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Assessment of Cow Dung on Nutrient Uptake, Soil Physicochemical Properties, Growth and Yield of Okra in Jalingo, Taraba State, Nigeria

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Abstract

Declining soil fertility remains a major constraint to sustainable agricultural production in the Guinea Savannah zone of Nigeria, necessitating the evaluation of organic amendments that can improve soil quality and crop productivity. This study evaluated the effects of cow dung application on nutrient uptake, soil physicochemical properties, growth, and yield of okra in Jalingo, Taraba State, Nigeria. A field experiment was conducted during the 2022 cropping season using a randomized complete block design with three replications. Five treatments were applied: control at 0 t ha^{-1} and cow dung at 15, 20, 25, and 30 t ha^{-1}. Okra leaves were sampled for nutrient uptake at 50% flowering, while soil samples were collected at a depth of 0–30 cm before planting and after harvest for the analysis of particle size distribution, pH, organic carbon, total nitrogen, available phosphorus, exchangeable bases, and cation exchange capacity. The findings showed that cow dung significantly enhanced nutrient uptake, with the 30 t ha^{-1} treatment recording the highest values for nitrogen, phosphorus, and potassium uptake. Soil analysis further indicated that higher cow dung rates, particularly 25–30 t ha^{-1}, significantly improved soil pH, organic carbon, available phosphorus, exchangeable bases, and cation exchange capacity compared with the control treatment. Significant differences were also observed in plant height, pod length, pod width, and pod weight across cow dung application rates. The highest pod yield of 8.65 t ha^{-1} was recorded under the 30 t ha^{-1} treatment, which was statistically similar to the 25 t ha^{-1} treatment, with 8.28 t ha^{-1}. The study concludes that cow dung application at 25–30 t ha^{-1} is more effective in improving soil fertility, nutrient uptake, okra growth, and yield under the conditions of the study area. These findings contribute to sustainable soil fertility management by supporting the use of cow dung as an organic amendment for enhancing okra production in the Guinea Savannah zone of Nigeria.

Keywords: Cow Dung; Nutrient Uptake; Organic Carbon; Cation Exchange Capacity; Okra Yield

INTRODUCTION

Soil fertility decline remains one of the most critical constraints to sustainable agricultural production in sub-Saharan Africa. In Nigeria, continuous cultivation, shortened fallow periods, erosion, nutrient mining, and inadequate nutrient replenishment have contributed to progressive soil degradation (Bationo *et al.,* 2012; Vanlauwe *et al.,* 2015). The problem is particularly severe in the Guinea savannah agro-ecological zone, where soils are predominantly highly weathered, inherently low in organic matter, and characterized by weak structural stability and low nutrient reserves (Lal, 2015; Sanginga and Woomer, 2009). These soils often exhibit low nitrogen availability, phosphorus fixation, reduced cation exchange capacity (CEC), and susceptibility to acidification, thereby limiting crop productivity.

In many parts of Nigeria, including Taraba State, smallholder farmers rely heavily on mineral fertilizers such as urea to improve crop yields. Urea (46% N) is widely used because of its high nitrogen concentration and rapid solubility, which ensures quick nutrient availability for plant uptake (Fageria, 2016). However, although mineral fertilizers can rapidly correct nutrient deficiencies, their continuous use without complementary organic inputs may accelerate soil degradation processes (Lal, 2015). Long-term dependence on inorganic fertilizers has been associated with soil acidification, nutrient imbalance, decline in soil organic carbon, and deterioration of soil physical properties such as aggregate stability and porosity (Guo *et al.,* 2010; Vanlauwe *et al.,* 2015).

Organic amendments, particularly livestock manure such as cow dung, are increasingly recognized as sustainable alternatives for improving soil fertility. Cow dung supplies essential macro- and micronutrients while contributing substantial organic matter to the soil (Ojeniyi *et al.,* 2013). Soil organic matter plays a central role in maintaining soil health by enhancing aggregate formation, increasing water-holding capacity, improving cation exchange capacity, buffering soil pH, and stimulating microbial activity (Lal, 2015; Sanginga & Woomer, 2009). Through gradual mineralization, organic amendments provide a steady nutrient release that supports crop growth while improving long-term soil resilience (Vanlauwe *et al.,* 2015).

The concept of Integrated Soil Fertility Management (ISFM) promotes the combined use of organic and inorganic nutrient sources to optimize agronomic efficiency and sustain soil productivity (Vanlauwe *et al.,* 2010; Vanlauwe *et al.,* 2015). ISFM has been shown to enhance nutrient use efficiency, improve soil structure, and increase crop yields compared with sole application of either organic or mineral fertilizers (Bationo *et al.,* 2012). Despite these documented benefits, adoption of integrated practices remains limited among smallholder farmers due to labor constraints, limited manure availability, and insufficient site-specific research evidence (Vanlauwe *et al.,* 2015).

Although numerous studies in Nigeria have examined the effects of either organic manure or mineral fertilizers on crop performance, relatively few have systematically compared their impacts on soil physicochemical properties across distinct agro-ecological zones within the same state (Ojeniyi *et al.,* 2013). Furthermore, many studies emphasize crop yield outcomes while paying limited attention to long-term soil quality indicators such as organic carbon, exchangeable bases, and cation exchange capacity (Onwu *et al.,* 2018). Sustainable agricultural intensification requires a stronger understanding of how different nutrient sources influence both soil physical and chemical properties. Given the urgent need for sustainable soil fertility restoration in Nigeria, this study was conducted to assess the effect of cow dung on soil physicochemical properties and yield of okra in Jalingo, Taraba State, Nigeria.

MATERIALS AND METHODS

Description of the Study Area

The field experiment was conducted during the 2022 cropping season at Agricultural Teaching and Research Farm, Taraba State College of Agricultural Science and Technology, Jalingo between latitudes 8°47'–9°01'N and longitudes 11°09'–11°30'E. The area experiences annual rainfall between 800 and 2,000 mm, with average temperatures ranging from 25°C to 34°C. Soils in this location are generally sandy loam to loamy sand, moderately drained, and prone to nutrient leaching due to their coarse texture.

Experimental Design and Treatments

The field experiment was laid out in a Randomized Complete Block Design (RCBD) replicated three (3) times each plot size was a 4 m x 5 m with a distance of 0.50 m between plots and 1 m between replications which produced total number 15 plots. The experiment comprises of five treatments: control (0 t ha-1), 15 t ha^{-1} cow dung, 20 t ha^{-1} cow dung, 25 t ha^{-1} cow dung and 30 t ha^{-1} cow dung

Land preparation and application of amendments

The land was cleared and stumped manually and thereafter manually ridged. okra seed were sown at a spacing of 30 cm within rows and 50 cm between rows at three seeds per hole and were thinned to one seedling per hole, two weeks after sowing. The required quantities of cow dung were incorporated into the soil two weeks before planting to ensure proper mineralization.

Soil Sampling

Cow dung was obtained from the livestock session of the Teaching and Research Farm, Federal University Wukari, Taraba State, Nigeria. The sample was air dried, crushed through a 2mm sieve and subjected to laboratory analysis following standard procedure in order to determine the chemical properties (IITA, 1989). Prior to the commencement of the experiment, top soil samples of 0 -30 cm deep were collected randomly from five spots using soil auger from the experimental plot and mixed together to form a composite sample. After harvest, top soil samples of 0 -30 cm deep were collected randomly from three spots within a plot and mixed together to form a composite sample of each treatment. It was air dried, sieved with a 2 mm mesh-size sieve and taken to the laboratory to determine the soil's physicochemical properties (particle size, pH, organic carbon, total nitrogen, available phosphorus, magnesium, calcium, sodium, potassium and cation exchange capacity) using standard laboratory procedures (Olsen, *et al.,* 1954; Jackson, 1973; Page *et al.,*1982; Dirk and Hargarty 1984 and Okalebo *et al.,*2002)

Data Collection and Statistical Analysis

Five plants were randomly tagged from two middle rows in each plot for sampling and data collected for growth and yields assessment – plant height, number of days to 50% flowering, pod length and pod weight. Data collected from the experimental field were subjected to analysis of variance (ANOVA) and significantly different mean values were compared using Duncan Multiple Range Test (DMRT) at 5% probability level.

RESULTS AND DISCUSSION

Initial Soil Properties

The physical and chemical properties of the soils of the experimental site before application of treatments are presented in Table 1. The results showed that the soil was slightly acidic with pH of 6.55.

Table 1. Initial soil analysis and nutrient content of cow dung

Parameters	Soil	Cow dung property
pH (H_20)	6.65	6.75
Nitrogen (g/kg)	0.34	0.26
Avail. P. (mg/kg)	0.90	8.01
K (Cmol/kg)	0.54	0.66
Na(Cmol/kg)	3.04	0.21
Ca (Cmol/kg)	0.09	0.12
Mg (Cmol/kg)	0.03	0.21
O C (g/kg)	1.69	2.10
Exch, acidic (Cmol/kg)	0.18	
Sand (%)	81.88	
Silt (%)	16.00	
Clay (%)	7.12	
Textural class	Sandy loam	

Other chemical analysis indicated that the soil was low in organic carbon, nitrogen, available phosphorus and magnesium. The exchangeable (potassium, calcium, and sodium) were also low. The particle size distribution shows that the soils are sandy loam. Nutrients analysis of cow dung used is also presented in Table 1. The values of N, P, K, Ca, and Mg in the cow dung manure were adequate for the growth of vegetable crop such as okra.

Effect of treatment on NPK uptake at 50 % flowering

The highest N was observed in plot treated with 30 t/ha of cow dung which recorded 24.66 g/kg and was statistically the same with plot treated with 25 t/ha (21.95 g/kg) and were significantly higher other treatments (Table 2). The plot treated with 20t/ha of cow dung recorded the value of 17.08 g/kg and was statistically different from other treatments. The lowest N was observed in plot treated with 0 t/ha (control) of cow dung which recorded the value of 14.99% and was statistically the same with plot enhanced with 15 t/ha which recorded 15.55%.

Table 2. Effect of treatment on NPK uptake at 50 % flowering

Treatments	TN (g/kg)	Avail.P (mg/kg)	K (cmol/kg)
0 t/ha CD	14.99^{d}	12.41^{e}	0.35^{b}
15 t/ha CD	15.55^{d}	17.12^{d}	0.36^{b}
20 t/ha CD	17.08^{c}	20.13^{c}	0.37^{b}
25 t/ha CD	21.95^{b}	23.61^{b}	0.42^{ab}
30 t/ha CD	24.66^{b}	26.62^{a}	0.44^{a}

Mean in the column with same letter show no significant different at $p<0.05$

Key: CD= Cow Dung

The highest available P uptake was observed in plot treated with 30 t/ha of cow dung which recorded 26.62 mg/kg and was statistically higher than other treatments. This was followed by plot treated with 25 t/ha cow dung which recorded 23.61 mg/kg and was statistically different from other treatments. The lowest available P was observed in plot treated with 0t/ha (control) of cow dung which recorded the value of 12.41 mg/kg and was statistically lower than other treatments. Plot treated with 30 t/ha recorded the highest uptake (0.44 cmol/kg) followed by 25 t/ha cow dung which recorded 0.42 cmo/kg were statistically the same. This was followed by plot treated with 20 t/ha which recorded 0.37% and was statistically the same with plots treated with 15 and 0 t/ha of cow dung which recorded 0.36% and 0.35% cmo/kg respectively. The lowest K uptake was obtained in plot enhanced with 0 t/ha cow dung. The result revealed that NPK uptake at 50% flowering increase with increase in levels of treatments. Significant higher uptake of nutrient was observed in higher rates of cow dung. This could be attributed to easy solubilization effect of released plant nutrients leading to improved nutrient uptake by the plant. This finding is in conformity with the findings of Aliyu (2000) who reported increase in growth with increase organic manure rates. However, the control plots showed lower values in all the nutrients assessed and this suggests poor nutrient utilization by the okra plant. Addition of FYM increased the uptake of phosphorus which increased the productivity and improvement in P content of the crop and the K uptake was improved significantly by all the fertilizer treatments compared to control (Pradeep *et al.*, 2019). Okra produced under organic amendments has better qualities (N, P, K, Ca, Mg, protein, ash and mucilage) compared with NPK fertilizer and control (Aruna *et al.*, 2020).

Effect of treatments on some soil properties

The effect of treatments on soil pH is presented in Table 3. Highest pH content was observed in plot treated with 30 t/ha cow dung which recorded 6.67 and was statistically the same with plots treated with 25 t/ha cow dung which recorded the values of 6.55. This was followed by plots treated with 20 t/ha cow dung which recorded 6.47 and was statistically the same with plots treated with 15 t/ha cow dung. The lowest pH value was observed in the control. Onwuka and Ogbona (2009) asserted that the basic cations present in organic wastes displaced the acidic cations from the soil exchangeable complex by neutralization and precipitation thereby increased soil pH with corresponding decrease in exchange acidity. This shows that organic manures could serve as good amendment materials in enriching soils acidity (Akpan *et al*, 2022). The additions of organic manure have a positive effect and ascribe the formation of CO_2 and the organic acids during the process of microbial decomposition towards the counteraction of the negative effects of soil pH (Rajendra *et al*, 2022).

Table 3. Effect of treatments on some soil properties

Treatments	pH H_2O	OC (g/kg)	TN (g/kg)	Avail.P (mg/kg)	K	Ca	Na	Mg	E.A	CEC	Sand	Silt	Clay	Textural Class
					------------------ cmol/kg -----------------------						----------(%) --------			
0t/ha CD	6.37^{c}	1.94^{c}	0.36^{c}	10.11^{b}	0.64^{c}	0.08^{b}	2.73^{c}	0.10^{b}	0.76^{b}	3.55^{d}	75.29^{a}	17.27^{d}	7.44^{b}	Sandy Loam
15t/ha CD	6.42^{b}	2.11^{bc}	0.60^{bc}	11.20^{b}	0.66^{bc}	0.09^{b}	3.48^{b}	0.10^{b}	0.96^{a}	4.33^{dc}	71.26^{b}	20.50^{cb}	8.24^{b}	Loamy Sand
20t/ha CD	6.47^{b}	2.21^{bc}	0.76^{bc}	13.01^{a}	0.69^{b}	0.13^{b}	3.50^{b}	0.10^{b}	1.18^{a}	4.42^{c}	68.25^{b}	23.09^{b}	8.66^{b}	Loamy Sand
25t/ha CD	6.55^{a}	2.35^{b}	0.84^{b}	13.34^{a}	0.76^{b}	0.14^{b}	4.13^{a}	0.20^{ab}	1.24^{a}	5.23^{b}	66.52^{cb}	24.30^{b}	9.18^{a}	Loamy Sand
30t/ha CD	6.67^{a}	2.71^{a}	1.33^{a}	13.90^{a}	0.96^{a}	0.21^{a}	4.17^{a}	0.30^{ab}	1.30^{a}	5.64^{a}	62.92^{c}	26.58^{a}	10.50^{a}	Loamy Sand

Mean in the column with same letter show no significant different at $p<0.05$
Key: WAS= Weeks after Sowing. CD= Cow Dung

Highest OC content was observed in plot treated with 30 t/ha cow dung which recorded 2.71 g/kg and was statistically higher than other treatments. This was followed by plots treated with 25 t/ha cow dung which recorded 2.35 g/kg and was statistically the same with plots treated with 20 t/ha and 15 t/ha of cow dung. The lowest OC content was observed in plot treated with 0 t/ha of cow dung which recorded the value of 1.94 g/kg and was statistically the same with plot treated with 20 t/ha cow and 15 t/ha cow dung. There was increase in the organic carbon content after the experiment resulting in significant different at $p>0.05$ among the treatments. Tiwari *et al.* (2002) also elucidated that application of OM in fertilization schedule improved OC status of soil. Organic carbon indicates organic matter accumulation that determines soil health (Liptzin *et al.*, 2022). Providing cow manure can increase Organic carbon in the media to improve the structure and increase aggregates, infiltration, and the ability of the soil to retain water. In addition, organic carbon can be a source of nutrients for plants because it contains N and P elements that can be released during the mineralization and decomposition of organic carbon to fulfill nutrients for plants (Gerke, 2022)

The result of total nitrogen (TN) content was presented in Table 3. Highest TN (1.33 g/kg) content was recorded at 30 t/ha cow dung and was statistically higher than others. This was followed by plot treated with 25 t/ha cow dung and was statistically the same with plots treated with 20 t/ha and 15 t/ha cow dung. The lowest TN (0.36 g/kg) content was recorded at the control and was statistically the same with plot treated with 15 and 20 t/ha cow dung. It is a well-known fact that incorporating organic manures into soils not only acts as a storehouse of major and micro nutrients, but also improves the soil's physical, chemical, and biological qualities (Ramesh *et al*, 2022). The result of available phosphorus (P) content is presented in Table 4.4. Highest P (13.90 mg/kg) content was observed in plot treated with 30 t/ha cow dung and was statistically the same with plots treated with 25 t/ha cow dung which recorded the value 13.34 mg/kg. The lowest P (10.11 mg/kg) content was observed in control and was statistically the same with plot treated with 15 t/ha cow dung. The P in manure is bio-available; thus, manure directly increases the soil available phosphorus content by supplying a high amount of P. In addition, manure also contains other types of matter, such as organic carbon, which indirectly impacts soil P availability by changing soil properties and microbial P transformation capacity (Lianglang *et al*, 2023).

The result of calcium (Ca) content of the soil of the study area is presented in table 3. Highest Ca content was observed in plot treated with 30 t/ha cow dung which recorded 0.21 cmol/kg and was statistically higher than other treatments. The lowest Ca content was observed in control which recorded 0.08 cmol/kg. Organic matter serves as a reservoir for cations, such as calcium (Ca), magnesium (Mg), potassium (K), and ammonium (NH_4^+), which are readily exchangeable with soil particles (Singh *et al.*, 2018). The incorporation of organic manure resulted in to a significant and consistent increase in Ca and Mg uptake (Mohana *et al*, 2017).

Highest Mg content was observed in plot treated with 30 t/ha cow dung which recorded 0.30 cmol/kg and was higher than other treatments. The lowest Mg content was observed at the control which recorded the value of 0.10 cmol/kg and was statistically the same with plots treated with 15 and 20 t/ha cow dung.

Highest K content was observed in plot treated with 30 t/ha cow dung which recorded 0.96 cmol/kg and was statistically higher than other treatments. The lowest K content was observed in control which recorded the value of 0.64 and was statistically the same with plot treated with 15 t/ha. Furthermore, the plots treated with 30 t/ha cow dung, 150 kg/ha urea, 30 t/ha +75 kg/ha urea, and 15 t/ha cow dung +150 kg/ha urea exhibited significantly higher levels of exchangeable potassium and sodium (Waizah and Onwu, 2024).

The highest Na content was observed in plot treated with 30 t/ha cow dung which recorded 4.17 cmol/kg and was statistically the same with plots treated with 25 t/ha cow dung which recorded the value 4.13 cmol/kg. This was followed by plot treated with 20 t/ha cow dung which recorded 3.50 cmol/kg and was statistically the same with plots treated with 15 t/ha cow dung which recorded 3.48 cmol/kg. The lowest Na content was observed in control which recorded the value of 2.73 cmol/kg and was statistically lower than other treatments. Slight increase was observed at the end of the experiment due to the application of cow dung. Similar result was observed by Sharifi *et al* (2021) that the highest amount of change in sodium absorption ratio was related to 5% cow manure treatment.

Highest Exchangeable acidity (EA) content was observed in plot treated with 30 t/ha urea which recorded 1.30 cmol/kg and was statistically the same with plots treated with, 25, 20, and 15 t/ha cow dung which recorded the values 1.24, 1.18 and 0.96 cmol/kg sequentially (Table 3). The lowest EA content was observed in plot treated with 0 t/ha of cow dung which recorded the value of 0.76 and was statistically different from other treatments. Akpan *et al* (2022) reported that organic manures have greater potential of raising soil pH compared to NPK fertilizer. This shows that organic manures could serve as good amendment materials in enriching soils acidity.

Plant height (cm)

The result on okra plant height in the study area is presented in table 4. The tallest plant (25.52 cm) at two weeks after sowing was obtained in plot treated with 30 t/ha and was statistically the same with plot treated with 25 and 20 t/ha cow dung which recorded 24.43 and 22.10 cm respectively. This was followed by the plot treated with 15 t/ha cow dung which recorded 20.47 cm and was statistically the same with plots treated with 150 kg/ha urea and control. The shortest plant was obtained from control.

Table 4. Effects of treatments on plant height (cm)

Treatments	2-WAS	4-WAS	6-WAS	8-WAS
0 t/ha CD	**19.03^{b}**	**41.67^{c}**	**85.01^{d}**	**135.7^{d}**
15 t/ha CD	**20.47^{d}**	**52.00^{bc}**	**110.3^{c}**	**149.3^{c}**
20 t/ha CD	**22.10^{ab}**	**55.47^{bc}**	**124.0^{c}**	**163.7^{b}**
25 t/ha CD	**24.43^{a}**	**69.00^{ab}**	**135.5^{b}**	**177.0^{a}**
30 t/h CD	**25.52^{a}**	**84.33^{a}**	**147.7^{a}**	**181.0^{a}**

Mean in the column with same letter show no significant different at $p<0.05$

Key: WAS= Weeks after Sowing. CD= Cow Dung

At four weeks after sowing the tallest plant (84.33 cm) was obtained from plot treated with 30 t/ha cow dung which recorded 84.33 cm and was statistically the same with plot treated with 25 t/ha cow dung which recorded 69.00 cm. Plot treated with 20 t/ha cow dung which recorded 55.47 cm and was statistically the same with plots treated with 15 and 0 t/ha cow dung. The lowest plant height was obtained from plot treated with control which recorded 41.67 cm. At six weeks after sowing, the tallest plant (147.7 cm) was obtained from plot treated with 30 t/ha cow dung and was statistically higher than others. Treated 25 t/ha cow dung recorded 135.5 cm and was statistically lower than 30 t/ha and higher than others. The lowest plant height was obtained from plot treated with control which recorded 85.01 cm and was statistically lower than other treatments. Tallest plant (181.00 cm) at eight weeks after sowing was obtained in plot treated with 30 t/ha and statistically the same 25 t/ha with and higher than others. The lowest plant height was obtained from plot treated with control which recorded 135.7 cm and was statistically lower than other treatments.

The application of cow dung has shown to increase plant high from two week after sowing to eight weeks after sowing. The highest level of cow dung (30t/ha) applied produced the tallest plants and the shortest plants were those of the control. Similar result was observed by Shehu *et al.* (2019) who reported increased height in amaranth plant at higher nitrogen application rate. Olowoake and Ojo (2014) also reported that amaranth require soils with high organic content, and adequate mineral nutrients favoured the production of higher plant height. This positive effect of cow dung on the growth of okra may be due to the release of the balanced nutrients contained in the organic manure. This result is in line with the report of Garjila *et al.* (2020) and Onwu and Gani (2024) who reported that the increase in plant height is attributed to increase in the fertility of the soil as a result of the application of cow dung manure which supplied Nitrogen, Phosphorus, Potassium and other chemicals which enhanced the growth of the plant.

Effects of treatments on pod length, width and pod weight

Results of the pod length of the okra tested are presented in Table 5. The longest pod (14.90 cm) was recorded at the plot treated with cow dung at 30 t/ha which was statistically the same with plot treated with 25 t/ha cow dung which recorded 13.53 cm. Shortest pod (8.83 cm) was obtained from the plot with 0 t/ha cow dung application and statistically lower than other treatments.

Table 5. Effects of treatments on pod length, width and pod weight.

Treatments	Pod Length (cm)	Pod Width (cm)	Pod Weight (t/ha)
0 t/ha CD	8.83^{c}	2.76^{c}	5.10^{c}
15 t/ha CD	10.77^{b}	3.36c	6.00^{c}
20 t/ha CD	11.13^{b}	3.96^{bc}	6.57^{b}
25 t/ha CD	13.53^{a}	4.33^{ab}	8.28^{a}
30 t/ha CD	14.90^{a}	4.86^{a}	8.65^{a}

Mean in the column with same letter show no significant different at $p<0.05$

CD= Cow Dung

The highest pod width (4.86 cm) was recorded at plot treated with cow dung 30 t/ha which was statistically the same with plot treated with 25 t/ha cow dung (4.33 cm). This was followed by plot treated with 20 t/ha cow dung which recorded 3.96 cm and was statistically the same with 25 t/ha cow dung (4.33 cm). The lowest pod width (2.76 cm) was obtained at the control and was statistically the same with plots treated with 15 and 20 t/ha cow dung.

Results of pod weight is also presented in Table 5. The differences in pod weight with respect to different rates of cow dung showed significantly different ($P<0.05$). Highest pod weight (8.65 t/ha) was recorded at the treated with 30 t/ha and was statistically similar with 25 t/ha cow dung which recorded 8.28 t/ha. This was followed by plot treated with 20 t/ha cow dung which recorded 6.57 t/ha and was statistically lower than 25 and 30 t/ha but higher than 15 t/ha and control. The control recorded lowest pod weight (5.10 t/ha). The results obtained from this study indicated a positive response of okra to increasing rate of cow dung. Increasing rates of cow dung manure enhanced the performance of various parameters measured. There was a general improvement in the growth and yield of crops due to application of organic manure and such improvement increased with rate of application (Onwu *et al*., 2017). Increasing levels of manure significantly increase pods weight. This enhancement in many cases is comparable to or even higher than what is obtained with inorganic urea fertilizer. The results obtained were in agreement with the findings of Onwu *et al*., (2014) who reported that yield of okra can be increased due to organic manure application. The same result was found by Adamu and Musa (2022) who said that cow dung at 10 kg with Clemson variety was found the highest weighted which was about 57.5% of other treatment plants. Gana *et al*. (2022) in their trial, weight of fruit (3.98 and 4.68 t/ha), bigger, longer fruits and a greater number of fruits was obtained at cow dung rates of 20 and 30 t/ha.

CONCLUSION

On basis of the field study on effect of cow dung on nutrient uptake, soil properties and yield of okra. the use of cow dung on okra production provides an environmentally friendly approach that has a beneficial effect on the health of the soil, the growth, yield, and nutritional quality of the crops. Cow dung at the rate of 25 and 30 t/ha performed better on soil improvement and okra yield than others in this study. It is recommended that, 25 and 30 t/ha of cow dung to be used for okra production and soil sustainability in the study area.

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