Jher Vol. 31 No. 1 September, 2024, pp. 126– 136

Evaluation of Response of Selected Watermelon (Citrullus Lanatus) Growth and Yield Attributes to Pig Manure in Owerri, South Eastern Nigeria

Poly-Mbah, Chinwe P., Offor, John I., Uzor, Darlington C.,& Eziefule Joy C.
Department of Agricultural Education,
Alvan Ikoku Federal University of Education, Owerri, Imo State
Corresponding Author:chinwepolymbah@gmail.com

Abstract

The general objective of this study was to evaluateresponse of selected watermelon growth and yield attributes to pig manure in Owerri, South Eastern Nigeria. Specifically, it determined response of watermelon to four rates of pig manure in terms of number of leaves produced per plant, vine length per plant, number of fruits harvested per plant and weight of fruits harvested per plant. The field experiments were conducted in 2020 and 2021 cropping seasons in the Teaching and Research Farm, Agricultural Science Department, Alvan Ikoku Federal University of Education, Owerri, Imo State, Nigeria. The investigation was carried out in a Randomized Complete Block Design with three replications. Treatments were composed of pig manure rates of 0, 5, 10, 15 tons per hectare. Parameters studied were number of leaves per plant, vine length per plant, number of fruits harvested per plant and weight of harvested fruits per plant. Data were subjected to Analysis of Variance (ANOVA) test and significant treatment means were separated using Least Significant Difference (LSD) protocol. Results obtained from the two experiments conducted show plants that received application of pig manure at the rate of 15 tons per hectare were outstanding in terms of vine length at 4weeks after planting (79.96 cm in 2020 and 58.93cm in 2021), 6 weeks after planting (162.46cm in 2020 and 89.73cm in 2021) and 8 weeks after planting (201.36cm in 2020 and 187.06 cm), number of leaves at 4 weeks after planting(25.50 in 2020 and 33.96 in 2021), 6 weeks after planting (28.50 in 2020 and 39.63 in 2021), 8 weeks after planting (31.10 in 2020 and 42.96 in 2021), number of fruits (4 fruits/plant in 2020 and 6 fruits/plant) as well as fruit weight(10kg in 2020 and 8kg in 2021) and is therefore to recommended for watermelon cultivation in Owerri, South Eastern Nigeria.

Keywords: Evaluation, Response, Growth, Yield, Attributes, Watermelon, Pig Manure, Owerri.

Introduction

Watermelon (*Citrulluslanatus*) is a warm season crop in the cucurbit family (Otunaiya and Adedeji, 2014). It is a crop with huge economic and nutritional benefits to man (Schippers, 2000; Schaffer and Paris, 2016). It is a highly nutritious, sweet, thirst-quenching fruit vegetable and it is relished by many people across the world due to its high water, sugar, and

vitamins A, B and C, content (Aniekwe and Nwokwu, 2013; Nthiga *et al.*, 2014). Watermelon contains one of the most important antioxidants in nature called lycopene which has been implicated in preventing cancer attack in humans thus making the watermelon fruit to be classified as anti-cancer (Ezeh, *et al.*, 2021). Potassium is also present in watermelon in huge amounts, which is believed to help in the control of blood pressure and possibly prevent stroke (Enujeke, 2013) Watermelon contains other phytochemicals such as beta - carotene, vitamin C which possess anti – inflammatory properties. These help to reduce hypertension and some coronary heart diseases due to the inhibition of the formation of free radicals in the human body system (Tarazona-Diaz *et al.,2011;* Maoto *et al.*, 2019) Watermelon is a rich source of L-citrulline (Perkins-Veazie, *et al.,2012).* Watermelon is known to reduce the inflammation that contributes to conditions like asthma, atherosclerosis, diabetes, colon cancer, arthritis (Tarazona-Diaz *et al.*,2011). It has diuretic properties (Nthiga *et al.*, 2014). The demand for watermelon for consumption in a fresh form as a thirst quencher and as a source of minerals and vitamins is greatly increasing globally (Dalorima, *et al.*,2022), hence, the need to increase the production of watermelon.

Watermelon like most vegetables is cultivated all over the world. In Nigeria, it is most widely cultivated in the Northern Nigeria but greatly consumed in the Southern Nigeria (Poly-Mbah, *et al.*,2008, 2012b). Farmers incur a lot of losses in transporting watermelon fruits from Northern Nigeria where it is produced to Southern Nigeria where it is consumed (Poly-Mbah, *et al.*, 2010a ,2010b and 2012a) This is responsible for the high market price which vegetables including watermelon command in South eastern Nigeria. There is a need for massive watermelon production in the South Eastern Nigeria where watermelon is highly consumed. One major way of increasing the production of watermelons is through optimum organic fertilizer application. Soil fertility management using organic fertilizer amendment is a relatively new strategy (Eifediyi *et al.*, 2018). Researches have shown that some tropical soils are low in plant nutrients, and proper manuring can truly play a major role in increasing crop productivity (Audi *et al.*,2013).

The use of organic manure in the cultivation of vegetables is preferred to the use of inorganic fertilizers because organic fertilizers have shown some positive results and also prevents any attack from soil micro-organisms that may be harmful to plants (Massri and Labban, 2014). It has been affirmed that organic manure amendment enhances crop growth and development as it is a source of minerals and important nutrients which are capable of releasing adequate nutrients and it aids in binding the nutrient in soils together (Azeez and Van Averbeke, 2010; Miranda *et al.*, 2012). Crops need slow releasing fertilizer so as to increase nutrient availability for the plant and lower the maintenance and labour cost during growing period. The use of inorganic fertilizers in crop production poses health risks as it has been found to be carcinogenic and contributes to environmental issues such as

contamination of the air, water, and soil. Chemical fertilizers use has a negative impact on soil texture and structure, as well as lowering soil organic matter and inhibiting soil microbial activity owing to toxicity (Dalorima *et al.*, 2022).

Some researchers have published reports on the use of poultry manure for the production of watermelon in South Eastern Nigeria (Enujeke, 2013; Dalorima *et al.*, 2022) but the sustained release of nutrients in poultry manure is inadequate. It has been found that poultry manure releases nutrients faster and it does not give the sustained release needed for the yield phase of some crops. Hence, there is a need to investigate the production of watermelon fruits in South Eastern Nigeria using other organic fertilizer sources. One of the other widely used organic fertilizer sources is pig manure. With increased pig farming, pig manure is readily available to crop growers who need them. Use of pig manure in fertilizing crop farms is a major way of controlling the pollution caused by pig rearing industry (Song *et al.*,2012). The difficulty in transferring the pig slurry from the pig rearing factories to farmlands for utilization can be solved by drying it before the transfer.

It has been reported that pig manure is a low cost organic fertilizer and it is effective as a good source of nutrients for sustainable crop production (Lourenzi *et al.*, 2014 ; Enujeke *et al,* 2021and Lijun and Shenfa, 2022). It can be used to replace inorganic fertilizers needed to fertilize crop fields. Pig manure has a more sustained way of releasing nutrients while the poultry manure releases its nutrient faster and may not sustain the plant all through the fruiting stage (Massri and Labban, (2014)).

However, research findings have revealed that the application of swine waste (pig manure) at the rate of 20 tons/ha could lead to toxic levels of sulphate in crop produce (Mbah *et al.*, 2005). There is no documented evidence on pig manure requirement of watermelon in Owerri, South Eastern Nigeria. There is a need therefore to determine the pig manure requirement for watermelon cultivation in Owerri, South Eastern Nigeria

Objectives of the Study

The general objective of the study was to evaluate the response of selected watermelon growth and yield attributes to pig manure in Owerri, South Eastern Nigeria. Specifically, it determined the response of watermelon to four rates of pig manure in terms of:

1. number of leaves produced per plant,
2. vine length per plant,
3. number of fruits harvested per plant
4. weight of fruits harvested per plant.

Materials and Methods

***Design of the Study*:**The two field experiments were laid out using the Randomized Complete Block Design with three blocks (replications) and four (4) treatments. Each replication comprised four plots to give a total of twelve plots in each of the experiments.

***Materials Used for the Study*:** Watermelon seeds were procured from the seeds supplied by the KUCH-99 (Thai Agro) seeds at the State Headquarters of the Agricultural Development Programme, Owerri. Well cured/dried pig manure was collected from a pig farm in Owerri. Equipment

used for the study include a tractor with its implements, weighing balance, measuring tape, spade, hoe and matchet.

***Description of the Experimental Site*:** The two field experiments were conducted in the Department of Agricultural Education Teaching and Research Farm, Alvan Ikoku University of Education, Owerri in 2020 and 2021 late session cropping in a typical humid environment that is characterized by a bimodal rainfall pattern with peaks in July and September and an interrupted dry spell in August otherwise called August break. Alvan Ikoku University of Education, Owerri is located in the South Eastern Nigeria between latitude 5° 15' and 5 ° 45'N and longitude 7 °30' and 6 °45'E. The site has been under the cultivation of vegetable crops for considerable number of years.

***Field Preparation*:**The field for the two experiments were cleared manually, ploughed, harrowed using a tractor and divided into three blocks.Each block wassub-divided into four plotswith each plot measuring 4.5 x 4.0 m with furrow distance of 0.6m and 1.0m between blocks.

The plots were experimental units or seedbeds to which treatments were applied. Raised beds were manually prepared in each of the plots. Treatments comprised four rates of well cured pig manure (0, 5, 10, and 15 tons/ha). Treatments were allocated to plots randomly within each block. The four rates of pig manure were incorporated into the soil two weeks before planting.

***Seed Planting*:**Seeds were planted at the rate of two seeds per stand/hole using 2m x 2m planting spacing. Planting was done using the garden hoe by digging up to 4cm depth and covering the hole gently with soil.

***Agronomic Measurements*:** Selected agronomic measurements taken were;

***Measurement of Vine Length*:**The vine length was measured from the base of plants to the growing tip of the main vine using a flexible metric tape. The main vine was traced from the base of the plant and extending to the tip of the vine. The vine length was measured at intervals of 14 days.

***Number of Leaves and Number of Harvested Fruits*:**Number of leaves per plant and number of mature fruits were obtained by direct counting. Mature fruits were selected based on marketable sizes. Immature fruits as well as malformed and diseased fruits were discarded. Harvestable fruits were counted per plant and recorded.

***Weight of Harvested Fruits*:**Weight of harvested fruits per plant were determined in kilogrammes immediately after harvest using a weighing scale. This is called fresh weight of fruits.

***Data Analysis*:**Data were analyzed using means and Analysis of Variance (ANOVA) test.Significant treatment means were separated using the Least Significant Difference (LSD)protocol. The decision rule is that if the difference between two treatment means is greater than the LSD value, it means that the two treatment means are statistically and significantly different. If the difference between two treatment means is less than the LSD value, it means that those two treatment means are equal or the same.

Results

Table 1: Effects of Pig Manure on Leaf Number at 4,6,8, and Weeks after planting

Manure rates	Expt. 1 4 WAP	Expt.2 4 WAP	Expt. 1 6 WAP	Expt. 2 6 WAP	Expt.1 8 WAP	Expt. 2 8 WAP
0 tons/ha	10.10	13.53	13.30	25.76	16.10	30.40
5tons/ha	16.20	31.63	22.30	33.53	26.50	35.86
10tons/ha	21.10	23.30	26.40	34.43	28.30	38.74
15tons/ha	25.50	33.96	28.50	39.63	31.10	42.96

	4 WAP	6 WAP	8 WAP
$LSD_{0.05}$ for Expt. 1	0.30	0.40	0.30
$LSD_{0.05}$ for Expt. 2	0.52	0.28	0.17

*$LSD_{0.05}$ = Least significance difference at 0.05 level of significance
WAP = Weeks after planting
Tons(tonnes) = Quantity of manure applied. One ton/tonne is equal to 1000kg
Ha = Hectare (10000m^2)
Expt. 1= Experiment 1 carried out in 2020
Expt. 2 = Experiment 2 conducted in 2021

In Table 1, which is a table of means, show that plants that received 15 tons/ha of pig manure were significantly outstanding in terms of number of leaves/plants at 4, 6, and 8 weeks after planting (WAP). Data in Table 1 reveals that the trend in the two experiments conducted was such that as the pig manure rate increased, the number of leaves produced per plant increased, such that the plants that did not receive pig manure (0 tons per hectare) produced the lowest leaf number at 4 weeks after planting(10.10 in 2020 and 13.53 in 2021), 6 weeks after planting (13.30 in 2020 and 25.76 in 2021) and 8 weeks after planting (16.10 in 2020 and 30.40 in 2021), while the plants that received the highest manure rate of 15tons per hectare produced the highest leaf number at 4 weeks after planting(25.50 in 2020 and 33.96 in 2021), 6 weeks after planting (28.50 in 2020 and 39.63 in 2021) and 8 weeks after planting (31.10 in 2020 and 42.96in 2021). There were significant differences among all the treatments as shown when the differences between the means were compared with the $LSD_{0.05}$ values. The differences between the means are greater than the $LSD_{0.05}$value.

Table 2: Effects of Pig Manure on the Vine Length (Cm) of the Watermelon at 4, 6 and 8 Weeks After Planting.

Manure Rate	**Expt. 1**	**Expt. 2**	**Expt. 1**	**Expt. 2**	**Expt. 1**	**Expt. 2**
	4WAP	**4 WAP**	**6WAP**	**6 WAP**	**8WAP**	**8 WAP**
0tons/ha	16.32	25.73	31.21	31.73	41.44	61.40
5 tons/ha	60.38	56.40	117.44	70.30	137.24	148.53
10tons/ha	73.98	34.60	131.30	81.83	155.47	165.20
15tons/ha	79.96	58.93	162.46	89.73	201.36	187.06

	4 WAP	6WAP	8 WAP	
$LSD_{0.05}$ for Expt.1	0.5		0.7	0.8
$LSD_{0.05}$ for Expt. 2	11.02		7.04	14

*$LSD_{0.05}$ = Least significance difference at 0.05 level of significance
WAP = Weeks after planting
Tons(tonnes) = Quantity of manure applied. One ton/tonne is equal to 1000kg
Ha = Hectare (10000m^2)
Expt. 1= Experiment 1 carried out in 2020
Expt. 2 = Experiment 2 conducted in 2021

Results obtained from the two experiments conducted and presented in a table of means , show that there were significant differences in vine length of watermelon as affected by pig manure rates (Table 2).From the research results obtained from the two experiments conducted (2020 and 2021) as presented in table 2, it was observed that as the pig manure rate increased, the vine length of watermelon also increased such that pig manure rate of 0 tons per hectare significantly produced the least values at 4weeks after planting (16.32 cm in 2020 and 25.73cm in 2021), 6 weeks after planting (31.21cm in 2020 and 31.73cm in 2021) and 8 weeks after planting (41.44cm in 2020 and 61.40 cm), while the manure rate of 15 tons per hectare significantly produced the highest values at 4weeks after planting (79.96 cm in 2020 and 58.93cm in 2021), 6 weeks after planting (162.46cm in 2020 and 89.73cm in 2021) and 8 weeks after planting (201.36cm in 2020 and 187.06 cm),. There were significant differences among all the treatmentsas shown when the differences between the means were compared with the $LSD_{0.05}$ values. The differences between the means are greater than the $LSD_{0.05}$value.

Table 3 – Effects of Pig Manure on Number of Fruits and Fruit Weight (Kg) Per Plant at Harvest

Manure	**Fruit Number**		**Fruit Weight**	
Rate	**Expt. 1**	**Expt. 2**	**Expt. 1**	**Expt. 2**
0 tons/ha	1	1	3.31	2.13
5tons/ha	2	2	6.43	5.73
10 tons/ha	3	4	8.74	6.93
15tons/ha	4	6	10.07	8.0

Fruit number	Fruit weight	
$LSD_{0.05}$ for Expt. 1	0.1	0.3
$LSD_{0.05}$ forExpt. 2	0.15	0.2

*$LSD_{0.05}$ = Least significance difference at 0.05 level of significance
WAP = Weeks after planting
Tons(tonnes) = Quantity of manure applied. One ton/tonne is equal to 1000kg
Ha = Hectare (10000m^2)
Expt. 1= Experiment 1 carried out in 2020
Expt. 2 = Experiment 2 conducted in 2021

Data obtained on the number of harvestable fruits and weight of harvested fruits showed that the plants that received 15 tons/ha significantly performed best among other treatments (Table 3). Results in Table 3 reveal significant differences among all the treatments in terms of number of fruits produced and weight of harvested fruits as shown when the differences between the means are compared with the $LSD_{0.05}$ values. The plants that received pig manure at the rate of 15tons per hectare significantly produced highest number of fruits per plant (4 fruits per plant in 2020 and 6 fruits per plant in 2021) and fruit weight (10.07kg in 2020 and 8kg in 2021) while the plants that did not receive pig manure treatment significantly performed poorly.

Discussion

Pig manure use as a fertilizerfor crop production has gained popularity due to its advantage of having slow release of nutrients (Miranda *et al*, 2012; Ibrahim *et al.,* 2021; Lijun and Shenfa, 2022). Results show that plants that received 15 tons/ha of pig manure were outstanding in terms of number of leaves per plants, vine length per plant at 4, 6, and 8 weeks after planting. This may be attributed to the release of nitrogen contained in pig manure which enhanced vegetative growth of watermelon. Increased vegetative growthshows that the manure applied was utilized effectively.

Data collected and analyzed showed that as the pig manure rate increased from 0 tons per hectare to 15 tons per hectare, the pig manure application rate of 15tons/per hectare produced the highest number of leaves of watermelon such that plants that received 15 tons of manure consistently produced highest number of leaves at 4 weeks after planting(25.50 in 2020 and 33.96 in 2021), 6 weeks after planting (28.50 in 2020 and 39.63 in 2021) and 8 weeks after planting (31.10 in 2020 and 42.96) . Similarly, the observed response of vine length of watermelon revealed that watermelon responded significantly to pig manure application such that as the pig manure application rate increased from 0 tons per hectare to 15 tons per hectare, the pig manure rate of 15tons/per hectare produced the highest vine length at 4weeks after planting (79.96 cm in 2020 and 58.93cm in 2021), 6weeks after planting (162.46cm in 2020 and 89.73 in 2021) and 8 weeks after planting (201.36cm in 2020 and 187.06 cm). This confirms the findings of a study carried out by Enujeke *et al.*,2021 in Asaba, Delta State, Nigeria where the effects of pig manure on the growth and yieldof watermelon were studied using five rates of the manure (0.5,10,15 and 20 tons per hectare).Theresults from that study indicated that the assessed parameters increased as manure level increased. Plants that received 20 tons per hectare of manure gave the best performance at 4,6 and 8 weeks after planting with respect to vine length and number of leaves. However, the investigation here reported did not study up to 20 tons per hectare of manure treatment because it has been found out that manure levels up to 20 tons per hectare and above could lead to toxic levels of sulphate in crop produce (Mbah *et al.,* 2005). Similarly, in a work

done by Eze *et al.,* 2021, it was found out that increased manure levels increased the growth and yield parameters studied. The results obtained from the experiment on the number of leaves per plant were in conformity with the studies made by Massri and Labban (2014). The implication of this finding is that watermelon cannot be grown successfully without the addition of organic manure with particular reference to pig manure. This is confirmed by a publication made by Aliyu, 2000 who stated that pig manure contains useful proportions of essential and major nutrients that sustains plant growth. Further researches have shown that tropical soils are low in plant nutrients, and proper manuring can truly play a major role in increasing crop productivity (Audi, *et al.*,2013; Enujeke, *et al.*,2013). The implication is that pig manure contains essential plant nutrients that encourages high photosynthetic rate which results in high vegetative growth (Ibrahim *et al.*,2021).

The significant high number of fruits and fruit weight as a result of manure application such that as manure rate increased, fruit number and fruit weight also increased, in which the number of fruits per plant and fruit weight were significantly increased with increased pig manure application. Watermelon plants that received pig manure application of 15 tons per hectare produced the highest number of fruits in the two experiments conducted (4 fruits per plant in 2020 and 6 fruits per plant in 2021) and also the highest fruit weight (10.07kg in 2020 and 8kg in 2021). This result tallies with the findings made by Mangila, 2007; Jianquang *et al.*, 2011; Aniekwe and Nwokwu, 2013; Enujeke ,2013;Eifediyi , 2018 and Dalorima, *et al.*, 2022) This result shows that application of pig manure at the rate of 15 tons/ha not only improved the soil conditions for watermelon establishment but also released adequate nutrient elements for yield enhancement. This finding is in line with reports made by Jianquang, *et al.*, 2011; Hassan and Solaiman, (2012); Pandolfo and Viega, (2016) and Enujeke *et al.,* 2021 who established through research studies that the use of organic fertilizers promotes vegetative growth in crops and consequently higher yields.

Conclusion

Fourparameters were assessed to achieve the objectives of the study which include vine length, number of leaves, number of harvested fruits and weight of fruits of watermelon. Increased rate of application of the manure resulted in corresponding increases in the parameters study.The findings of tis study confirm that the application of pig manure significantly affected all the parameters studied in the two experiments conducted in 2020 and 2021, such that the pig manure rate of 15 tons gave the highest values in all the parameters studied. It can therefore be concluded that watermelon vine length, number of leaves, number of fruits, and weight of fruits are significantly higher when the soil is treated with pig manure.

Recommendations

Based on the findings of the study,it is recommended that:

1. watermelon should not be grown without the application of organic fertilizer such as pig manure.
2. farmers in Owerri, South Eastern Nigeria should apply pig manure at the rate of 15 tons per hectare for increased growth and yield of watermelon.

References

Aliyu, L., (2000). The effects of organic and mineral fertilizer on growth, yield, and composition of pepper (*Capsicum annum L.). Biol. Agric. Hort.,* 18: 29-36.

Audi W, Aguyoh J.N, Gao-Qiong L. (2013) Yield and quality of watermelon as affected by organic and inorganic nitrogen sources. *Asian J Agric Food Sci. 1: 180–185.*

Azeez, J.O. and Van Averbeke, W., (2010). Nitrogen mineralization potential of three animal manures applied on a sandy clay loam soil. *Bioresource Technnology, 101:5645 -5651*

Dalorima, T, Siti, Z.S. and Ramisah, N. S. (2022). Vegetative growth and yield of two watermelon varieties as influenced by different organic fertilizers. *Australian Journal of Crop Science,16 (6): 691- 699.*

Eifediyi E.K., Remison S.U., Ahamefule H.E., Azeez K.O., Fesobi P.O. (2018). Performance of watermelon (*Citrullus lanatus* .) in response to organic and NPK fertilizers. *Acta Univ Sapientiae, Agric Environ 9:5–17.*

Enujeke, E. N., (2013). Response of watermelon to five different rates of poultry manure in Asaba Area of Delta State, Nigeria. *Journal of Agriculture and Veterinary Science, 5 (2) : 40 – 50.*

Enujeke E.C., Ojeifo I.M, and Nnaji G.U (2013) Residual effects of organic manure and inorganic fertilizer on maize grain weight and some soil properties in Asaba area of Delta State. *International Journal of Advanced Biological Research* 3(3):433-442.

Enujeke, E. C, Egbuchua, C, Ogbunaka, E., Jimmy Andrew, E. F.,and Nduka, A. P. (2021). Effects of pig manure on the growth and yield indices of watermelon in Asaba Area of Delta State, Nigeria. *Journal of Biological and Environmental Sciences 19 (5) :109-115.*

Ezeh, I.N, Ukwu, U.N and Uzoigwe,D.A., (2021). Comparative effects of two manure types and their combinations on growth and yield of watermelon (Citrullus lanatus (Thunb) Matsum and Nakai) in Nsukka, Southeast Nigeria. *Asian Journal of Advances in Agricultural Research 17(2):30* – 41

Hassan, M. R. and Solaiman, A. H. M. (2012). Efficacy of organic and inorganic fertilizers on the growth of Brassica oleracea L. (cabbage). *International Journal of Agriculture, Crop Science, 4:128-138*

Ibrahm, W.; Graham, M; and Leitner, S., (2021). Characteristics of pig manure management and associated environmental ad health issue in Central Uganda. *International Livestock Research Institute (ILRI) 96. Nairobi, Kenya, ISBN:92-9146-699-9*

Jianquang W; Miu W.; Peng L.; Leyang C. ;Mingyi, M.; Boyu,X., Shuyuan,Z; Chenyan, S; Chummei Y, Lijun, X and Shenfa, H., (2022). Effects of pig manure and its organic fertilizer application in Archaea and methane emission in paddy fields. *Lands 11(4):499*

Lourenzi, C.R.; Ceretta, C. A; Brunetto, G.; Curotto, E.; Trecher, T.L.; Vieira, R. C.; Cancian, A, and Ferreira, P.A., (2014). Pig slurry and nutrient accumulation and dry matter and grain yield in various crops. *Revisita Brasileira de Ciencia do solo, 38 :949-958*

Maoto, M.M.;Beswa, D.; Jideani, A.I.O., (2019). Watermelon as a potential fruit snack. *International Journal of food properties, 22(1): 355-370*

Mangila, E., Tabiliran, F. P., Naguit, M. R. A. and Malate, R. (2007). Effects of organic fertilizer on the yield of watermelon. *Threshold* 2:27-35.

Massri M, and Labban L. (2014) Comparison of different types of fertilizers on growth, yield and quality properties of watermelon (*Citrllus lanatus*). *Agric Sci. 5: 475–482*

Mbah, C. N., Anikwe, M.A.N. and Mbagwu, J.S.C. (2005). Effect of animal waste application on soil acidity and sulphate of an ultisol in South eastern Nigeria. *Nigerian Journal of Soil Sciences,15 (2): 93-100.*

Miranda, M; Scheffer-Basso, S. M.;Escoteguy, P. A., Laius, C. R.;Scherer, L.T. and Denardin, R. R., (2012). Dry matter production and nitrogen use efficiency of giant missionary grass in response to pig slurry application. Revista Brasileira de Zootenica 41(3): 537-543

Nthiga E.W., Wanjau R, Murungi J.I. (2014) Levels of chromium in peel, seeds, red flesh and white flesh of varieties of watermelons grown in Kenya. *Journal of Kenya Chemical Society, 8 (8): 73.*

Otunaiya, A. O. and Adedeji, I. A., (2014). Technical efficiency of watermelon (*Citrullus lanatus*) production in Ogun State, Nigeria. *International Journal of Applied Agricultural and Apicultural Research (IJAAAR),10 (1&2): 44-45.*

Pandolfo, C. M. and Viega, M. D. (2016). Crop yield and nutrient balance influenced by shoot biomass management and pig slurry application. *Revista Brasileira de Engenharia Agricola Ambiental, 20 (4):302 -307.*

Perkins-Veazie, P; Davis, A, and Collins, J. K., (2012). Watermelon: dessert to functional food. *Israel Journal of Plant Science 60: 395-402*.

Poly-Mbah, C.P., Obiefuna, J.C. and Ibeawuchi, I.I. (2008). Yield attributes of Watermelon as influenced by cropping season, manure and density in the tropical rainforest. In: Organic Agriculture and the millennium development goals. *Proceedings of the 1st West African Summit and 4th National Conference on Organic Agriculture, UNAAB 137 – 140.*

Poly-Mbah, C.P.; Onuoha, R.E. and Uzowuru, E.I. (2010a). Effect of Soil Nursery Mixture on the growth of pepper seedlings in Owerri, South Eastern Nigeria. *International Journal of Agriculture and Rural Development (IJARD) 13(2): 332 -335*.

Poly-Mbah, C.P.; Ukaegbu, E.P. and Ezeobidi, O.O, (2010b). Growth performance of grain amaranth under different soil nursery mixtures in Owerri, South Eastern Nigeria. *International Journal of Agriculture and Rural Development (IJARD) 13 (2): 336-339.*

Poly-Mbah, C.P.; Obiefuna, J.C. and Njoku, A.O., (2012a). An evaluation of the nursery performance of some varieties of tomato in an witsol in Owerri, South Eastern Nigeria In: Agricultural Productivity and growth; Strategies for meeting the MDGs. *Proceedings of the 26th Annual Conference of the Farm Management Association of Nigeria (FAMAN), Oct 15th-19th, 2012: 364-369*.

Poly-Mbah C.P; Obiefuna, J.C., Ofoh, M.C. and Ibeawuchi, I.I., (2012b). Effect of planting density and manure rates on Watermelon *(Citrullus lanatus*) vine length and fruit weight in Owerri, South Eastern Nigeria In: productivity: addressing the challenges of food security. *Proceedings of the International Agricultural Conference, 6th-9th May, 2012: 465-470.*

Schaffer A.A., Paris H.S. (2016) Melons, Squashes, and Gourds. *Horticultural reviews*.36(1): 165-198

Schippers, R.R., (2000). *African Indigenous Vegetables. An Overview of the Cultivated Species,* Chattan UK/ACO, EU, 214pp.

Song, K.Y.; Li, y; Quyang, W;Hao, F.H. and Wei, X. F. (2012). Manure nutrients of pig excreta reactive to the capacity of

crop land to assimilate nutrients in China. *Procedia Environmental Sciences 13:1846-1855*

Tarazona-Diaz, M. P.; Viegas, J; Moldayo, M.M.,and Aguayo, E., (2011). Bioactive compounds from flesh and by product of fresh – cut watermelon cultivars. *Journal of Science, Food and Agriculture 91:805 -812*