EFFECTS OF DIFFERENT RATES OF PELLETED ORGANIC MANURE AND INORGANIC FERTILIZER ON TWO VARIETIES OF OKRA (Abelmoschus esculentus (L.) Moench)

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ABSTRACT: The experiment was conducted in the teaching and research farm, Federal University Wukari, Taraba state to evaluate the effect of organic and inorganic fertilizer on the growth and yield performances of two different varieties of okra (*Abelmoschus esculentus L. Moench*). Randomized Complete Block Design (RCBD) with three replications was used. Four different treatments (no fertilizer, 5 tons/ha pelleted organic manure, 10 tons/ha pelleted organic manure and 0.15 tons/ha NPK fertilizer) were used for the experiments. The data were collected on the growth and yield parameters including plant height (cm), number of leaves per plant, leaf area (cm^2), length of pods (cm), diameter of pods and weight of pods per plot. Data collected were subjected to Analysis of Variance and means found to be statistically significant were separated using Duncan's Multiple Range Test (DMRT) at 5% level of probability. From this study, the application of 10 tons/ha pelleted organic manure increased significantly the growth and yields performances on okra compared to the other organic and inorganic fertilizer treatments. The results indicated a significant increase in growth parameters of okra including (plant height, number of leaves per plant and leaf area) and yield parameters (weight of pods per plot). Plots treated with 10 tons/ha pelleted organic manure significantly had highest vegetative growth especially plant heights of 88.42 cm for Clemso Okra and 76.14 cm for Kosoko Okra while the control (no fertilizer) plots had the least plant heights of 50.70 cm for Clemso Okra and 44.36 cm for Kosoko Okra. The pod length and pod diameter show no significant difference across all weeks of observation, while the pod weight showed significant difference, where the highest weight of pods per plot of 237.19 g for Clemso Okra and 298.6 g for Kosoko Okra were obtained from plot treated with 10 tons/ha pelleted organic manure while the lowest weight of pods per plot of 127.25 g for Clemso Okra and 135.5 g for Kosoko Okra were obtained from the control (no fertilizer) plots. However, the application of 10 tons/ha pelleted organic manure for optimum yield of okra is recommended.

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1.0 INTRODUCTION

Okra (Abelmoschus esculentus Moench) is an annual, herbaceous flowering plant in the plant family Malvaceae, which originated from tropical and subtropical Africa and is natural to the West Africa (Aladele *et al*., 2008). Okra is mainly cultivated for its young immature fruits and consumed as a vegetable, raw, cooked or fried in countries like Sudan, Egypt and Nigeria; it is also important in other tropical areas including Asia central and South America often used as ingredient of soups and sauces. Okra is the rich source of carbohydrates, amino acids, vitamins, minerals, calories which has multipurpose use like fresh or cooked consumption, as fodder to animal, medicinal and industrial use (Farinde *et al*., 2007; Seran *et al*., 2010; Kumar *et al*., 2017). The fruits can be conserved by drying or pickling, the roasted seed is considered as coffee substitute; the leaves, flower buds, flowers and calyces can be eaten cooked as greens (Ajari *et al*., 2003).

Fertilizers are chemical compounds, which occur in pellets, crystals, jellies or less commonly fluids (liquid or gaseous), they are produced from non-living sources and contain specific mineral nutrients combined in a standard ratio, which may be added to the soil to improve its fertility. Based on the composition, fertilizers may be classified as nitrogenous (e.g. ammonium sulphate) or phosphate-based or combined nutrient fertilizer e.g. NPK-fertilizers. Fertilizers could be very useful in increasing soil nutrient base and by extension, soil fertility but improper or excessive application could be detrimental to plants, pollute soil water bodies and deteriorate the soil structure (Dina *et al*., 2003).

Manure is any material obtained from plants, or animals or its remains, which may be added to the soil

to improve its fertility. Manure contributes to the fertility of the soil by adding organic matter and nutrients such as nitrogen to the soil and tends to bind loose soil particles together thus increasing its water retention capacity (Anyanwu and Anyanwu, 1985). The word manure originates from a Greek word "manure" meaning "to cultivate land" and initially from a French word "mainoeuvre" which means "handwork". There are two main types of manure namely: green manure and animal manure. Green manure is produced from fresh plant materials and animal manure from the excrement/dropping of plant-eating mammals (herbivores) and poultry or from plant materials, which have been used as bedding for animals and so is heavily contaminated with feaces and urine. The process of spreading or incorporating manure is termed manuring (Goldstein, 1991). Organic manure helps to improve the physical condition of soil and provide adequate amount of necessary nutrients for the soil productivity (Qhureshi, 2007).

Pelleting is a process of biomass densification which increases bulk density and decreases volume. The process uses some form of mechanical pressure to reduce the volume of grind material and converts the material to a solid form (pellets), which is easier to handle and store, than original material. Pelleted organic manure is a slow release N fertilizer with long-term effects including reduced leaching losses and enhanced N uptake, as well as positive effects on both health and soil nutrient levels (Tahir *et al*., 2017).

In developing countries like Nigeria, the population growth rate is so high that improved technologies including rational use of fertilizers must be employed to meet the food requirement of the people. Improving soil fertility through the application of fertilizers is an essential factor enabling the world to feed the billions of people that are added to its population. Declining soil fertility is a major production constraint in Africa, especially in Nigeria, and it is becoming increasingly critical to secure sustainable soil productivity (Oladotun, 2002).

It is common knowledge that farmers in our locality use fertilizer and /or manure on gardens with the view of promoting growth in plants regardless of the soil types or the appropriate dose of application. With this in mind, this research seeks to investigate the effect of organic and inorganic fertilizers application on the growth and yield components of two varieties of okra.

2.0 MATERIALS AND METHODS

2.1 Experimental Site

The experiment was conducted in 2021 during rainy season (cropping season) in the Teaching and Research Farm, Federal University Wukari, Taraba State. Wukari is within the southern guinea savannah agroecological zone of Nigeria. It is located on the Latitude of 7.85ºN and Longitude 9.78ºE at 152m above sea level. Taraba state has a tropical (hot) wet-dry climate, well-drained fertile soil and has both savanna and rain forest vegetations. The rainfall varying between 100mm to 250mm per annum in the north with the driest and wet less season from December to February and July to September as well (Kottek *et al.*, 2006), The average daily temperature of 24 to 33 ºC during the rainy season and annual relative humidity of 78%. It has the total population of 241,546 people according to 2006 census with a land mass of 54.426 km². It shared boundary with Adamawa State in the North East and Republic of Cameroon in the South west.

2.3 Experimental Design and Treatment

The experiment was designed in a Randomized Complete Block Design (RCBD) with three replicates, with each plot measuring 2×2 m with an alley of 1m between plots and 1m between the replication. The treatments are as follows (Okee, 2020):

T1: Control (No Treatment),
T_2: 5 tons/ha of POM,
T_3: 10 tons/ha of POM,
T_4: 0.15 tons/ha NPK (15:15:15) Fertilizer.

2.4 Agronomic Practices for Okra Production

Hand tilling was done twice to provide sufficient tilth for okra growth. This was done before the first rain. Two okra improved varieties (Clemson and kosoko) were obtained from the Department of Crop Production and Protection, Federal University Wukari for planting. Sowing was done during 2021 cropping season. The seeds were manually sown on rows at to 3 cm depths after 2 weeks of incorporating the POM into the soil. The seedlings were later thinned to one per hole at 30 cm intra-row plant –to –plant spacing at Two Weeks After Sowing (2 WAS). Weeding was done manually at three weeks interval. Hand weeding was done regularly especially during early stages of growth.

Harvesting was done when the pods were fully matured. Pods were harvested at 3 days interval throughout the period of harvesting. Harvesting was done manually by holding with one hand and slicing the fruit stalk with a sharp knife.

2.5 Plant Data Collection

2.5.1 Plant growth parameters

The plant growth data collected includes plant height, number of leaves per plant and leaf area. The plant growth data were measured and recorded at 6 and 8 Weeks After Sowing (WAS).

Plant height: This was carried out by measuring the heights of the tagged plants with a meter rule from the top soil level to the tip of the terminal buds and the average recorded for each of the treatment.

Number of leaves per plant: This was taken by counting all fully expanded leaves on each of the tagged plants and the average value was recorded for each of the treatment.

Leaf area: The length and width of leaves of the tagged plants were measured using the meter rule. Then, the leaf area was determined by multiplying with the factor (0.66).

Leaf area = length×width×0.66.

2.5.2 Plant yield parameters

The plant yield data collected includes pod length, pod diameter and weight of pods per plot. The plant yield data were collected at maturity.

Pod length: The length of six pods were taken from each plot, these were measured using meter rule and the average was recorded for each treatment.

Pod diameter: This was measured using Vernier Caliper.

Weight of pods per plot: A weighing balance was used to weigh the harvests of fruits per plots.

2.6 Data Analysis

Data collected were subjected to analysis of variance (ANOVA) whereby the means of the significant F-test values were separated using the Duncan's Multiple Range Test (DMRT) at 5% level of probability (Obi, 2001).

3.0 RESULTS AND DISCUSSIONS

3.1 Effects of Pelleted Organic Manure and Inorganic Fertilizer on Clemso Okra Growth

Table 1 shows the effect of pelleted organic manure and inorganic fertilizer on clemso okra growth. The results show the significant effect of the various treatments on plant height, number of leaves and leaf area at 6 and 8 WAS, significant difference exist for all treatments with lots treated with 10 tons/ha pelleted organic manure having the highest mean plant height, number of leaves and leaf area for both the 6 WAS and 8 WAS data. The lowest mean plant height, number of leaves and leaf area were obtained in the control treatment for both the 6 WAS and 8 WAS data. Statistical similarities exist among the pelleted organic manure and inorganic fertilizer treatments for all the plots except the leaf area of 0.15 NPK fertilizer which is statistically different from pelleted organic manure treatments at 8 WAS.

There was significant increase in okra plant height on the plot treated with 10 tons/ha of pelleted organic manure, this progression conforms with findings of Aniefiok (2013) who reported that poultry manure increases plant height. This is also in line with Okee (2020) who also reported that plot treated with 10 tonnes per hectare of poultry manure significantly had highest vegetative growth especially plant height of okra in Lokoja, Kogi State, Nigeria.

There was also significant increase in okra number of leaves on the plot treated with 10 tons/ha of pelleted organic manure. Pelleted organic manure at 10 tons/ha which gave the highest number of leaves is in agreement with the findings of Ajari *et al*. (2003) in okra production who reported that organic manure especially poultry manure could increase plant height and number of leaves in crops. This is also in line with Okee (2020) who also reported that higher vegetative growth (plant height and number of leaves) were obtained in plots treated with organic fertilizer (poultry manure). Thus, indicating the importance of poultry manure on the vegetative growth of okra.

The importance of leaf area in relation to basic plant metabolic processes, such as photosynthesis and respiration, is generally recognized. Furthermore, the quantification of several growth analysis parameters requires the measurement of leaf area at several stages during the life cycle of the plant (Bueno, 1979). It was observed that organic fertilizer treatment significantly increased the leaf area of okra plant under field conditions. The plants at 10 tons/ha POM treatment had the highest leaf area while the control plot gave the lowest leaf area for both the 6 WAS and 8 WAS data. This finding was supported by the results of Ufera *et al*. (2013) who stated that the largest leaf area was produced by the application of poultry manure. This is also in line with Khandaker *et al*. (2017) who also observed that organic fertilizer treatment significantly increased the leaf area of okra plant under field conditions.

Table 1: Effect of Pelleted Organic Manure and Inorganic Fertilizer on Clemso Okra Growth

Treatment (tons/ha)	6-WAS			8-WAS		
	Plant height (cm)	Number of leaves	Leaf area (cm^2)	Plant height (cm)	Number of leaves	Leaf area (cm^2)
0 (control)	21.65^{b}	7.13^{b}	261.30^{b}	50.70^{b}	7.87^{b}	329.71^{c}
5 POM	32.23^{a}	8.33^{a}	452.64^{a}	86.63^{a}	8.93^{a}	523.64^{a}
10 POM	32.29^{a}	8.87^{a}	490.68^{a}	88.42^{a}	9.40^{a}	564.39^{a}
0.15 NPK	30.18^{a}	8.40^{a}	366.54^{a}	70.87^{ab}	8.80^{a}	469.58^{b}
SE(±) P<0.05	7.0734	1.1044	158.39	1.1044	1.5969	174.21

3.2 Effect of Pelleted Organic Manure and Inorganic Fertilizer on Kosoko Okra Growth

Table 2 show the effect of pelleted organic manure and inorganic fertilizer on kosoko okra growth. The results showed that all the plant height, number of leaves and leaf area at both the 6 WAS and 8 WAS data for all the 5 tons/ha POM, 10 tons/ha POM and 0.15 NPK fertilizer treatments were statistically different from the control treatment but were statistically similar to one another. The 10 tons/ha POM treatment had the highest plant height, number of leaves and leaf area at both the 6 WAS and 8 WAS data while the control treatment had the lowest plant height, number of leaves and leaf area at both the 6 WAS and 8 WAS data.

Table 2: Effects of Pelleted Organic Manure and Inorganic Fertilizer on Kosoko Okra Growth

Treatment tons/ha	6-WAS			8-WAS		
	Plant height (cm)	Number of leaves	Leaf area (cm^2)	Plant height(cm)	Number of leaves	Leaf area (cm^2)
0 (control)	26.74^{a}	7.20^{c}	208.69^{b}	44.36^{b}	7.33^{b}	225.3^{b}
5 POM	32.30^{a}	7.80^{ab}	422.81^{a}	61.50^{ab}	8.33^{a}	432.2^{a}
10 POM	36.72^{a}	8.07^{a}	474.07^{a}	76.14^{a}	8.27^{a}	492.8^{a}
0.15 NPK	33.81^{a}	7.45^{bc}	385.15^{a}	69.20^{ab}	8.20^{a}	443.6^{a}
SE(±) P<0.05	13.597	0.48	186.15	25.567	1.4017	1762.1

3.3 Effect of Pelleted Organic Manure and Inorganic Fertilizer on Clemso and Kosoko Okra Yields

Table 3 shows the effect of pelleted organic manure and inorganic fertilizer on Clemso and Kosoko Okra yields. The results showed that pod lengths and pod diameters of the Clemso and Kosoko Okra obtained from all the 5 tons/ha POM, 10 tons/ha POM and 0.15 NPK fertilizer treatments were statistically similar to the pod lengths and pod diameters of the Clemso and Kosoko Okra obtained from the control treatment. The pod weight per plot of all the 5 tons/ha POM, 10 tons/ha POM and 0.15 NPK fertilizer treatments were statistically different from the control treatment but were statistically similar to one another for both the Clemso and Kosoko Okra varieties. The plants at 10 tons/ha POM treatment had the highest pod weight while the control plot gave the lowest pod weight for both the 6 WAS and 8 WAS data.

The increase in fresh pod weight of okra was due to pelleted organic manure application could be attributed to easy solubilization effect of released plant nutrient leading to improved nutrient status and water holding capacity of the soil. The results obtain were in agreement with the findings of Premsekhar and Rajashree (2009) in which they reported that higher yield response of crops due to organic manure application could be attributed to improved physical and biological properties of the soil resulting in better supply of nutrients to the plants. This is also in line with Khandaker *et al*. (2017) who also reported that higher pod yields were obtained in plots treated with organic fertilizer (poultry manure).

Table 3: Effects of Pelleted Organic Manure and Inorganic Fertilizer on Clemso and Kosoko Okra Yields

Treatment tons/ha	Clemso Okra			Kosoko Okra		
	Pod length (cm)	Pod diameter (cm)	Pod weight (g)	Pod length (cm)	Pod diameter (cm)	Pod weight (g)
0 (control)	8.17^{a}	4.73^{a}	127.25^{b}	8.75^{a}	4.93^{a}	135.5^{b}
5 POM	8.65^{a}	4.79^{a}	226.13^{a}	9.63^{a}	5.13^{a}	260.2^{a}
10 POM	9.37^{a}	5.12^{a}	237.19^{a}	9.91^{a}	5.28^{a}	298.6^{a}
0.15 NPK	8.54^{a}	4.71^{a}	194.52^{a}	9.86^{a}	4.84^{a}	247.8^{a}
SE(±) P<0.05	0.77	0.28	75.82	0.88	0.75	86.13

4.0 CONCLUSION

Regardless of positive control: NPK fertilizer and negative control: no fertilizer, 10 tons/ha pelleted organic manure treatment showed the best effect in all the growth parameters (plant height, number of leaves and leaf area) and yield parameters (pod length, pod diameter and pod weight per plot) and no fertilizer was the least. It can be concluded that application of 10 tons/ha pelleted organic manure treatment significantly increase the growth and yields performances on Albemoschus esculentus L. Moench (okra) compared to the other fertilizer treatments. The differences between NPK fertilizer and organic manure are due to the differences in rates of decomposition and nutrient release pattern. Therefore NPK fertilizer is good for those who want to harvest their yield early but by using organic manure especially poultry manure they can save the production cost, and improving the soil physical

properties because organic manure is friendly to environment.

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