm, while the Control had the least of 3.51cm. The result showed that length of Garlic bulb obtained from the four treatments were significantly different.

DISCUSSION

Comment [TEI45]: I think this is your conclusion

The findings revealed that DFPP which had the leading growth parameters also produced the highest leading growth parameters also produced the highest bulb diameter of Garlic, similar to the work of Akpan *et al.*, (2021) and Akpan *et al.*, (2024) that shows the highest value obtained in DFPP and Poultry Manure on carrot and okra, was as a result of increase in soil nutrient level that had relatively higher elemental content in chemical properties, while PM recorded the highest fresh weight of Garlic, number of cloves and bulb length, Akata *et al.*, (2024; Angus *et al.*, (2016) obtained that PM soil amendment had significantly influence on growth and yield plants (okra). this could implies that DFPP and PM supported production of Garlic and is preferred in Obio Akpa, Oruk Anam Nigeria. Poultry Manure and OPBA (Udounang, *et al.*, 2023; Essien *et al.*, 2023) improves the physical characteristics and conditions of the soil, nutrient uptake and crop productivity (Okon *et al.*, 2021; Akata *et al.*, 2015; Akpan *et al.*, 2013). The high performance of DFPP in growth parameters and PM in yield parameters of Garlic supports finding of Akata (2016) that organic manure is widely regarded as an alternate source of fertilizer to improve soil health, plant growth and yield.

However, the result suggests that these organic fertilizers may not release their nutrient at the same rate. Somme like DFPP may release its nutrients faster than PM and such that the nutrient easily got exhausted causing the Control to perform better than others at the peak of the growth period as in the case of the plant height at 8, 10 and 14 WAP, it may also mean that single does of these organic fertilizer may not sustain the plant through the entire growth period of the crop. PM took most of its leading roles towards the end of the growth period. This could suggest that the release of nutrient from DFPP is faster than that of PM and OPBA. This agrees with Sarkar *et al.,* (2003) which stated that one of the benefits of organic fertilizer is that the nutrients are released more slowly than chemical fertilizers. This slow process allows the plant to process the fertilizer in a more natural way and will not result in over fertilizing which could damage the plant.

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