FIELD EVALUATION OF DIFFERENT RATES OF COW DUNG ON GROWTH, YIELD OF OKRA AND SOIL RESTORATION

Abstract

Field experiments were conducted during 2021 and 2022 rainy seasons at the Teaching and Research Farm of Federal University Wukari, Taraba State to study the growth and yield responses of okra to different rates of cow dung and soil restoration. The experiments consist of five rates 0, 6, 8, 10 and 12 t ha-1 of cow dung were laid out in a Randomized Completed Block Design (RCBD), replicated three times. Okra parameters measured were; plant height, leaf number, pod length, diameter and total pod weight. For plant height and leaf area a non-significant treatment effect was observed for the first 2 weeks respectively whereas, plants provided with 10 and 12 t ha-1 of cow dung significantly ($p<0.05$) increased plant height and leaf area in the last 4 to 8 weeks respectively. Similarly, the highest application rate of 10 and 12 t ha-1 significantly ($p<0.05$) increased the pod length, pod diameter and pod weight for the entire period of study as compared to the rest. Control (0 t ha-1) was significantly lower than all the plots that received cow dung in the experiments. Application of cow dung improved soil chemical properties such as pH, N, OM, P, K, Mg and CEC compare with the initial and control treatments. The study concluded that application of poultry manure improved okra production and increased available nutrients and soil restoration.

Keywords: cow dung, organic manure, pod weight, growth and soil restoration

INTRODUCTION

"Okra (*Abelmoschus esculentus* L.) is considered in Nigeria as a local vegetable grown as rain fed or irrigated crop" (Tiamiyu *et al*., 2010). "It is generally a multipurpose versatile crop with the leaves, pods and flowers eaten. Okra *(Abelmoschus esculentus* (L.) belongs to the Malvaceae family and is one of the most popular fruit vegetables cultivated in Africa (Schippers, 2000). The slimy, fresh pods are rich in vitamin A and C. The young tender fruits are usually prepared into pieces for use in sauce to be served with starchy diets like maize, rice, sorghum, yam, cassava etc". (Omeje *et al*., 2013). "In spite of the popularity of okra as a vegetable crop, and as a crop that almost all its parts can be put to economic use, it has not been given the attention it deserves in research for increased yield. Okra production in Nigeria is primarily at a back yard home garden for which few attention has been given by commercial farmers, researchers and consumers despite its nutritional value, income and employment generation and potential" (Omeje *et al*., 2013).

"The nutritional values of okra and its geographical distribution, as well as adaptability to varying climatic conditions, the yield of okra is still very low. This was attributed to continuous decline in soil fertility, especially in the tropics, and unstable climatic conditions. Normally, okra, being a tropical plant, grows well under warm conditions with sufficient moisture levels and light intensities. With the recent change in climate and the problem of soil fertility, the yield of okra has been reduced. Okra production is being constrained by a complex of biotic and abiotic factors at every stage of growth" (Anne and Carter, 2004). In Nigeria, the crop is cultivated in over 1.5 million hectares (Majanbu *et al*., 1986), but low yields are often recorded. This low yield experienced has been attributed to poor soil fertility and soil deficiency in important mineral nutrients. Fertilizer is an important input contributing to crop production because it increases productivity and improves yield quality and quantity (Adeniyan and Ojeniyi, 2003).

"In vegetable production, especially in protected vegetable production, the excessive and irrational use of chemical fertilizers not only leads to low fertilizer use and production efficiency, but also causes to a series of serious problems, such as the reduction of soil organic matter content, massive enrichment of available nutrients (nitrogen, phosphorus, etc.), secondary salinization, accumulation of heavy metals, edible parts of vegetables and excessive nitrate in groundwater, which seriously limits the sustainable development of vegetable industry" (He *et al.,* 2016;Yang *et al.,* 2016; Wang *et al.,* 2018). "Nutrient imbalance and soil physical degradation hinder sustainable use of inorganic fertilizers in the tropics" (Ewulo *et al*., 2008). "In order to sustain soil fertility over a long period of time the use of organic manure is been advocated. This is because the nutrients contained in organic manures are released more slowly and are stored for a longer time in the soil, thereby ensuring a long residual effect" (Onwu *et al*., 2018). Abou El-Magd *et al*., (2005) also reported that "manures provide a source of all necessary macro- and micro-nutrients in available forms, thereby improving the physical and biological properties of the soil". "For sustainable agriculture, organic fertilization is inevitable in the future as it improves soil properties, increases crop productivity and maintains crop quality" (Adekiya *et al.,* 2020). There are different types of organic manure including cow dung, compost, green and farm yard manure etc. The current study was therefore conducted to determine the growth and yield responses of okra to different rates of cow dung and soil restoration.

MATERIALS AND METHODS

The experiments were conducted during the 2021 and 2022 cropping seasons at the Teaching and Research Farm of Federal University Wukari, Taraba State located on latitude 7˚51'N and longitude 9˚46' E, in the Southern Guinea savanna. The sites had been cultivated in the last three years. Five levels of grinded cow dung: 0, 6, 8, 10 and 12 t $ha^{-1}$was tried on Clemson variety of okra. The treatments were replicated three times using a randomized complete block design (RCBD). Each of the plots was 3 m by 4m with an alley of 0.5 m between plots and 1 m between replications. The land was cleared and ridged manually; cow dung was incorporated and allowed to decompose for a period of two weeks before sowing. Sowing of okra was carried out manually, (three seed per hole) on rows to 3cm depth at spacing of 25 cm by 75 cm within and between rows. Weeding were manually at three weeks intervals.

The following growth parameters were measured at two weeks intervals after sowing: plant height and leaf area,yield parameters were pod length, diameter and total pod weight.

Cow dung was collected from the cattle section of the Teaching and Research farm, Federal University Wukari. The sample collected was air dried and grinded to a powder form using crusher into fine particles before incorporation into the soil. It was analyzed for pH, organic carbon (OC), Nitrogen (N), Phosphorus (P), Potassium (K), Magnesium (Mg), Calcium (Ca) and Sodium (Na).

Surface (0 – 20 cm) soil samples were taken over each site before start of experiment. The samples were bulked and air-dried for analysis. After the experiment, samples were taken again per plot for routine analysis as described by Carter (1993). Organic matter (O.M) was determined by Walkley-Black dichromate digestion method (Nelson and Sommers, 1982) and total soil nitrogen was determined by the kjeldahl method (Bremner and Mulvancy, 1982). Available P was determined by Bray-1 method and colour was developed in soil extracts using the ascorbic and acid blue colour method (Murphy and Riley, 1962). Exchangeable K, Ca and Mg were extracted using ammonium acetate. K was determined on flame photometer and Ca and Mg by EDTA titration. The soil pH in 0.01 M $CaCl_2$ was determined using a glass electrode.

Data collected was subjected to analysis of variance after which means that shows significant F-test values was separated using the Duncan Multiple Range Test (DMRT) at 5% level of probability.

RESULT AND DISCUSSION

Table 1 shows the nutrient analyses for poultry manure used. Nutrients analysis of poultry manure used is also presented in Table 1. The routine analysis reveals that cow dung values for N, P, K, Ca and Mg were adequate for the growth of vegetable crop such as okra.

Table 1 Cow dung analysis

Parameters	2021	2022
pH (H_2O)	7.00	6.98
OC (%)	0.12	0.13
Total N (%)	2.03	2.08
Available P (mg kg^{-1})	8.79	8.68
K (cmol kg^{-1})	0.38	0.36
Ca (cmol kg^{-1})	3.90	3.87
Mg (cmol kg^{-1})	0.66	0.65
Na (cmol kg^{-1})	0.29	0.31

Effect of Cow dung on plant height

The cow dung application did not have a significant effect on plant height at two weeks of growth after sowing (Table 2).Since organic fertilizer constitutes a slow release source of plant nutrients (Nevens and Reheul, 2003; Chaoui *et al.,* 2003) this could have affected the growth of the plants in the first two weeks hence the non-significant treatment effect. However, at week four after sowing a significant difference emerged. From week four to eight cow dung had a positive influence on the plant height. The tallest plants were observed in the application of 12 t ha^{-1} but statistically similar to the application of 10 t ha^{-1} and significantly different from other application rates. There was significant increase in okra plant height on the plots treated with organic manure, this progression conforms to findings of Aniefiok (2013) who reported that poultry manure increases plant height. The increase in height of plants amended with organic manure is probably due to release of nutrients which promoted vigorous plant growth through efficient photosynthesis (Iqtidar *et al.,* 2006). The control (0 t ha^{-1}) recorded the shortest plant height and statistically lowers than other applications. Organic manure improves the moisture level, aeration and temperature of the soil and therefore facilitates plant growth, which in turn increases plant height (Agrawal *et al.*, 2003). These results were similar to the work of Gul *et al.*,(2021) which reported that application of organic manure tends to promote higher plant height. It is also in agreement with Onwu and Waizah (2023) that organic manure is a valuable fertilizer whose use needs to be encouraged as it showed significantly the vegetative growth parameter i.e. plant height. Application of organic manures results in increase the plant height, number of leaves per plant (Oad *et al.*, 2004)

Table 2 Effect of Cow dung on plant height (cm)

	Weeks after sowing							
	2		4		6		8	
Treatments	2021	2022	2021	2022	2021	2022	2021	2022
0 t ha^{-1}	14.68^{a}	14.85^{a}	34.6^{c}	36.87^{c}	56.98^{d}	61.91^{e}	75.24^{d}	77.87^{d}
6 t ha^{-1}	14.88^{a}	14.93^{a}	42.3^{b}	41.54^{b}	74.72^{c}	72.07^{d}	101.87^{c}	99.47^{c}
8 t ha^{-1}	15.44^{a}	15.31^{a}	44.48^{ab}	44.27^{ab}	80.11^{b}	78.44^{c}	108.95^{b}	106.65^{b}
10 t ha^{-1}	15.54^{a}	15.63^{a}	46.12^{a}	46.90^{a}	89.43^{a}	88.74^{b}	119.75^{a}	118.05^{a}
12 t ha^{-1}	16.13^{a}	16.16^{a}	46.83^{a}	46.93^{a}	93.37^{a}	95.64^{a}	120.75^{a}	121.49^{a}

Means followed by the same letter(s), within each column are not significantly different at P = 5%

Effect of Cow dung on Leaf Area

In Table 3, the effect of different application rates of cow dung on leaf area was significant at $p<0.05$. Leaf area differed significantly among the treatments from weeks 4 to 8 with plants amended with 12 t ha^{-1} of cow dung significantly increasing the leaf area as compared to the rest. This is in agreement with Bharadwaj and Nainawat (2003) who reported that organic fertilizer increased the leaf area of two wheat varieties compared to the control. The control (0 t ha^{-1}) showed the least leaf area and statistically lowers than all plots that received cow dung application. Nitrogen (N) is one of the main plant nutrients affecting plant growth and yield (Tafteh and Sepaskhah, 2012) and leaf area increase with increase in N level Oscar and Tollennar, 2006). "Increased leaf area in soil amended with organic fertilizer could probably be attributed to N availability which promoted leaf area during vegetative development and also helped to maintain functional leaf area during the growth period" (Cox *et al*., 1993).The nutrients from organic fertilizer support rapid root development (Abou El-Magd., *et al*., 2005) which might have enhanced leaf growth more than the control. Application of organic fertilizers probably increased nitrogen in the soil which positively affected leaf fresh weight and quality of the leaves because nitrogen stimulates plant vegetative growth and increases leaf area; as a result increment in the leaf area increases the rate of plant photosynthesis and thus higher leaf quality and leaf weight. This is in line with the findings of different studies elsewhere on spinach (Guiser, 2005). This is in agreement with the work done by Senjobi *et al.*, (2010) who reported that the use of organic manure (poultry, cow, goat, pig) improved all the growth parameters of leaf vegetables.

Table 3Effect of Cow dung on Leaf Area (cm^{2})

	Weeks after sowing							
	2		4		6		8	
Treatments	2021	2022	2021	2022	2021	2022	2021	2022
0 t ha^{-1}	49.66^{a}	49.12^{a}	118.82^{d}	112.00^{c}	171.23^{d}	162.10^{d}	248.43^{c}	255.89^{d}
6 t ha^{-1}	51.92^{a}	49.80^{a}	209.94^{c}	211.80^{b}	301.18^{c}	297.80^{c}	498.42^{b}	495.70^{b}
8 t ha^{-1}	52.35^{a}	51.84^{a}	223.89^{b}	225.00^{b}	352.81^{b}	337.50^{b}	532.61^{a}	526.50^{a}
10 t ha^{-1}	53.17^{a}	52.06^{a}	281.26^{a}	261.70^{a}	391.74^{a}	388.20^{a}	569.46^{a}	574.30^{a}
12 t ha^{-1}	53.58^{a}	52.84^{a}	294.61^{a}	292.30^{a}	403.28^{a}	411.90^{e}	571.22^{a}	569.20^{a}

Means followed by the same letter(s), within each column are not significantly different at P = 5%

Effect of Cow dung on yield parameters

The data pertaining to effect of cow dung upon fruit length clearly showed its significant effect (Table 4). The fruit length was observed significantly highest (12.83 and 12.44 cm in 2021 and 2022 respectively) under 12 t ha^{-1} treatment but the same with 10 t ha^{-1} and different from other treatments. The lowest fruit length (7.42 and 7.57 cm in 2021 and 2022 respectively) were recorded with control which was statistically lower than other treatments.

Among the different levels of cow dung 12 t ha^{-1} recorded maximum pod diameter of 2.11 and 2.14 cm in 2021 and 2022 respectively, followed by 10 t ha^{-1}, 8 t ha^{-1}, 6 t ha^{-1} and 0 t ha^{-1}. Organic manure improves the yield and quality of a plant (Yanar *et al.*, 2011). The control recorded the minimum pod diameter of 1.34 and 1.31 cm in 2021 and 2022 respectively and statistically lower than all the plots that received cow dung. Cow dung 12 t ha^{-1}affected pod diameter significantly and higher than all other treatments in 2021 but statistically the same with plots that received cow dung 10 t ha^{-1}in 2022.

Pod weights are also presented in Table 4. Cow dung had significant effect ($P<0.05$) on fresh pod weight in both seasons. In the two seasons, 10 and 12 t ha^{-1} of cow dung produced statistically similar fresh pod weight and significantly higher than other treatments. The control (0 t ha^{-1}) was found to produce significantly lowest fresh pod weight than other treatments. The higher fruit weight in these treatments might be due to accelerated mobility of photosynthetic from the source to the sink as influenced by the growth hormone, released or synthesized due to the organic sources of fertilizers (Susan, 1995). The findings of this study are in accordance with those of Mal *et al*. (2014) in okra. Dahama (2003) reported that "the favourable C/N ratio and optimal level of nutrients available from organic manure for longer period due to slow release might be the possible reasons to influence fruit yield of okra". Edward and Daniel (1992) reported that "the increase in vegetative growth, yield and yield attributing characters were mainly due to translocation of nutrients from organic manure and assimilation of photosynthetic activities during the crop growth stage". This is in agreement with Jagadeesha *et al* (2019) who reported that application of organic was found to be effective as it enhanced productivity of soil and crop yield

Table 4Effect of Cow dung on yield parameters

Treatments	Pod length (cm)		Pod diameter (cm)		Pod weight (kg ha^{-1})	
	2021	2022	2021	2022	2021	2022
0 t ha^{-1}	7.42^{d}	7.57^{d}	1.34^{d}	1.31^{c}	915.32^{d}	943.70^{d}
6 t ha^{-1}	9.32^{c}	9.73^{c}	1.86^{c}	1.95^{b}	1361.31^{c}	395.50^{c}
8 t ha^{-1}	11.46^{b}	11.30^{b}	2.04^{b}	2.05^{b}	1573.28^{b}	1566.30^{b}
10 t ha^{-1}	12.48^{a}	12.52^{a}	2.08^{b}	2.11^{a}	1852.56^{a}	1896.60^{a}
12 t ha^{-1}	12.83^{a}	12.64^{a}	2.11^{a}	2.14^{a}	1853.50^{a}	1845.82^{a}

Means followed by the same letter(s), within each column are not significantly different at P= 5%

Effect of cow dung on soil properties

Initial and post-harvest soils were analyzed to observe the pre and post-harvest nutrients status in soil (Table 5). The pH values of initial soil were6.04 and 6.05 organic carbon status were0.8and 0.8% in 2021 and 2022 respectively. Soil analysis showed that organic matter status and soil pH was lower in initial soil than the post-harvest sample except the control. Manure application resulted in significantly greater soil organic matter level and a positive organic matter balance in the soil. In a study to evaluate the effects of organic matter and nutrients in manure on soil organic matter dynamics and crop production, Eghball *et al*., (2002) reported “significantly greater soil organic matter level in plots treated with organic manure”. This agreed with Citak and Sonmez (2011) that “organic manure applications cause the soil pH and organic carbon to increase. Due to residual effect of organic manure the pH values were increased after harvest soil”.

The total N, available P, exchangeable K, Ca, Mg, Na and acidity values were higher after harvest soil than initial soil sample (Table 5). The results showed that organic manure applied improved soil chemical properties as compared to the control and initial soil analysis. This showed that the application of organic manures released nutrients into the soil following their degradation by soil biota. Agbede *et al.* (2017) and Kolawole *et al*.(2014) noted “significant improvement of soil chemical properties such as pH, N, OM, P, K, Mg and CEC on application of organic in West African soils”. This is in conformity with Si Ho Han *et al* (2016) that “organic manure increased soil pH, the concentrations of nitrogen, phosphorus, and major cations”. The ability of organic manures to increase soil pH was studied by Duruigbo *et al* (2007) who related it to the presence of base cations contained in these organic manures. Soil nutrient levels were higher in plots amended with cow dung which might be as a result of the good chemical composition of the manure. “The application of organic manure to the soil may have improved soil fertility and soil structure, increased soil organic matter and enhanced microbial activity” (Rehman *et al.*, 2010; Kundu *et al.*, 2007). “Increased organic matter in the soil from application of poultry manure, cow dung and compost improved both soil physical and chemical properties compared to the control” (Ofosu-Anim *et al.*, 2006). “Application of organic manures improved soil physical and chemical properties by lowering soil bulk density, increasing total porosity, water holding capacity, soil pH, organic matter, available P, total N, CEC and exchangeable nutrients (K, Ca and Mg), and exhibited high soil quality index" (Eloi *et al.*, 2022). "The application of organic manure increased levels of cations in soils and helped to neutralize soil acidity. Thus, organic manure treatments maintained a high soil pH, and protonation of organic anions to form central molecules was the main mechanism to resist soil acidification" (Shi *et al.*, 2019).

Table 5 Initial and post-harvest soils analysis

Treatments	pH	OC	N	P	K	Ca	Mg	Na	Exch Acidity	Sand	Silt	Clay
	H_2O	—(%)—		mg kg^{-1}	————	cmol kg^{-1}	————			———	%	———
					2021 cropping season							
Initial	6.04	0.80	0.03	7.76	0.21	4.02	0.81	0.17	0.08	70.60	11.00	18.40
0 t ha^{-1}	6.02	0.71	0.03	7.63	0.22	4.40	1.02	0.21	0.07	69.60	10.00	18.40
6 t ha^{-1}	6.41	1.02	0.12	10.64	0.27	4.50	1.42	0.21	0.13	70.60	9.00	20.40
8 t ha^{-1}	6.46	1.60	0.17	11.71	0.28	4.50	1.43	0.22	0.15	65.60	12.00	22.40
10 t ha^{-1}	6.63	1.65	0.18	12.16	0.27	4.60	1.44	0.23	0.16	71.60	10.00	18.40
12 t ha^{-1}	6.65	1.80	0.18	12.34	0.28	4.61	1.47	0.22	0.15	70.60	11.00	18.40
					2022 cropping season							
Initial	6.05	0.80	1.24	7.76	0.29	4.20	0.81	0.27	0.05	18.40	2.00	79.60
0 t ha^{-1}	6.03	0.90	0.14	11.63	0.27	4.40	0.82	0.21	0.05	38.40	2.00	59.60
6 t ha^{-1}	6.46	1.02	0.15	11.64	0.27	4.50	0.82	0.21	0.05	24.40	2.00	73.60
8 t ha^{-1}	6.51	1.60	0.18	11.71	0.28	4.50	0.83	0.22	0.05	42.40	2.00	55.60
10 t ha^{-1}	6.63	1.10	0.20	12.06	0.27	4.60	0.81	0.23	0.05	12.40	6.00	81.60
12 t ha^{-1}	6.67	0.80	0.14	11.64	0.28	4.50	0.81	0.22	0.05	18.40	4.00	77.60

CONCLUSION

Based on the finding of this study, it may be concluded that, the used of cow dung in crop production is desirable as it had variable impacts on the growth and yield of okra. The used of cow dung will improve soil organic matter status, nutrient availability and good crop yield as well as ensures soil restoration and sustainability effects on soil. The cow dung is cheap, more easily accessible and available. It is a good alternative to chemical fertilizer and has soil restoration effect. Therefore it is advisable to use cow dung 10 to 12 t ha^{-1} for the production of okra and soil sustainability.

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