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RESEARCH ARTICLE

EFFECT OF CATTLE DUNG RATES ON SOIL PHYSICOCHEMICAL PROPERTIES, MICROBIAL GROUP AND YIELD OF CUCUMBER (CUCUMIS SATIVUS L.) IN IFITE OGWARI, SOUTHEASTERN, NIGERIA

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ABSTRACT

Application of animal manures is considered to be an efficient technique to increase soil fertility and crop yield. A field experiment was conducted in the Teaching and Research Farm, Department of Soil Science and Land Resource Management, Faculty of Agriculture, Nnamdi Azikiwe University, Ifite-Ogwari to evaluate the impact of different rates of cattle dung on soil physicochemical properties and yield of cucumber. Treatment consisted of cattle dung at 0t/ha CD, 5t/ha CD, 10t/ha CD, 15t/ha CD, and 20 t/ha CD. Randomized complete block design with four replications was followed. Plant morphological characteristics such as vine length and number of leaves were recorded at second, fourth, and sixth weeks after planting. Number of fruits, fruit size (length and width), and fresh weight of fruits were recorded at maturity. Soil samples were collected before and 12 weeks after incorporation of organic matter and analyzed for particle size distribution (% sand, silt, and clay), bulk density, total porosity, moisture content, and various chemical properties such as pH, total nitrogen, available phosphorus, organic carbon, exchangeable bases, and acidity. The data collected from the field and laboratory were subjected to analysis of variance using GenStat. Separation of the means was done using least difference (LSD) at 5% probability level. The results showed that the plot that received 20 t/ha CD had higher values for some physical properties parameters such as bulk density, total porosity, and moisture content. It also had higher values for some chemical properties such as pH, available phosphorus, total nitrogen, Mg2+, and base saturation. In contrast, 15 t/ha CD had higher values for organic carbon, basic cations such as Ca2+ and K+, and CEC. The control had higher values for Na+. The use of 20 t/ha CD had higher values for the number of leaves, length of the vine, number of fruits, fresh fruit weight, length, width of fruit, and also for the microbial population on the soil.

KEYWORDS

Cattle dung, Organic manure, Soil physicochemical properties, Microbial population, Cucumber yield

1. INTRODUCTION

Cattle dung is a significant organic resource. It is rich in buffering power. Hence, it is used in regulating the acidity of the soil, improving the infiltration rate of the soil, etc. (Franklin, 2014). It increases the carbon content in the soil. This may result in the increased activity of the beneficial microorganisms present in the soil (Manas, 2014). Cucumber, according to Collen and James (2014), responds well to organic fertilizers, preferably cattle dung. However, for the farmer to get the maximum benefit from the manure, it is necessary that it is applied in the right amount and frequency to a specific soil type (Pahla et al., 2013). The use of the above organic sources of nutrients for plant production has been found to have a positive impact on the productivity of the soil, as reported by several researchers (Luka and Arunah, 2021; Nnabude et al., 2000; Nweke et al., 2014). New high-yielding varieties of cucumbers are continuously being released, but the farmer's yields are continuously falling. The release of new varieties of cucumbers has not been accompanied by the nutrient requirements of the plant and the farming systems. Besides, most of the Nigerian farmers are resource poor, and their population is growing at a rate of 3.26%. This has led to increased cultivation of the land, resulting in soil fertility problems. The use of cattle dung is a major source of nutrients for replenishing and improving soil productiveness to increase crop yields.

Cucumbers (Cucumis sativus) are nutrients-rich crops that are highly medicinal; thus, they are widely used as ingredients in culinary vegetables as well as in cosmetic industries worldwide. It is rich in vitamins, minerals, and contains 96% water. Hence, it is used in dehydration, weight loss, controlling blood sugar levels, improving bowel movements, etc. (Rachael, 2017). For improving the quality and quantity of the yield, it is necessary to have a sufficient quantity of nutrients present in the plants. These nutrients are available through organic means. These organic means are available through the implementation of ecologically based pest control measures, biological fertilizers, etc., which are chemical-free and have a high decomposing power (Roland & Adamchak, 2008).

Crop production largely depends on soil properties, and efficient nutrient management is critical in attaining sustainable crop productivity. The limitation of effective nutrient supply is controlled by organic matter content in addition to physical and chemical properties of the soil (Warman, 1981; Chan et al., 2003). The organic content of soils is a major factor that is important for the maintenance of soil productivity; thus, organic wastes can be employed to increase organic content in soils (Nwaiwu et al., 2025). Organic content is important to soils as it holds soil particles together as aggregates, thus enhancing the water-holding capacity of soils, especially in sandy and loamy soils. Organic content also enhances the permeability of soils to water, thus enhancing the cation

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exchange capacity of soils. Organic content is important as it enhances the pH of soils. Moreover, organic content enhances the formation of metal-organic matter complexes, thus enhancing the availability of micronutrients such as Fe, Mn, Cu, and Zn during the vegetation season (Ikeh et al., 2012). The organic wastes' benefits for maintenance of soil fertility are related to its effect on nutrients availability, water retention capacity, and soil structure. Organic nutrients are a major source of micronutrients as well as some secondary nutrients such as (S, Mg, Fe, Cu Chan et al., 2003).

This study is significant to agricultural research aimed at ensuring food security through increased production of cucumbers using less expensive resources such as cattle dung. This will help farmers understand how much cattle dung is required to increase yields for a given amount of cucumbers. This study will improve and amend soil productiveness. To extension workers, this study is significant in that more knowledge will be acquired to help them advise farmers on how to use cattle dung as a fertilizer. This study will help researchers be stimulated on how to manipulate organic fertilizers and scholars carrying out related research will be able to use this study as literature. This study is aimed at evaluating the comparative effect of cattle dung rates on soil physical and chemical properties, microbial populations, and yield of cucumbers in Ifite-ogwari.

2. Materials And Methods.

2.1 Description of Site

The field experiment was carried out at the experimental research Farm of Soil Science and Land Resources Management, Faculty of Agriculture, Nnamdi Azikiwe University, Ifite-Ogwari in Ayamelum local government area, Anambra State. The location of the experimental site is at a latitude of 6°36'27" and longitude 6°57'23". The soil type in this location is generally sandy with accumulation of clay and gravel in most subsurface horizon and moderately to imperfectly drained (Nnabuihe et al., 2023).

2.2 Experimental design and field layout

The experimental design was arranged in a Randomized Complete Block Design with four (4) replications. The treatment consists of the five rates of cattle dung. Treatment consists of five rates of cattle dung, namely, (0 t/ha-Control), (5 t/ha), (10t/ha), (15 t/ha), and (20t/ha).

2.3 Materials and Sources

The cattle dung used in this experiment was sourced from a cattle ranch in Ifite-ogwari in Ayamelum Local Government Area, Anambra State. The cucumber variety used in this experiment is darina and was purchased from a reliable seed company, Seminis. Irrigation is done if there is little or no rainfall.

2.4 Land preparation

The area of 66.5m^2 was cleared, tilled, and pulverized to ensure that the soil is properly mixed. After that, wooden pegs were used to map out the experimental plot of 1 m by 1.5 m, leaving a furrow of 0.5 m.

2.5 Treatment Application

The experiment design and layout were applied to the experimental plot. The experiment design and layout were applied to the experimental plot by broadcasting and then mixing with the soil. Two weeks interval were given before sowing to allow for the decomposition and mineralization of nutrients in the cattle dung. Two cucumber seeds were sown per hole at 10 inches spacing across and between rows. Cucumber plant was staked 14 days after emergence with the help of bamboo stick and twine. Weeding practice was conducted manually using hoe at regular intervals, most often every 2 weeks, to minimize competition between the crops.

2.6 Pre and Post Crops Soil Sampling and Handling

Disturbed and undisturbed soil samples were collected for pre-treatment and post-harvest, with the help of auger for disturbed and core sampler for undisturbed at 0-10 cm depth. The undisturbed core samples were subjected to soaking to saturation, followed by drying at 30°C, while the disturbed samples are air dried, crushed, and sieved with 2mm sieve for chemical parameters of the soil, as per the standard procedures of analysis. The pre-treatment samples are collected randomly, composited, and subjected to preparation, followed by analysis. The post-treatment samples are collected at the time of maturity of the test crop, based on the various treatments applied after harvest. The soil sample collected would be subjected to the following parameters of analysis: Bulk Density was determined by the core method as described by (Anderson and Ingram, 1993). Determination of Particle Size Distributions was done using Bouyoucus hydrometer method as explained by (Bouyoucus, 1962). Soil texture was determined using textural triangular. Total Porosity indicates the percentage of the soil that contains pores. It was determined as follows: Soil porosity = (1 - (Bulk Density/Particle Density)) x 100. Soil pH was determined in H2O using glass electrode pH meter at a soil liquid ratio of 1:2.5 as explained by (Udo et al., 2009). Soil Organic Carbon/Organic Matter was determined by Walkley and Black wet oxidation method and modified, the wet digestion method. Total Nitrogen was determined by Kjeldhal digestion method (Bremmer and Mulvaney, 1996; Nelson and Sommers, 1996). Available Phosphorus was determined by Bray 1 method as explained by Bray and Kurtz (1945. Exchangeable Bases (Ca, Mg, K and Na) was determined in 1N ammonium acetate saturation (NH4AOC) extract method at pH 7 (Udo et al., 2009). Calcium and Magnesium was determined using atomic absorption spectrophotometer while potassium and sodium was determined using flame photometer. Exchangeable acidity (H+ and Al3+): This was determined using 1N KCl method as described by (Udo et al., 2009). Cation Exchange Capacity was calculated by summing base and acid cations as described by (Chapman, 1982).

2.7 Plant Data

Some growth at 2 weeks, 4 weeks, and 6 weeks after planting, as well as yield characteristics of cucumber at harvest, were obtained for this study. The yield characteristics include: Number of leaves, which was obtained by counting, Vine length, which was obtained by measuring, Fresh fruit weight, which was obtained by measuring using a weighing balance, Length of fruit, which was obtained by measuring, Width of fruit, which was obtained by measuring, and Number of fruits, which was obtained by counting.

2.8 Microbial Group

Microbial population, which includes fungi and bacteria, was determined using viable plate counting method. The isolates, which include bacteria and fungi, were determined using cultural, morphological, and biochemical characteristics as described by standard procedures.

2.9 Statistical Analysis

The data obtained was analyzed using Analysis of variance (ANOVA) for randomized completely block design (RCBD) using Genstat 4th edition, and significant difference was separated using Fishers LSD at 5% probability level, where significant difference existed.

3. Result And Discussion

3.1 Soils of the experimental site

The initial physicochemical properties of the soils of the experimental area is presented in Table 1. The data regarding the particle fraction of the soils, shows that the soils of the experimental area are of sandy loam type with low fertility, as indicated by the low levels of organic matter (15.3g/kg), organic carbon (7.52g/kg), and total nitrogen (0.92g/kg). The low level of OC indicates that the soils have no ability to retain cations in the exchangeable form. The pH of the soils of the experimental area was slightly acid, with an average value of 5.3. The level of available phosphorous (9.06 mg/kg) was moderate. In addition, the level of Al3+ and H+ was low, with 1.98 Cmol/kg and 0.51 Cmol/kg, respectively. Also, it has moderate levels of exchangeable Ca and low levels of other exchangeable bases (Mg, K, and Na), which indicates that the soils of the experimental area are of low base status, suggesting the use of organic manures.

Table 1: Some selected physical and chemical properties of pretreated soil

Parameters	Values
Particle size distribution (%)	
Sand	61.00
Silt	18.00
Clay	21.00

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Table 1(Cont.): Some selected physical and chemical properties of pretreated soil	
Textural class	Sandy loam
pH (H_2O)	5.3
Bulk density (mgm^{-3})	1.35
Moisture content (%)	14.6
Total porosity (%)	49.4
Organic carbon (g/kg	7.52
Organic matter (g/kg)	15.3
Available Phosphorus (mg/kg)	9.06
Exchangeable acidity (Cmol/kg)	
TEA	1.18
Al^{3+}	1.98
H^+	0.51
Exchangeable base cation (Cmol/kg)	
Ca^{2+}	1.73
Mg^{2+}	0.47
K^+	0.10
Na^+	0.41
CEC (Cmol/kg)	4.26
BS (%)	68.10

Note: Ca^{2+}= Calcium, Mg^{2+}= Magnesium, k^+= Potassium, Na^{2+}= Sodium, Al^{3+}= Aluminum, H^+= Hydrogen, CEC= Cation exchangeable capacity, BS= Base saturation, TEA= Total exchangeable acidity.

Table 2: Nutrient content of cattle dung used	
Cattle dung	
Parameter	**Values**
pH (H_2O)	5.60
Organic carbon (g/kg)	200
Total nitrogen (g/kg)	9.00
Exchangeable bases (Cmol/kg)	
Ca^{2+}	4.60
Mg^{2+}	2.70
K^+	8.33
Available phosphorus (mg/kg)	13.10

Note: Ca^{2+}= Calcium, Mg^{2+}= Magnesium, k^+= Potassium

Table 3: Effect of cattle dung rates on physical properties of soil in Ifite Ogwari

Treatment	Bulk density (mgm^{-3})	Total porosity (%)	Moisture content (%)	Sand (%)	Silt (%)	Clay (%)	Textural class (%)
0t/ha CD	1.41	46.57	15.35	66.35	21.95	11.70	Sandy loam
5t/ha CD	1.32	50.20	16.88	73.00	12.60	14.40	Sandy loam
10t/ha CD	1.19	55.10	19.00	75.00	11.68	13.32	Sandy loam
15t/ha CD	1.03	60.87	19.98	78.55	8.90	12.55	Sandy loam
20t/ha CD	0.89	66.33	22.43	81.94	7.18	10.88	Sandy loam
LSD ($p \leq 0.05$)	**0.01**	**0.71**	**0.83**	**11.36**	**8.66**	**10.31**	

Note LSD= Least significant difference, CD= Cattle dung.

3.2 Effects of cattle dung rates on some selected physical properties of soil.

3.2.1 Particle size distribution (% sand, silt, and clay)

Table 3 shows the effect of the applied treatment on particle size distribution of the soil. From the result obtained, it can be deduced that there was a significant difference between the effect of the treatments on the particle size distribution of the soil. However, the range of the percentage of sand particles was between 66.32% and 81.94%, with the highest percentage of sand particles obtained from the plot that was treated with 20 t/ha CD, which was 81.95%. On the other hand, the range of the percentage of silt particles was between 7.18% and 21.95%, with the highest percentage of silt particles obtained from the control plot, which was 21.95%. Moreover, the range of the percentage of clay particles was between 10.88% and 14.40%, with the highest percentage of clay particles obtained from the plot that was treated with 5 t/ha CD, which was 14.40%. The textural class of the soil was sandy loam (SL).

3.2.2 Bulk Density and Total Porosity

Table 3 showed the effect of the applied treatment on bulk density and total porosity. From the result obtained, it is clear that there is a significant difference among the treatments' effect on soil bulk density and total porosity. Bulk density varied from 0.89 to 1.41 mgm-3. The maximum value obtained is from the control plot, 1.41 mgm-3, while the minimum value obtained is from the plot that received 20 t/ha CD. Addition of cattle dung to the soil significantly reduced bulk density compared to the control. However, total porosity varied from 46.57 % to 66.33 %. The maximum value obtained is from the plot that received 20 t/ha CD, while the minimum value obtained is from the plot that did not receive any treatment, i.e., 0 t/ha CD. The result showed that cattle dung improved the total porosity of the soil compared to the control plot. This result corroborates the findings of who found that the application of organic manure increased the total porosity of the soil (shulan et al., 2012). In addition, the result also corroborates the findings of who found that the application of organic manure increased the total porosity (Doaa, 2012).

3.2.3 Moisture Content

The result obtained from the treated plot of the soil, as shown in Table 3, revealed that there was a significant difference between the various plots of the treated soils. In addition, the result revealed that the plot that received 20 t/ha CD gave the highest result (22.43 %) while the control plot gave the lowest result (15.35 %). This result corroborates the findings of Guo et al., that manure application can improve the structure of the soil to hold more water and nutrients in the soil, thereby increasing crop yields.

Table 4: Effect of cattle dung rates on some selected chemical properties of soil in Ifite ogwari

Treatment	pH	Av. P (mg/kg)	TN (g/kg)	OC (g/kg)	OM (g/kg)
0t/ha CD	5.52	12.45	1.09	10.62	20.48
5t/ha CD	5.62	18.37	1.12	13.93	28.19
10t/ha CD	5.74	20.61	1.11	15.11	28.72
15t/ha CD	5.78	22.41	1.19	15.99	30.01
20t/ha CD	6.20	23.055	1.90	13.91	28.79
LSD (p≤0.05)	**0.06**	**0.60**	**0.09**	**0.24**	**3.75**

Note LSD= Least significant difference, CD= Cattle dung, Av. P= Available Phosphorus, TN= Total Nitrogen, OC= Organic carbon, OM= Organic matter

3.3 Effect of cattle dung rates on some selected chemical properties of soil in Ifite Ogwari.

3.3.1 Soil pH

From the effect of the treatment as presented in Table 4, it was evident that there was a significant difference ($p \leq 0.05$) in the soil pH. The plot that received 20 t/ha CD had the highest soil pH, which was 6.20, followed by the plot that received 15 t/ha CD, which had the lowest soil pH, 5.78, while the least soil pH was obtained from the control plot, which had 5.52. This result corroborates the findings of Sanderson and Jones (1997) that stated that the soil pH obtained from the plots that received manure treatment was greater than the soil pH obtained from the control plots. The capability of organic manure to increase soil pH was explored who stated that it was due to the presence of base cations in the organic manure, hence improving soil fertility by (Duruigbo et al., 2007).

3.3.2 Available Phosphorus

From the result obtained from the effect of treatment on available phosphorus in Table 4, it was clear that there was a significant difference ($p \leq 0.05$). The highest value was recorded from the plot that was treated with 20 t/ha CD, and it was 23.05 mg/kg, while the least value was recorded from the control plot and was 12.45 mg/kg. The increase in phosphorus availability from the plot that was treated with cattle manure could have resulted from the fact that soils that were amended with manure have a high amount of phosphorus. The study have shown that cattle manure application to soil can increase soil available macronutrients such as nitrogen, phosphorus, and potassium (Matsi et al., 2003).

3.3.3 Total nitrogen

Since the result obtained from the effect of the treatment on total nitrogen in Table 4 was significant ($p \leq 0.05$), there was a variation in the data values as well as an increase in the value from the control plot (1.09%). The maximum value (1.90%) for nitrogen obtained was from the plot treated with 20 t/ha CD. This result obtained is similar to that obtained by that "application of cattle manure and poultry manure alone or in combination with chemical fertilizers improved soil organic C. total N, P, and K status." Hence, this present study finding is similar to that obtained indicating the effectiveness of manure as a source for nitrogen in crop production (Kaur et al., 2005; Kaur et al., 2005).

3.3.4 Organic Carbon

From the result in Table 4 for the effect of treatment on organic carbon, it was shown that organic carbon ranged from 10.62 to 15.99 g/kg. The result obtained showed that there was a significant difference ($P \leq 0.05$). The highest values were obtained from plot treated with 15 t/ha CD, which gave 15.99 g/kg, while the second highest values were obtained from plot treated with 10 t/ha CD, which gave 15.11 g/kg. The least values were obtained from the control plot, which gave 10.62 g/kg respectively. The increase in organic carbon in this study may have resulted from the availability of organic matter in the soil from cattle dung. The result obtained in this study is in agreement with the report found that there was a significant increase in organic carbon content in plots treated with organic matter by (Okonwu and Mensah, 2012). Also, in agreement with found that organic fertilizers such as cattle manure and poultry manure were as good as inorganic fertilizers in improving cucumber production due to their high content of organic carbon (Moral et al., 2005).

Table 5: Effect of cattle dung rates on soil exchangeable cation, total exchangeable acidity and percentage base saturation of soil at Ifite Ogwari

Treatment	Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}	Al^{3+}	H^{+}	CEC	TEA	BS (%)
0t/ha CD	2.06	0.74	0.19	0.36	2.78	0.67	4.75	1.30	72.53
5t/ha CD	2.22	0.88	0.22	0.21	2.90	0.72	4.25	1.25	75.55
10t/ha CD	2.68	1.24	0.23	0.19	3.14	0.66	5.44	1.36	79.62
15t/ha CD	3.11	1.06	0.32	0.20	3.40	0.70	6.68	1.58	79.58
20t/ha CD	2.97	1.15	0.23	0.24	3.62	0.72	5.97	1.48	82.93
LSD (p≤0.05)	**0.16**	**0.05**	**0.02**	**0.03**	**0.04**	**0.05**	**0.35**	**0.04**	**1.61**

Note: LSD= Least significant difference, CD= Cattle dung, Ca^{2+}= calcium, Mg^{2+}= Magnesium, k^{+}= Potassium, Na^{2+}= Sodium, Al^{3+}= Aluminum, H^{+}= Hydrogen

3.4 Effect of cattle dung rates on soil exchangeable bases, exchangeable acidity and percentage base saturation of soil at Ifite-ogwari.

3.4.1 Exchangeable Bases (Ca, Mg, K, Na)

3.4.1.1 Potassium (K^+) and Sodium (Na^+)

The result obtained from the treated soil as shown in Table 5 above showed that K^+ values ranged from 0.19 to 0.32 Cmol/kg. The highest value of potassium (0.32 Cmol/kg) was obtained from the plot that was treated with 15 t/ha CD, followed by plots that were treated with 20 t/ha CD and 10 t/ha CD with 0.23 Cmol/kg respectively. The lowest value of potassium was obtained from the control plot at 0.19 Cmol/kg. It has been reported that K levels remain significantly higher in manure-amended soils. This was in agreement with the research done by Ullah et al., 2008, who reported that the highest level of K was available in cattle dung-amended soils followed by poultry manure-amended soils. The value of Sodium ranged from 0.19 to 0.36 Cmol/kg. The highest value of Sodium (0.36 Cmol/kg) was obtained from the plot that did not receive any treatment, followed by the plot that was treated with 20 t/ha CD with 0.24 Cmol/kg. The lowest value of Sodium (0.19 Cmol/kg) was obtained from the plot that was treated with 10 t/ha CD. The results showed that there was a significant difference among the treatment applied ($p \leq 0.05$).

3.4.1.2 Calcium (Ca^{2+}) and Magnesium (Mg^{2+})

The result shown in Table 5 indicates that there was a significant difference ($P \leq 0.05$) between the treatment over the control. It was observed that the highest value of calcium was obtained from the plot that was treated with 15 t/ha CD, which had the highest value of 3.11 Cmol/kg, followed by the plot that was treated with 20 t/ha CD, which had the value of 2.97 Cmol/kg. The least value of calcium was obtained from the control plot, which had the value of 2.06 Cmol/kg. It was also observed that the highest value of magnesium obtained from the treated soil was 1.24 Cmol/kg, which was obtained from the plot that was treated with 10 t/ha CD, while the least value of magnesium was obtained from the control plot, which had the value of 0.74 Cmol/kg. It was also observed that the result obtained showed that there was a significant difference between the treatment applied, which corroborates with the finding of that poultry, cow dung, and swine manures increased the uptake of k, Ca, and Mg by maize on leptosol of Southeast Nigeria (Mbah, 2006).

3.4.1.3 Hydrogen (H^+) and Aluminum (Al^{3+})

From the results obtained, hydrogen ion concentration in soil solution varied from 0.66 Cmol/kg to 0.72 Cmol/kg, while aluminum ion concentration in soil solution varied from 2.78 Cmol/kg to 3.62 Cmol/kg. From the results obtained, the highest concentration of hydrogen ion in soil solution was obtained from the plot that was treated with 20 t/ha CD, while 5 t/ha CD had 0.72 Cmol/kg. The lowest concentration of hydrogen ion in soil solution was obtained from the plot that was treated with 10 t/ha CD. From the results obtained, there was a significant difference ($p \leq 0.05$) among the treatments that were applied. From the results obtained, the highest concentration of aluminum ion in soil solution, 3.62 Cmol/kg, was obtained from the plot that was treated with 20 t/ha CD, while 15 t/ha CD had 3.40 Cmol/kg. The lowest concentration, 2.78 Cmol/kg, was obtained from the control. From the results obtained, there was a significant difference ($P \leq 0.05$) among the treatments that were applied.

3.4.2 Cation Exchange Capacity (CEC)

From the result obtained for CEC in the soil as presented in table 5, it was evident that the values obtained for CEC ranged from 4.25 to 6.68 Cmol/kg. The result obtained revealed that there was a significant difference among the treatments applied ($p \leq 0.05$). The highest value obtained for CEC, which is 6.68 Cmol/kg, was obtained from plot treated with 15 t/ha CD, while the lowest value, which is 4.25 Cmol/kg, was obtained from the plot that received 5 t/ha CD. The increase in CEC might have been due to the increase in organic matter, especially for the plot that received 5 t/ha CD. The result obtained for CEC in the soil is in conformity with the findings that increases in soil CEC and soil nutrient were obtained in soils treated with residues as compared to the untreated ones of (Hulugalle and Maurya, 1991). As a study reported that the application of organic manure increases cation exchange capacity (CEC) of soils, thus, indicating greater nutrient retention capacity of soil (Mbah and Mbagwu, 2006).

3.4.3 Total Exchangeable Acidity

From the result presented in Table 5, it is clear that the range of total exchangeable acidity in the soil was between 1.25 and 1.58 Cmol/kg. The result obtained in this experiment also revealed that there was a significant difference in the values of total exchangeable acidity in the soil due to the treatments applied ($p \leq 0.05$). The highest value of 1.58 Cmol/kg was obtained from the plot that had been treated with 15 t/ha CD, while the least value of 1.25 Cmol/kg was obtained from the plot that had been treated with 5 t/ha CD. Similarly, the second highest value of 1.48cmol/kg was obtained from the plot.

3.4.4 Base Saturation (BS)

From the results in Table 5, it is evident that base saturation ranges from 72.53 % to 82.93 % with 82.93 % being obtained from the plot that had 20 t/ha CD. This is followed by 79.62 % from the plot that had 10 t/ha CD. The lowest value, 72.53 %, was obtained from the control plot. From the results, it is evident that there is a significant difference in the results obtained from the treatments that were applied ($P \leq 0.05$). This could be attributed to the fact that calcium carbonate is present in cattle dung, which in turn increases exchangeable calcium, thereby neutralizing soil acidity, resulting in base saturation, which is good for plant growth.

Table 6: Effect of cattle dung rates on morphological characteristics (number of leaves and vine length) of cucumber at 2, 4 and 6 weeks after planting

Treatment	Number of leaves			Vine length		
	(2WAP) (cm)	(4WAP) (cm)	(6WAP) (cm)	(2WAP) (cm)	(4WAP) (cm)	(6WAP) (cm)
0t/ha CD	5.25	9.50	17.25	13.10	36.50	43.00
5t/ha CD	6.75	11.25	19.00	23.80	43.20	51.20
10t/ha CD	5.75	11.25	20.50	18.50	34.80	45.20
15t/ha CD	7.50	11.75	19.75	29.20	52.50	60.80
20t/ha CD	7.75	14.50	21.25	24.80	61.80	70.0
LSD (p≤0.05)	**1.61**	**1.89**	**2.68**	**11.88**	**11.80**	**11.82**

NOTE: WAP= Weeks after planting, CD= Cattle dung

6. Effect of cattle dung rates on morphological characteristics (number of leaves and vine length) of cucumber at 2, 4 and 6 weeks after planting

The effect of the treatment on plant morphological characteristics such as the number of leaves and vine length is presented in Table 6. The effect of the treatments on the number of leaves at 2WAP, 4WAP, and 6WAP differed significantly ($P \leq 0.05$) with the highest value 7.75cm, 14.50 cm, and 21.25cm being recorded from the plot that had 20 t/ha CD respectively. On the other hand, the lowest values were obtained from the control. The effect of the treatments on vine length at 2WAP, 4WAP, and 6WAP differed significantly ($P \leq 0.05$) with the highest length 29.20 cm, 61.80 cm, and 70.00 cm being recorded from the plot that had 15 t/ha CD, 20 t/ha CD, and 20 t/ha CD respectively. The relationship between the increase in cattle dung rates and vegetative growth could be established from the availability of nutrients that are readily absorbed by the plant resulting in more production of photosynthesis and nutrients for the growth of the vegetative parts. This aligns with the findings observed that organic manures can sustain cropping system through better nutrient recycling which would give rise to crop improvement in growth and development as well as yield of (Eifediyi and Remison, 2010).

Table 7: Effect of cattle dung rates on yield and yield related characteristics of cucumber at harvest				
Treatment	**Number of fruits at harvest**	**Fruit length at harvest (cm)**	**Fruit width at harvest (cm)**	**Weight of fruit at harvest (kg)**
0t/ha CD	4.00	16.12	0.07	16.20
5t/ha CD	6.00	22.60	0.31	21.60
10t/ha CD	7.75	24.10	0.38	22.35
15t/ha CD	9.00	24.12	0.47	22.00
20t/ha CD	9.75	27.00	0.55	24.45
LSD (p≤0.05)	**2.01**	**2.57**	**0.31**	**2.71**

Effect of cattle dung rates on yield and yield related characteristics of cucumber at 6wap.

The effect of the treatment on the yield and yield related characteristics (number of fruits, fruit length, fruit width, and fresh pod weight) is presented in Table 7. From the effect of the treatment, there was a significant difference ($p \leq 0.05$) among the values in the data obtained. From the results obtained, the plot that had 20 t/ha CD had the highest value among the parameters (number of fruits, fruit length, fruit width, and fresh pod weight) with values 9.75, 27.00 cm, 0.55 cm, 24.45 kg, respectively. These results obtained were in agreement with those obtained that reported that there is an increase in yield with the application of manure treatment compared to the control by (Molik et al., 2016). This is in harmony with the findings that reported that with an increase in the amount of manure, there is an increase in crop yield of (Aliyu, 2000; Adekiya and Ojeniyi, 2002; Agbede et al., 2008).

Table 8: Effect of cattle dung rates on soil microbial population (bacterial and fungal population)		
Treatment	**Bacterial population ($CFUg^{-1}$)**	**Fungal population ($CFUg^{-1}$)**
0t/ha CD	5860	615
5t/ha CD	8460	780
10t/ha CD	10875	2848
15t/ha CD	40250	5888
20t/ha CD	91750	8840
LSD (p≤0.05)	**4658.7**	**480.7**

Note: CD= Cattle dung.

The result obtained in indicated that there was a significant difference at p 0.05 between the treatment, which means that the different rates of cattle dung applied have an effect on the soil micro population, namely bacteria and fungi. The highest value of bacteria and fungi populations was recorded on the plot that received 20 t/ha CD, with 91750 CFUg-1 and 8840 CFUg-1 respectively. The lowest value of bacteria and fungi populations was recorded on the plot that did not receive any treatment, namely 0 t/ha, with 5860 CFUg-1 and 615 CFUg-1 respectively.

From the results, the high rates of micro-organism population in the amended soils compared to the unamended ones could be attributed to the nutrient and organic matter contained in the cattle dung, which provided a conducive environment for the living of the micro-organism population. This finding can be supported by the works of Zhen et al., 2014, who stated that animal manure compost increased bacteria and fungi diversity by increasing the carbon pool of the soil, thus improving the living conditions of indigenous microorganisms and plant growth.

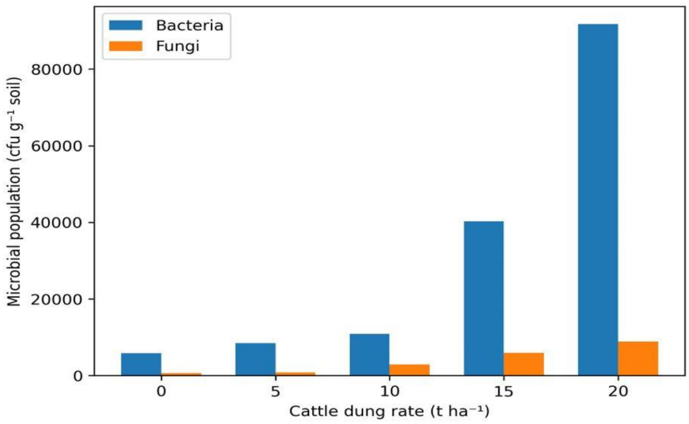

Figure 1: Effect of cattle dung rates on cucumber yield

The result indicates that the cucumber yield increased with the increasing cattle dung application rate, and the maximum yield was obtained at 20 t ha^{-1}, while the minimum yield was obtained at the control treatment, i.e., 0 t ha^{-1}. The application of cattle dung had a significant effect on cucumber yield (Figure 1).

The microbial populations increased progressively as the rate of cattle dung application increased. The highest microbial populations were observed at 20 t ha^{-1} of cattle dung application. The cattle dung application significantly affected the microbial populations of the soil (Figure 2). This shows that the application of cattle dung enhances the microbial activities of the soil.

4. Conclusion

From the result obtained in this study, it is concluded that cattle dung at the application rates used in this study had a significant effect in improving soil essential nutrients such as N, P, K, Ca, Mg, and the microbial population in the soil. A significant difference was obtained in almost all the parameters over the control. At an application rate of 20 t/ha, CD had a significant effect in improving the physical properties such as bulk density, total porosity, and moisture content of the soil required for optimum growth. It also had a significant effect in improving the pH, available P, total N, Mg^{2+}, and base saturation of the soil. At an application rate of 15 t/ha, CD had a significant effect in improving organic carbon, basic cation content such as Ca^{2+}, K^{+}, and CEC in the soil. The control had a higher content of Na^{+}. 20 t/ha CD gave a better result in terms of number of leaves, vine length, number of fruits, fresh weight of fruits, fruit length, width of fruit, and soil microbial population (bacterial and fungal). It is recommended that farmers should use 15 to 20 t/ha cattle dung as an organic fertilizer for optimum improvement in soil fertility. It is cost-effective and provides the required nutrients for improving plant growth and yield.

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