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Response of Okro *(Abelmoschus esculentus)* to five different rates of cow dung in Abraka, Delta State

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Abstract

This study was conducted in the Teaching and Research Farm of Delta State University, Abraka to examine the response of Okro to five different rates of cow dung. The treatments- rates of the manure in tonnes per hectare were 0, 5, 10, 15 and 20. It was carried out in a Randomized Complete Block Design (RCBD) with three replicates. Eleven parameters were assessed to achieve the research objectives, including initial pre-planting soil analysis, chemical composition of the cow dung used for the study, percentage emergence, plant height, number of leaves, leaf area, stem girth, number of pods/plant, number of seeds/pod, pod weight and effects of soil amendment on chemical properties of Okro. Results obtained showed that the parameter assessed increased as rate of cow dung increased. Plants that received 20tha^{-1} manure application rate were superior in percentage emergence (98), plant height at 12 weeks after planting (WAP) (98cm), stem girth at 12 WAP (0.96cm), number of leaves at 12 WAP (8), number of pods/plant (3), number of seeds/pod (26) and weight of pods (0.92kg). Based on the findings of the study, it was recommended that farmers apply 20tha^{-1} of cow dung for increased growth and yield of Okro in the environment.

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Introduction

Okro (*Abelmoschus esculentus* L) or lady's finding, as it is also called, belongs to *malvaceae* family grown in the tropical, subtropical and warm temperate regions of the world. It is an annual drought tolerant leafy vegetable cultivated for its fresh green fruits (Thakur and Arora, 1986). The pods have high mucilage content which can be used as plasma replacement or blood volume expander (Hague *et al.*, 2015). As a nutritious and delicious crop commonly used in soup-making, Okro is rich in minerals and vitamins. Rashid (1990) reported that every 100gm of the edible parts of pod has a moderate level of vitamin A (0.01mg), C (18g), calcium (90mg), phosphorus and potassium. The report further implicated Okro as containing 0.07mg of thiamine, 0.08 of riboflavin and 0.08mg of niacin per 100g edible portion of pod which is higher than that of many vegetables. Okro contains Fe, Zn, Mn and Ni (Moyin-Jesu, 2007). The leaf buds and flowers are also edible, while the oil obtained from the seed can be used as a biofuel (Farooq *et al.*, 2010). The roots and stems of Okro are used for clarification of sugarcane juice from which brown sugar is prepared (Singh *et al.*, 2018).

The numerous benefits of Okro notwithstanding, its yield is low compared with the ever increasing world population, which demand for it. The need arises therefore to seek ways of applying substances (fertilizers) that introduce the required nutrients which are capable of improving chemical and physical properties for proper growth and development of the crop. Inorganic fertilizers are not only costly to resource – poor farmers but sometimes cause health hazards, to man and crops. They also damage soil structure and texture, as well as affect soil microbial activities negatively. Hence the best available option lies in the use of organic manure such as cow dung which are environmentally friendly to crops and other living organisms.

Cow dung is the dark green coloured waste product (feaces) of cattle (Wikipedia, 2022). It is used as manure in gardens in many rural areas. It has high level of ammonia which mineralizes to release nitrogen needed for vegetable growth of crops (Enujeke *et al.*, 2022). It is high in organic materials and rich in nutrient. Tilley (2022) reported that crow dung contains about 3% nitrogen, 2% phosphorus and 1% potassium. Cow dung increases organic carbon content of degraded soil leading to increased activity of beneficial microorganisms as well as fertility status of soil by making nutrients available for plants use. Cow dung significantly increased the growth and yield of several plants (Gudugi, 2013, Akande *et al.*, 2006; Mehedi *et al.*, 2011). This study, therefore, was conducted to examine the response of Okro to five different rates of cow dung in Abraka area of Delta State.

Materials and methods

Study area

This experiment was carried out at Teaching and Research Farm of Delta State University, Abraka during the early cropping season of 2022 to examine the effects of cow dung on the growth and yield of Okro (*Abelmoschus esculentus*), Abraka is in Ethiope East Local Government Area of Delta State. It lies between Latitude 5° 47¹ 24.83'N, and Longitude 6° 6¹17.03E among the several communities along the New and Old Sapele/Agbor highway. Abraka area is a coastal plain that is lowland and flat with a gentle slope towards River Ethiope. Being an equatorial climate, the temperature ranges from 23 to 37°C and relative humidity is between 50 and 70%. The dry season starts in November and ends in February, while rainy season commences in March and ends in October with peak of rains in July. The vegetation is rainforest, though it has been replaced with secondary forest due to regular farming activities (Efe and Aruegodor, 2003).

Field work

A land measuring 360m² was ploughed and harrowed using tractor. It was marked out according to the experimental layout. The field was divided into 3 blocks containing 5 plots each, giving a total of 15 plots. Each plot measured 6m x 4m. A distance of 0.5m separated each plot, while the distance between the blocks was 1m. Soil samples were collected from the plots at 0-15cm depth with a view to assessing the initial soil physiochemical properties. Cow dung was taken from the cattle unit of Delta State University farm and applied to the plots according to the treatments. After 2 weeks, soil samples were collected from individual plots. These samples were air-dried at room temperature of 27°C for 3 days, crushed and sieved using a 2mm aperture. Particle size distribution was determined by hydrometer method (Gee and Bauder, 1986). The pH was measured using Pye Unican model MK2pH Oxidation method (Nelson and Sommer, 1982). Total nitrogen was assessed by micro-Kjedahl distillation technique as described by Bremmer and Mulvancy (1982). Available phosphorus was ascertained using Bray No 1 method (IITA, 1979). Exchangeable potassium was known using flame photometer, while cation exchange capacity (CEC) was determined by Ammonium acetate saturation method (Roades, 1982). The cattle dung used for the study was analyzed and measured as directed by IITA manuals (1979).

The experimental design was RCBD replicated three times. Rates of cow dung applied in tonnes per hectare were 0, 5, 10, 15 and 20, making a total of five treatment. The manure was incorporated into the soil before planting. Seed of Okro were procured from Delta Agricultural Development Agency (DAPA) and planted at rate of 3 seeds/stand at a spacing of 60cm x 40cm, but later thinned to one plant/stand. Regular weeding was done using hoe.

Data collection and analysis

Eight middle stands made up the sample population. Percentage germination was first assessed, thereafter plant height, number of leaves/plant, leaf area, stem girth of Okro were measured at fort-night intervals starting from the 4th week after planting. Percentage germination was done by counting and converting the value obtained to percentage. Stem girth was measured using a thread and tape rule. Plant height was measured from the base of the tape. Number of leaves was known by counting, leaf area was measured using tape rule, fruit weight was determined using a weighing scale. Data collected was subjected to analysis of variance (ANOVA) and differences between means were separated using Duncan Multiple Range Test (DMRT) according to SAS (2005).

Results

Initial physico-chemical properties of the soil used for the study

The initial physic-chemical properties of the soils used for the study is shown in Table 1. The particle size distribution indicates that the soils were sandy loam but low in fertility as shown by the low content of organic matter 16.0gkg^{-1} and total nitrogen of 0.82gkg^{-1}. The pH of 5.3 showed that the soil was strongly acidic. Available phosphorus (P) and water soluble potassium (K) with values of 5.40 mgkg^{-1} and 0.15cmolkg^{-1} were low according to FMANR (1996) ratings for Abraka ecology. The low fertility of the soil is characteristic of most humid environments where torrential rains causes erosion, leaching, weathering of low activity clay minerals and high acidification.

Table 1. Physico-chemical properties of experimental site used for the study.

Parameters measured	Values obtained
Particle size fractions (%)	
Sand	86.0
Silt	9.4
Clay	4.6
Textural class	Sandy loam
pH H_2O	5.4
Organic matter (gkg^{-1})	16.0
Total Nitrogen (gkg^{-1})	0.82
Available P (mgkg^{-1})	5.40
Exchangeable K (cmolkg^{-1})	0.15
CEC	10.16

Chemical properties of the cow dung used for the study

The analytical values of the cow dung used for the study are shown in Table 2. The result showed that the quantities of macro and micro nutrients in the cow dung were adequate to enhance increased growth and yield of crops, including Okro.

Table 3 shows the effects of cow dung on percentage emergence of Okro at one week after planting (WAP) and stem girth (cm) at 12 WAP. There were significant differences in both percentage emergence at one WAP and stem girth of Okro at 12 WAP. Both parameters assessed increased as manure application rates increased.

Plants that received 20tha^{-1} manure application had the highest percentage emergence (98%), while plants that did not receive cow dung (0tha^{-1}) had the lowest percentage emergence (86%). Stem girth followed similar trend. Plants that received 20tha^{-1} of cow dung had the highest stem girth of 0.96cm, while plants in the control plot had the lowest stem girth of 0.74cm.

Table 2. Chemical properties of the cow dung used for the study.

Nutrient elements	Values obtained
N(%)	1.52
P %	1.02
K %	0.51
Ca %	3.52
Mg%	0.34
Fe(mgkg^{-1})	1624
Mn(mgkg^{-1})	484
Zn(mgkg^{-1})	602
Cu(mgkg^{-1})	492

Table 3. Effects of cow dung on percentage emergence of Okro at one week after planting (WAP) and stem girth (cm) at 12 WAP.

Rates of cow dung (tha^{-1})	Percentage emergence (%)	Stem girth at 12WAP (cm)
0	86e	0.74e
5	90d	0.76d
10	93c	0.82c
15	96b	0.86b
20	98a	0.96a

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

Effects of cow dung on plant height (cm) of Okro

The response of plant height of Okro to different rates of cow dung from 4 weeks after planting (WAP) to 12 weeks after planting is shown in Table 4. The different rates of manure resulted in significant differences in the plant height of Okro. Higher application rates of cow dung resulted in higher plant height of Okro. At 4 WAP, plants that received 20tha^{-1} of cow dung had the highest plant height (28cm) while plant grown in the control plot which received zero application rate (0tha^{-1}) had the lowest plant height of 10cm. The trend remained unchanged up till the 12th week, where plants that received 20tha^{-1} of manure had highest plant height of 98cm, while plants grown without cow dung (0tha^{-1}) had the lowest plant height of 64cm.

Table 4. Effects of cow dung on plant height (cm) of Okro.

Rates of cow dung (tha^{-1})	← Weeks after planting →				
	4	6	8	10	12
0	10e	18e	28e	38e	64e
5	12d	20d	32d	44d	82d
10	18c	24c	38c	52c	88c
15	24b	30b	42b	58b	94b
20	28a	36a	48a	62a	98a

Means having the same alphabets under the same column are not statistically different ($P \leq 0.05$) using Duncan Multiple Range Test (DMRT)

Effects of cattle dung on number of leaves of Okro

Table 5 shows the effects of cow dung on number of leaves of Okro. There were no significant differences in the number of leaves of Okro from 4 WAP to 12 WAP. During the 4th week, both the plants which did not receive cow dung and plants that received manure had equal number of leaves (3). Similar trend occurred in the 6th week where all the plants had 4 leaves in each plot (whether manured or not). There were slight changes in weeks 8, 10 and 12, where plants that received 20tha^{-1} of cow dung exceeded other plants by one leaf (6, 7, 8, respectively) though significant differences were not also observed.

Table 5. Effects of cow dung on number of leaves of Okro.

Rates of cow dung (tha^{-1})	← Weeks after planting →				
	4	6	8	10	12
0	3a	4a	5a	6a	7a
5	3a	4a	5a	6a	7a
10	3a	4a	5a	6a	7a
15	3a	4a	5a	6a	7a
20	3a	4a	6a	7a	8a

Means having the same alphabets under the same column are not statistically different ($P \leq 0.05$) using Duncan Multiple Range Test (DMRT).

Effects of cow dung on leaf area (cm^2) of Okro

Responses of leaf area of Okro to different rates of application of cow dung is shown in Table 6. Significant differences were observed in the leaf area of Okra from 4WAP to 12 WAP. During the 4th week, leaf area of Okra increased with corresponding increases in manure application rates of 0tha^{-1} (3.30cm^2), 5tha^{-1} (4.40cm^2), 10tha^{-1} (6.05cm^2), 15tha^{-1}

(8.10cm²) and 20tha⁻¹ (10.20cm²). Similar trend was observed up till the 12th week where the values were 0tha⁻¹ (10.40cm²), 5tha⁻¹ (12.10cm²), 10tha⁻¹ (14.20cm²), 15tha⁻¹ (16.50cm²) and 20tha⁻¹ (19.40cm²) of leaf area.

Table 6. Effects of cow dung on leaf area (cm²) of Okro.

Rates of cow dung (tha^{-1})	← Weeks after planting →				
	4	6	8	10	12
0	3.30e	4.62e	6.10e	8.20e	10.40e
5	4.40d	6.14d	8.20d	10.40d	12.10d
10	6.05c	9.42c	10.24c	12.60c	14.20c
15	8.10b	11.50b	12.42b	14.40b	16.50b
20	10.20a	13.10c	15.20a	17.60a	19.40a

Means having the same alphabets under the same column are not statistically different ($P \leq 0.05$) using Duncan Multiple Range Test (DMRT)

Effects of soil amendment on yield parameters of Okro at 16 WAP

The effects of cow dung on yield parameters of Okro at 16 WAP is shown in Table 7. There were significant differences in the number of pod/pant of Okro. Plants that received manure application rate of 20tha⁻¹ had the highest number of pods/plant (4), followed by plants that received 15tha⁻¹ (3) and 10tha⁻¹ (3). Plants that were in the control plot (0tha⁻¹) had the lowest number of pods/plant (1). The number of seeds/pod significantly increased as the rate of cow dung application increased. Plants that received 20tha⁻¹ of cow dung had the highest number of seeds/pod (26) while plants that did not receive manure had the lowest number of seeds/pod (12).

Table 7. Effects of cow dung on yield parameters of Okro at 16 WAP.

	← **16 WAP** →		
Rates of Cow dung (tha^{-1})	Number of pods/Plant	Number of seeds/pod	Weight of pod(g)
0	1b	12.0e	0.52e
5	2b	14d	0.64d
10	3ab	18c	0.70c
15	3ab	12b	0.84b
20	4a	26a	0.92a

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

The order of superiority in number of seeds/pod with respect to rate of cow dung applied in tonnes/hectare was 20 > 15 > 10 > 5 > 0.

There were also significant differences in weight of pods produced. Plants that receive 20tha-1 of cow dung had the highest weight (0.92g) while plants in control plot had the lowest weight (0.52g). The order of superiority in weight of pods with respect to rate of cow dung applied in tonnes/hectare was 20 > 15 > 10 > 5 > 0.

The effects of soil amendment on chemical properties of Okro at 16WAP

The effects of soil amendment on chemical properties of Okro at 16WAP are shown in Table 8. The results showed that nutrients present in the analyzed Okro were those absorbed from both applied cow dung (Table 2) and the nutrients previously existing in the soil (Table 1) which were made available to the crop through the activities of beneficial organisms. This confirms the reports of Gudugi (2013), Mehedi *et al.* (2011) and Tilley (2022) which indicated that nutrients present in cow dung positively enhanced growth and yield indices of crops.

Table 8. Effects of soil amendment on chemical properties of Okro at 16WAP.

Rates of Cow dung (tha^{-1})	pH (H_2O)	Organic matter (gkg^{-1})	Total N (gkg^{-1})	C	Mg	K
				($cmolkg^{-1}$)		
0	6.4	0.84	0.78	3.20	0.46	0.14
5	6.3	0.92	0.82	4.0	0.50	0.18
10	6.3	0.96	0.84	4.2	0.54	0.17
15	6.2	1.10	0.86	4.1	0.60	0.19
20	6.1	1.12	1.22	4.0	0.74	0.22

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

Discussion

Effects of cow dung on growth parameters of Okro

Percentage emergence, plant height, number of leaves, leaf area and stem girth of Okro increased as the manure application rate increased.

This could be attributed to improved supply of nutrients; better utilization of carbon and subsequent synthesis of assimilates as reported by Eifediya and Remison (2010) on growth parameters of cucumber. It may also be adduced to the release of nitrogen from mineralization of ammonia contained in cow dung. Nitrogen has been reported by Enujeke *et al. (*2022) to have enhanced the growth parameters of watermelon, including vine length, number of leaves and branches. This is consistent with the findings of Gudugi (2013). Akaude *et al.* (2006), Mehedi *et al. (*2011) and Tilley (2022) which reported that cow dung significantly increased the growth and yield of plants as it contains about 3% nitrogen, 2% phosphorous and 1% potassium. It is also synonymous with the findings of Akanbi *et al.* (2005), Olamiyi *et al.* (2008) and Stevens *et al.* (2018) which reported increased vegetative growth of vegetables due to addition of nitrogen released from organic fertilizers.

Effects of cow dung on yield parameters of Okro

The number of pods/plant, seeds/pod and weight of pod of Okro were highest in plants that received 20tha^{-1} of cow dung, while decrease in manure application rate resulted in decrease in yield indices of the crop. This suggests that higher manure application rates resulted in higher carbon content leading to increased activities of beneficial micro-organisms that improve soil fertility and make nutrients available for plants' use.

Similar result was reported by Iputu *et al.* (2019) who observed that highest rate of manure gave a corresponding highest fruit weight of tomato. It also confirms the report of Enujeke (2013) who observed that highest rate of organic manure gave a corresponding increase in fruit yield of cucumber.

Conclusion

The research was carried out to examine the response of Okro to five different rates of cow dung in Abraka, Delta State. Eleven parameters were investigated to achieve the objectives of the study; initial pre-planting soil analysis, chemical composition of cow dung used for the study, percentage emergence, plant height, number of leaves, stem girth, leaf area, number of pods/plant, number of seeds/pod, pod weight and effects of soil amendment on the chemical properties of Okro. Increased manure application rate resulted in corresponding increase in the parameters investigated. Plants the received 20tha^{-1} of cow dung were outstanding in percentage emergence, plant height, number of leaves, leaf area, number of pod/plant, number of seeds/pod and weight of pod.

It was therefore recommended that farmers in the study area apply 20tha^{-1} of cow dung for increased growth and yield of Okro.

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