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Effect of Different Rates of Goat Manure on the Performance of Cucumber [*Cucumis sativus*] and Soil Chemical Properties in Southwestern Nigeria

Eleduma, A. F.

Department of Agricultural Technology, Rufus Giwa Polytechnic,
P. M. B. 1019, Owo, Ondo State, Nigeria

Abstract: This study evaluated the effect of varying rates of goat manure on cucumber. The study was carried out at the Teaching Research and Commercial Farms, Rufus Giwa Polytechnic, Owo, Ondo State (latitude 7°12'N and longitude 5°12'E) during the rainy season of 2016 (May – July). The experiment followed a randomized complete block design (RCBD) at four (4) treatment levels and control with each replicated three (3) times to give a total of fifteen (15) plots. Each block measured 12m × 2m (24m^2) while plots measured 2m × 2m (4m^2) each and the discard between replicates and plots was 0.5m. The total area of the experimental site was 13m and 8m (104m^2). Treatment rates applied were 5, 10, 15 and 20tha^{-1} of goat manure and control at 0kg. The control gave the lowest growth and yield parameters with 1.19, 43.58cm, 105.28cm^2, 9.67, 1.50, 8.40cm, 8.04cm and 0.31kg as stem girth, vine length, leaf area, number of fruits, fruit circumference, fruit length and fruit weight respectively as results result while best results in terms of growth and yield were obtained from plots treated with 2.0kg of goat manure had 2.76cm, 63.43cm, 118.19cm^2, 12.50, 4.17, 11.56cm, 12.01cm and 1.55kg as stem girth, vine length, leaf area, number of leaves, number of fruits, fruit circumference, fruit length and fruit weight respectively. The result of the study showed that the application of goat manure at the rate of 20tha^{-1} would provide the best result in terms of growth and yield of cucumber in the study area.
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Keywords: Effect; Different; Rate; Goat; Manure; Cucumber; *Cucumis sativus*; Nigeria

Introduction

Cucumber (*Cucumis sativus* L.) is one of the ancient vegetable crops indigenous to Africa and Asia cultivated for its freshly consumed fruit (Dilson 2002; Okonmah, 2011). Cucumber fruits are highly nutritious and medicinal, apart from containing carbohydrates, proteins, fibres, vitamins and minerals. Matured fruits comprise of wide range of enzymes that aid digestion and assimilation of fatty and protein constituents. The mineral salt constituents have alkaline properties, hence facilitating the neutralisation of blood fluid acidity, softening kidney stones, and increasing urine production. It is believed to be highly beneficial for treating both high and low blood pressure (Chadha, 2006; Kashif *et al*., 2008). While Mukherjee et al. (2012) reported that fruits possess antioxidant, anti-inflammatory, and anti-cancer.

Cucumber cultivation in Nigeria, has greatly multiplied in the last 10 years due to its potential nutritional and medicinal value, economic returns influenced by increased market demand and early maturity duration (Sanni et al., 2021) with the major areas of cultivation found in the Sudan and Guinea Savannah agro-ecological zones. However, in recent times, its cultivation has been pushed down to the rainforest ecological zone of South Western and South Eastern Nigeria (Ekwu, 2018). Despite the increasing relevance of cucumber in Nigeria owing to its nutritional and medicinal values, still, this crop is still low in productivity as low yields are obtained in farmers' fields because of declining soil fertility due to continuous cropping and disregard for soil amendment materials (Ayotamuno *et al*., 2007; Enujeke, 2013).

Generally, farmers rely on the use of inorganic fertilizers to improve soil fertility and enhance crop growth and yield but its utilization has been observed to destroy soil texture and structure which often leads to soil erosion, and acidity as a result of leaching effects of mineral nutrients (Ojeniyi, 2000). All these gave rise to reduced crop yields as a result of soil degradation and nutrient imbalance (Ojeniyi, 2000). The use of organic manures has been recommended for long-term cropping in the tropics as slow mineralization of these manures promotes crop yield for a long period (Gambo *et al*., 2008). Also, organic manure sustains cropping systems through better nutrient recycling and improvement in soil physical, chemical and biological properties (Ojeniyi, 2000). In light of the foregoing, this

experiment was conducted to study the effects of goat manure on the performances of cucumbers in the tropical rainforest south southwestern Nigeria.

Materials and Methods

Research location, land preparation and design

The research was arranged in a Randomized Complete Block Design (RCBD) on 13m × 8m (104m^2) area of land using four (4) treatment levels and control (0 kg) replicated three (3) times to give a total of fifteen (15) plots at the Horticultural Section, Teaching, Research and Commercial Farms of Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria, situated in the Tropical Rain Forest zone of Nigeria (latitude 7°12'N and longitude 5°12'E).

The experimental site has been subjected to over three years of uninterrupted maize/cassava farming with no history of either organic or inorganic fertilizer application and the land was dominated by some common weeds such as *Tridax procumbens, Euphobia hirta, E. heterophylla, Imperata cylindrical*. The land was manually cleared with a cutlass, thrash and burnt. Afterwards, was divided into three (3) blocks of 12 × 2m (24m^2) each with a discard of 0.5m between each plot to allow for ease of farm operations. Each experimental plot measured 2 × 2m (4m^2) giving a total of 15 plots. The soil was tilled with hand hoes to prepare seedbeds for planting.

Soil Sample Collection and Analysis

Soil samples were collected at different spots using soil auger from the experimental site before land preparation at a depth of 0- 15 cm for physiochemical properties analysis. The samples were bulked together to form a composite sample and air-dried. The air-dried samples were passed through a 2mm mesh sieve before analysis following routine laboratory procedures. The particle size analysis was done by using the hydrometer method (Gee and Bauder, 1986). Soil pH was determined using 1:2 soil distilled water suspension using a pH meter (Summer, 1994). Available phosphorus was estimated by the Bray and Kurtz No.1 method as modified by Schmidt et al. (2004). Percentage organic matter was derived by multiplying % organic carbon by the Broadbent factor of 1.72 following the Walkley-Black method (Nelson and Somners 1996). Total N was determined by the Macro-Kjeldahl method of Bremner and Mulvaney (1982), while exchangeable bases (Na, K, Ca, Mg) were extracted with 1N solution of NH_4OA buffered at pH 7.0 and read directly using a flame photometer (Thomas, 1982).

Goat manure application

Well-decomposed goat manure with no visible straw and sand was collected from goat farmers in Owo, Ondo State, Nigeria. A sample of the goat manure was bulked, air-dried, crushed and subjected to routine laboratory standard procedures to determine its chemical constituents before application. The manure was evenly spread on the soil surface in each experimental plot according to their application rates and then integrated into the soil at a depth of 5 cm within the plots using hoes, two (2) weeks before planting to promote breakdown, mineralization and nutrient release for cucumber plant use. Treatment levels were; T_1 = 0tha^{-1} Goat Manure (Natural fertility in the soil was used as the 0% manure in the control treatment), T_2 = 5tha^{-1} Goat Manure (GM), T_3 = 10tha^{-1} GM, T_4 = 15tha^{-1} GM and T_5 = 20tha^{-1} GM.

Crop establishment and cultural practices

Apulia semences cucumber seeds variety used for the study was purchased from Let Farm Agro Service a reputable agro input dealer in Akure, Ondo, State, Nigeria. The seeds were propagated at a spacing of 50cm × 50cm between and within rows with two (2) seeds per hole and later thinned to one vigorous seedling per stand at two (2) weeks after planting (WAP) when the first manual weeding exercise was carried out to avert competition with the plant. Thereafter, was done weekly by handpicking. While staking was carried out, four (4) WAP and synthetic insecticides were applied when necessary to control foliage insect pest infestation.

Data Collection and Statistical Analysis

Five plants per plot were randomly labelled and dedicated for growth and yield parameters data collection. Growth parameters were collected at 8 WAP. The growth parameter was calculated for each by dividing the sum by their number (Al-Fehaid et al., 2022).

- Vine length (cm) was determined by measuring the length of the plant from the soil surface to the top of the terminal growing point using measuring tape (Tahir *et al*., 2015).
- Stem girth (cm) was measured by putting measuring tape around the stem of the plant about 5cm above the ground/soil level (Tahir *et al*., 2015).
- Number of leaves: This was done by visually counting the number of leaves on every tagged plant in the plot (**Salisu, 2018**).
- Leaf area (cm^2): This involved the measurement of the length and the breadth of the leaves multiplied by the leaf coefficient (Okee et al., 2020).

The yield parameters were collected from 10 WAP and for three picks. The yield parameters were calculated by dividing the sum of each variable by the number of fruits in the experimental plot (Al-Fehaid et al., 2022).

- Number of fruits, this was done by counting all the harvested fruit from each plot.
- Fruit length (cm): this involved the measurement of the length of the fruits from the base to the tip of the fruit using a measuring tape.

- Fruit diameter (cm), this involved the measurement of the fresh fruits after harvest with the aid of a Vernier caliper.
- Fruit fresh weight (g), this involved weighing cucumber fruit after harvesting by the use of a digital sensitive balance scale.

All data collected were subjected to one-way Analysis of Variance (ANOVA) procedures for Randomized Complete Block Design (RCBD) as described by Gomez and Gomez (1984). Duncan Multiple Range Test (DMRT) was used to compare the significant treatment means at a 5 % ($P \leq 0.05$) level of significance using the SAS statistical analysis (SAS, 2004).

Results

Physio-Chemical Properties of Soil and Manure Analysis Prior Cropping

The physio-chemical properties of the soil (0 – 30cm depth) of the experiment field before planting in 2016 and the goat manure analysis result were presented in Table 1 and 2 respectively. The result of the soil analysis was presented in (Table 1). The result of the soil analysis showed that the soil had a sand fraction of the surface at 78%, followed by clay at 17.2% and silt at 4.8%, the soil textural classification was sandy loam. It was well aerated for easy penetration of roots. The result of the soil pH showed that the soil was acidic with a pH value of 4.24. Total nitrogen was low at 0.14 (0.14kg), and the organic matter was quite low at 0.653 (0.65kg), the low total Nitrogen could also be caused by the low organic matter of about 51% of total organic nitrogen in the soil (Haan**,** 2001). The available P was low at 0.45 mg/kg, this may be attributed to the low fixation of P in the experimental site by parent materials. The exchangeable cation in com/kg level is very low of Na 0.956 cooking-1, Ca 1.70 cooking-1, K 0.39 $comkg^{-1}$ and mg 6.80 $comkg^{-1}$ respectively. Therefore, it will not be able to produce high crop yield without the addition of external input. The goat manure analysis result shows that it had organic carbon of 13.97%, pH of 6.26%, Organic matter of 24.08% total nitrogen level of 0.31%, available phosphorus of 0.35mg/kg^{-1}, exchangeable cation was K, 62.56mg/kg^{-1}, Na 4.78mg/kg^{-1}, Ca 2.90mg/kg^{-1}, Mg 6.10mg/kg^{-1}. Gulshan *et al*., (2013) recommended that the farmers of developing countries must be used to the application of animal manure in their fields to fulfil the deficiency of mineral nutrition in the soil. Thus, by the application of these, local manure farmers will obtain good quality and quantity of yields of their crops, vegetables and fruits. Moreover, economic and energy stresses being experienced across the global population have made synthetic fertilizers beyond the bought capacity of the farmers of Third World countries. With the growing of organic vegetables as a rapidly growing enterprise, the amendment of the soil of the study area with goat manure would be a good option.

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

Soil	Before planting	Post planting
Sand (%)	78	66.76
Silt (%)	4.8	5.64
Clay (%)	17.2	27.6
Textural class	Sandy loam	Sandy loam
Soil pH (H_2O)	4.24	6.00
Organic Carbon (%)	0.38	0.34
Organic Matter	0.65	0.58
Total Nitrogen	0.14	0.18
Available P (mg/kg)	0.45	21.49
Exchangeable cation		
Na (com/kg)	0.96	0.23
Ca (com/kg)	1.70	3.30
K (com/kg)	0.392	0.22
Mg (com/kg)	6.80	0.50
CEC	5.06	6.61

Effect of Goat Manure on Soil Chemical Properties at the End of the Experiment

The effects of goat manure on the physio-chemical properties of the soil are shown in (Table 1) below. Goat manure increased soil organic matter, Total Nitrogen, available P, total carbon, exchangeable Ca, and Mg significantly. However, exchangeable cation K was decreased by the application of goat manure. Soil pH tends to increase with goat manure application. The increase in the organic matter of the experimental plots is in agreement with the findings of Adrien (2006) who reported that the application of organic manures significantly increased levels of organic C and N and the formation of water-stable aggregates. The increase in EC of soil might occur due to more solubilization of fixed nutrients. Yaduvanshi (2001) postulated the increase in available nutrients with vermicompost or FYM application due to the mineralization of nutrients from organic manures in soil. While, Sharma *et al.* (2004) and Sharma *et al*., (2009) observed improvement in the availability of all essential plant nutrients during the crop period in soil with the use of organic manures. Sreenivas *et al.* (2000) recorded that the use of organic manure improves the overall soil health, nutrient reaction and availability.

The findings from this study indicate that an increase in the application of organic manure helps the soil to release these nutrients in large quantities for plant absorption (Smith and Ayenigbara, 2001). Thus, the improvements in soil parameters lead to a significant increase in crop growth and obtainable yield (Adedrian *et al.*, 2003, Anukworji *et al.* 2012).

Table 2: Nutrient Composition of used Goat Manure

Goat Manure	Value
pH (H_20)	6.26
O.C (%)	13.965
O.M (%)	24.076
N (mg/kg)	0.31
K (mg/kg)	62.564
Na (mg/kg)	4.782
Ca (mg/kg)	2.90
Mg (mg/kg)	6.10
Available P (mg/kg)	0.346

Effect of Varying Rate of Goat Manure on the Growth Performance of Cucumber

The goat manure increased the growth of cucumber in the study area at an increasing rate (Table 3). The lowest values were recorded in the control while the highest values were recorded at T_5 (2.0kg/plot). The values recorded for stem girth at T_1 (1.19cm), T_2 (1.45cm) and T_3 (1.98cm) were not significantly different (P>0.05), same for stem girth at T_4 (2.45cm) and T_5 (2.76cm). The vine length at T_2 (55.42cm), T_3 (56.98cm) and T_4 (56.43cm) were not significantly different (P>0.05). The leaf area development was not significantly different likewise the number of leaves at T_1 (9.67), T_2 (10.92) and T_3 (11.58).

The result of this study shows that goat manure can significantly increase growth, and yield. The result of this study is similar to Usman, (2015) who reported that the application of goat manure increased the growth of tomatoes. In a related development Sanni and Adenubi, (2015) reported that okra responded well to goat manure at the rate of $5tha^{-1}$. The result of this study also confirms the submission of Sanni and Adenubi, (2015) that the application of goat manure will improve soil organic matter, nutrient availability and yield at a rate of $5tha^{-1}$. The significant increases in cucumber vine length and vine girth in cucumber grown in goat manure-amended plots compared to control are necessary for competition and crop survival as opined by Akanda *et al*. (2010). This translates to mean that the longer the vine length, the higher the number of leaves produced by the cucumber also shows that it will support photosynthesis activity and high crop yield. The improved vegetative growth obtained in the cucumber from the goat manure plots may be due to an increase in the activity of enzymes like chitinases and proteases present in the manure which break down the organic-rich compounds and stimulate plant nutrient uptake and metabolism increasing plant growth.

Table 3: Effect of Varying Rate of Goat Manure on the Growth of Cucumber

Treatments	Stem Girth (cm)	Vine Length (cm)	Leaf Area (cm^2)	Number of Leaves
T_1 ($0tha^{-1}$)	1. 19^a	43.58^a	105.28^a	9.67^a
T_2 ($5tha^{-1}$)	1.45^a	55.42^b	112.22^a	10.92^a
T_3 ($10tha^{-1}$)	1.98^a	56.98^b	115.02^{ab}	11.58^a
T_4 ($15tha^{-1}$)	2.45^{ab}	56.43^b	116.80^{ab}	12.17^{ab}
T_5 ($20tha^{-1}$)	2.76^{ab}	63.43^c	118.19^{ab}	12.50^{ab}

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

Effect of Varying Rates of Goat Manure on the Yield of Cucumber

The goat manure in terms of yield produced results similar to those obtained in growth (Table 4). The growth parameters increased as the application rate increased with the lowest values at T_1 (control) and the highest at T_5 (2.0kg/plot). The number of fruits in the control, T_2 and T_3 were not significantly different (P>0.05). The circumference of fruits at T_1 (8.40cm) and T_2 (8.59cm) were not significantly different (P>0.05). The least fruit length was recorded at the control and was not significantly different (P>0.05) from the fruit lengths recorded at T_2 (0.5kg/plot) and T_3 (1.0kg/plot). The fruit weight was not significantly different (P>0.05), except for T_5 (1.55kg) where there was a slight significant difference (P<0.05). The results obtained in the present study are in line with the findings of Premshekar and Rajashree (2009) in which higher crop yield was achieved in response 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 (Dudhat *et al*., 1997).

Table 4: Effect of Varying Rates of Goat Manure on the Yield of Cucumber

Treatments	Number of Fruits	Fruit Circumference (cm)	Fruit Length (cm)	Fruit Weight (Kg)
T_1 (0tha^{-1})	1.50^{a}	8.40^{a}	8.04^{a}	0.31^{a}
T_2 (5tha^{-1})	1.67^{a}	8.59^{a}	8.21^{a}	0.48^{a}
T_3 (10tha^{-1})	2.33^{a}	10.54^{ab}	9.75^{a}	0.61^{a}
T_4 (15tha^{-1})	3.01^{b}	10.98^{ab}	11.17^{ab}	0.89^{a}
T_5 (20tha^{-1})	4.17^{b}	11.56^{ab}	12.01^{ab}	1.55^{ab}

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

Conclusion

The amendment of the soil with an organic source of nutrients is imperative with the decline of the soil nutrients of the study area. The amendment of the soil with goat manure at a rate of 5tha^{-1} would increase the production of cucumber in the study area in terms of growth, yield and production as the results of this study showed that 2.0kg of goat manure per plot (i.e. 20tha^{-1}) provided best results. The application of goat manure at a rate of 20tha^{-1} in the study area is recommended for enhanced growth and yield of cucumber in the study area.

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