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Effects of pig manure on the growth and yield indices of watermelon in Asaba area of Delta State, Nigeria

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Abstract

This study was conducted in the Research Farm of Delta State University, Asaba Campus in 2021 to assess the effects of pig manure on growth and yield of watermelon. Five rates of the manure in tonnes per hectares (0.5,10,15 and 20) were applied as per the treatments. It was carried out in a Randomized Complete Block Design (RCBD) replicated three times. Eight parameters were assessed to achieve the research objectives, including initial pre-planting soil analysis, chemical composition of manure used for the study, vine length, number of leaves/plant, number of branches/plant fruit diameter, fruit length and fruit weight of watermelon after harvest. Results indicated that assessed parameters increased as manure level increased. Plants that received 20 tha^{-1} of manure were outstanding at 4,6 and 8 weeks after sowing with respect to vine length (cm) (48.0, 55.0, 62.2), number of leaves (28.0, 30.4, 42.0), branches/plant (5.4, 6.4, 7.5) respectively. After harvest, plants that received 20tha^{-1} were also superior with respect to fruit length (58cm), fruit diameter (36cm) and weight (26.4$kgha^{-1}$). Based on the study, it was recommended that farmers apply 20 tha^{-1} of manure for increased production of watermelon in Asaba environment.

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Introduction

Watermelon (*Citrullus lantatus* (Thumb), a member of cucuribitaceae family, originated in Sahara region of Africa where it is cultivated throughout most of Brazil due to favourable soil and climate conditions (Tosta *et al*, 2010). It is also grown for its fruit and vegetable part and account for 6.8% of global vegetable production. Vegetable growing is a major enterprise in horticulture which is becoming more popular owing to greater application of their food value (Gardner, 2004). Watermelon is used for fruit salad, served fresh cooked and used as confectionary (Wikipedia.com, 2010). It is a crop with huge economic importance to man. The fresh fruit is relished by many people across the world because it is known not only to be low in calories but highly nutritious, sweet and thirst quenching (Mangila *et al.,* 2007). Watermelon contains vitamin A and C in form of a disease fighting beta-carotene- Potassium is also available in it, which is believed to help in regulating of blood pressure and possibly prevent stroke (IITA, 2013).Watermelon is a good dietary item which contains high amount of mineral and other nutrients. Inspite of increasing relevance of this crop to countries, yield across countries is getting poorer due rapid reduction in soil fertility caused by both continuous cropping and negligence of soil amendment materials (Enujeke, 2013).Watermelon being a heavy feeder of nitrogen requires a liberal application of NPK compound fertilizer to be applied before sowing (Emughara, 2020).

Watermelon prefers a well-tilled fertile soil with good drainage. One of the ways of increasing the nutrient status of the soil is by application of organic materials such as animal waste (Dauda *et al.*, 2008). It needs slow releasing fertilizer so as to increase nutrient availability for the plant and lower the maintenance and labour cost during growing period.

The major constraint to crop production according to United Nation Organisation (Codex Alimentarious Commission, 2001) is poor soil fertility. Organic manure has beneficial effects on soils and it promotes the production of safe plant, with good non-source of better availability of nutrients (Steveson, 1994; O`Brien and Barker 1996). Many investors obtained best result by using organic manure for several plant (Aflatum, 1993) thus, the role of organic manures in improving soil structure and fertilizer is well understood.

Watermelon thrives best in well drained and slightly acidic soil with pH range of between 6.0-6.5. Application of 10-50tha^{-1} of pig manures improves physical properties by reducing temperature, bulk density while increasing total porosity (Ewulo *et al.,* 2008; Agbede *et al.*, 2008)

At present, resource poor traditional farmers are not buoyant enough to afford the purchase of costly inorganic or commercial fertilizers. The use of such organic amendment as pig manure therefore becomes the cheaper and economical or important element that promotes photosynthesis, growth and productivity of crops. Pig manure, like other inorganic manure improves physical condition and increases soil nutrient. The manure also increases plant height, vine length, leaf area, stem girth, number of root, root weight, shoot weight, 100 seed weight and gain, weight in the years of evaluation

Despite the enormous potentials of organic manure, there are no recommended standards with respect to level of pig manure for increased growth and productivity of the crop in the environment at the moment. This investigation was therefore aimed at determining how five different levels of pig manure can boost watermelon production in Asaba and environs.

Materials and methods

Description of the experimental site

The experiment was carried out during the early cropping season of 2021 at the of Delta State University, Asaba Campus Research farms to assess how watermelon will be affected by five rates of pig manure. The site is located within latitude 06^{o} 14` N and longitude 06$^{o}$ 49` E of the equator. This tropical environment is noted for two patterns of rainfall with peaks in July and September and a short dry period in August.

The mean annual rainfall is about 1,600 mm, mean annual temperature is about 37.2°C while the relative humidity is 73.2% (NIMET, 2020). Such area, according to Egbuchua (2007), contains gneisses and pegamitites that give rise to coarse-textured soils which are deficient in dark ferromagnessium materials. The topography is undulating with hills at certain parts and the land use purely based on rain-fed agriculture cultivated with such crops as cassava, yam, pulses and vegetables. The vegetation is of rainforest origin but has been reduced to derived savannah because of continuous cropping.

Field work

A land measuring 360m² was ploughed and harrowed using a tractor. It was marked out according to the experimental layout. Fifteen plots of 6m × 4 m each were made, and soil samples taken from the plots at 0 -15cm depth so as to assessing the initial soil physico-chemical properties.

Pig manure which was taken from the piggery unit of the Delta State University Farm was applied to the plots according to the treatments, and after 2 weeks soil samples were collated from individual plots. These samples were air-dried at room temperature of 27°C for 3 days, crushed and sieved using a 2mm aperture. Particles size distribution was determined by hydrometer method (Gee and Bauder, 1986). The pH was measured using Pye unican model MK 2 pH meter in a 1:2:5 soil water suspension ratio. Organic carbon was determined by Walkley-Black wet oxidation method (Nelson and Sommer, 1982). Total nitrogen was assessed by micro-Kjeldahl distillation technique as described by Bremmer and Mulvancy (1982). Available phosphorus was known using Bray No.1 method (IITA, 1979). Exchangeable potassium was ascertained by Flame photometer, while cation exchange capacity (CEC) was determined by Ammonium acetate saturation method (Roades, 1982). The pig manure used for the research work was analysed measured as directed by IITA manuals (1979).

The experimental design was (RCBD) replicated three times. Levels of pig manure applied in tons per hectare were 0.5,10,15 and 20, making five treatments on the whole. The manure was ploughed into the soil two weeks before planting. Seeds of Sugar Baby watermelon variety was procured from Delta Agricultural Development Project Agency (DAPA), and sown at rate of 2 seeds/stand at 1m × 1m spacing, at depth of 2.5cm, but later thinned to one plant/stand, which gave a plant population of 24 plants per plot. Alley pathways of 1 m apart were made to ease access to the plots. Regular weeding was done using hoe.

Data collection and analysis

Eight middle stands made up of sample population; Vine length, number of leaves, and branches/plant were counted at forth-night intervals starting from the 4th week after sowing. Vine length was measured from the base of the plant to the top of the leaves using a measuring tape. Fruit diameter and fruit length were measured with tape. Fruit weight was measured after harvest using a weighing scale. Data collected were subjected to analysis of variance (ANOVA). Differences between means were separated using Duncan Multiple Range Test according to Wahua (1999).

Results

Initial pre-planting soil analysis

Table 1 shows the initial soil analysis. The texture of showed that it was sandy loam. The soil pH was moderately acidic with pH of 6.0. The organic carbon (14.4gkg^{-1}), total nitrogen (1.14gkg^{-1}), available phosphorus (4.32mgkg^{-1}) and cation exchange capacity (6.50cmolkg^{-1}) were low, indicating that the site was low in fertility status.

Table 1. Pre-planting soil analysis of the research site.

Soil properties	Values
Particle size distribution (%)	
Sand	84.60
Silt	11.20
Clay	4.20
pH (H_2O)	6.0
Organic carbon (gkg^{-1})	14.4
Total nitrogen (gkg^{-1})	1.14
Available Phosphorus (mgkg^{-1})	4.32
Cation exchange capacity (cmolkg^{-1})	6.50
Textural class	Sandy loam

Chemical properties of the manure used for the study

The analytical values of the pig manure used as treatment are shown in Table 2. The result showed that both macro and micronutrients in the manure were high, and can support increased productivity of crops, including watermelon.

Table 2. Chemical properties of the pig manure used for the study.

Characteristics	Values Obtained
N(%)	1.52
P(%)	2.31
K(%)	0.72
Ca(%)	3.75
Mg(%)	0.50
Fe($mgkg^{-1}$)	1650
Mn($mgkg^{-1}$)	500
Zn($mgkg^{-1}$)	620
Cu($mgkg^{-1}$)	505

Effect of pig manure on vine length (cm) of watermelon

The response of vine length of watermelon to different rates of pig manure at 4,6 and 8 weeks after planting is shown in Table 3. Significant differences were observed in the vine length of crop because of application of the manure. At 4th week, plants that received manure applications rate of 5tha^{-1} had vine length of 40.0cm against those that did not receive manure (0tha^{-1}) which had length of vine of 36.0cm. Similar pattern of growth were observed during the 6th and 8th weeks where plants that received 5tha^{-1} of manure had vine length of 45.4cm and 49.4cm, respectively against plants in the control plot (0tha^{-1}) that had 41.2cm and 46.4cm, respectively. Generally, plants that received higher rates of pig manure had higher vine length of watermelon than plants that received lower rates of manure. Plants that were grown with 20 tha^{-1} of manure were outstanding in vine length of watermelon when compared to plants that grew with other rates of application at 4,6 and 8 weeks with values of 48.0cm, 55.0cm and 62.2cm, respectively.

Table 3. Effects of pig waste on vine length (cm) of watermelon.

	Weeks after sowing		
	4	6	8
	Vine length (cm)		
Rates of pig manure (tha^{-1})			
0	36.0^{e}	41.2^{e}	46.4^{e}
5	40.0^{d}	45.4^{d}	49.4^{d}
10	42.3^{c}	48.0^{c}	56.2^{c}
15	45.2^{b}	52.4^{b}	58.4^{b}
20	48.0^{a}	55.0^{a}	62.2^{a}

Means with the same letter(s) under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range Test (DMRT)

Effects of swine waste on number of leaves/plant of watermelon

Table 4 shows the response of pig manure on number of leaves/plant of watermelon to different levels of manure. Number of leaves/plants correspondingly increased with higher application rates. During the 4th week after sowing, plants that received 20tha^{-1} of manure had the highest number of leaves/plant of 28.6 compared to plants which had lower application rates. Plants in the plot which did not receive manure had the lowest number of leaves/plant with values of 16.2. Similar trend was observed during the 6th week after sowing where plants that had 20tha^{-1} of manure had more number of leaves/plant of 30.4 compared to plants that were grown with lower rates of manure. Plants that did not receive pig manure had the least number of leaves/plant with value of 20.4. During the 8th week after sowing, the trend did not change. Plants that received 20tha^{-1} of manure were superior in number of leaves/plant (42.0) compared to plants that had other manure application rates. Also, plants in plot that had no manure (0tha^{-1}) had the lowest number of leaves/plant of watermelon (26.1).

Table 4. Effects of pig manure on number of leaves/plant of watermelon.

	Weeks after sowing		
	4	6	8
	Number of leaves/plant		
Rates of pig manure (tha^{-1})			
0	16.2^{e}	20.4^{e}	26.1^{e}
5	20.0^{d}	23.3^{d}	30.2^{b}
10	23.4^{c}	25.4^{c}	36.4^{c}
15	26.2^{b}	28.3^{b}	39.2^{b}
20	28.0^{a}	30.4^{a}	42.0^{a}

Means followed by the same letter(s) within the treatment groups are not significantly different at 5% level of probability using DMRT.

Effects of pig manure on number of branches/plant of watermelon

The response of number of branches/plant of watermelon to different rates of pig manure at different weeks after planting is shown in Table 5. Number of branches gradually increased from 4 weeks to 8 weeks after planting relative to application of manure. There were significant differences in number of branches/plant.

During the 4th week, increased level of manure led to a corresponding increase in number of branches/plant. More branches/plant were observed in plants that received 20tha^{-1} of manure (5.4) while few number of branches/plant were counted in plants that had no manure (3.2).

The trend remained the same during the 6th week after sowing. Plants that received 20tha^{-1} of manure had more number of branches/plants (6.4), while plants that received no manure had the least number of branches/plants (4.2). During the 8th week after sowing, plants that received 20tha^{-1} of manure also had the highest number of branches/plants (7.5) while plants in the control plot (otha^{-1}) had fewest number of branches/plants (5.2).

Table 5. Effects of pig manure on number of branches/plant of watermelon.

	Weeks after sowing		
	4	6	8
	Number of branches/plant		
Rates of pig manure (tha^{-1})			
0	3.2^{e}	4.2^{e}	5.2^{e}
5	4.2^{d}	4.4^{d}	5.4^{d}
10	4.4^{c}	5.2^{c}	6.2^{c}
15	5.3^{b}	5.5^{b}	6.4^{b}
20	5.4^{a}	6.4^{a}	7.5^{a}

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

Effects of pig dung on fruit length (cm), fruit diameter (cm) and fruit weights (kgha^{-1}) of watermelon

Table 6 shows the effects of pig manure on fruit length, diameter and weight of watermelon. Fruit length, fruit diameter and weight increased significantly as a result of rates of manure received. Plants that received 20tha^{-1} of pig manure were superior with value of 58 cm, 32 cm and 26.4kgha^{-1} of fruit length, fruit diameter and fruit weights while plants that did not receive manure had 40 cm, 23cm and 17.2 kgha^{-1} of fruit length, fruit diameter and fruit weight respectively.

The order of superiority relative to weight of fruits of watermelon based on rate of pig manure received in tonnes/hectare was 20 > 15 > 10 > 5 > 0.

Table 6. Effects of pig dung on percentage emergence and weight (tha^{-1}) of fruit of watermelon.

Rates of pig manure (tha^{-1})	Fruit length (cm)	Fruit diameter (cm)	Weight of fruits (kgha^{-1})
0	40^{e}	23^{e}	17.2^{e}
5	43^{d}	26^{d}	19.1^{d}
10	48^{c}	29-c	22.2^{c}
15	54^{b}	33^{b}	24.3^{b}
20	58^{a}	36^{a}	26.4^{a}

Means followed by the same alphabet(s) within the treatment groups are not significantly different at 5% level of probability using DMRT.

Discussion

Initial Pre-planting soil analysis

The sandy loam texture of the experimental site could be due to the parent material from which the soil was formed and the climatic condition of the area. the soil may be formed from such parent materials as sandstone and quartz which impart sandy texture to soil (Brady ad Weils, 1999; Egbuchua, 2007). The site was acidic probably because of leaching of base cations due to high torrential rainfall which characteristizes the environment (NIMET, 2011). This low organic carbon, total nitrogen, available phosphorus and CEC which showed that fertility of the site was low suggests that utisols of most humid environments are weathered soils due to high precipitation, with the attendant problems of water run-off and leaching.

Chemical properties of pig manure used for the study

The high levels of macro and micro nutrient in the pig manure used for the investigation showed that organic manure has the enormous potentials of creating favourable environment for increased crop production by improving soil porosity moisture content, bulk density, microbial activities and micrology (Stevenson *et al.*, 2018; Iputu *et al.*, 2019).

Effect of different rates of pig manure on growth parameters of watermelon

Vine length, number of leaves and number of branches/plant of watermelon increased as the level of the manure increased. This may not be unconnected to release of nitrogen contained in pig manure which enhanced vegetative growth of watermelon – an implication of effective utilization of the applied manure by the crop. This is similar to the observations of Akanbi *et al.* (2005), Olaniyi *et al.* (2008) and Stevens *et al.* (2018) who reported increased vegetative growth of vegetables due to addition of nitrogen, which confirmed the role of organic fertilizers in promoting vigorous growth of fruit vegetables (Olaniyi and Ajibola, 2008; Eifediyi and Remison, 2010). Similar results were also obtained by Aduloju *et al.* (2010), Dada and Fayinminnu (2010) who reported improved supply of plant nutrients to cucumber by applied, better utilization of carbon and subsequent synthesis of assimilates.

Effect of different rates of pig manure on fruit length (cm), fruit diameter (cm) and fruit weight (kgha^{-1}) of watermelon

The highest rate of pig manure gave the highest fruit length, fruit diameter and fruit weight of watermelon while plants that did not receive manure had the least values of the assessed parameters possibly because 20 tha^{-1} contained a preponderance of complete nutrients, both macro and micro nutrients which enriched the soil fertility, enhanced humus levels and encouraged the life of microorganisms, all of which culminated to increased weight of fruit of watermelon. Similar observation was made by Ipulu *et al.* (2019) who observed that the highest rate of pig manure gave a corresponding highest fruit weight of tomato. Such research work was done by Enujeke (2013) who observed that highest rates of organic manure gave corresponding increases in fruit yields of cucumber.

Conclusion

The research was embarked upon to assess how different levels of pig manure will affect watermelon production in Asaba environment.

Eight parameters were assessed to achieve the objectives of the study; initial preplanting, soil analysis, chemical properties of pig manure used, vine length, number of leaves and branches per plant, fruit length, fruit diameter and weight of fruits of watermelon. Increased rate of application of the manure resulted in corresponding increases in the parameters investigated.

Plants that received 20tha^{-1} of pig manure were superior in vine length, number of leaves/plants, number of branches/plant, fruit length, fruit diameter and weight of fruits of watermelon.

It was therefore suggested that farmers apply 20tha^{-1} of pig manure for enhanced production of watermelon in Asaba area.

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