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Effect of Different Organic Manure Sources on the Growth, Yield, and Nutritional Quality of Cucumber (*Cucumis sativus* L.)

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ABSTRACT

Background and Objective: Cucumber (*Cucumis sativus* L.) is widely cultivated in Eastern Nigeria primarily for food, often using available organic manure sources. However, these manures vary in their influence on the crop's growth, yield, and nutritional composition. This study aimed to evaluate the effects of different organic manure sources on the growth, yield, and nutritional qualities of cucumber cultivated in Ishiagu, Ebonyi State. **Materials and Methods:** The field experiment was conducted at the Federal College of Agriculture, Ishiagu, during the 2023 planting season, while the proximate analysis was carried out at the Crop, Soil, and Pest Laboratory of the Federal University of Technology, Akure. Five manure treatments control (no manure), cow dung, pig dung, goat dung, and poultry droppings were applied at 10 ton/ha in a Randomized Complete Block Design (RCBD) with three replications. Seven agronomic parameters were evaluated, and data were analyzed using appropriate statistical tests at significance levels of $p \leq 0.01$ and $p \leq 0.05$. **Results:** Significant differences were observed among treatments for plant height, number of leaves, number of flowers, fruit weight, and fruit number at various weeks after planting. Pig dung treatment produced the highest moisture content (94.71%), while goat dung yielded the highest ash content (0.27%). The control recorded the highest protein content (1.29%), cow dung resulted in the maximum fat content (2.71%), and both cow and poultry dung treatments showed the highest carbohydrate levels (1.36 and 1.33%, respectively). **Conclusion:** Different organic manures significantly influenced cucumber growth, yield, and nutritional composition. Poultry manure proved most effective for enhancing growth and yield performance in Ishiagu, while other manure types showed specific advantages for different nutritional parameters. Further studies are recommended to optimize manure combinations for improved cucumber productivity and quality.

KEYWORDS

Cucumber, manure, yield, organic manure, growth performance, nutritional quality, Ishiagu, Nigeria

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INTRODUCTION

Cucumber (*Cucumis sativus* L.) is an important fruit from the Cucurbitaceae family and is one of the oldest vegetables cultivated by early man[1]. Among the major vegetables grown in Nigeria, it is popular and widely distributed across all regions. It matures early, being the second most widely cultivated cucurbit after watermelon[2]. It is cultivated throughout the country in the area extending from high altitude to the plains and along the riverbeds[3].

Cucumber production in Nigeria is usually on a small scale[4] mainly for local consumption, although some cucumbers are exported to neighboring West African countries such as Chad, Cameroon, Niger, and Benin Republic[5]. Production is mostly done in the northern part of the country, where it was once believed cucumber could only be grown. However, cultivation in southeastern Nigeria is achievable under moderate rainfall[5]. Currently, the crop is being cultivated in some southeastern areas, although yields per unit area remain low. There was a general belief that cucumber can only be grown in the north. Low yields in cucumber production in Nigeria can be attributed to a range of factors such as genetic, environmental, cultural practices, and fertilization[6]. Increasing production requires appropriate mineralization which can be provided through manuring.

Organic manures are useful in replenishing the soil fertility. In contrast, inorganic fertilizers can increase soil acidity, cause leaching and lead to nutrient imbalance. Research has shown that organic manures such as cow, swine, poultry, and sheep/goat droppings are rich in nutrients and beneficial for crop production, especially cucumber. Organic manures are recommended for long-term cropping in the tropics because their slow mineralization promotes sustained crop yield[7]. With the rising demand for cucumbers, extensive research has focused on improving fruit yield and quality. Many factors affect cucumber quality, including environmental conditions[8], genotype[9], and agricultural practices such as fertilizer management and irrigation[10]. Among these, fertilizer application is considered the most important for improving plant nutrition and fruit quality.

While mineral, chemical[11], animal[12], and biological fertilizers[10] have been studied, excessive use of chemical fertilizers may harm the environment and human health[13]. Animal manure use also carries potential risks such as heavy metal contamination[10], water pollution[12], and harmful residues in fruits. Therefore, this study evaluates the effects of different organic manure sources on cucumber growth, yield, and nutritional quality under Ishiagu agroecological conditions.

MATERIALS AND METHODS

Study area: The study duration was fourteen months (May, 2023 to June, 2024), and the field experiment was conducted at the Teaching and Research Farm of the Federal College of Agriculture, Ishiagu, Ebonyi State, Nigeria. The area lies within a latitude of 05°56'N and longitude 07°41'E in the derived savannah zone of southeastern Nigeria, characterized by the combination of shrubs, trees and grassland. The average annual temperature and rainfall is 29°C and 1050 mm, respectively[14].

Experimental design: The experimental site was cleared of existing vegetation, and packing of debris was carried out before the experimental area was marked into plots. The experiment was arranged in a Randomized Complete Block Design (RCBD) with three replicates (5 plots per replicate) consisting of 5 treatments. Each plot size measured 3×3 m (9 m^2) with an alley of 1m between replicates and plots. Three seeds were planted per hole on raised beds, spaced at 50x50 cm apart. The seedlings were thinned to 1 seedling per hole at 2 weeks after planting (2WAP).

Organic manure (poultry droppings, cow droppings, swine droppings, and goat droppings) was obtained from the farm unit of the Federal College of Agriculture, Ishiagu, Ebonyi State. The manures were applied according to treatment specifications at a rate of 10 ton/ha, 2 weeks before sowing. The treatments

included goat droppings (10 ton/ha), poultry droppings (10 ton/ha), swine droppings (10 ton/ha), cow droppings (10 ton/ha), and control (no manure). Manual hand weeding was carried out twice, at 4 and 6 WAP. Fruits were harvested manually by handpicking at seven weeks after sowing, when they had turned green in color. Agronomic and yield parameters recorded included vine length (at 2, 4, and 6 WAP), number of leaves (at 2, 4, and 6 WAP), days to 50% flowering, number of fruits per plant (at harvest), and fruit weight (at harvest).

Nutritional analysis: For nutritional analysis, harvested fruits from each treatment, control (T1), cow dung (T2), poultry droppings (T3), pig dung (T4), and goat manure (T5) were taken to the Crop, Soil, and Pest Laboratory of the Federal University of Technology, Akure. Samples were cleaned, freed from foreign material, and milled into flour for proximate analysis. The analyses followed AOAC[15] and AOAC and Helrich[16] standard methods for determining moisture, ash, crude fiber, fat, protein, and carbohydrate content.

Percentage moisture determination: Moisture was determined by the standard official methods of analysis of the AOAC and Helrich[16]. This involves drying to a constant weight at 100°C and calculating moisture as the loss in weight of the dried samples. The percentage moisture content was calculated from the equation:

$$\text{Moisture (\%)} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where:

W_1 = Initial Weight of empty curable
W_2 = Weight of crucible+sample before drying
W_3 = Final weight of crucible+sample after drying.

Percentage ash determination: Ash was determined by furnace incineration, described by AOAC and Helrich[16], using about 1.0 g of the final ground dried samples. The analytical methods are based on the vaporization of water and volatiles with burning organic substances in the presence of oxygen in the air to CO_2 at a temperature of 600°C (dry ashing). The percentage ash content was calculated as:

$$\text{Ash (\%)} = \frac{\text{Weight of ash}}{\text{Weight of original sample}} \times 100$$

Percentage crude fiber determination: Crude fiber was determined by using the methods of AOAC and Helrich[16]. The percentage crude fiber was calculated as:

$$\text{Crude fiber (\%)} = \frac{\text{Weight of after drying}}{\text{Weight of sample}} \times 100$$

Percentage fat determination: Total fat was determined using Soxhlet extraction for 4 hours, starting with methanol and ethanol, respectively[17]. The percentage fat was computed using the formula:

$$\text{Fat (\%)} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times 100$$

Determination of crude protein: Crude protein was determined by using the Micro Kjeldahl method of AOAC and Helrich[16]. These involve protein digestion and distillation.

The percentage crude protein is calculated from the % nitrogen as: Crude protein = % N×F, where F (conversion factor), is equivalent to 6.25.

Percentage carbohydrate content determination: Percentage of carbohydrate was determined by the difference method as reported by Onyeike *et al.*[18]. These methods involve adding the total values of % crude protein, lipid (%), crude fiber (%), moisture (%), and ash (%) constituents of the sample and subtracting it from 100. The value obtained is the percentage. Carbohydrate constituent of the sample. The carbohydrate (%) =100-(moisture (%)+crude fibre (%)+protein (%)+lipid (%)+ash(%)). The collected data were subjected to analysis of variance and the means were separated using the Tukey's test at 5% level of significance (Minitab version 17 software).

Statistical analysis: The data collected were subjected to analysis of variance (ANOVA), and significant means were separated using the Tukey's test at 5% level of probability with Minitab version 17 software.

RESULTS

The result for the analysis of variance for the effect of different manure sources on the growth and yield of cucumber is presented in Table 1. At $p \geq 0.01$, significant variation was recorded for Plant height at 2 WAP, Plant height at 4 WAP, Number of leaves at 6 WAP, and FR6. Similarly, significant variations were also recorded for NOL4, NOFL6, and NOFR6 at $p \leq 0.05$. The mean performance for the effect of poultry dropping, goat dropping, cow dropping and swine dropping, and no treatment (control) in Ishiagu on the growth and yield of cucumber for eleven agronomic traits at is presented in Table 2. For plant height, poultry dropping had the highest mean of 29.66, 154.22, and 211.61 cm at 2, 4, and 6 weeks after planting and were significantly different from the other treatments. Similarly, the number of leaves increases every week with poultry droppings having the highest mean value of 12.28, 74.11, and 139.17 at 2, 4, and 6 weeks after planting, respectively, while control (no treatment) gave the least mean value of 6.49, 19.28, and 41.56 at 2, 4, and 6 weeks after planting, respectively. Furthermore, poultry droppings also had the highest number of flowers at 4 and 6 weeks after planting, with a mean of 37.67 and 85.17, respectively which was significantly different from the mean value of the other treatments. The mean performance for number of fruits, ranges from 5.28 to 14.67. Poultry droppings had the highest mean value of 14.67, while cow droppings had the least mean value of 5.28. At 6 weeks after planting, poultry dropping gave the maximum mean value of 22.50 cm while control gave the least mean of 5.67 cm for fruit length. On the basis of fruit weight per se, poultry dropping had the maximum value of 320.61g, which was significantly different from the mean value of the other treatment, while goat dropping had the relative mean value of 223.67 g. Cow dung had the minimum mean value of 124.50 g.

Percentage moisture, ash, protein, crude fibre, fat, and carbohydrate content of cucumber grown using different organic manure in Ishiagu are presented in Table 3. Cucumber treated with pig dung had the highest percentage of moisture (94.71%) followed by goat dung (94.70%), while cow dung-treated cucumber had the least (93.89%). Goat dung-treated cucumbers gave the highest ash content with a mean of 0.27% and were significantly different from the other treatments at $p \leq 0.05$, while control (no treatment)

Table 1: Analysis of variance for the effect of different manure source on the growth and yield of cucumber

Source	Df	PH2	NOL2	PH4	NOL4	NOFL4	PH6	NOL6	NOFL6	NOFR6	FRL6	FRw6
Replicate	2	11	8.57	202	19.46	48.76	3169	354.6	53.35	7.63	130.87	2662.5
Treatment	4	189.35**	16.49	4653.2**	1543.51**	451.00**	4525	4854.2**	1395.01**	40.81*	148.94	14813.00**
Error	8	5.58	6.41	165	32.87	28.4	1524	176.3	54.84	3.91	87.54	455.2

*,**Significant and highly significant at 5 and 1%, respectively. 2PH: Plant height at 2 weeks after planting, 4PH: Plant height at 4 weeks after planting, 6PH: Plant height at 6weeks after planting, 2NOL: Number of leaves at 2 weeks after planting,4NOL: Number of leaves at 4 weeks after planting, 6NOL: Number of leaves at 6weeks after planting, 4NOFL: Number of flowers at 4 weeks after planting, 6NOFL: Number of flowers at 6 weeks after planting, 6NOFR: Number of fruit at 6 weeks after planting, 6FRL: Fruit length at 6 weeks after planting and FRW: Fruit weight at harvest

Table 2: Mean performance and descriptive statistics for the effect of different manure sources on the growth and yield of cucumber for eleven agronomic taits

Treatment	NOL2	PH2	PH4	NOL4	NOFL4	PH6	NOL6	NOFL6	NOFR6	FRL6	FRW
Poultry doppings	12.28^{a}	29.66^{a}	154.22^{a}	74.11^{a}	37.67^{a}	211.61^{a}	139.17^{a}	85.17^{a}	14.67^{a}	22.50^{a}	320.61^{a}
Goat doppings	8.71^{a}	16.80^{b}	104.17^{b}	35.50^{b}	20.50^{b}	165.72^{a}	9.67^{b}	51.22^{b}	9.00^{b}	13.25^{a}	223.67^{b}
Cow doppings	6.60^{a}	10.86^{bc}	62.11^{cd}	20.38^{bc}	7.01^{b}	130.50^{a}	47.00^{bc}	37.87^{b}	5.28^{b}	17.89^{a}	124.50^{c}
Control	6.49^{a}	9.62^{c}	55.83^{d}	19.28^{c}	8,93^{b}	120.03^{a}	41.56^{c}	34.67^{b}	6.17^{b}	5.67^{a}	196.64^{b}
Swine doppings	8.60^{a}	16.33^{b}	94.72^{bc}	26.78^{bc}	15.72^{b}	204.45^{a}	53.28^{bc}	34.22^{b}	7.89^{b}	13.25^{a}	214.80^{b}
Mean	8.54	16.66	94.21	35.21	17.97	170.5	72.1	48.63	8.6	13.34	216.00
SE Mean	0.8	1.98	9.84	5.55	3.18	13.8	10.1	5.4	0.99	2.72	18.06

Means in a column with the same letter(s) are not significantly different by Tukey's test, 2PH: Plant height at 2 weeks after planting, 4PH: Plant height at 4 weeks after planting, 6PH: Plant height at 6weeks after planting, 2NOL: Number of leaves at 2 weeks after planting, 4NOL: Number of leaves at 4 weeks after planting, 6NO: Number of leaves at 6weeks after planting, 4NOFL: Number of flowers at 4 weeks after planting, 6NOFL: Number of flowers at 6 weeks after planting, 6NOFR: Number of fruit at 6 weeks after planting, 6FRL: Fruit length at 6 weeks after planting and FRW: Fruit weight at harvest

Table 3: Mean performance for the nutritional composition of cucumber grown using different organic manure sources.

Treatment	Moisture content (%)	Ash (%)	Protein (%)	Crude fibre (%)	Fat (%)	Carbohydrate (%)
Control	94.66^{b}	0.16^{d}	1.29^{a}	0.80^{a}	2.14^{e}	0.95^{b}
Poultry dung	94.27^{c}	0.17^{d}	1.12^{c}	0.79^{ab}	2.31^{d}	1.33^{a}
Pig dung	94.71^{a}	0.21^{c}	1.19^{b}	0.67^{d}	2.42^{c}	0.79^{c}
Goat dung	94.70^{a}	0.27^{a}	0.98^{d}	0.78^{b}	2.51^{b}	0.75^{c}
Cow dung	93.89^{d}	0.24^{b}	1.10^{c}	0.71^{c}	2.71^{a}	1.36^{a}
Mean	94.44	0.21	1.14	0.75	2.42	1.04
St dev	0.33	0.04	0.11	0.05	0.19	0.27
CV (%)	0.35	19.57	9.18	7.07	8.09	25.77

Means that share the same alphabets are not significantly different from each other at $p \leq 0.05$ and St dev: Standard deviation

gave the least with a mean of 0.16%. The highest protein content was recorded for the control (1.29%) and was significantly different from the other treatments, while pig dung gave the relative highest (1.19%). The crude fibre increases with control (0.80%), followed by goat dung (0.78%) while it decreases with pig dung (0.67%). Cow dung treatment recorded the maximum mean of 2.71% for the percentage fat which was significantly different from the remaining four treatments. Furthermore, goat dung gave the relative highest value of 2.51% while control gave the least with 2.14%. The highest percentage carbohydrate was recorded for cow dung (1.36%) and poultry dung (1.33%) followed by control (0.95%), while the least was recorded for goat dung (0.75). The mean, standard deviation and coefficient of variations (%) are also presented in Table 3 The mean value ranges from 0.21% (Ash) to 94.44% (Moisture content). The coefficient of variation values was ≤30% which ranges from 0.35% (Moisture content) to 25.77% (Carbohydrate).

DISCUSSION

Crop development is enhanced through the application of organic manure of different types to soil. Often, their addition improves soil physical and chemical properties including pH[19]. Results from this study showed that applying poultry droppings, goat droppings, cow dung, and pig dung at 10 ton/ha significantly increased cucumber growth and yield parameters. These findings agree with earlier studies that reported improved growth and yield in cucumber with fertilizer application[19,20]. However, among all treatments, poultry manure performed best for all the traits, likely due to its high nitrogen content. This result aligns with Okee[21], showing increases in vine length, number of leaves, number of branches, leaf area and stem girth with the application of poultry manure. Furthermore, Ewulo[22] reported that poultry droppings contain a high percentage of nitrogen and phosphorus essential for healthy plant growth. The superior effectiveness and richness of poultry droppings over other manures has been confirmed in other crops as well[5,23].

Depending on the type of manure utilized, different nutritional contents were found by the proximate analysis. Fruits of *C. sativus* have a high moisture content and a comparatively high concentration of other elements. The type of fruit under analysis may be the cause of the highest proximate content noted for

percentage moisture. Aina *et al.*[24] reported that fresh fruits have high percentage of moisture. However, high moisture contents in fruit, hastens the rate of fruit damage. Furthermore, the highest protein content recorded for *Cucumis sativus* grown when no treatment was applied is not in agreement with the findings of Okereke *et al.*[25] who studied the proximate composition of cucumber grown with different organic manure. The highest carbohydrate content was observed with cow dung and poultry manure, possibly due to higher nutrient release during flowering and fruiting stages. This supports the observation that nutrient release accelerates nutrient transfer from leaves to reproductive organs[25,26]. Plant fibers are long-chain carbohydrates that the digestive enzymes in the human digestive tract cannot break down. They support the body's elimination of waste products and maintain the health of the digestive system[27]. Crude fiber content was highest in the control treatment, contrasting with findings that showed the highest crude fiber with cow dung application[25]. Similarly, Eze and Izundu[28] reported an increase in crude fibre content in tomato as the nitrogen content increases. Ash content of a plant-based food is the function of the mineral elements present in it. Ash content, which reflects mineral composition, was highest in goat dung treatment, followed by cow dung, indicating higher mineral content with these manures. This result is in agreement with Mofunanya *et al.*[19] who reported an increase in ash content with the addition of organic manure. Fat content was highest in the cow dung treatment, providing essential lipid nutrients and energy, while the lowest fat content was observed in the control.

CONCLUSION

The application of different organic manure sources significantly influenced the growth, yield, and nutritional composition of cucumber in Ishiagu. Poultry manure consistently produced superior results in terms of plant height, number of leaves, number of flowers, fruit length, fruit weight, and overall yield. Nutritional composition varied depending on manure type: Goat dung produced the highest ash content, cow dung resulted in the highest fat and carbohydrate content, and pig dung yielded the highest moisture content. The control treatment recorded the highest protein content. Poultry manure is recommended for achieving optimal growth and yield performance of cucumber in Ishiagu, while specific nutritional attributes can be enhanced through targeted use of other manure types.

SIGNIFICANCE STATEMENT

This study discovered the differential influence of various organic manure sources on the growth, yield, and nutritional qualities of cucumber, highlighting how each manure type uniquely contributes to crop performance. The findings reveal that poultry manure markedly enhances vegetative growth and yield attributes, while other manures such as pig, goat, cow, and control treatments offer specific benefits for moisture, ash, fat, protein, and carbohydrate contents, respectively. These outcomes are beneficial for farmers, agronomists, and agricultural extension agents seeking cost-effective and sustainable organic nutrient sources for cucumber production in the Eastern Region of Nigeria. This study will help researchers uncover critical areas of organic manure-crop interactions that many were not able to explore. Thus, a new theory on optimized organic nutrient management for cucumbers may be arrived at.

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