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Full Length Research Article

GROWTH AND SEED YIELD RESPONSES OF OKRA TO DIFFERENT RATES OF KITCHEN WASTE COMPOST APPLICATION IN A TROPICAL ENVIRONMENT

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ABSTRACT
Okra is a valuable vegetable crop which is known to be rich in vitamins, calcium, potassium, and other minerals. However, poor soil fertility in the tropics has become a barrier for quality okra seed production. The objective of this study was to determine the effect of different rates of kitchen waste compost on the growth, and seed yield of okra. The experiment was laid out by using Randomized Complete Block Design (RCBD) with four treatments and replicated three times. Three different rates of kitchen waste compost (270 g, 540 g and 830 g) with topsoil and topsoil only (as control) were used as the treatments. The study revealed that number of leaves, number of pods and aborted flowers did not significantly affect the compost rates. However, plants treated with kitchen waste compost at a rate of 830 g had the best performance in terms of plant height, stem girth, days to 50% flowering, number of flowers, days to physiological maturity and seed yield. Additionally, kitchen waste compost at a rate of 830 g amended topsoil had significant influence on seeds per pod, total seed weight and 1000 seed weight. A correlation analysis showed that there was a strong, positive and significant (r=0.99) relationship between number of seeds per pod and total seed yield. The study concluded that the application of 830 g of kitchen composts significantly improved vegetative, reproductive and seed yield attributes of okra.

Keywords: physiological maturity, dry weight, seed filling, histodifferentiation, viability.

INTRODUCTION
Okra (*Abelmoschus esculentus* L. Moench), popularly known as lady's finger or bhendi is one of the most well-known and commonly used species in the *Malvaceae* family (Gemede, 2015). It is a valuable vegetable crop grown in tropical and subtropical regions around the world (Thakur *et al*., 2020). The main nutrients obtained from the consumption of okra are vitamins, folic acid, dietary fibre, protein, fat, carbohydrate potassium, sodium, magnesium, calcium and other minerals that are usually deficient in a staple food (Adekiya *et al*., 2019, Abubaker *et al*., 2012; Amoo *et al*., 2019). The nutritious value of okra pods has rekindled interest in commercializing the crop (Abd El-Kader *et al*., 2010).When utilized as a plasma substitute or blood volume expander, okra mucilage has medical potential. Okra mucilage binds cholesterol and bile acid carrying poisons that the liver dumps into it. Immature pods are often used to make pickles (Gemede, 2015) India leads the global okra production with 6.18 million tons followed by Nigeria with 1.82 million tons whiles worldwide production is estimated to be around 9.96 million tons (FAOSTAT, 2020). Ghana produces over 100,000 metric tonnes of okra annually (Tridge, 2020). This yield gap is an issue of huge concern since it has an overall impact on the contribution of the crop to Ghana's Gross Domestic product (GDP).
Poor soil fertility is a major barrier for okra cultivation in the tropics (Adekiya *et al* 2019). This has been ascribed to the continual cultivation of a plot of land for food with insufficient care for the land in terms of external nutrient (organic or inorganic fertilizer) application (Unagwu, 2019). Poor soils adversely affect the growth, yield and quality of seed crops. Fertilizers supply plants with the nutrients they require for healthy growth. Aside from macronutrients, there is a known set of micronutrients that play key roles in plant metabolism. Organic fertilizers, such as compost or manure made from vegetative matter or animal excreta, have been used because of their high value in physical and chemical qualities (Thakur *et al*., 2020). Organic fertilizers are environmentally benign, improving soil health, water-holding capacity, cation exchange capacity, and bulk density, as well as fostering a diverse population of beneficial soil microbes (Akhter, 2020). Biofertilizers can supplement chemical fertilizers for nutrient needs and help improve crop yield and quality. However, the cost of inorganic fertilizers, as well as the environmental risk caused by excessive use, are major concerns (Friday & Akinfemi, 2021).
High-quality materials enhance plant nutrition by releasing nutrients. To this end, there is a need to investigate the potential of various plant materials as compost, as well as their relative effects on soil chemical characteristics and mineral composition of crops grown in them (Adekiya *et al*., 2019). The nutritional content of okra, on the other hand, can be modified by the use of organic fertilizers such as compost (Adewole & Ilesanmi, 2011). For instance, Nyande *et al*., (2021) reported that the application of poultry manure in combination with papaya leaf gave satisfactory performance for growth and yield of okra. Additionally, Adekiya *et al.,* (2020) reported that there was a considerable improvement in okra yield (57.9% and 45.5%) with the application of cow dung and pig manure respectively. Most research works have focused on the effect of compost and manure on the growth and yield of okra but less attention is paid to the influence on seed yield and quality. Consequently, the overarching objective of this study was to determine the effect of kitchen waste compost amended topsoil on the growth and seed yield of okra.

MATERIALS AND METHODS
EXPERIMENTAL SITE
The experiments were conducted at the Department of Horticulture, Faculty of Agriculture, Kwame Nkrumah University of Science and Technology, Kumasi. Ghana. The area lies within the semi deciduous forest zone. The pattern of rainfall in the area is bimodal. From between May and July, there is heavy rainfall, then a short dry weather in August and then a frequent rainfall from

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September to October. During these rainy periods, the humidity is very high. Usually, high relative humidity of 90 % is prevalent in June and as low as 55% is recorded in February when it is dry.

Source of materials

The okra seeds were obtained from the Department of Horticulture, KNUST in Kumasi. The cultivar of okra used in the study was Clemson spineless. The compost was obtained from the Department of Horticulture, KNUST, Kumasi. Golan insecticides were purchased from K. Preprah Agrochemical shop in Kumasi.

Experimental design and procedure

A pots experiment was set up in a Randomized Complete Block Design (RCBD) with four treatments in three replications. In the study, 48 pots were used, 16 pots for each block and 4 pots per amendments in each block. Each pot was filled with top soil. The amendments were kitchen waste compost (270 g, 540 g, 830 g) amended topsoil and Topsoil only were randomly assigned to the plants in each of the blocks. The amendments were applied to the respective plants four weeks after planting. The plants were irrigated daily (excluding days of good rainfall) by hand watering in the bid to provide and maintain sufficient amount of moisture throughout the period of growth. Golan insecticides were applied using a knapsack sprayer at a rate of 5mls/7litres of water every two weeks to control pests that were feeding on the leaves to reduce the leaf area. Weeds were controlled by handpicking.

DATA COLLECTION

Samples of top soil and Kitchen waste compost were taken to the Department of Crop and Soil Science laboratory for soil chemical analysis. The protocol for the analysis were:

Determination of organic carbon in samples

The protocol described by Nelson and Somers (1996) was used to determine organic carbon following Walkley and Black procedures (modified). Using a mixture of potassium dichromate and sulphuric acid there was a wet combustion of the organic matter after which there was a titration of excess dichromate with ferrous sulphate. One gram of sample was put into a conical flask which included reference sample and a blank after which ten millilitres of 0.166 *M* (1.0 *N*) potassium dichromate solution was added to the sample as well as the blank flask. With a measuring cylinder 20 ml of concentrated sulphuric acid was carefully added, swirled and allowed to stand for 30 minutes on an asbestos mat. Distilled water (250 ml) and 10 ml concentrated orthophosphoric acid were added and allowed to cool. A titration of 1.0 *M* ferrous sulphate solution was done and One milliliter of diphenylamine indicator was added.
Calculation:

$$\% \text{ Organic C} = \frac{M \times 0.39 \times mcf\ (V_1 - V_2)}{g}$$

where:

M = molarity of solution of ferrous sulphate
V_1 = solution of ferrous sulphate for blank titration in ml
V_2= solution of ferrous sulphate for sample titration in ml
g = weight of air – dry sample in grams mcf = moisture correction factor (100 + % moisture) / 100
0.39= 3 x 0.001 x 100 % x 1.33 (3 = equivalent weight of C)
1.3 = a compensation factor for the incomplete combustion of organic matter

Determination of Total nitrogen

Bremner and Mulvancy (1982) protocol for determining the total nitrogen was used. Digestion and distillation procedure using the Kjeldahl method was followed
Calculation:
14g of N contained in one equivalent weight of NH_3

$$\text{Weight of N in the soil} = \frac{14 \times (A - B) \times N}{1000}$$

where:
A= sample titration-volume of standard HCl
B= blank titration-volume of standard HCl
N = Normality of standard HCl
Mass of soil sample used,

$$= \frac{10\text{ g} - 10\text{ ml}}{100\text{ ml}}$$

= 1g
Thus, the nitrogen percentage is,

$$\% \text{ Total N} = \frac{14 \times (A - B) \times N \times 100}{1000 \times 1}$$

Note:
When N = 0.1 and B = 0
% Total N = A x 0.14

Phosphorus determination

The readily acid – soluble forms of phosphorus were extracted with Bray No. 1 solution as outlined by Olsen and Sommers (1982).
Calculation:

$$P\ (mg / kg) = \frac{(a - b) \times 35 \times 15 \times mcf}{g}$$

Where: a= mg P/l in the sample extract b = mg P/l in the blank g= sample weight in grams mcf = moisture correction factor
35 = volume of extraction solution
15 = final volume of the sample solution

GROWTH PARAMETER AND SEED YIELD

Plant height

This was measured from the soil level (base of the plant) to the tip of the plant using a metre rule. The mean plant height was then recorded for each treatment. The plant height measurements were taken at 2 Weeks After Planting (WAP), 4 WAP, 6WAP, 8WAP and 10 WAP.

Number of leaves per plant

The number of leaves per plant was determined by counting the green and functional leaves on each of the ten plants and the mean per plant recorded at 2WAP, 4 WAP, 6 WAP, 8 WAP and 10 WAP.

Stem girth

Stem girth was measured at 60 cm above soil level for each of the plants with a Vernier caliper. The mean stem girth was then recorded in millimeters (mm). The measurements were done at 2 WAP, 4 WAP, 6 WAP, 8 WAP and 10 WAP.

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Number of days to 50% flowering
The number of days to 50% flowering was determined by counting from the day of sowing until the day 50% of the plants flowered.

Number of aborted flowers
The number of aborted flowers per plant was determined by counting the flowers that were aborted and the mean per plant recorded.

Number of days to physiological maturity
The days to physiological maturity was determined by counting the number of days it took each fruit to reach its physiological maturity from the day of planting.

Pod numbers
The total pod numbers were counted.

Number of seeds per pod
After harvesting, breaking of pods was done to separate seeds from the pod.

1000 seeds weight of seed yield
This was done by counting 100 seeds from the pure seed sample and replicated 8 times. With an electronic balance each replicate was then weighed and the mean multiplied by 10 (ISTA, 2007).

DATA ANALYSIS
The data collected on the soil properties, growth, and seed yield parameters were analyzed by performing an Analysis of Variance (ANOVA) using Statistix software version 10.0. The means were separated using Tukeys Honestly significant difference at a 5% probability level.

RESULTS
CHEMICAL ANALYSIS OF SOIL AND THE KITCHEN WASTE COMPOST
Chemical analysis carried out on the samples of the topsoil, composted to determine the various nutrients present and their respective proportions.

Chemical properties of the topsoil and kitchen waste compost used in the study
The soil analysis showed that the soil used for the study was sandy loam. There were significant differences in between the topsoil and the compost for the chemical properties (Table 1). Kitchen waste compost gave the highest Nitrogen (2.68 %), Potassium (2.51%), Organic carbon (33.69) whiles Topsoil recorded the highest Phosphprous (28.48%) and C:N ratio (16.39).

Table 1: The results of the chemical analysis of the kitchen waste compost and topsoil

Sample	N	P	K	Organic Carbon	C:N ratio
Topsoil	0.17b	28.48a	0.29b	2.69b	16.39a
Kitchen waste compost	2.68a	2.88b	2.51a	33.69a	12.71b
P-value	0.00	0.00	0.00	0.00	0.00
CV (%)	0.90	0.11	3.79	0.49	0.60
Lsd (1%)	0.05	0.07	0.20	0.34	0.3

N: Nitrogen, P: Phosphorus, K: Potassium, C:N: Carbon Nitrogen; P-value: 1%; CV:Coefficient of Variation, LSD (1%): Means followed by the same letter(s) within a treatment group are not significantly different at 1% level of probability using Least Significant Difference (LSD)

Plant height of okra as influenced by Kitchen Waste Compost (KWC) amended topsoil of at 2, 4, 6, 8 and 10 Weeks After Planting (WAP)
The differences between the means of the amendments for plant height at 2, 4, 6, 8 and 10 weeks after planting were statistically significant (p ≤0.05) as illustrated in Table 2. Okra plants fertilized with KWC 830g + Topsoil produced the tallest plants at weeks two, eight and ten (7.57 cm), (66.38 cm) and (81.35 cm) respectively. The shortest plants were produced by okra plants fertilized with KWC 540g + Topsoil at week two (7.09 cm) and six (25.37 cm) whiles Topsoil only produced the shortest plants at weeks eight (61.22 cm) and ten (67.30 cm). Okra plants fertilized with KWC 270g + Topsoil produced the tallest plants (30.98 cm) at week six and the shortest (25.37 cm) was produced by KWC 540g + Topsoil. In the fourth week after planting, there were no significant (p0.05) difference between the amendments in relation to plant height (Table 2).

Table 2: Plant height of okra as influenced by Kitchen Waste Compost (KWC) amended topsoil of at 2, 4, 6, 8 and 10 Weeks After Planting (WAP)

Amendments	Plant height (cm)				
	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP
KWC 830g + Topsoil	7.57a	12.10a	29.34ab	66.38a	81.35a
KWC 540g + Topsoil	7.09d	11.48a	25.37c	65.11a	72.07b
KWC 270g + Topsoil	7.22c	13.38a	30.98a	61.60b	71.11c
Topsoil only	7.32b	12.09a	27.37bc	61.22b	67.30d
P-Value	0.00	0.29	0.0004	0.00	0.00
CV (%)	0.40	9.00	2.62	0.74	0.31
LSD (0.05)	0.08	3.12	2.09	1.33	0.64

WAP: Weeks after planting; P-value: Probability level measured at 0.05; CV: Coefficient of variation.; LSD: Least significant difference; KWC: Kitchen waste compost; Means followed by the same letter(s) within a treatment group are not significantly different at 5% level of probability using Least Significant Difference Test (LSD).

Number of leaves of okra as influenced by Kitchen Waste Compost (KWC) amended topsoil on plant height at two, four, six, eight and ten Weeks After Planting (WAP)
The differences between the means of the amendments for number of leaves at weeks two, four, six, eight and ten after planting were statistically not significant (p ≥0.05) as indicated in Table 3.

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Table 3: Number of leaves of okra as influenced by Kitchen Waste Compost (KWC) amended topsoil on plant height at 2, 4, 6, 8 and 10 Weeks After Planting (WAP)

Amendments	Number of leaves				
	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP
KWC 830g + Topsoil	6.00a	9.67a	9.33a	11.00a	9.33a
KWC 540g + Topsoil	5.67a	9.00a	9.00a	10.00a	11.33a
KWC 270g + Topsoil	5.57a	8.67a	9.00a	9.00a	9.33a
Topsoil only	5.67a	9.00a	7.67a	8.33a	9.00a
P-Value	0.8022	0.4547	0.2106	0.2894	0.2503
CV (%)	8.70	8.00	10.26	16.77	14.20
LSD (0.05)	1.41	2.05	2.54	4.54	3.91

WAP: Weeks after planting; P-value: Probability level measured at 0.05; CV: Coefficient of variation.; LSD: Least significant difference; KWC: Kitchen waste compost; Means followed by the same letter(s) within a treatment group are not significantly different at 5% level of probability using Least Significant Difference Test (LSD).

Stem girth of okra as influenced by Kitchen Waste Compost (KWC) amended topsoil at 2, 4, 6, 8 and 10 Weeks After Planting (WAP)

The differences between the means of the amendments for plant height at at 2, 4, 6, 8 and 10 weeks after planting were statistically significant (p ≤0.05) as shown in Table 4. Okra plants fertilized with KWC 830g + Topsoil produced widest girth at weeks four (3.39 mm), six (8.56 mm), eight (16.28 mm), and ten (17.05 mm). The narrowest girth were produced by okra plants fertilized with Topsoil at week two (1.01 mm), weeks four (2.34 mm), six (5.57 mm), eight (14.79 mm), and ten (15.60 mm).

Table 4: Stem girth of okra as influenced by Kitchen Waste Compost (KWC) amended topsoil at 2, 4, 6, 8 and 10 Weeks After Planting (WAP)

Amendments	Stem girth (mm)				
	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP
KWC 830g + Topsoil	1.01b	3.39a	8.56a	16.28a	17.05a
KWC 540g + Topsoil	1.65a	3.36a	7.01b	15.43ab	16.57b
KWC 270g + Topsoil	1.65a	3.34a	6.12bc	15.22b	16.51b
Topsoil only	1.01b	2.34b	5.57c	14.79b	15.60c
P-Value	0.0000	0.0000	0.0006	0.0097	0.0000
CV (%)	1.70	1.61	6.19	2.23	0.59
LSD (0.05)	0.64	0.14	1.19	0.97	0.27

WAP: Weeks after planting; P-value: Probability level measured at 0.05; CV: Coefficient of variation.; LSD: Least significant difference; KWC: Kitchen waste compost; Means followed by the same letter(s) within a treatment group are not significantly different at 5% level of probability using Least Significant Difference Test (LSD).

Effect of Kitchen Waste Compost (KWC) amended topsoil on number of days to first and 50% Flowering

The differences between the means of the amendments for number of days to first and 50% flowering were statistically significant (p ≤0.05) as shown in Table 5. Okra plants fertilized with Topsoil only took the longest number of days to first flower initiation (50.00 days) and the shortest (47.00 days) was KWC 830g + Topsoil. Additionally, it took the longest number of days (52.00 days) for okra plants fertilized with Topsoil only to reach 50% flowering and the shortest (approximately 48.00 days) was KWC 830g + Topsoil fertilized okra plants (Table 5).

Table 5: Effect of Kitchen Waste Compost (KWC) amended topsoil Number of days to first and 50% Flowering

Amendments	Number of days to first flowering	Number of days to 50% flowering
KWC 830g + Topsoil	47.00c	48.33b
KWC 540g + Topsoil	48.67b	49.67b
KWC 270g + Topsoil	49.67ab	51.33a
Topsoil only	50.00a	52.00a
P- Value	0.0006	0.0007
CV (%)	0.90	1.10
LSD (0.05)	1.25	1.56

P-value: Probability level measured at 0.05; CV: Coefficient of variation.; LSD: Least significant difference; KWC: Kitchen waste compost; Means followed by the same letter(s) within a treatment group are not significantly different at 5% level of probability using Least Significant Difference Test (LSD).

Number of flowers and aborted flowers as influenced by Kitchen Waste Compost (KWC) amended topsoil

The differences between the means of the amendments for number of flowers and aborted flowers were statistically significant (p ≤0.05) as shown in Table 6. Okra plants fertilized with KWC 830g + Topsoil produced the highest number of flowers (7.33) and Topsoil only recorded the least (4.00) flower numbers. Statistically, there was no significant (p0.05) differences between the means of the number of aborted flowers.

Table 6: Number of flowers and aborted flowers as influenced by Kitchen Waste Compost (KWC) amended topsoil

Amendments	Number of flowers	Number of aborted flowers
KWC 830g + Topsoil	7.33a	2.00a
KWC 540g + Topsoil	6.00b	2.00a
KWC 270g + Topsoil	5.67b	2.67a
Topsoil only	4.00c	3.33a
P- Value	0.0002	0.19
CV (%)	6.48	29.81
LSD(0.05)	1.05	2.11

P-value: Probability level measured at 0.05; CV: Coefficient of variation.; LSD: Least significant difference; KWC: Kitchen waste compost; Means followed by the same letter(s) within a treatment group are not significantly different at 5% level of probability using Least Significant Difference Test (LSD).

Number of days to physiological maturity as influenced by Kitchen Waste Compost (KWC) amended topsoil

The differences between the means of the amendments for number of days to physiological maturityof okra pods were statistically significant (p ≤0.05) as shown Table 7. Okra plants fertilized with Topsoil only took longer days (approximately 83 days) to reach physiological maturity whiles KWC 830g+Topsoil took the shortest days (approximately 66.00 days) to reach physiological maturity.

Table 7: Number of days to physiological maturity as influenced by Kitchen Waste Compost (KWC) amended topsoil

Amendments	Number of days to physiological maturity
KWC 830g + Topsoil	66.33c
KWC 540g + Topsoil	74.33b
KWC 270g + Topsoil	82.00a
Topsoil only	83.33a
P- Value	0.00
CV (%)	1.85
LSD (0.05)	2.83

P-value: Probability level measured at 0.05; CV: Coefficient of variation.; LSD: Least significant difference; KWC: Kitchen waste compost; Means followed by the same letter(s) within a treatment group are not significantly different at 5% level of probability using Least Significant Difference Test (LSD).

Number of okra pods as influenced by Kitchen Waste Compost (KWC) amended topsoil

There were differences between the means of the amendments for pod numbers was not significant (p ≥0.05) as shown Figure 1.

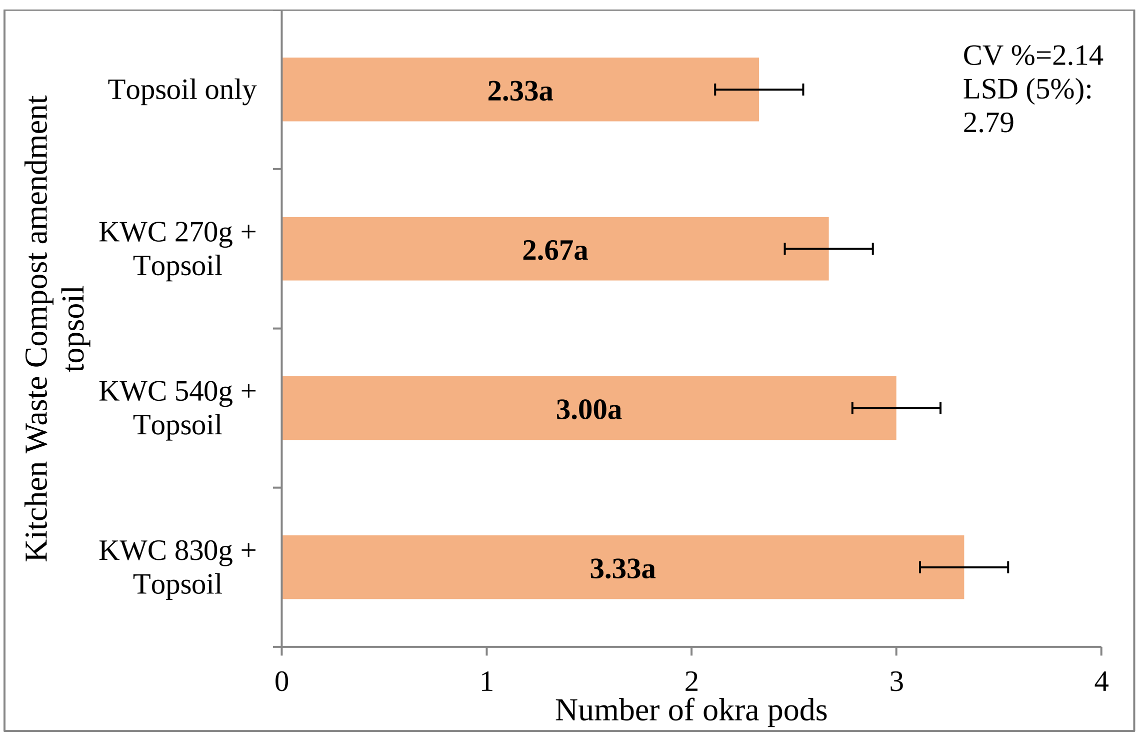

Figure 1: Number of okra pods as influenced by Kitchen Waste Compost (KWC) amended topsoil

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Number of seeds per pod influenced by Kitchen Waste Compost (KWC) amended topsoil

The differences between the means of the amendments for number of seeds per pod were statistically significant (p ≤0.05) illustrated in Figure 2. Okra plants fertilized with KWC 830g + Topsoil produced the highest number of seeds per pod (100.67) and those fertilized with Topsoil only recorded the least number (84.33) of seeds in the pod (Figure 2).

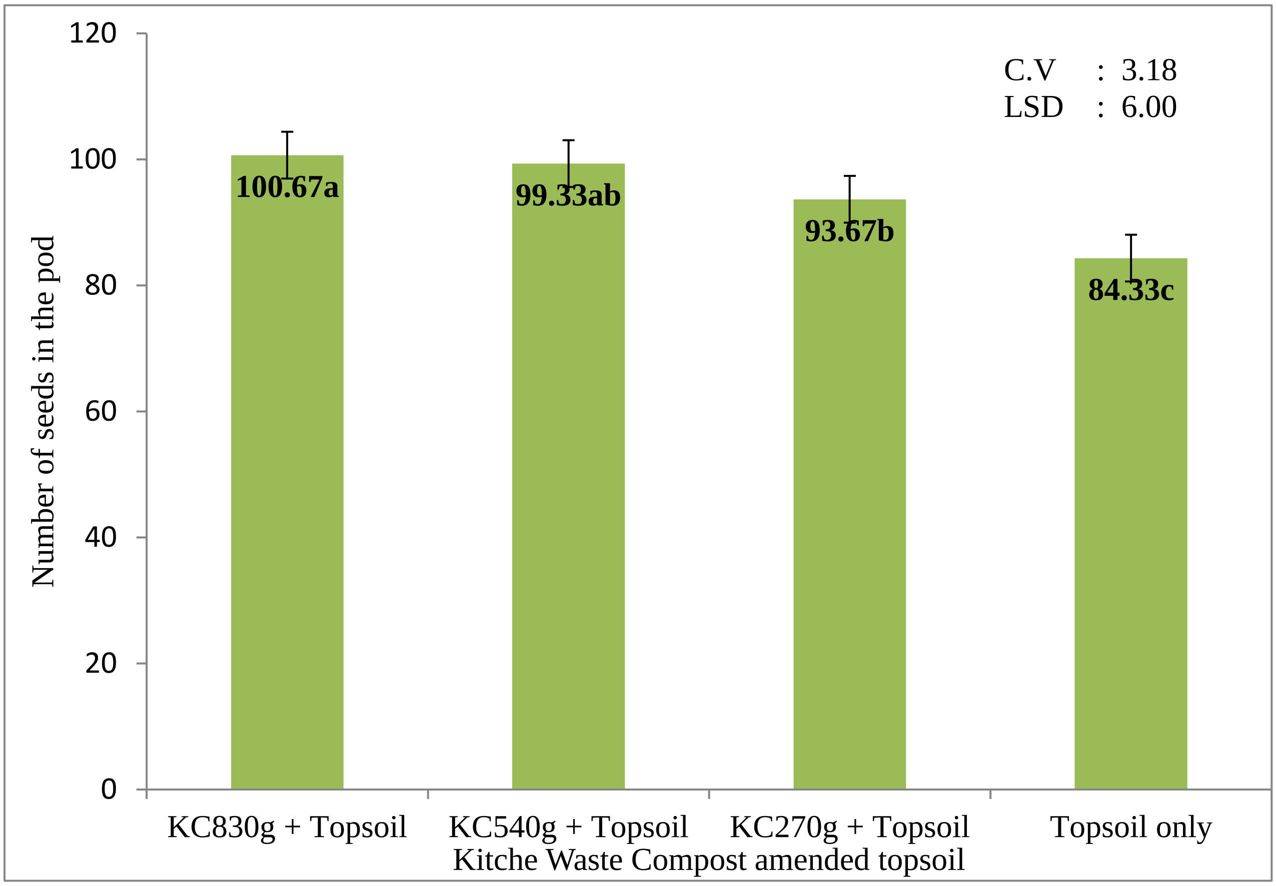

Figure 2: Number of seeds per pod as influenced by Kitchen Waste Compost (KWC) amended topsoil

Seed yield of okra as influenced by Kitchen Waste Compost (KWC) amended topsoil

The differences between the means of the amendments for seed yield of okra were statistically significant (p ≤0.05) as shown in Figure 3. Highest seed yield (18.28 g) was obtained from okra plants fertilized with KWC 830g + Topsoil and the least (16.03 g) was those plants fertilized with Topsoil only.

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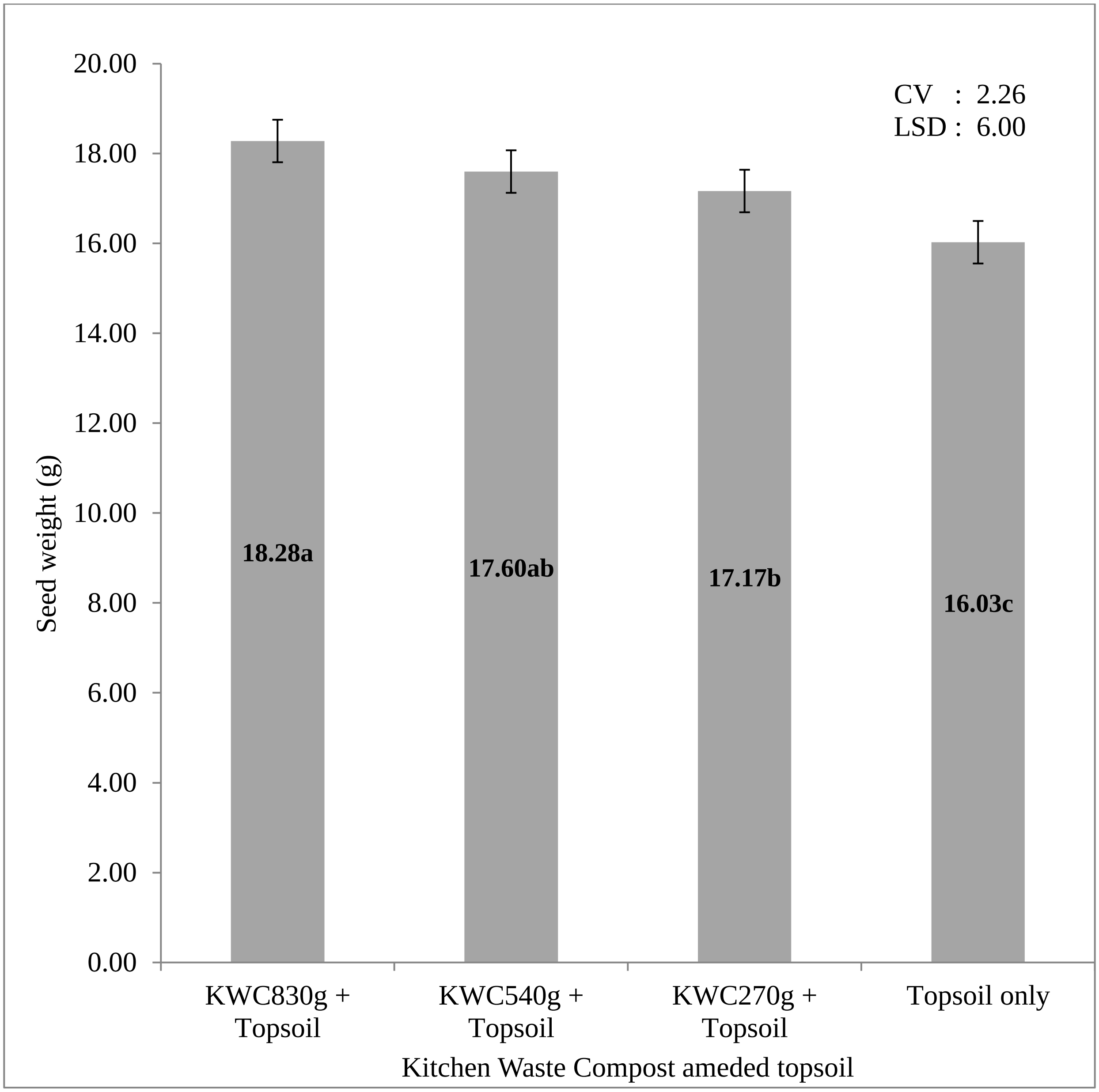

Figure 3: Number of seeds per pod as influenced by Kitchen Waste Compost (KWC) amended topsoil

1000 seeds weight as influenced by Kitchen Waste Compost (KWC) amended topsoil
For 1000 seed weight of okra, there were significant ($p \leq 0.05$) variations between the amendments (Figure 4). Highest seed yield (59.53 g) was obtained from okra plants fertilized with KWC 830g + Topsoil and the least was all the other amendments.

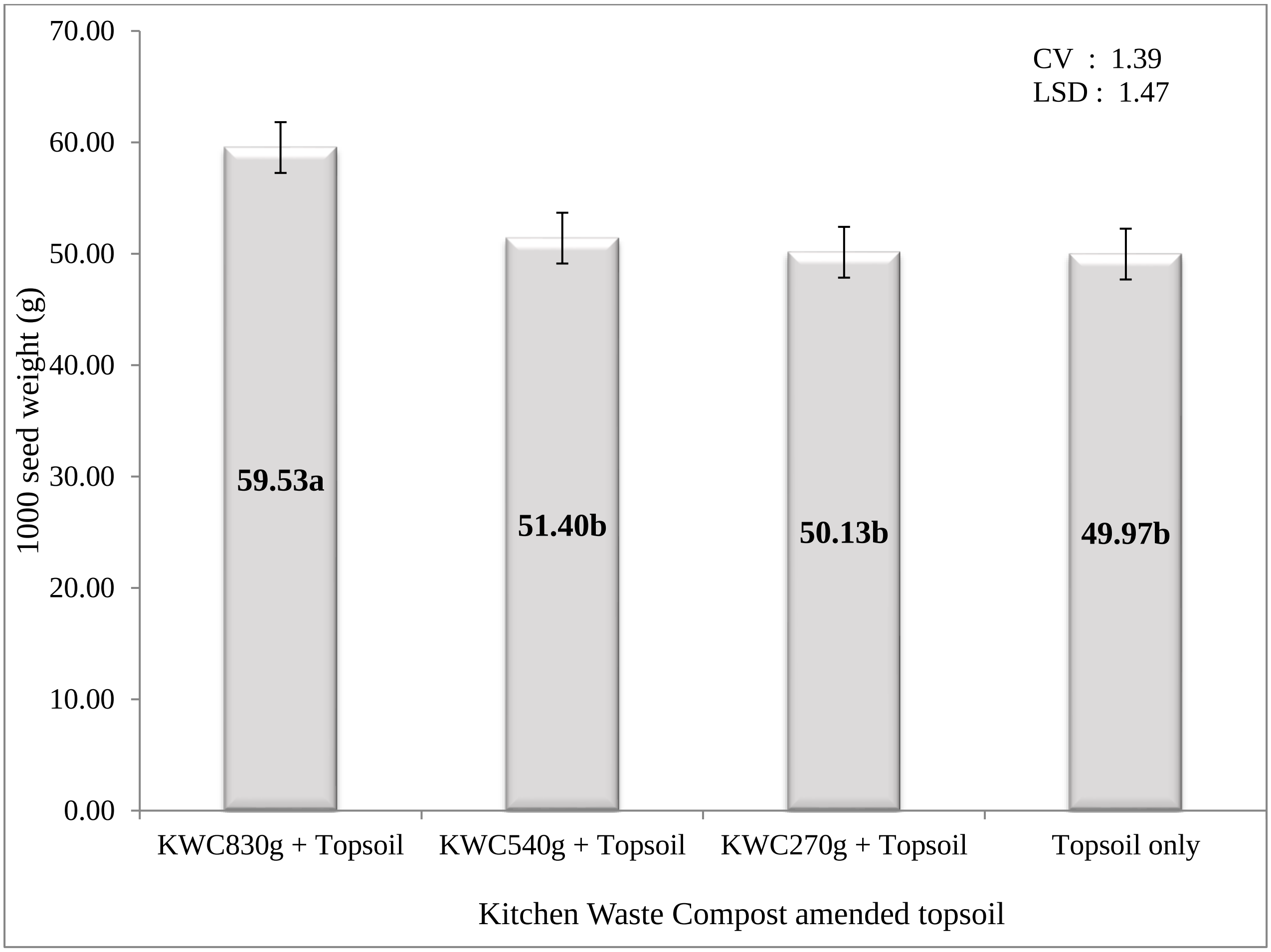

Figure 4: 1000 seed weight (g) as influenced by Kitchen Waste Compost (KWC) amended topsoil

Correlation between seed yield and number of seeds in pods
A correlation analysis showed that there was a strong, positive and significant (r=0.99) relationship between number of seeds per pod and total seed yield.

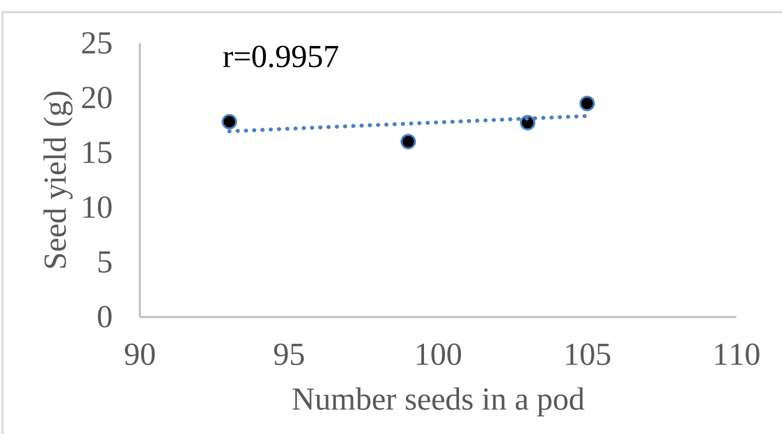

Figure 5: Correlation between seed yield and number of seeds in pod

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DISCUSSION

Our results showed that kitchen waste compost 830g + topsoil gave the maximum plant height plant, leaf numbers and stem girth. This could be due to the high amount of Nitrogen and Potassium as compared with the other amendments. This will facilitate cell division and rapid growth leading to increased height of the okra plants. It has important role as a basic element of protein, nucleic acids, chlorophyll and growth hormones (Hassan *et al*., 2022). It is due to the effect of the increase in auxin concentration associated with higher levels of nitrogen resulted in the increased plant height. Moreover, during early period of plant growth, there was nitrogen availability which led to the movement of nutrients in the root zone of soil and promoting physiological activity. Plant growth and development is chiefly regulated by Nitrogen. Metabolic reactions, energy conservations and biological energy transformations are affected by increased supplies of available phosphorus. Again, increased activity in cell growth and provision of energy to the cells are highly activated due to the formation of storage compounds (ATP and ADP). The results of the current study corroborates the findings of (Ferdous *et al*., 2022) who explained that significant amount of plant nutrients, including carbon (C), nitrogen (N), phosphorus (P), potassium (K), and calcium (Ca), were present in the compost made from kitchen garbage. These nutrients encourage rapid plant vegetative growth (plant height plant, leaf numbers and stem girth). Sahu *et al*. (2017) reported that application of Phosphorus significantly increased plant height. In addition, plant height plays a significant role in a coordinated set of life cycle characteristics that also includes seed mass, time to reproduction, longevity, and the annual seed production capacity (Moles *et al*., 2009). Higher leaf numbers obtained by the Kitchen waste compost 830g + topsoil treated plants could have a profound impact on the photosynthetic activities of the okra. Domaratskyi (2021) reported that leaf photosynthetic apparatus of plants plays a crucial role in the formation of productivity of all agrocenoses. This organ performs the function of photosynthesis and the formation of organic matter occurs in it. Stem girth is usually a good index of plant vigour, which may contribute towards greater productivity Oke *et al*., (2020) and in this study, okra plants treated with Kitchen waste compost 830 g + topsoil produced the widest stems which suggests a rapid cell division as a result of the available nutrients such Nitrogen.

Kitchen waste compost 830g + topsoil treated plants flowered earlier probably due to the increased plant growth due to availability of nitrogen and potassium. Potassium has a direct effect on flower number and consequent fruit set. The control of sugar quantities which is processed to the meristematic regions help in forming the primary structures of flower primordia due to the increase in potassium fertilization levels. This may have improved vegetative growth, such as plant height and thereby resulting in the increase of the number of flowers. Furthermore, Potassium helps in activation of couple of enzymes, enhancing protein production, and triggering the absorption of carbohydrates and other nutrients and hence increasing flower numbers (Al-Abbasi, 2009). Again, Potassium also plays crucial role in CO_2 stabilizing, turgor pressure control and chlorophyll content regulating (Zhao *et al*., 2001). Uddin *et al*., (2014) reported that number of days for flowering was reduced due to application of the proper level of phosphorus. Kitchen waste greatly impact crop growth and efficiency while decreasing their flowering times (Shukla & Singh, 2013). By speeding up photosynthesis and the export of solute to the plant's sink site, mineral nutrients like nitrogen may have an impact on the onset of flowering (Singh *et al*., 2020). Also Uddin *et al*., (2014) stated that the right amount of phosphorus administration decreased the number of days needed for blossoming. The number of flowers showed significant differences among all the treatments. The element nitrogen, which is a part of the chlorophyll molecule, encourages vegetative development, which in turn aids in flowering and fruit set (Mutua *et al*., 2021). Okra plants need the most potassium since it has a direct impact on a number of physiological processes that determine the yield (Silva *et al*., 2021). According to Hau, (2022), nitrogen fertilizer is essential for improving okra's growth, fruit yield and quality. Nitrogen (N), Phosphorus (P), and Potassium (K) are the three basic elements of compost. Nitrogen has many of benefits include speeding up plant growth and increasing seed production (Dada & Adejumo, 2015). Study by Zhang *et al* (2020), revealed that seed yield is determined by pods per square meter (m^2), seeds per pod and individual seed weight. Our results showed that the application of KWC 830g + Topsoil resulted in the highest seed yield (18.28 g) and the least (16.03 g) was those plants fertilized with Topsoil only. This could be due to high amount of nutrients in the KWC 830g + Topsoil amendment which resulted in higher pod numbers and seed yield.

Amjad (2001) reported that phosphorus administration considerably boosted the amount of seeds per pod in okra varieties. Furthermore, Phosphorus in plants improves flower formation and seed production, more uniform and earlier crop maturity, increases Nitrogen fixing capacity and improving seed yield (Limeneh *et al*., 2020). The basic solubilization effect of released plant nutrients that result to an increased nutrient status and water retention capacity of the soil could be the cause of the rise in seed weight of okra caused by compost application (Tiamiyu *et al*., 2012).

Conclusion

The study revealed that the compost rates did not influence the number of leaves, number of pods and aborted flowers. However, plants treated with kitchen waste compost at a rate of 830 g had the best performance in terms of plant height, stem girth, days to 50% flowering, number of flowers, days to physiological maturity and seed yield. Additionally, kitchen waste compost at a rate of 830 g amended topsoil had significant influence on seeds per pod, total seed weight and 1000 seed weight. A correlation analysis showed that there was a strong, positive and significant (r=0.99) relationship between number of seeds per pod and total seed yield. The study concluded that the application of 830g of kitchen composts significantly improved vegetative, reproductive and seed yield attributes of okra.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data availability statement

Original data for this study is with the corresponding author and can be supplied upon request.

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