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Agronomic and Yield Performances of Cucumber [*Cucumis sativus*] on Soil Amended with Different Rates of Cattle Manure in Derived Savannah Agroecological Zone of Ondo State, Nigeria

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ABSTRACT: Most soils have experience nutrient depletion as a result of long-term farming, making good yields only possible with the application of fertilizers. A randomized complete block design (RCBD) was used to create a total of fifteen (15) plots in the study, which was conducted at the Rufus Giwa Polytechnic's Teaching Research and Commercial Farms in Owo, Ondo State, Nigeria. The study examined the impact of various rates of cattle manure on cucumber. The results revealed that the performance of cucumbers was significantly impacted by an increase in the rate of cattle manure, with 15 tha-1 of cattle manure producing the best results in terms of growth and yield (3.45cm, 73.46cm, 171.22cm2, 16.83, 9.83cm, 21.89cm, 17.19cm, and 5.14kg as stem girth, vine length, leaf area, number of leaves, number of fruits, fruit weight and fruit circumference) and the lowest from control. According to the study, applying cattle manure in the study area at a rate of 15 tha^{-1} considerably improves cucumber growth and yieldt. In order to improve the physical and chemical properties of the soil and eliminate the need to apply inorganic fertilizer, farmers in the research area are advised to amend their soils with 15 tha-1 cattle dung.
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Introduction

One of the most significant vegetables in the Cucubitaceae family, cucumber (Cucumis sativus L.) is grown for its fruit, which is a rich source of vitamins and minerals. According to Eifediyi and Remison (2010), it comes in second place to tomatoes in Western Europe and ranks fourth in Asia behind tomatoes, cabbage, and onion. However, the crop hasn't been ranked because of its sparse use in tropical Africa.

Due to its excellent nutritional and economic potential, cucumber cultivation is quickly gaining popularity throughout Nigeria (Nweke et al., 2013). This crop has numerous health advantages when consumed fresh, including important antioxidant, anti-inflammatory, and anti-cancer advantages (Mukherjee et al., 2013).

Cucumbers' fiber-rich skin, high potassium and magnesium content, and ability to assist the body excrete uric acid all serve to lower blood pressure and support nutritional processes. This is especially helpful for people with arthritis. Cucumbers' magnesium content also helps to improve blood circulation while calming nerves and muscles.

The basic soil minerals were mined via continuous farming of tropical soils without the use of soil additives; these nutrients must be replaced to stop the loss of nutrients and preserve production. Due to low soil fertility, this was typically to blame for the low yields of cucumbers observed in the tropics. Infertile soils result in bitter and deformed fruits, which are frequently rejected by consumers, in addition to low production (Eifeyidi and Remison, 2009).

According to Wang et al. (2020), organic manure has traditionally been used as a soil supplement to improve soil productivity, raise organic carbon content, microbes, crumb structure, the soil's nutritional status, and increase crop production. In addition to calcium, potassium, phosphorus, magnesium, salt, and magnesium, which are all vital for plant growth, cattle manure also contains a significant amount of nitrogen, making it a great organic fertilizer. Contrary to inorganic fertilizer, organic manure enriches the soil with organic matter, enhancing its structure, nutrient retention, aeration, capacity to hold moisture, and water infiltration (Deksissa et al., 2008). Additionally, it contains vital nutrients that are linked to high photosynthetic activity, which encourages the growth of roots and vegetables (John et al., 2004).

In view of the quest for organically produced agricultural produce, this study was therefore designed to evaluate the growth and yield responses of cucumber to different rates of cattle manure under field condition in derived savannah agro ecological of Ondo State, Nigeria.

Materials and Method

Experimental site and land preparation

The study was carried out on a total area of 104 m^2 (13 m x 8 m) at the Rufus Giwa Polytechnic's Teaching, Research, and Commercial Farms in Owo, Ondo State, which is situated between latitudes 7° 12 N and 5° 12 E in Nigeria's Tropical Rain Forest Ecological Zone. An intense rainy season and a bimodal rainfall pattern are features of the experimental site. The used area had been continuously tilled for roughly three years with no evidence of the application of either inorganic or organic fertilizer. To make the soil level and smooth to form seed beds suitable for simple germination and crop establishment, the earth was mechanically plowed and harrowed using a tractor and then ground with a shovel.

Soil Sample Analysis

Core soil samples were collected using a soil auger at a depth of 0 – 15cm from 10 different points on the experimental field before planting. The samples were bulked, air dried, and sieved through a 2mm sieve prior to analysis for physico-chemical properties. The composite samples were analyzed for pH using a 1:2 (soil:water) suspension (Maclean, 1982). Particle size distribution was determined using the hydrometer method (Gee and Bauder, 1986). Total nitrogen was evaluated by the Macro Kjeldahl method (Bremner and Mulrang, 1982) and exchangeable cations (K, Ca, Mg, and Na) after extraction with NH_4OH (pH7) using a flame photometer (Thomas, 1982). K in the filtered extract was determined using an Atomic Absorption Spectrometer (IITA, 1979; Enujeke, 2013). Available phosphorus was determined with the Bray I method (Bray and Kurtz, 1965), as modified by Olsen and Sommers (1994). Total organic carbon was determined by the Walkey Black method (Nelson and Sommers, 1982).

Source of Cattle Manure and Analysis

Manure from cattle was sourced from the teaching, research, and commercial farms at Rufus Giwa Polytechnic in Owo, Ondo State. Before use, the sample was subjected to typical routine laboratory analysis, crushed, and shade dried to assess the nutrient contents (Adesina et al., 2018).

Experimental Design and Treatments

Five treatment levels were used in the experiment, and each level was replicated three times for a total of fifteen (15) plots. The experiment was set up using a randomized complete block design (RCBD). T1 = 0tha-1 of cattle dung (used as the control), T2 = 5tha^{-1} of cattle manure, T3 = 10tha^{-1} of cattle manure, T4 = 15tha^{-1} of cattle manure, and T5 = 20tha^{-1} of cattle manure were the treatment levels. The dimensions of each block were 12 x 2 m (24 m^2), the plots were 2 2 m (four m2), and the discard between replicates and plots was 0.5 m. Two weeks before planting, the cattle dung was spread equally across the plots and worked into the soil with a hoe to promote further decomposition and nutrient release.

Crop Establishment and Management

The National Institute for Horticultural Research and Training (NIHORT), located in Ibadan, Oyo State, Nigeria, provided the cucumber seeds for the experiment (Apulia semences variety). When the first weeding exercise was performed two (2) weeks after planting, the seeds were thinned to one seedling per stand, resulting in a population of 25 plants per plot and a total plant population of 375 plants on the entire experimental site. The seeds were sown at a rate of two seeds per hole with a spacing of 50cm by 50cm between and within rows. Regular weeding was done as and when it was necessary. To manage infestations of fruit flies and foliage insect pest, insecticide (Cypermethrin) was used at the prescribed dosage of 20 ml/15 liters per knapsack sprayer.

Data Collection and Statistical Analysis

Five (5) stands per plot were randomly tagged for growth and yield parameter collection. Vine length (cm) was determined using measuring tape. The tape was used to measure the height of the plant from the level of the soil to the top of the shoot apex (Tahir *et al*., 2015). The number of leaves was determined by visually counting the number of leaves per plant (Edegbai and Oki, 2022). Stem girth was determined using measuring tape by putting the tape around the stem of the plant (Tahir *et al*., 2015). Leaf area (cm^2) was determined by placing the leaf on graph paper. Yield attributes were determined by counting the number of cucumber fruits per plant, and the weight of harvested fruit (kg) was determined by weighing using a digital weighing balance. Fruit length (cm) was determined using measuring tape to measure the length of the fruit from the base to the tip, while fruit circumference (cm) was determined by putting the measuring tape around the fruit. Data collected were subjected to two-way analysis of variance (ANOVA) procedures for Randomized Complete Block Design (RCBD) using the SAS statistical package Version 9 ((SAS Institute, 2010) and means were compared at 5% using the Duncan Multiple Range Test (DMRT).

RESULTS

Initial Physio-Chemical Properties of Soil and Manure Analysis

Table 1 shows the physio-chemical characteristics of the soil (0–30 cm depth) in the experiment field prior to planting and the findings of the examination of the cattle dung. The outcome revealed that the sandy loam soil textural categorization was acidic in nature (4.24). Organic matter (0.65 kg), accessible P (0.45 mg/kg), and total nitrogen (0.14%) were all at low levels. Additionally, very little was present for the exchangeable cations Na (0.96 comkg-1), Ca (1.70 comkg-1), K (0.392 comkg-1), and Mg (6.80 comkg-1).

The study of the cattle dung revealed that it had 13.86% organic carbon, 6.36% pH, 23.904% organic matter, 0.35% total nitrogen, 0.406 mg/kg of accessible phosphorus, and exchangeable cations of 54.615 mg/kg of K, 3.913 mg/kg of Na, 3.30 mg/kg of Ca, and 6.90 mg/kg of Mg.

Table 2 shows the analysis of the impacts of cattle manure on the physio-chemical characteristics of the soil revealed that these properties—soil organic matter, total nitrogen, accessible P, total carbon, exchangeable Ca, and Mg—were only slightly elevated. With the application of cattle dung, soil pH tends to rise.

Table 1: Soil Physical and Chemical Properties before Planting and Manure Analysis

Soil	Pre-cropping	Post cropping	Cattle Manure	Value
Sand (%)	70	72.76	pH (H_20)	6.36
Silt (%)	6.8	3.64	O.C (%)	13.87
Clay (%)	23.2	23.60	O.M (%)	23.90
Textural class	Sandy loam	Sandy loam	N (mg/kg)	0.35
Soil PH (H_2O)	4.24	6.40	K (mg/kg)	54.62
Organic Carbon (%)	0.38	0.64	Na (mg/kg)	3.91
Organic Matter	0.65	1.09	Ca (mg/kg)	3.30
Total Nitrogen (%)	0.14	0.16	Mg (mg/kg)	6.90
Available P (mg/kg)	0.45	19.95	Av. P (mg/kg)	0.41
Exchangeable cation				
Na (com/kg)	0.96	0.49		
Ca (com/kg)	1.70	2.20		
K (com/kg)	0.39	0.30		
Mg (com/kg)	6.80	1.40		

Effect of Cattle Manure on Vegetative Growth Parameters of Cucumber

According to result in Table 2, vegetative growth of cucumber is considerably (P > 0.05) influenced by the varied rates of cattle manure. The growth characteristics responded favorably to rising manure application rates. The development of stem girth ranged from 1.02 to 3.45 cm, with the thinnest girth (1.02 cm) being measured at T1 and the greatest girth (4.21) at T4. There was no discernible change between the stem girth of T1 and T2 (P > 0.05). However, there was a significant difference between T3 (2.79cm) and T5 (4.21cm) (P 0.05).

T4 had the longest vines (76.03 cm), whereas T1 had the shortest (57.87 cm). The length of the cucumber vine varied significantly across all treatments (P 0.05). Even so, a statistical comparison of the cucumber vine length in T4 and T5 reveals no appreciable variation (P > 0.05). All of the treatments had significantly varied leaf areas (P 0.05), with T4 producing the broadest (195 cm2) and T1 producing the smallest (149.35 cm2) leaves. The number of leaves generated varies depending on the amount of cattle manure applied; T4 reported the largest number of leaves (22.49) and T1 the lowest (12.50). However, there was no noticeable difference generated (P > 0.05) between T1 (12.50) and T2 in terms of the quantity of leaves (Table 2).

Table 2: Effect of Varying Rates of Cattle Manure on the Vegetative Growth of Cucumber

Treatments	Vine Girth (cm)	Vine Length (cm)	Leaf Area (cm^2)	Number of Leaves
T_1 (0tha^{-1})	1.02^a	57.87^a	149.35^a	12.50^a
T_2 (5tha^{-1})	1.45^a	64.78^{ab}	158.68^b	13.79^a
T_3 (10tha^{-1})	2.79^b	69.03^b	156.68^{ab}	16.24^{ab}
T_4 (15tha^{-1})	4.21^c	76.03^c	195.38^d	22.49^b
T_5 (20tha^{-1})	3.45^{cb}	73.46^{bc}	171.22^c	16.83^{ab}

*Means with the same superscript in a column are not significantly different (P>0.05).

Table 3: Effect of Varying Rates of Cattle Manure on the Yield of Cucumber

Treatments	Number of Fruits	Fruit Circumference (cm)	Fruit Length (cm)	Fruit Weight (Kg)
T_1 (0tha^{-1})	2.33^{a}	14.27^{a}	7.68^{a}	0.32^{a}
T_2 (5tha^{-1})	5.17^{ab}	15.62^{a}	9.52^{a}	0.80^{a}
T_3 (10tha^{-1})	6.50^{ab}	15.49^{a}	14.86^{c}	1.22^{a}
T_4 (15tha^{-1})	9.83^{b}	21.89^{c}	17.19^{d}	5.14^{c}
T_5 (20tha^{-1})	7.00^{ab}	16.41^{ab}	12.69^{bc}	3.21^{b}

*Means with the same superscript in a column are not significantly different (P>0.05).

According to result in Table 3 yield attributes for cucumbers grown in the study area after various rates of cattle manure application, T1 produced the fewest fruits (2.33), while T4 produced the most (9.83). However, there was no statistically significant difference in the number of fruits taken from T2 (5.17), T3 (6.50), and T5 (7.00) ($P > 0.05$). The fruit's circumference ranged from 14.27 cm in treatment T1 to 17.19 cm in treatment T4. The fruit circumference in T1, T2, and T3, however, was not significantly influenced by the rates of animal manure. The length of cucumber fruits obviously varies with the amount of cattle manure applied, with T4 producing the longest fruits (17.19 cm) and T1 producing the smallest (7.68 cm). Although it was observed that treatments T1 and T2 had no effect on fruit length, T4 recorded the lowest fruit weight (0.32kg), and treatments T1 and T2 had the highest (5.14kg). While T4 and T5 considerably influenced the fruit weight, the weight of the fruit recorded at T1, T2, and T3 was found not to be significantly inclined ($P > 0.05$) to the application of cattle manure.

Discussion

The majority of the vital plant nutrients were insufficient in the experimental soil, suggesting that the soil lacks the fundamental elements needed for good crop growth and output. According to Adesina et al. (2018), the low soil fertility was caused by extensive and continuous cropping without any documented soil amendment methods to maintain its productivity. Soil fertility needs to be increased by the use of fertilizers in order to sustainably cultivate crops. The majority of soil physiochemical properties, such as soil structure, consistency, porosity, water binding potency, soil fertility, lower soil acidity, and also maintain the soil's biological balance, would be improved by the presence of essential plant nutrients in the cattle manure in a significant amount (Atmojo, 2003).

A lack of crucial nutrients may be the cause of the cucumber's poor performance in control plots when compared to those receiving cattle manure, which led to low yield and poor vegetative growth. The growth and output of cucumbers significantly increased when the rates of cattle dung were increased. The linear relationship between increases in cattle manure rates and vegetative growth and yield may be explained by the increased availability of nutrients that are more easily absorbed by the plants, resulting in increased production of photosynthates and efficient translocation for the development of the vegetative and reproductive parts, which in turn leads to higher fruit yields. This backs up the conclusions reached by Anjad et al. (2003) and Adesina et al. (2008), who believed that the usage of organic fertilizer improved the performance of maize and okra, respectively, in the treated plots compared to the untreated plots.

Due to the residual nutrient content of the soil being unsuitable for supporting cucumber plant growth, treatment 0 t ha^{-1} (i.e., without cattle manure) could not support the proper growth of the plants. This resulted in the plants producing shorter vine length (Hamma et al., 2012) and poor crop performance. However, plants that received 20 t ha^{-1} of cattle manure provided sufficient nutrients to maintain the test plant's proper nutrition and growth. As a result, the crop has grown and developed more due to these plants' capacity for photosynthetic growth, resulting in the creation of longer vines per plant.

The maximum mean was found at T4 (15 tha^{-1}), while the lowest mean was found at 0 t ha^{-1} (i.e., without cattle manure). There was a substantial difference in vegetative growth between the various rates of cattle manure. The lowest mean recorded in the 0 t ha^{-1} could be attributed to the fact that it could not support appropriate plant growth because the soil's residual nutrient content was inappropriate to support cucumber growth; likely, the nutrient content of the soil was below the critical level, which resulted in poor crop performance. In other words, the more nutrients added to the soil, the more leaves, vine length, vine girth, and leaf area there recorded. This outcome is in line with observations made by Ikeh et al. (2012), Hamma et al. (2012), Musara, and Chitamba (2014), who found that cucumbers grown in soil that had been supplemented with manure had the highest growth parameters.

The role that cattle manure played in improving soil nutrients, physical and chemical conditions, water holding capacity, soil structure, and increased microbial activities in the soil could be attributed to the significant improvement in growth attributes and yield parameters such as vine length, leaf area index, vine girth, number of leaves, fruit circumference, fruit length, number of fruits, and fruit weight. These improvements in turn led to an increase in growth rate and yield. As an organic component of the soil, cow dung helps to improve soil texture and bind water so that plant roots may more easily absorb nutrients. The conclusions of this study were consistent with those of Fefiani and Barus (2014), who found that cow manure significantly increased the length of the plant and the number of leaves on cucumbers. They were also in line with Ako's (1997) claim that cow manure could increase the leaf area index in the growth of sorghum plants.

The availability of better nutrients, improved plant growth, and increased leaf production as a result of the positive effects of cattle manure on the physical and chemical properties of the soil may have made it possible for cucumber fruit yield attributes to significantly increase. Nevertheless, in spite of the obvious correlation between the rate of improvement in cucumber growth and the rate of application of cattle manure. The cucumber's performance started to deteriorate at T5 (20 tha^{-1}), which contradicted earlier research from Enujeke (2013) and Musara and Chitamba (2014) that claimed cucumber plants that received 20 t ha-1 of poultry manure experienced greater vegetative growth and fruit mass.

Due to the experimental site's poor soil fertility, the application of cattle dung had a considerable advantage over the control treatment. According to Ndaeyo et al. (2005), nutrient reserve in the soil influences crop response to fertilizer application. Crops respond more favorably to fertilizer application in soil with very low nutrient content than in soil with substantial nutrient reserve.

Conclusion

According to the current study, applying cattle manure greatly enhances cucumber growth and productivity. Therefore, it is crucial that farmers in the research region amend their soils with 15 tha^{-1} cattle manure in order to get a higher fruit production. This would significantly reduce over dependence on inorganic fertilizer for crop production and the amount of environmental pollution brought on by the disposal of livestock dung, which is typically thought of as a waste product in livestock enterprises would be significantly reduced.

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