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Original Research

MORPHOMETRIC GROWTH ANALYSIS OF *ABELMOSCHUS ESCULENTUS* L., *CUCUMIS SATIVUS* L. AND *CITRULLUS LANATUS* L. UNDER THE INFLUENCE OF THREE DIFFERENT KINDS OF ORGANIC MANURES

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ABSTRACT

Field experiments to investigate the effects of different kinds of organic manures (cow, rice husk and poultry manure) on morphometric growth and yield of *Abelmoschus esculentus* (okra), *Citrullus lanatus* (watermelon) and *Cucumis sativum* (cucumber) was carried out at the Research and Teaching Farm Presco campus of Ebonyi State University, Abakaliki, during the 2014 planting season. Treatments were laid out in a Randomized Complete Block Design (RCBD) and data were collected on growth and yield parameters (plant's height, pod/fruit length and weight). Results obtained indicated that growth and yields of these crops were higher in the cow and poultry dung manure compared to the control while the rice husk manure was relatively at par with the control. This suggests that the organic manures used in the study especially cow and poultry manure, positively influenced the performance and yield of the investigated crops. Cow dung and Poultry manure positively increased the positively increased the growth of okra, cucumber and watermelon plants by about 129% and 250%, 904% and 569%, and 660% and 306%, respectively compared to control treatments. However, rice husk manure showed a negative effect on the growth of okra plant. Fresh pods' weights were significantly increased by organic manures compared to control treatment. However fruits' lengths were not significantly affected by the treatments. The study suggests that cow dung and poultry manure promotes higher growth and yield in cucumber, okra and watermelon plant, and thus recommended as better organic manure the cultivation of these crops.

Keywords: *Abelmoschus esculentus, Citrullus lanatus, Cucumis sativum,* organic Manure

INTRODUCTION

Growth is an irreversible increase in size and height of a species. Growth in plants is unlimited and depends upon several factors. These factors are basically classified as edaphic (soil temperature, pH, texture structure and nutrient components) and climatic factors (rainfall, sunlight, wind, humidity and pressure) (Adams, 1975).

Most agricultural crops require soils that have high nutrients contents to attain maximum growth. Organic manures from plants' or animals' wastes which are more readily available to peasant farmers have long been used to improve the soil fertility for increased productivity (Amah, 1997). This requirement could be adequately met by using inorganic manure since they are good sources of nitrogen. However, extensive use of inorganic fertilizer has a depressing effect on yield. It leads reduction in number of fruits, delays and reduces fruits setting, which consequently results in delay ripening and heavy vegetable growth (Schippers *et al*., 2000). The undesirable effects of inorganic fertilizers has encouraged farmers and scientists toward making use of organic materials (both organic manures as well as organic waste) for improving the physical properties of soils that allow profitable crop production (Mangala and Mausia, 2006). However, the relative positive effect of these manures on crops has not been well documented especially among staple crops and vegetables like okra, watermelon, cucumber, etc., grown for both household and commercial consumption in Nigeria. Okra (*Abelsmoschus esculentus* L.), watermelon (*Citrillus lanatus*) and cucumber (*Cucumis sativus* L.) are among the important vegetables grown in Nigeria. They are annual crops grown mainly as fruits and leafy vegetable in both green and dried state in the tropics (Gibbon and Pain, 1984). Both the cucumber and watermelon are among the most popular members of the Cucurbitaceae family (Lower and Edwards, 1986).

Abelmoschus esculentus L. (okra) known in many English-speaking countries as ladies fingers, bamia, ochro or gumbo is one of the most important vegetables grown in Nigeria. It belongs to the Malvaceae family. It is an annual crop growing mainly as fruits and leafy vegetables in both fresh (green) and dried state in the tropics (Gibbon and Pain, 1984). Okra is a coarse, erect, branched, more or less hairy, annual herb, 0.6 to 1.5 m high. Leaves are long petiole, orbicular or orbicular ovate, about 25 cm long or less; corolla large and yellow, and inside, deep purple at the base. Fruit is elongated, 10 to 25 cm long 1.5 to 3 cm in diameter tapering to a blunt point and containing rows of rounded, kidney shaped seeds (Maritus and Biswas, 2001).

Cucumis sativus L. (Cucumber) is native of Asia and Africa, where it has been consumed for 3,000 years. It is a popular fresh market vegetable in salads and is also processed into kitchen and oriental-type pickles in Hawaii (Alan, 1989). Cucumber is an annual deep-rooted (approx. 1 m) crop with tendrils and hairy leaves. The plants may have an indeterminate, determinate, or a compact plant habitat. The compact growth habit consists of plants with shorter internodes length than plants with indeterminate or determinate growth habit (Ajari *et al.,* 2003). Optimum growth occurs between 70-75˚F (20-25˚C), with growth reduction occurring below 60˚F (16˚C) and above 90˚F (Alan, 1989). Several flowering habits exist in cucumbers. It is believed that cucumber originated in India, and consequently large genetic variability of cucumber had been found in different parts of India. It is thought to be the oldest vegetable cultivated by man and with a historical records dating back 5,000 years (Sonia, 2011). Cucumber is a herbaceous trailing annual crop that is capable of spreading in all directions (Nonneck and Lubner, 1992) and it has been rated suited for green house cultivation in comparison with traditional practices. Both animal manures and inorganic fertilities are used in cucumber production.

Citrillus lanatus L. (watermelon) is a member of the family Cucurbitaceae. *Citrillus lanatus* is an annual plant with long, weak, trailing or climbing stems which are five –angled and up to 3 m (10 ft) long. Young growth is densely woolly with yellowish-brown hairs which disappear as the plant ages. The leaves are stemmed and are alternate, large and pinnately-lobed, stiff and rough when old (Rimando and Perkins-Veazie, 2005). The plant has branching tendrils. The flowers grow singly in the leaf axils and the corolla is white or yellow inside and greenish-yellow on the outside. The flowers are unisexual, with male and female flowers occurring on the same plant (monoecious). The male flowers predominate at the beginning of the season and the female flower which develop later, have inferior ovaries. The styles are united into a single column and the Pulp. This has a thick exocarp and fleshy mesocarp and endocarp. The exocarp of this fruit is mid- to dark-green and usually mottled or striped and the flesh contains numerous pips and is red, orange, pink, yellow or white (Perkins-Veazie *et al*., 2006).

This study thus aimed to establish the better organic

manure source by estimating the growth rate and yield potentials of these vegetable crops using three different kinds of organic manures. The morphometric growth and crop yield of okra (*Abelmoschus esculentus* L.), cucumber (*Cucumis sativus* L.) and watermelon (*Citrillus lanatus* L.), which are staple vegetables in Nigeria were analyzed and reported.

MATERIALS AND METHODS

Materials

The materials used for the study include 2000 g of each organic manures (cow dung, rice husk and poultry dung), hoe, cutlass, measuring tape, pegs, hand gloves, weighing balance, stakes and seeds of *Abelmoschus esculentus*, *Citrullus lanatus* and *Cucumis sativus* sourced from Faculty of Agricultural Sciences in the Department of Crop Science and Land Management, Ebonyi State University (EBSU), Abakaliki Campus and were identified by a renowned Plant taxonomist Professor J. C. Okafor of Applied Biology Department, Ebonyi State University, Abakaliki. The site's soil was analyzed at the Department of Industrial Chemistry EBSU, Abakaliki.

Study area

Field experiments were carried out at the research and teaching farms of Presco campus of Ebonyi State University, Abakaliki which lies within latitude 6.32N and longitudes 8.12E of the equator. The experiment was conducted during the 2014 cropping season in a typical tropical environment that is characterized by a bimodal rainfall pattern with peaks in June and November and an interrupted dry spell in December otherwise called (Harmattan). The average annual rainfall range from 1,150 mm to2,000 mm while the mean annual temperature range from 21^{o}C to 29^{o}C (Sonia, 2011). By nature of its geomorphologic settings, the study area falls within the classification of ancient meta-morphicrystalline basement complex formation which is more acidic than basic. The vegetation of the study area is of sub-savannah region and the soil is sandy loam.

Field studies

A land measuring 150 m^2 was selected for the study and prepared by using a hoe to cultivate the land. It was marked out according to experimental layout. Twelve beds of 60 cm by 30 cm each were made. Soil samples from (0-15 cm) depth were collected from 12 different spots in the study area and were composited, air dried and sieved through a 5 mm sieve and their physical and chemical characteristics were determined before application of treatment.

Experimental design

The treatments consisted of three types of organic manure (cow dung, poultry dung and rice husk). The experiments were laid out in a randomized complete block design (RCBD) with three replications. Manure was applied by broadcasting and thoroughly worked into the experimental plot. The beds measuring 60 x 30 cm were watered and left for two days before planting the seeds on them. This was to enable the dissipation of carbon-dioxide thus preventing burning and scorching on the tender seedlings. After viability test, the *Abelmoschus esculentus*, *Citrullus lanatus* and *Cucumis sativus* seeds were sown 3, 2 and 2 respectively per hole at a depth of 2 cm. After germination, seedlings were thinned to one plant per stand three weeks after planting. Cultural operations such as spraying of ash, weeding were strictly observed. However, the control received no manure treatment. The initial physico-chemical characteristics of the soil (0-30 cm) were noted in the study.

Data collection

Control stands were used as reference population. Data collated were growth records, and yield attributes such as plant height, number of fruits per plant, fruit (pods) length (cm) and fruit weight (kg). Plants heights were measured with calibrated tape from the base to the growing tip of the plants. Numbers of fruits per plant was by counting while fruits weights were measured using a weighing scale after harvest. However, experiment was carried out for 8-9 weeks and measurements were taken on weekly bases.

Statistical analysis

Data collected were subjected to Chi Square Analysis at $\alpha = 5\%$ (i.e. 0.05) to establish the positive effect of the manure on the parameters according Arua and Okoro (2014). The data as subjected to Chi Square analysis were significant

RESULT AND DISCUSSION

Initial soil properties

The physico-chemical properties of the experimental sites are shown in Table 1. The result revealed that sand constituted the major particle size fraction in the soil followed by silt and clay. Thus, the soil used

in the study had a sandy-loam texture and could be classified as such.

Table 1: Results of the initial physico-chemical characteristics of the soil

Soil properties	Values obtained
Soil (texture)	Sandy-loam
pH (H_2O)	5.3
Total nitrogen (gkg^{-1})	0.87
Organic carbon	12.5
Available phosphorus ($mgkg^{-1}$)	5.35
Exchangeable elements	0.17

Effects of organic manures on the crops' growth morphometrics parameters

The effects of the organic manures on *Abelmoschus esculentus, Cucumis sativus* and *Citrullus lanatus* are depicted in Tables 2 to 11. The response of plant height and growth percentage is shown in Table 2 & 3 for *A. esculentus*, Tables 4 & 5 for *C. sativus* and Tables 6 & 7 for *C. lanatus*. Statistical analysis revealed that the growth parameters were significantly (α = 5%) affected by the different organic manure.

Table 2: Incremental growth (cm) of *Abelmoschus esculentus* in soil treated with different organic manure

Weeks	SC	SCD	SRH	SPD
1st	3.00	6.00	4.00	8.00
2nd	8.00	18.00	10.00	30.00
3rd	14.00	20.00	10.00	48.00
4th	18.00	30.00	25.00	50.00
5th	34.00	48.00	30.00	70.00
6th	48.00	50.00	40.00	150.00
7th	55.00	75.00	34.00	124.00
8th	92.00	102.00	50.00	200.00
Total	272	352	208	680

Key: SC = control sites, SCD = Site treated with cow manure, SPD = Site treated with poultry manure, SRH = Site treated with Rice husk manure.

Table 3**:** Percentage growth of *Abelmoschus esculentus* in soil treated with different organic manure

Soil Type	Total growth (cm)	% growth
SC	272	100
SCD	352	129.41
SPD	680	250.00
SRH	208	76.47

From Tables 2 & 3 above, the weekly incremental growth and the total growth percentage of *A. esculentus* grown in the various soils treated with different kinds of organic manure, relative to the control, was highest in plant grown on soil treated with poultry dung, followed by cow dung, and then rice husk manure. The plant grown on rice husk did not grow as much as the control soil suggesting a negative growth influence on the plant.

For *Cucumis sativum* (Tables 4 & 5) and *Citrullus lanatus* (Tables 6 & 7), cow dung manure had the highest percentage growth value (904.76% and 660%), followed by poultry dung (569.05% and 306%) and rice husk had the least value (521.43% and 301%), respectively. This indicated that both plant will do well in soils treated with any of the three kinds of organic manure.

It has been established that the plant height of most crops are genetically determined (IAR, 1985). However, the findings in this study suggests that the heights of the *A. esculentus*, *C. lanatus* and *C. sativus* are perhaps more dependent on environmental conditions rather than genetic traits. The positive effect of organic manure on plant height could be due to the contribution made by manure to the soils fertility status since the initial soil was low in organic carbon (12.5%), and mildly acidic (pH 5.3). Manure when decomposed, it increases both macro and micronutrients as well as enhances the physico-chemical properties of the soil. This probably led to the rich vegetative growths which were observed for all the crops. The non-significant difference in growth observed in the rice husk manure and control treatment for *A. esculentus* (okra) could be suggestive of depletion of the particular micro or macro nutrients necessary for improved vegetative growth, from the initial soil and the rice hush manure. Watermelon, cucumber and okra grown on poultry and cow dung manure performed better in terms of heights and yield than rice husk manure. This suggested that nutrients from poultry and cow dung manures were readily available and in the best form for easy absorption by the plant roots, hence there was a boost in the morphological growth of the plants. The findings of this study corroborated the findings of Ajari *et al.* (2003) in okra production which reported organic manures (especially poultry and cow dung manure) could increase plant height of crops when compared with other sources of manures.

Table 4: Incremental growth (cm) of *Cucumis sativum* in soil treated with different organic manure

Weeks	SC	SCD	SPD	SRH
1st	1.00	8.00	4.00	4.00
2nd	2.00	22.00	20.00	20.00
3rd	2.00	35.00	29.00	35.00
4th	3.00	60.00	30.00	40.00
5th	5.00	85.00	50.00	50.00
6th	8.00	11.00	70.00	55.00
7th	12.00	130.00	75.00	60.00
8th	22.00	150.00	85.00	94.00
9th	28.00	160.00	95.00	100.00
Total	84.00	760.00	458.00	458.00

Table 5**:** Percentage growth of *Cucumis sativum* in soil treated with different organic manure

Soil Type	Total growth (cm)	% growth
SC	84	100
SCD	760	904.76
SPD	478	569.05
SRH	438	521.43

Table 6: Incremental growth (cm) of *Citrullus lanatus* in soil treated with different organic manure

Weeks	SC	SCD	SPD	SRH
1st	1.50	8.00	4.00	6.00
2nd	3.00	50.00	20.00	20.00
3rd	6.00	70.00	35.00	40.00
4th	20.00	95.00	40.00	50.00
5th	25.00	134.00	42.00	60.00
6th	30.00	180.00	60.00	70.00
7th	31.00	220.00	70.00	100.00
8th	34.00	200.00	85.00	110.00
9th	40.00	255.00	130.00	120.00
Total	191	1262	586	576

Table 7: Effect of treatment on percentage growth of *Citrullus lanatus*

Soil Treatment	Total growth (cm)	% growth
SC	191	100
SCD	1262	660.73
SPD	586	306.81
SRH	576	301.57

Table 8: Effects of manure treatments on the average weekly growth rate (cm/wk)

Soil treatments	Average weekly growth rate (cm)		
	Okra	Cucumber	watermelon
Control	34	7	15
Cow dung	44	75	128
Poultry dung	85	36	56
Rice husk	26	45	34

Table 8 above shows the average growth rate of *A. esculentus, C. sativus* and *C. lanatus* for eight weeks (two months). From the table, poultry dung manure seemed to be the most effective manure for A. esculentus (okra), while cow dung manure seemed to be more effective manure for both *C. sativus* (cucumber) and *C. lanatus* (watermelon). However, in Table 9, the rice husk manure had the highest positive effect on fruit yield of *A. esculentus* suggesting that though rice husk manure may not promote the vegetative growth, it thus excellently promote fruit yield. This was very revealing and should be investigated further to determine what could be responsible for such effect. Table 9 also revealed that the manures generally proved the fruits' yields of both *A. esculentus* and *C. sativum* but had no significant effect on the yield of *C. lanatus*.

The mean pods length (cm) and weight (g) seemed generally higher in all the treatments than the control, but they were not significantly different statistically among the different manure treatments (Tables 10 & 11). This could be due to the fact that the size and weight of most fruits and pods of crop are mostly genetically determined and less dependent on environmental conditions (IAR, 1985). The least positive effects on pod length and weight were observed in treatments containing poultry dungs and rice husks manure respectively.

Table 9: Effects of treatments on fruit yield

Soil treatments	Fruit yield		
	Okra	Cucumber	Watermelon
Control	20	8	5
Cow dung	28	12	5
Poultry dung	44	15	8
Rice husk	75	14	6

Table 10: Effects of treatments on fruit/pod's length

Soil treatments	Fruit/Pod Length (cm)		
	Okra	Cucumber	Watermelon
Control	32	42	25
Cow dung	40	48	30
Poultry dung	35	38	25
Rice husk	45	48	32

Table 11: Effects of manure treatments on fresh pod weight (g)

Soil treatments	Average Pods' weight		
	A. esculentus	*C. sativus*	*C. lanatus*
Control	60	72	84
Cow dung	82	98	105
Poultry dung	85	104	116
Rice husk	70	78	88

The non-significant effect of organic manure sources on fruits' length may be due to the effect of these sources of organic manure on enhancing vegetative growth. All the nutrients supplied by the different manure sources might have been diverted to vegetative growth thus, resulting in their bulkiness. The increase in fresh pod/fruit weight of the crops due to organic manures application could be

attributed to easy disolution of released plant nutrient leading to improved nutrient status and water holding capacity of the soil. The results obtained were in agreement with the findings of Nonneck *et al.* (1992) who attributed the positive growth response to manure treatment to improved physical and biological properties of the soil resulting in better supply of nutrients to the vegetable crops (*Cucumis sativum* and *A. esculentus*).

CONCLUSION

The study showed that application of cow dung, poultry dung and rice husk manures had significant positive effect on growth height, fruits' yield and weight of *A. esculentus, C. sativum and C. lanatus*. Thus, it is recommended that small-scale farmers could adopt the application of organic manures in rural farming where poor economic background may not permit large-scale farming for improve crop productions.

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