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Assessment of the Growth of Agronomic Parameters of Pumpkin (*Curcubita pepo* L.) to Rates of Poultry Manure

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Abstract

Cucurbita pepo is a squash belonging to the Cucurbitaceae family and genus Cucurbita that resembles a gourd. It is an annual crop native to Mexico but cultivated worldwide for its fruit, leaves, and seeds used in cooking and in medicine. The use of poultry manure as an organic fertilizer significantly impacts Cucurbita pepo growth and yield. Poultry manure (pm) is enriched in nitrogen, phosphorus, and potassium, as well as various micronutrients which promote plant growth and development. An experiment to determine the growth response of pumpkin (Cucurbita pepo L.) to different rates of poultry manure was conducted at the teaching and research farm of the Faculty of Agriculture, University of Nigeria, Nsukka. The treatments used were poultry manure applied at 0t/ha, 5t/ha, 10t/ha, and 15t/ha. The experiment was laid out in a Randomized Complete Block Design (RCBD), with four (4) treatments and three (3) replications per condition assessed. Data collected included vine length, number of leaves, leaf length, number of branches, and stem girth at certain growth stages. Data analysis for statistical significance was obtained via analysis of variance (ANOVA) test using GenStat, a statistical software package. Separation of treatment means was done using Fisher's Least Significant Differences (F-LSD) at 5% probability level. Significant effect at (P≤0.05) for vine length, leaf length, number of leaves, and number of branches per plant was observed, but generally, poultry manure at 15t/ha showed the highest value on most of the parameters studied. The treatment with the application of zero poultry manure gave the highest percentage of moisture loss. For sustainable pumpkin production, the application of poultry manure at 15t/ha is suggested for use in pumpkin production, as pumpkin treated with poultry manure at that level produces significantly higher organic yield than any other treatment levels.

Keywords: *Poultry manure, Pumpkin, Growth Response, Rates, Agronomic parameters.*

Introduction

Vegetables are gradually acknowledged as crucial for food and nutrition security [22]. However, organic vegetables are increasingly preferable to many consumers as they are shifting their food choice priorities towards food they perceive to be healthier for themselves and the environment. *Cucurbita pepo* is a squash or pumpkin belonging to the *Cucurbitaceae* family and genus *cucurbita* that resembles a guard, with over 130 genera and up to 800 species [21]. In the agricultural industry, pumpkins are cultivated as vegetables on a large scale, contributing to the agricultural economy. The production and sale of pumpkins, whether for fresh consumption or processing into various products, generate revenue for farmers and the agricultural sector. They are processed into a wide range of food products such as pumpkin soup, pumpkin-based snacks, pumpkin pie filling, etcetera. These processed products contribute to the food industry's revenue and provide employment opportunities in processing and manufacturing plants. The seasonal demand for pumpkins drives retail sales of fresh pumpkins, decorative pumpkins, and pumpkin-related products, contributing to the economy, especially in regions with a vibrant pumpkin culture. In some cultures, pumpkins are an important part of traditional dishes and celebrations, such as pumpkin pie in the USA, or pumpkin lanterns on Halloween.

Pumpkin is a natural treasure full of health benefits, from its *Cucurbita* seed kernels have been employed as functional materials and nutrient supplements in baking, cooking, and seeds to its flesh and even leaves; almost every part of pumpkin can be used for healing, nourishment, or even beauty. Pumpkin is highly nutritious and enriched in vitamins A, C, and E, dietary fiber, and potassium [11]. Pumpkin is rich in potassium, which helps to balance the effects of so much sodium in the body. These nutrients support overall health and well-being, making pumpkins a valuable addition to a nutritious diet. The fiber in pumpkin aids absorption of sugar in the bloodstream thus regulating blood sugar levels, supports digestion, and relieves constipation ([6]. Their vibrant orange colour is indicative of their high beta-carotene content, which helps to improve eyesight and reduce the risk of eye diseases like night blindness and age-related macular degeneration. These carotenoids possess properties associated with a reduced risk of certain chronic diseases, such as cardiovascular diseases and certain types of cancer, and support immune function [17,23]. Also, *cucurbitacins*, a group of compounds found in *Cucurbita pepo*, reportedly possess anti-inflammatory and potentially alleviate symptoms associated with inflammatory conditions such as arthritis and certain autoimmune disorders [7]. *Cucurbita* fruit is low in calories and provides many advantages for human health, including blood cleansing, constipation relief, improved digestion, and energy production [9].

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ground meat compositions [25,13]. It has been observed that the seed extract possesses antioxidant, antitumor, antibacterial, anticancer, and antimutagenic properties [7]. Strong hypo-triglyceridemic and serum cholesterol-lowering effects have also been observed [16]. The nutrients in pumpkin are essential for various bodily functions important for good health such as hydration and boosting immune support [26]. Its high-water content and antioxidants make it great for feeling full and boosting your body's defense. Pumpkin seeds, also called pepitas, are used to reduce prostate enlargement. The high quantity of zinc in the seed can be used for the management of prostate problems. Pumpkin seed oil is mostly composed of linoleic acid, oleic acid, palmitic acid, tacophenol, ß-sitosterol, and delta-7-sterols. Pumpkin pulp is rich in nutrients and health-promoting properties such as proteins, carotene, mineral salts, vitamins, and polysaccharide-like proteins [8].

The significance of this crop in human life makes it crucial to research on and to boost its production to keep up with the rising demand for its products. Soil fertility is a significant issue that hinders the productivity of crops [19]. The optimum temperature range for pumpkin growth and development is paramount to determining yield and quality. Pumpkin plants prefers well-drained, loamy soils with a good balance of sand, silt, and clay and the optimum soil pH range is between 6.0 and 7.5 (slightly acidic to neutral soils). Additionally, environmental factors such as soil moisture, light intensity, and relative humidity, can also influence the plant's growth and development [14]. Poultry manure is a well-established and desirable organic fertilizer that bolsters soil fertility by adding both essential nutrients and soil organic matter. Each of these components contribute positively to moisture and nutrient retention in the soil [15]. Of all animal-derived manures, chicken manure is considered best organic soil fertilizer forfor crops due to its richness in most of the major nutrients required for plant growth. Some of these qualities include microbiological activities, soil tilth, and chemical properties [28,29]. The application of poultry manure in record yielded over 53% increases in N level in the soil, from 0.09% to 0.14 % and exchangeable cations increased with manure application [10]. When added in the appropriate amount, poultry manure enhances soil quality and provides nutrients for crop growth because it is high in organic matter and other nutrients required for plant growth [27]. According to [12], adding poultry manure to the soil enhanced its water-soluble qualities and carbon content while decreasing its bulk density. The ideal rates of poultry manure application can vary based on soil nutrient levels, manure source/composition, and specific cultivar needs. Having a soil test done is recommended to determine precise fertilizer requirements when using manures and over application of the poultry manure can lead to nutrient imbalances or salt issues. Poultry manure is considered a high-nitrogen fertilizer, and too much application can lead to excessive vegetative growth at the expense of fruiting. Poultry manure is abundant in nitrogen (3-4% N) and moderate in phosphorus (2-5% P2O5). It is low in potassium, so supplementing with K may be needed, especially for fruiting. The nutrient ratio is around 3-2-1 for N-P-K in poultry manure. It was previously reported that applying poultry manure at rates up to 20 tons/ha significantly improved pumpkin plants' growth and yield parameters, including vine length, number of leaves, number of branches, leaf length, and stem girth [2]. In a later report, poultry manure application promoted early flowering and fruiting in pumpkin plants is likely due to improved nutrient availability and soil conditions [3].

is the goal of this study is to evaluate the influence of different application rates of poultry manure on the growth parameters of *Cucurbita pepo* and to determine the optimal level of poultry manure application that results in the maximum vegetative growth and vigor of *Cucurbita pepo* plants.

Materials and Methods

Experimental Location

The experiment was conducted at the Department of Crop Science Teaching and Research Farm, University of Nigeria, Nsukka. The study area is at a latitude of 6°52N, a Longitude of 07° 24E, and an altitude of 447m above sea level. The experimental site is in the Derived Savannah zone of the southeastern ecology. The climate is humid-tropical, characterized by distinct seasons: wet season (usually April to October) and dry season (usually November to March). The mean annual rainfall of the area is about 1600mm, with a bimodal pattern of rainfall distribution with peaks between July and September. The average minimum and maximum temperatures are 21°C and 31°C, respectively. Relative humidity can be variable yearly, often in the range of 55~90%.

Experimental Materials

Experimental materials included pumpkin seeds sourced from a licensed seed vendor located at Nsukka Local Market, Enugu State. A well-cured poultry manure was obtained from a poultry farm at the University of Nigeria, Nsukka.

Experimental Design

The experiment was laid out in the field in a Randomized Complete Block Design (RCBD) involving four (4) treatments and repeated three (3) times.

The four treatments include

- 0tons of poultry manure(control)
- 5tons of poultry manure
- 10tons of poultry manure
- 15tons of poultry manure

Treatment Application

Poultry manure was added to the soil a day before planting as per the treatment imposed. Thus, control b1 received no manure, b2 received 5t/ha of poultry manure, b3 received 10t/ha of poultry manure, and b4 received 15t/ha of poultry manure.

Planting and Spacing

The pumpkin was planted uniformly on the 19th of February 2024. Planting was done late in the evening at a spacing of 0.85cm between the rows. Each hole had two plants per stand. Seeds were sown at a depth of 34cm at the rate of two (2) seeds per hole [24].

Irrigation

The plants were hand-watered uniformly, with each stand receiving 2 liters of water.

Data Collection

Data was collected at two-week intervals for six weeks. Data was collected on all plants based on Agronomic traits. The agronomic parameters collected were:

- Vine length: This was collected with a measuring tape from the tip of the leaves to the point where the leaves join the stem in cm.
- The number of leaves was counted.

- Stem girth: was obtained by measuring around the stem 4cm above the ground using a measuring tape in cm.
- Leave length: which was measured with a measuring tape in cm.
- The number of branches was counted.

Statistical Analysis

Data obtained were subjected to analysis of variance (ANOVA) on RCBD Experiment using GenStat Release 10.3 Discovery Edition 4 software. Treatment means were compared using Fisher's least significant difference (F-LSD) at 5% level of probability [18].

Soil nutrient analysis

Prior to the planting, soil samples were obtained from the fields at a depth of 0-20cm (topsoil) and taken to the Department of Soil Science lab for determination of nutrients available in the sample before and after the experiment.

Table 1: Soil nutrient analysis before and after planting

Period	%N	%P	%K	%Ca^{2+}	%Mg^{2+}	%Fe	%Zn
Before the experiment	0.07	0.03	0.01	0.08	0.06	0.01	0.04
After the experiment	0.07	5.13	0.11	1.00	0.80	0.08	0.16

Results

Table 2 displays the effect of manure rates on pumpkin vine length. From the result, the vine length recorded a higher value (27.78cm), although not-significant (P>0.05) at the use of 10 tons application and recorded the least value (23.36cm) at the use of 0 tons (control). At four weeks, the vine length recorded a significantly higher value (47.60cm) at 15 tons application and the least value (35.07cm) at 0 tons. At six weeks, the vine length recorded a significantly higher value (66.00cm) at 15 tons application, while the lowest value (46.90cm) was recorded at 0 tons

Table 3 describes the effect of manure rates on the number of pumpkin leaves. From the result, at two weeks, the number of leaves recorded a significantly higher value (3.90) at 15 tons application and the lowest value (3.44) at 0 tons. At four weeks, the number of leaves recorded a significantly higher value (4.89) at 10 tons application and the lowest value (4.65) at 0 tons. At six weeks, the number of leaves recorded a significantly higher value (21.91) at 15 tons application and the lowest value (17.52) at 0 tons application.

Table 4 shows how manure rates impact the leaf length of pumpkin. From the result, in two weeks, the leaf length recorded a significantly higher value (4.53cm) at 15 tons application and the lowest value (3.64cm) at 0 tons. At four weeks, the leaf length recorded a significantly higher value (19.06cm) at 15 tons application and the least value (13.77cm) at 0 tons. At six weeks, the leaf length recorded a significantly higher value (29.77cm) at 15 tons application, while the lowest value (23.04) was recorded at 0 tons application.

Table 5 below shows the effect of manure rates on the stem girth of pumpkins. From the result, at two weeks, the stem girth recorded a non-significant (P>0.05) higher value (0.39cm) at 10 tons application and the lowest value (0.32cm) at 5 tons application. At four weeks, the stem girth recorded a significantly higher value (0.93cm) at 15 tons application and the lowest value (0.79cm) at 0 tons application. At six weeks, the stem girth recorded a non-significantly (P>0.05) higher value (2.24cm) at 15 tons application and the least value (1.07cm) was recorded at 0 tons.

Table 6 shows the effect of manure rates on the number of branches of pumpkins. From the result, at four weeks, the number of branches recorded a significantly higher value (2.11) at 15 tons application and the lowest value (1.64) at 0 tons application. At six weeks, the number of branches recorded a non-significantly (P>0.05) higher value (5.91) at 15 tons application and the least value (4.56) at 5 tons application.

Table 2: Effect of manure rates on pumpkin vine length(cm) at various weeks post planting

MANURE RATES(t/ha)	2WKS	4WKS	6WKS
0t/ha	23.36	35.07	46.90
5t/ha	26.23	39.07	57.90
10t/ha	27.78	43.06	60.60
15t/ha	26.09	47.06	66.00
F-LSD (0.05)	**NS**	**6.48**	**11.72**

F-LSD (0.05) = Fischer's least significant difference at 5% probability level

Table 3: Effect of manure rates on number of leaves of pumpkin at various weeks post planting

MANURE RATES(t/ha)	2WKS	4WKS	6WKS
0t/ha	3.44	4.65	17.52
5t/ha	3.45	4.67	17.53
10t/ha	3.74	4.89	21.14
15t/ha	3.90	4.84	21.91
F-LSD (0.05)	**0.03**	**0.55**	**3.03**

F-LSD (0.05) = Fischer's least significant difference at 5% probability level

Table 4: Effect of manure rates on pumpkin leaf length (cm) from weeks after planting

MANURE RATES (t/ha) 2WKS 4WKS 6WKS			
0t/ha	3.64	13.77	23.04
5t/ha	4.01	15.29	23.24
10t/ha	3.75	16.15	25.61
15t/ha	4.53	19.06	29.77
F-LSD (0.05)	**0.59**	**1.48**	**3.45**

F-LSD (0.05) = Fischer's least significant difference at 5% probability level

Table 5: Effect of Manure rates on stem girth (cm) of pumpkin from weeks after planting

MANURE RATES (t/ha) 2WKS 4WKS 6WKS			
0t/ha	0.38	0.79	1.07
5t/ha	0.32	0.88	1.96
10t/ha	0.39	0.89	1.97
15t/ha	0.38	0.93	2.24
F-LSD (0.05)	**NS**	**0.12**	**NS**

F-LSD (0.05) = Fischer's least significant difference at 5% probability level

Table 6: Effect of Manure rates on number of branches of pumpkin from weeks 4-6 after planting

MANURE RATES (t/ha) 4WKS 6WKS		
0t/ha	1.64	5.19
5t/ha	1.85	4.56
10t/ha	2.07	5.06
15t/ha	2.11	5.91
F-LSD (0.05)	**0.33**	**NS**

F-LSD (0.05) = Fischer's least significant difference at 5% probability level

Discussion

Based on the observations obtained, it is evident that the application of poultry manure significantly and positively support the growth and development of pumpkin (*Cucurbita pepo*) plants. Similar to previous results [3], our findings corresponds with the observation in the experiment that higher rates of poultry manure application (15 tons/ha) resulted in better growth parameters like vine length, number of leaves, stem girth, number of branches, and leaf length at various growth stages (2, 4, and 6 weeks after planting). The improvement in growth parameters can be traced back to the enhanced nutrient availability, improved soil structure, and increased soil microbial activity provided by the poultry manure.

While the highest rate of 15 tons/ha generally showed the best results for most growth parameters, there were some instances where lower rates (5 or 10 tons/ha) performed better or showed non-significant differences. Determining the optimal rate is essential to maximize the benefits while avoiding potential issues associated with excessive application, such as nutrient imbalances or environmental concerns. The findings of this study are consistent with several other studies that have investigated the use of organic manures, including poultry manure, for vegetable production. The positive effects observed align with the ability of organic manures to improve soil's physical, chemical, and biological properties, as well as provide essential nutrients for plant growth [4, 20, 3, 1].

A relatively recent report emphasized the importance of conducting site-specific trials to determine the appropriate application rates for organic manures, as excessive rates can potentially lead to nutrient imbalances or environmental concerns [5]. This is consistent with the discussion in the text about the need to identify the optimal rate of poultry manure application for pumpkin cultivation, as the highest rate (15 tons/ha) did not always perform the best for all growth parameters. Overall, the results shown in this experiment strongly support the use of poultry manure as an organic amendment for pumpkin cultivation. The application of poultry manure, particularly at higher rates, can significantly enhance the plant's growth and development, ultimately contributing to sustainable vegetable production practices. These similar findings from other studies highlight the potential benefits of using organic manures like poultry manure for vegetable production while also considering optimal application rates and site-specific conditions.

Conclusion

Poultry manure application to planting soil had a significantly positive effect on the growth and development of pumpkin (*Cucurbita pepo*) plants. Higher rates of poultry manure application (15 tons/ha) promoted growth parameters such as vine length, number of leaves, stem girth, number of branches, and leaf length. The positive effects of poultry manure can be attributed to improved nutrient availability, enhanced soil structure, and increased soil microbial activity. The findings of this study are consistent with other studies that demonstrated the benefits of using organic manures, including poultry manure for vegetable production. Incorporation of 15 tons of poultry manure as an organic amendment to the soil is recommended for pumpkin cultivation to enhance plant growth, development, and yield. Site-specific trials should be conducted to determine the optimal rate of poultry manure application for pumpkin cultivation, as excessive rates may lead to nutrient imbalances or environmental concerns. Further research is needed to investigate the long-term effects of poultry manure application on different types of soil, nutrient dynamics, and crop productivity to ensure sustainable vegetable production practices. Proper handling, storage, and application methods for poultry manure should be followed to maximize its benefits and minimize potential risks, such as nutrient leaching or pathogen contamination. Awareness and training programs should be implemented to educate farmers on the benefits and proper use of organic manures, including poultry manure, for sustainable vegetable production.

References

1. Adediran-Agbo, O.A., Adenuga, D.A., Odeyale, O.C., Musa, F.B. and Agboola, F.O. (2020). Effect of poultry manure and cow dung on growth of *Entomidrophragma*. Journal of Research in Forestry, Wildlife and Environment, Vol. 12(3), p.279-283.
2. Adediran, J.A., Taiwo, L.B., AKande, M.O., Sobulo, R.A. and Idowu, O. J. (2005). Application of organic and inorganic fertilizer for sustainable maize and cowpea fields in Nigeria. *Journal of Plant Nutrition Vol. 27*, Issue 7, p. 1163-1181.
3. Adediran, O., Gana, Z., Oladiran, J. and Ibrahim, H. (2015). Effect of age at harvest and leaf position on yield and nutritional composition of *Celosia argentea L*. *International Journal of Plant and Soil Science, 5*(6): 359-365.
4. Agbede, T.M., Olasekan, A.A. and Eifediyi, K. (2017). Impact of poultry manure and NPK fertilizer on soil physical properties and growth and yield of carrot. *Journal of Horticultural Research, 25*(1), 81-88.
5. Agbede, T.M., Olasekan, A.A., Odoja, A.S., Bayode, L.N., Omotehinse, P.O. and Adepehin, I. (2020). Effect of biochar and poultry manure on soil properties, growth, quality and yield of cocoyam (*Xanthosoma sagittifolium* Schott) in degraded tropical sandy soil. Experimental Agriculture, 56, 528-543.
6. Aletor, O., A.A. Oshodi and K. Ipnmoroti (2002). Chemical composition of common leafy vegetables and functional properties of their leaf protein concentrates. *Food Chemistry, 78*, 63-68.
7. Azbaid, S. M., Esmail, A. L., & Sami, A. (2020). Anti-inflammatory and cytotoxic effects of cucurbitacins from Cucumisprophetarum and Cucurbita pepo. *Molecules, 25*(6), 1406.
8. Badifu, G. I. O. and A. O. Ogunsua (1991). Chemical composition of kernels from some species of cucurbitacea grown in Nigeria. *Plant Food Human Nutrition, 41*: 35-44.
9. Bisognin, D.A. (2002). Origin and evolution of cultivated Cucurbits. *Rural Science: Santa Maria, 32*, 715-723.
10. Boateng, S., Zickermann A.J. and Kornaharens, M. (2006). Effect of poultry manure on growth and yield of maize. *West Africa J. App. Eco., 9*:1-11.
11. Dunsin, O., Aboyeji, C. M., Adekiya, A. O., Adegbite, K. A., Adebiyi, O. T. V., Bello, R. O., ... & Dunsin, D. M. F. (2019). Growth, yield, fruit mineral and Vitamin C content of Cucurbita pepo. L as affected by Organic and NPK fertilizer. *Open Agriculture*, *4*(1), 795-802.
12. Egerszegi, E. (1990). Effect of sewage sludge and compost applied to the soil on some physical and chemical properties. *Journal of Environmental Quality, 15*, p.122-127.
13. El-Adawy, Tarek. A and Taha, Khaled . (2001). Characteristics and composition of different seed oils and flours. *Food Chemistry Vol. 74*, Issue 1, p. 47-54.
14. FAO (2012). Crop water information: Pumpkin. Water Development and Management Unit, Food and Agriculture Organization of the United Nations.
15. Farhad, W.M.F, Saleem, M.A. Cheema and H.M. Hammad, (2009).Effect of poultry manures levels on the productivity of spring maize (Zea mays L.). The journal of animal and plant sciences, Department of agronomy, university of agriculture, Faisalabad, Pakistan, edition 19, P 122-124.
16. Fu, D., Wu, X., Duan, C., Chadwick, D.R. and Jones, D.L. (2020). Response of soil phosphorus fractions and fluxes to different vegetation restoration types in a subtropical mountain ecosystem. *CATENA Vol. 193*.
17. Holden, J. M., Eldridge, A. L., Beecher, G. R., Buzzard, I. M., Bhagwat, S., Davis, C. S., and Haytowitz, D. (1999). Carotenoid content of US foods: An update of the database. *Journal of Food Composition and Analysis, 12*(3), 169-196.
18. Obi, I. U. (2002).statistical methods of detecting differences between treatment means and research methodology issues in laboratory and field experiments. Nsukka Nigeria.

19. Ogbonna, P. E. (2008). Effect of combined application of organic and inorganic fertilizers on fruit yield of egg plant (Solanummelongena). Pro. 42nd Annual conf. Agricultural Society of Nigeria (ASN) October 19 – 23 p. 236 - 250.
20. Okalebo, J., Gathua, K. and Woomer, P. (2002). Laboratory methods of plant and soil analysis: A working manual. *TSBF-UNESCO Nairobi Kenya, 2*, p. 29-68.
21. Oyeleke, A.W., Oluwajsyitan, D.T., Oluwamukomi, M.O., Enujiugha, N.V. (2019). Amino acid profile, functional properties and in-vitro antioxidant capacity of *cucurbita maxima* and *cucurbita mixta* fruit pulps and seeds. *European Journal of Nutrition and Food Safety, 10*(4), 224-241.
22. Pepijn Schreinemachers, Emmy, B. Simmons, Marco C.S. Wopereis (2018). Tapping the economic and nutritional power of vegetables. *Global Food Security, 16*, 36-45.
23. Rao, A. V., & Rao, L. G. (2007). Carotenoids and human health. *Pharmacological Research, 55*(3), 207-216.
24. Reiners, S., & Riggs, D. I. M. (1997). Plant spacing and yield among pumpkin cultivars grown for processing. *Hort Science, 32*(6), 1129-1131.
25. Tsaknis John, Stavros Lalas and Evangelos, S. Lazos (1997). Characterization of crude and purified pumpkin seed oil. *Grasas Y. Aceites Vol 48*. Fasc 5 pp267-272.
26. USDA Nutrient Database: https://fdc.nal.usda.gov/fdc-app.html#/food-details/168482/nutrients.
27. Van Ryssen, J.B.J., Van, Malsen, S. and Verbeck, A.A. (1993). Mineral composition of poultry manure in South Africa with reference to the Farm Feed Act. *South Africa Journal of Animal Science, 23* (2), 54-57.