Growth and Yield Response of Okra (*Abelmoschus esculentus* L.) to Organic Manures and their effect on Postharvest in Makurdi, Benue state, Nigeria.

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Abstract

The study was conducted to investigate growth and yield response of okra (Abelmoschus esculentus l.) to organic manuresand their storability. A study conducted in the Joseph Sarwuan Tarka University, Makurdi, Benue State. Three treatments (Cow-dung, goat dropping and rabbit dropping) of organic manure were used to determine growth and yield response of okra. Each organic manure of 1kg/2m by 2m was incorporated into the soil one week before transplanted. The experiment designed for this study was Completely Randomized Block Design with three replicates. Data collected on growth and yield parameters included: Plant height, Leaf area, and Number of branches and First flowering, Days to 50% flowering, Days to 50% maturity, Fruit length, Number of fruit/plant, Fruit weight (g) and Fruit weight (t/ha). Data collected was subjected to analysis of variance (ANOVA) using GENSTAT statistical soft-ware version 17.1 (2015). There were significant differences ($P<0.05$) among the treatments for each growth parameter and yield measurement. From the result, there was significant effect of treatments on the number, length and fresh weight of fruit per plant. The application of Cow-dung manure resulted in a significant ($P < 0.05$) increase in the number of okra fruit (46.07) compared to the rabbit dropping, goat dropping and the control (37.30, 35.25 and 30.15 respectively). The fruits produced by the cow-dung manure treatment were higher than the control and other treatments. From the result Cow-dung was a better source of organic manure for okra production than goat dropping and rabbit dropping and hence is recommended to farmers for optimum production of Okra in Makurdi. Cow-dung gave the best results for fruit firmness compared with the other treatments during the storage periods. Fruits firmness indicator of freshness and determines the quality of okra under storage.

Key note: *okra, organic manure, growth, yield, storage period*

INTRODUCTION

Okra (Abelmoschus esculentus L. Moench), belonging to Malvaceae family is originally included in the genus Hibiscus; however, section Abelmoschus is now accepted as distinct genus on the basis of its caducous nature of the calyx (Patel *et al*., 2019)**.** Among these vegetables, Okra (*Abelmoschus esculentus*), stands out for its nutritional value and economic significance. It is mainly grown for its pods which are used as fresh, canned or dried fruits. okra gum is obtained from an edible material, okra itself is used as a flavoring material and bodying agent in food stuff, and okra gum has some unique properties; the use of okra gum in foods and pharmaceuticals warrants further consideration (Chen *et al*, 2016). The immature tender fruit is cut into small pieces, then boiled and served with the soup. Fruits are rich source of protein, vitamins, fibre and minerals like calcium, magnesium, potassium. However, successful cultivation of Okra demands the judicious application of nutrients, especially organic and inorganic manures, to ensure optimal growth, yield, and quality of the crop (Smith *et al.,* 2017).

Organic and inorganic manures play an important role in enhancing soil fertility and structure, thereby promoting sustainable agricultural practices. The utilization of different types of organic and inorganic manures have been a subject of intensive research, as they influence various plant growth parameters. *Clemson Spineless* Okra, a popular cultivar known for its spineless pods, has been the focus of numerous studies to understand the effects of various organic manures on its growth and yield (Gupta and Yadav, 2019). Compost is one of the most widely studied organic manures. Compost is known to improve soil structure, enhance water retention, and provide a balanced nutrient supply to plants. Research by Smith *et al*., (2017) highlighted that the incorporation of compost into Okra cultivation resulted in improved soil fertility and increased yield. Compost's slow-release nature ensures a steady nutrient supply, which can lead to prolonged plant growth and higher pod production (Smith *et al.,* 2017).

In addition to compost, another prominent organic manure is vermicompost, produced through the digestion of organic material by earthworms. Vermicompost is rich in essential nutrients, plant growth regulators, and beneficial microorganisms that contribute to soil health and plant development. Studies by Gupta and Yadav (2019) demonstrated that vermicompost-amended soils exhibited improved nutrient content and microbial activity, leading to enhanced growth parameters in Clemson Spineless Okra plants. The plant's ability to absorb nutrients efficiently from vermicompost can result in robust vegetative growth and an increased number of pods (Gupta and Yadav, 2019).

Furthermore, the utilization of organic residues, such as crop residues and green manures, has gained attention for its potential in improving soil structure and nutrient availability. Incorporation of leguminous green manures, as studied by Patel and Sharma (2018), not only contributed to nitrogen fixation but also enhanced soil organic carbon content. In essence, the effects of different organic manures on *Clemson Spineless* Okra plants are pivotal in determining the crop's growth, yield, and quality. Compost, vermin compost, and green manures have shown promising results in enhancing soil fertility, nutrient availability, and overall plant performance. As sustainable agriculture gains momentum, understanding the influence of various organic manures on Okra

cultivation can provide valuable insights into optimizing crop management practices for improved productivity and environmental conservation.

The cultivation of Okra (*Abelmoschus esculentus*) holds substantial agricultural and economic significance globally, owing to its nutritional value and versatile culinary uses. However, ensuring sustainable and high-quality Okra production is challenged by the need to optimize nutrient management practices. The effects of various organic manures on the growth, yield, and overall health of Okra plants, specifically the *Clemson Spineless* variety, remain a critical area of investigation (Khan and Arshad, 2020). While organic manures are known to enhance soil fertility and plant nutrient uptake, the specific impacts of different types of organic manures on Clemson Spineless Okra plants are not yet fully understood, leading to a gap in knowledge that needs to be addressed. Organic manures, such as compost, vermicompost, and green manures, are rich sources of essential nutrients and organic matter (Rajashekar and Reddy, (2017). However, the selection of the most suitable organic manure for optimal Okra growth remains a challenge (Rajashekar and Reddy, (2017). Furthermore, the variability in nutrient composition, microbial activity, and nutrient release patterns among different organic manures can impact Okra plant responses differently. This raises questions about the effectiveness of these organic manures in meeting the specific nutritional requirements of Clemson Spineless Okra and maximizing its yield potential. Consequently, there is a pressing need to comprehensively investigate and compare the effects of diverse organic manures on the growth, yield, and nutrient content of *Clemson Spineless* Okra plants to inform best practices in organic cultivation. Okra is highly perishable, it can store well in a lower temperate environment. During postharvest storage, any environmental or physiological factor that adversely effects cellular components can lead to deterioration or loss of firmness, resulting to undesirable changes in the quality of fresh fruits.

The study on the effects of different organic manures on *Clemson Spineless* Okra plants is of significant importance due to its potential to enhance sustainable agricultural practices and address the challenges associated with nutrient management in vegetable cultivation.

Organic agriculture has gained momentum as a means to promote environmentally friendly and resource-efficient farming methods. Given the increasing concerns over the detrimental impacts of synthetic fertilizers on soil health, water quality, and overall ecosystem sustainability, investigating the role of organic manures in enhancing soil fertility and crop productivity becomes crucial. Moreover, with the rising global demand for nutrient-rich foods, understanding how various organic manures influence the growth, yield, and nutrient content of Okra can contribute to improving the nutritional value and quality of this important vegetable crop. By elucidating the specific effects of different organic manures on *Clemson Spineless* Okra plants, this study can provide valuable insights that guide farmers towards adopting more effective and sustainable nutrient management strategies for enhanced crop production while minimizing environmental impacts. The Objectives of the research is to assess the impact of organic manures on the growth and yield parameters of *Clemson Spineless* Okra plants, to evaluate the effects of organic manures on the storability of okra.

MATERIALS AND METHODS

The study was conducted in Joseph Sarwuan Tarka University Makurdi, a city located in Benue state. The experimental design employed for this study was a randomized complete block design (RCBD) with three replicate. The *Clemson Spineless* Okra cultivar was chosen based on its popularity and adaptability to the region's growing conditions. Three (3) different organic manure types were selected for the study (Cow dung, Goat dropping, Rabbit dropping and control). The experimental design for the study was Completely Randomized Block Design with three replicates. Okra seeds were sown in seedling trays filled with a commercial potting mix. The seeds were watered regularly and provided with appropriate lighting until they developed healthy seedlings. Healthy seedlings were transplanted into the prepared experimental plots at the two-leaf stage. The spacing used was 5cm. The designated organic manure of 1kg/plot of 2m by 2m was applied to each plot one week before transplanting for the release of nutrient. The manures were spread evenly over the soil surface and gently incorporated into the soil using a hand trowel. Data was collected on growth parameters including plant height, leaf area, and number of branches. They were measured at regular intervals throughout the growing season. Plant height was measured from the soil surface to the highest point of the plant. Leaf area was determined using a leaf area meter. At harvest, yield measurements were recorded for each treatment. Yield measurement such as Days to 50% flowering, fruit length, plant Fruit, Fruit weight were also recorded from a representative sample of plants within each plot.

After harvesting was done, healthy okra fruits were selected washed dried with plane paper and stored the same basket wrapped with polyethylene and polyurethane (evaporative cooler) and were kept under shed with 28^0C. Fruit Firmness was determined in the middle of the fruit using a manual penetrometer Instrument PTR=100 with a 5mm diameter tip. For each treatment. 6 fruits were analyzed per evaluation day. Data collected was subjected to analysis of variance (**ANOVA**) using **GENSTAT** statistical soft-ware version **17.1 DE (2015**) and significant means were separated using fisher's least significant differences at 5%level of probability.

RESULTS AND DISCUSSION

Table 1. Effect of three different Organic Manures on growth parameters of okra (Clemson spineless) grown in Makurdi. **(**Weeks after Planting).

Treatments	2wk	4wk	6wk	2wk	4wk	6wk	2wk	4wk	6wk
	Plant height (cm)			Number of Branches			Number of leave		

Control	18.10	28.32	32.34	3.20	6.26	10.23	15.05	19.45	24.81
Cow dung	27.43	36.12	44.53	5.20	8.25	15.20	9.34	23.83	28.79
Rabbit	22.72	30.52	33.28	4.00	7.53	12.65	13.32	19.53	25.52
Goat	4.32	32.74	38.12	3.00	5.08	10.02	13.72	18.52	25.74
LSD	**0.40**	**0.34**	**0.12**	**1.40**	**1.17**	**1.24**	**1.10**	**1.12**	**1.13**

LSD=Least Significant Differences at 5% Level of Probability

This study in table 1 investigates the influence of three distinct organic manures, namely Cow Dung, Rabbit Manure, and Goat Manure, on the growth parameters of okra (Clemson Spineless) at various stages (2 weeks, 4 weeks, and 6 weeks after planting) in Makurdi. The evaluated growth parameters include plant height (cm), number of branches, and number of leaves. A control group was maintained for reference.

The results reveal significant variations in the growth parameters across the different treatments and time intervals. In terms of plant height, Goat Manure consistently demonstrated the highest values across all weeks, followed by Rabbit Manure and Cow Dung, while the control group exhibited the lowest values. Similar trends were observed in the number of branches and leaves, indicating that organic manures positively influenced the overall growth of okra compared to the control. On plant height cow dung gave the highest value of 27.43cm while goat manure recorded the lowest value of 4.32cm at 2 weeks after planting, but at 6 weeks after planting, control gave the lowest value of 32.34cm followed by Rabbit dung which gave 33.28cm while cow dung recorded the highest value of 44.53cm. Cow dung recorded highest number of branches of 15.20 while the goat gave the lowest number of 10.02. The highest number of leave was recorded in cow dung was 28.79 while control gave the lowest of 24.81. Research has shown that the application of organic manures positively influences these parameters, fostering enhanced vegetative growth and laying the foundation for robust yield potential (Ramesh and Suganthi, 2017). The slow-release nature of organic manures ensures a steady supply of nutrients over time, aligning with the plant's growth requirements. Moreover, the organic matter content of these manures improves soil structure, enhancing root penetration, water infiltration, and nutrient accessibility. This results in improved root establishment and nutrient absorption, which directly translate into enhanced plant height, leaf area, and stem diameter (Nourbakhsh and Mahboobi, 2019). The study emphasizes the importance of selecting appropriate organic manures for enhancing the growth of okra. Farmers and researchers can utilize these findings to make informed decisions regarding the choice of organic manure to maximize the yield and overall health of okra crops in the specific agroclimatic conditions of Makurdi.

Table 2**:** Effects of three different Organic Manures on days of First flowering, 50% flowering And Days to % Maturity of okra (Clemson spineless) grown in Makurdi.

Treatments	First Flowering	Day to 50% Flowering	Days to 50 % Maturity
Control	22.76	46.40	72.32
Cow dung	28.02	50.24	68.13
Rabbit	24.13	49.13	70.58
Goat	23.05	47.03	75.05
LSD (0.05)	**1.01**	**1.39**	**3.01**

LSD=Least Significant Differences at 5% Level of Probability

This research investigates the effects of three distinct organic manures - Cow Dung, Rabbit Manure, and Goat Manure - on key developmental stages of okra (Clemson Spineless) grown in Makurdi. The focus is on the days of First Flowering, Days to 50% Flowering, and Days to 50% Maturity. A control group was maintained for comparative analysis. The results indicate significant variations in the timing of flowering and maturity among the treatments. Cow Dung exhibited the shortest duration to First Flowering and 50% Flowering, indicating its potential to accelerate these developmental stages compared to Rabbit and Goat Manures. Additionally, Goat Manure showed a prolonged period to reach 50% Maturity, suggesting a potential delay in the maturation process compared to the other treatments which could be as a result of slow releases of nutrient as reported by Madina and Akinyemi (2023)

The Least Significant Differences (LSD) analysis at a 5% level of probability confirmed the statistical significance of these observed differences. The LSD values for each parameter underline the reliability of the findings, providing valuable insights into the impact of specific organic manures on the reproductive and maturation phases of okra. This study contributes valuable information for farmers and researchers in Makurdi, aiding in the selection of organic manures based on their influence on flowering and maturation timings. These findings can be utilized to optimize crop management practices, ultimately enhancing the overall yield and quality of okra in the region FOA (2020)

Table 3. Effect of three different Organic Manures on yield parameters of okra (Clemson spineless) grown in Makurdi

Treatments	Fruit length (cm)	Number of Fruit/plant	Fruit weight (g)	Fruit weigh (t/ha)
Control	3.00	30.15	20.10	1.89
Cow dung	3.50	46.07	28.17	2.84
Rabbit	3.20	37.30	26.02	2.42
Goat	2.10	35.25	22.41	2.02
LSD (0.05)	**0.12**	**0.17**	**1.24**	**1.13**

LSD=Least Significant Differences at 5% Level of Probability.

This study explores the influence of three distinct organic manures - Cow Dung, Rabbit Manure, and Goat Manure - on key yield parameters of okra (Clemson Spineless) grown in Makurdi. The evaluated parameters include Fruit Length (cm), Number of Fruits per Plant, and Fruit Weight (g) per plant and on a per-hectare basis. A control group was maintained for comparative analysis. The results reveal significant variations in the yield parameters across the different treatments. Cow Dung consistently outperformed Rabbit and Goat Manures in all parameters, exhibiting longer fruit length, a higher number of fruits per plant, and greater fruit weight. Rabbit Manure showed intermediate values, while Goat Manure consistently demonstrated the lowest values for all parameters. Cow dung recorded the highest fruit length while goat dung gave lowest. The result for the fruits/plant for control, cow-dung, rabbit and goat was recorded as thus: 30.15, 46.07, 37.30 and 35.25 respectively. Cow dung recorded the highest number of fruit per plant while goat gave the least. The same observation was recorded in fruit length of okra. The values for the result of fruit weight t/ha) for control, cow-dung, rabbit and goat was recorded as follows: 1.89, 2.84, 2.42 and 2.02 respectively. Cow dung gave the highest fruit weight of okra with 2.84 t/ha followed by Rabbit which gave 2.42t/ha. This could be attributed to the facts that cow dung may have released it nutrient during the productive stage of the plant, which is supported by the finding of Madina at al 2021 in his work on lettuce.

There was significant effect of treatments on the number of fruit per plant, length fruit and fresh weight of fruit. The application of goat manure resulted in a significant increase in the number of okra pods compared to the control. The pods produced by the cow-dung manure treatment were almost double in number than in the control. There was significant difference in the number of fruit per plant was observed. Significant difference was observed in fruit length from control. Cow-dung manure produced the longest fruit (3.50cm). Fruit weight per plant was significantly increased with cow-dung manure application compared to the control.

Plants responded to the improved conditions under manure, especially poultry manure, with an increased yield. The significant increase in total yields in manure plots might also be attributed to the increased branching. In okra, more branching accounts for increased yield as fruit developed

in the axil of every branch once flowering has begun. Similarly, the significant difference in pod length, girth and fruit weight with manure plots compared to the control might be due to differences in soil structure and fertility. Increased organic matter in the soil from application of goat manure, cow dung and rabbit manure improved both soil physical and chemical properties compared to inorganic fertilizer alone and the control. Cow-dung manure was identified as a better source of organic manure for okra production than goat and rabbit. These findings offer practical guidance to farmers and researchers in Makurdi for the selection of organic manures to enhance the yield of okra crops. The study emphasizes the potential of Cow Dung in particular, providing a basis for sustainable and informed agricultural practices aimed at maximizing okra production in the region

Table 4. The effect of organic manures on Fruit Firmness of okra fruits Clemson spineless) **stored in evaporative cooler.**

Treatments	**0 day**	**7 days**	**14 days**	**21 days**
Control	5.54	5.30	5.10	5.01
Cow dung	5.54	5.45	5.37	5.28
Rabbit	5.54	5.35	5.32	5.25
Goat	5.54	5.33	5.30	5.22
LSD (0.05)	**0.00**	**0.15**	**0.23**	**0.30**

LSD=Least Significant Differences at 5% Level of Probability

Table 4 This study explores the influence of different organic manures - Cow Dung, Rabbit Manure, and Goat Manure - on the fruit firmness of okra (Clemson Spineless) during storage in an evaporative cooler. The assessment was conducted over a 21-day period, with measurements taken at 0 days, 7 days, 14 days, and 21 days. A control group was included for comparative analysis shown, the results reveal varying effects of organic manures on fruit firmness at different storage intervals. Cow Dung consistently maintained higher fruit firmness levels compared to Rabbit and Goat Manures at all-time points. The control group exhibited a gradual decline in firmness over the storage period, while the organic manure treatments showed relatively more stable firmness levels. the acceptance of okra fruits by consumers depend on numerous factors such as appearance, texture, taste and nutritional value. Cow-dung gave the best results for fruit firmness compared with the other treatments during the storage periods. Fruits firmness indicator of freshness and determines the quality of okra, because loss of firmness, is evaluated as a sign of senescence. During postharvest storage, any environmental or physiological factor that adversely effects cellular components can lead to deterioration or loss of firmness, resulting to undesirable changes in the quality of fresh fruits. Saberi et al. (2018). The study gave a valuable contribution for post-harvest management practices, guiding farmers and researchers in Makurdi on the selection of organic manures to enhance the storage quality of okra fruits. The findings highlight the importance of choosing appropriate organic amendments to prolong the shelf life and maintain the quality of okra produce under evaporative cooler storage conditions

CONCLUSION

The study which covered the effect of organic manure (cow-dung, goat and rabbit manure) on okra crop has proven to be a very important study with vast benefits. From the study, it has been observed that organic manure (cow-dung, goat and rabbit manure) has effect to the growth of okra plant. In essence, it enhances the growth of this important crop and therefore aid more of its production.

From the study carried out increased organic matter in the soil from application of goat manure, cow dung and rabbit manure improved the soil compared to control as shown from the yield results in table 3. Cow-dung manure was identified as a better source of organic manure for okra production than goat and rabbit. The result in table 4 contributes important information on how long fresh okra can be stored and still maintain good quality with high nutritional value.

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