

# Assessment of soil chemical properties and pod yield of okra (*Abelmoschus esculentus*) as influenced by farm yard manure and urea in Southern Guinea Savannah agro-ecology of Nigeria

Terhide Samuel Ter<sup>1\*</sup> and Terkula Joseph Maga<sup>2</sup>

<sup>1</sup>Department of Soil Science, Joseph Sarwuan Tarka University, Makurdi, Benue State, Nigeria.

<sup>2</sup>Department of Plant Breeding and Seed Science, Joseph Sarwuan Tarka University, Makurdi, Benue State, Nigeria.

\*Corresponding author. Email: [terterhide@gmail.com](mailto:terterhide@gmail.com)

Copyright © 2023 Ter and Maga. This article remains permanently open access under the terms of the [Creative Commons Attribution License 4.0](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Received 28th November 2022; Accepted 19th December 2022

**ABSTRACT:** Plant and animal debris are fast becoming an environmental hazard in many urban, semi-urban and rural settlements in most parts of the tropics. This is due to the poor management of this debris in the environment. Plant and animal remains if properly managed will be a rich farm resource. Therefore, a field trial was conducted in Makurdi in the 2021 cropping season to study the effects of farm yard manure (FYM) and urea fertilizer on selected chemical properties of soil and yield of okra. The experiment consisted of nine treatments; control, 2.0 t/ha FYM, 3.5 t/ha FYM, 5.0 t/ha FYM, 15 kgN/ha, 30 kgN/ha, 2.0 t/ha FYM + 15 kgN/ha, 3.5 t/ha FYM + 15 kgN/ha, and 5.0 t/ha FYM + 15 kgN/ha. The design of the experiment was a randomized complete block design in three replications. The results show that the sole application of inorganic fertilizer lowered soil pH and organic matter content. Manure application either as sole (i.e 2.0 t/ha or 3.5 t/ha or 5.0 t/ha) or mixed with inorganic fertilizer (i.e 2.0 t/ha FYM +15kgN/ha, or 3.5t/ha FYM+15kgN/ha, or 5.0 t/ha FYM+15kgN/ha), increased soil pH and concentrations of nutrient elements in the soil. Similarly, pod yield was significantly affected by manure and inorganic fertilizer; the highest number of pods yield and weight (12 and 613 kg/ha respectively) were obtained from 30 kg N/ha. This was followed by yield obtained from manure plus NPK (611kg/ha) at 5.0 t/ha FYM + 15 kgN/ha. Notwithstanding pod yield obtained at 30 kgN/ha, the study reveals that combined use of farm yard manure and urea fertilizer improves the concentration of nutrients in the soil and enhances yield of okra in the study area.

**Keywords:** Farm yard manure, NPK, organic matter, okra.

## INTRODUCTION

As in most parts of sub-Saharan Africa, population growth in Nigeria has been on the rise, with a population of 100 million in 1988, Nigeria's population is estimated to be above 200 million (NBS, 2017). The continuous growth in population has raised the demand for food supply which can only be achieved if crop yield per unit area of land is enhanced considering that land is fixed. In recognition of this challenge farm yard manure which hitherto, was used to enhance soil nutrient supply to crops was substituted by mineral fertilizer (Aduayi *et al.*, 2002). The use of mineral fertilizer assured timely and greater percentages of

nutrient elements supply to crops when applied and presented a much more reliable source of nutrients for high-yielding and improved crop varieties.

However, the successes recorded by mineral fertilizer have been eclipsed by the deleterious consequence of the commodity on the soil environment (Agboola, 1975; Juo *et al.*, 1995; Awodun *et al.*, 2007). Conversions among stakeholders in the farm sector suggest that there is an inclination towards the incorporation of manure to overcome the inherent challenges associated with mineral fertilizer (Ayeni *et al.*, 2008). The use of farm yard manure

as a farm input is a common traditional agricultural practice and the successes associated with it is well documented; the ability of farm yard manure to supply organic carbon, key crops elements, nitrogen, phosphorus and sulphur is well recognized (Makinde *et al.*, 2001). Also, manure is a good source of exchangeable cations (K, Mg, Ca and Na). Manure provides good soil structure, soil water retention, temperature regulation etc. (Agboola, 1975). Despite the benefits derived from the use of farm yard manure, most farmers in Nigeria still prefer to use inorganic fertilizers without the incorporation of manure (Agbede and Adekiya, 2012). Although, farm yard manure exists in large quantities in most communities in Nigeria, its usage has not been widely adopted as most livestock keepers engage in indiscriminate disposal of this rich farm resource and thus causing environmental pollution. With the global community focusing attention on the use of organic inputs for crop production, it expedient to stir farmers' interest in the suitability of farm yard manure as an essential farm input.

Okra is grown in Nigeria for its nutritional value. The plant is rich in vitamins, minerals, calories and amino acids (Shahriazzaman *et al.*, 2014). Like most crops, okra requires nitrogen, phosphorus and potassium for optimum growth and yield. Although, the quantity of nutrients required may vary with crop variety and the soil conditions of a given area. In Makurdi, okra is cultivated by smallholder farmers who erroneously think that the crop does not require fertilizer application for optimum yield. Thus, this trial was conducted to test the efficacy of complimentary application of farm yard manure and urea in enhancing the concentration of soil nutrients and yield of okra in Makurdi, Nigeria.

## MATERIALS AND METHODS

The field trial was conducted in Commercial Crops Farm, Federal University of Agriculture, Makurdi, Nigeria under rain fed condition, in 2019 cropping season. The site location was within latitude 7°44N and longitude 8°37E at an elevation of 97 m above sea level. The average amount of annual rainfall varies from 1137 to 1470 mm.

### Treatments and experimental design

The experiment consisted of nine treatments as stated below:

1. Control
2. 2.0 t/ha FYM
3. 3.5 t/ha FYM
4. 5.0 t/ha FYM
5. 15 kgN /ha
6. 30 kgN /ha
7. 2.0 t/ha FYM +15 kgN/ha
8. 3.5 t/ha FYM +15 kgN/ha
9. 5.0 t/ha FYM +15 kgN/ha

The treatments were laid out in randomized complete block design (RCBD) in three replications.

### Land preparation and sowing

Land preparation was effected using traditional implements, land was cleared using cutlass. Ridges were constructed using hoes. The unit plot size was 4 m x 3 m. A plant spacing of 0.75 m by 0.5 m was adopted resulting in a total of 32 plants per plot.

### Data collection and analysis

#### Soil properties

Before the commencement of land preparation, surface (0-5cm) soil samples were randomly collected from 10 points and bulked. The soil samples were analysed for soil pH, organic matter (OM), total nitrogen (N), available phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and sodium (Na), using the procedure outlined by Anderson and Henderson (1986).

#### Farm yard manure (FYM) analysis

The farm yard manure used for the experiment was air-dried and grounded to pass through a 2 mm sieve. The FYM was analysed for pH, using pH meter, Nitrogen was determined using the Macro Kjeldal method of Isaac and Johnson (1985), and total P by the H<sub>2</sub>SO<sub>4</sub> digestion method (Mehra *et al.*, 1954). Ca and Mg were determined using Atomic Absorption Spectrophotometer (AAS) while K and Na were determined using flame photometer.

#### Crop data

Two crop parameters were obtained at harvest, the number of pods yield per plant and the weight of pods (kg/ha).

#### Statistical analysis

The crop yield data were subjected to statistical analysis of variance and means that indicated statistical difference were separated using Fisher's Least Significant Difference (Gomez and Gomez, 1984).

## RESULTS AND DISCUSSION

### Properties of the soil before sowing

The data presented in Table 1 indicates that the soil N was 0.06%, available P was 7.5 mg kg<sup>-1</sup> and K contents of the soil was 0.16 cmol/kg. Like most soil in the tropics, N, P and K fell below the critical values (>0.15%, >10.0 mg/kg and 0.28 cmol/kg respectively) suggested for optimum

**Table 1** Properties of soil before land preparation and chemical composition of FYM.

Parameter	Soil	FYM
Sand (%)	81.1	-
Silt (%)	5.6	-
Clay (%)	13.3	-
pH (H <sub>2</sub> O 1:1)	6.4	-
pH (0.01 N CaCl <sub>2</sub> 1:2)	5.6	-
Organic matter (%)	2.02	-
Organic carbon (%)	1.14	-
Total nitrogen (%)	0.06	5.18
Available P(mg/kg)	7.50	1 0.98
Mg (cmol kg <sup>-1</sup> )	0.30	0.41
Ca (cmol kg <sup>-1</sup> )	1.55	2.08
Na (cmol kg <sup>-1</sup> )	0.32	-
K (cmol kg <sup>-1</sup> )	0.16	3.53
CEC (meq 100 g <sup>-1</sup> )	2.01	-

**Table 2.** Properties of soil as affected by treatment.

Treatment	pH(H <sub>2</sub> O)	OM (%)	N (%)	Avail.P (mg/kg)	K (cmol/kg)	Mg (cmol/kg)	Ca (cmol/kg)	Na (cmol/kg)	CEC (cmol/kg)
Tr <sub>1</sub>	6.38	2.00	0.04	7.47	0.14	0.27	1.52	0.30	1.93
Tr <sub>2</sub>	6.46	2.04	0.16	7.58	0.16	0.32	1.52	.032	2.00
Tr <sub>3</sub>	6.65	2.18	0.19	9.17	0.20	0.38	1.60	0.32	2.18
Tr <sub>4</sub>	6.68	3.77	0.23	9.90	0.23	0.38	1.98	0.34	2.59
Tr <sub>5</sub>	6.38	2.02	0.04	7.39	0.14	0.27	1.45	0.27	1.86
Tr <sub>6</sub>	6.35	2.04	0.06	7.50	0.13	0.27	1.45	0.27	1.85
Tr <sub>7</sub>	6.44	2.27	0.09	7.55	0.13	0.30	1.61	0.30	2.04
Tr <sub>8</sub>	6.48	2.81	0.15	7.86	0.21	0.36	1.68	0.33	2.25
Tr <sub>9</sub>	6.51	2.81	0.23	9.98	0.21	0.38	1.76	0.33	2.35

**Key:** Tr<sub>1</sub> = Control, Tr<sub>2</sub>= 2.0t/ha, Tr<sub>3</sub>=3.5t/ha. Tr<sub>4</sub>=5.0t/ha, Tr<sub>5</sub>= 15 Kg N/ha, Tr<sub>6</sub>=30KgN/ha, Tr<sub>7</sub>=2.0 t/ha +15KgN/ha, Tr<sub>8</sub> = 3.5 t/ha +15kg N/ha, Tr<sub>9</sub> = 5.0 t/ha +15KgN/ha.

crop yield in Nigeria (FFD, 2011). However, Ca in the soil was relatively high above the critical value (>1.5 cmol/kg) for crops as suggested by Akinrinde and Obigbesan (2000) indicating that Ca supply in the soil was not a constraint to crop yield in the study area. The low compositions of N, P and K of the soil in the study area agrees with the study by FFD (2011) which observed that, soils in the tropics were highly degraded and to achieve sustainable and optimum crop yield, external soil nutrients inputs must be introduced.

#### Chemical composition of farm yard manure

The composition of nutrient elements in the FYM used to supply nutrients to the soil of the study area is presented in Table 1. It was observed that the manure had relatively high concentration of nutrients element which could boost crop yield when incorporated in the soil.

#### Post-harvest properties of soil

The chemical properties of soil as affected by treatment are summarized in Table 2. FYM at 3.5 and 5.0 t/ha showed great influence on the chemical properties of soil after harvest. The soil pH was improved (6.64-6.8) in all plots in which FYM was incorporated. The baseline pH values control were below the values obtained where manure was applied as sole or mixed with mineral fertilizer. Similarly, manure improved the SOM (2.02–2.81%) and concentrations of; N (0.06–0.23), P (7.5–9.90 mg/kg), K (0.16–0.23 cmol/kg), Ca (1.55–1.98 cmol/kg), Mg (0.30–0.38 cmol/kg) and Na (0.32–0.34 cmol/kg) ions in the soil. The combined use of FYM and mineral fertilizer increased the chemical composition of soil as compared to control and non-manure treatments. Organic fertilizers derived from plant and animal sources have been reported to significantly increase soil organic matter (SOM), as well as supply nutrient elements to the soil Vanlauwe *et al.* (2001).

**Table 3.** Effect of fertilizer treatments on pods yield.

Treatment	No. of pods per plant	Weight of pods/plant (g)	Fresh Wt of pods (kg/ha)
Tr <sub>1</sub>	10.0	167.3 <sup>a</sup>	480.0 <sup>a</sup>
Tr <sub>2</sub>	10.0	183.7 <sup>b</sup>	502.0 <sup>ab</sup>
Tr <sub>3</sub>	10.0	197.3 <sup>b</sup>	525.0 <sup>bc</sup>
Tr <sub>4</sub>	11.0	201.9 <sup>bc</sup>	547.0 <sup>cd</sup>
Tr <sub>5</sub>	12.0	208.2 <sup>bc</sup>	560.0 <sup>d</sup>
Tr <sub>6</sub>	12.0	216.0 <sup>c</sup>	613.2 <sup>e</sup>
Tr <sub>7</sub>	11.0	204.9 <sup>bc</sup>	571.1 <sup>d</sup>
Tr <sub>8</sub>	12.0	209.6 <sup>bc</sup>	601.3 <sup>e</sup>
Tr <sub>9</sub>	12.0	211.1 <sup>bc</sup>	611.3 <sup>e</sup>
LSD (0.05)	NS	17.14	25.83

Mean with same alphabet are statistically the same at 5% level. **Key:** Tr<sub>1</sub> = Control, Tr<sub>2</sub> = 2.0t/ha, Tr<sub>3</sub> = 3.5t/ha, Tr<sub>4</sub> = 5.0t/ha, Tr<sub>5</sub> = 15 Kg N/ha, Tr<sub>6</sub> = 30KgN/ha, Tr<sub>7</sub> = 2.0 t/ha +15KgN/ha, Tr<sub>8</sub> = 3.5 t/ha +15kg N/ha, Tr<sub>9</sub> = 5.0 t/ha +15KgN/ha.

Sole application of mineral fertilizer and zero fertilizer treatments had lower soil pH and depleted organic matter (OM) as can be seen in Table 3. This validates the importance of manure as a necessary farm input for sustainable crop production in the study area. Vanlauwe *et al.* (2007) and Agbede and Adekiya (2012) also reported that a combination of manure and inorganic fertilizer is a sound fertilizer management strategy particularly, among smallholder farmers in the tropics where fertilizers either organic or inorganic are grossly inadequate.

#### Effect of fertilizer on pods yield

The number of pods yield per plant and weight of pods (kg/ha) was significantly ( $p < 0.005$ ) affected by manure and fertilizer application (Table 3). The lowest number of pods yield was obtained from control plots while the highest number of pod yields per plant and weight per hectare (12 and 613 kg/ha respectively) were obtained from the application of mineral fertilizer at 30 kgN/ha. This was followed by yield (611 kg/ha) obtained from manure plus NPK (i.e 5.0 t/ha +15 kg N/ha). Although the highest yield was obtained with inorganic treatment, there was no significant ( $p < 0.005$ ) difference when compared with the yield obtained with manure plus inorganic fertilizer at all levels of combination.

The use of fertilizer input to increase the yield of crops per unit area of land has long been adopted into conventional agriculture. Pavan *et al.* (2004) and Shahriazzaman *et al.* (2014) reported an increase in the number of pods yield of okra upon poultry manure incorporation as nutrients source. The yield increase of okra with fertilizer inputs could be attributed to the fast sustainable release of plant nutrients from combined manure and inorganic fertilizer which was absorbed by the plants to facilitate plant growth and yield.

#### Conclusion

The study concludes that combined use of FYM and

inorganic fertilizer is essential for sustainable growth of okra in the study area. It was observed that the yield obtained from sole inorganic fertilizer was highest but with attendant deleterious consequences on the soil as evident in low soil pH and organic matter. Therefore, incorporation of farm yard manure plus inorganic fertilizer should be adopted for sustainable cropping of okra in the study area.

#### CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

#### REFERENCES

- Aduayi, E. A., Chude, V. O., Adebuisi, B. A., & Olayiwola, S. O. (2002). *Fertilizer use and Management Practices for Crops in Nigeria* (3rd edition) Federal Fertilizer Department, Federal Ministry of Agriculture and Rural Development Abuja. Pp. 47-48.
- Agbede, T. M., & Adekiya, A. O. (2012). Effects of poultry manure and soil fertility, growth and yield of white yam and yellow yam. *Journal of Agricultural Sciences* 20(3), 286-303.
- Agboola, A. A. (1975). Problems of improving soil fertility by the use of green manure in the tropical farming system. In: *Organic materials as fertilizers*. Report of an expert consultation, Rome 2, December 1974: Food and agriculture organization /Swedish international development agency, Rome, Italy. Pp. 147-163.
- Akinrinde, E. A., & Obigbesan, G. O. (2000). Evaluation of the fertility status of selected soils for crop production in five ecological zones of Nigeria. In: Babalola, O. (ed.). *Proceedings of the 26th Annual Conference of Soil Science Society of Nigeria*; 2000 Oct 30–Nov 3. Ibadan, Nigeria. Pp. 279-88.
- Anderson, D. L., & Henderson, L. J. (1986). Sealed chamber digestion for plant nutrient analyses 1. *Agronomy Journal*, 78(5), 937-939.
- Awodun, M. A., Omonijo, L. I., & Ojeniyi, S. O. (2007). Effect of goat dung and NPK fertilizer on soil and leaf nutrient content, growth and yield of pepper. *International Journal of Soil Science*, 2(2), 142-147.
- Ayeni, L. S., Adetunji, M. T. & Ojeniyi, S. O. (2008). comparative nutrient release from cocoa pod ash, poultry manure and NPK

- 20:20:20 fertilizer and their contributions incubation study. *Nigeria Journal of Soil Science*, 11, 114 -123.
- Federal Fertilizer Department (FFD) (2011) Fertilizer Use and Management Practices for Crop Production in Nigeria (4th edition). Abuja Nigeria: Federal Ministry of Agriculture and Rural Development. Pp. 1-300.
- Gomez, K. A., & Gomez, A. A. (1984). *Statistical Procedure for Agricultural Research* (2nd edition.). International Rice Research Institute Pp. 28-192.
- Isaac, R. A., & Johnson, W. C. (1985). Elemental analysis of plant tissue by plasma emission spectroscopy: collaborative study. *Journal of the Association of Official Analytical Chemists*, 68(3), 499-505.
- Juo, A. S. R., Dabiri, A., & Franzluebbers, K. (1995). Acidification of a kaolinitic Alfisol under continuous cropping with nitrogen fertilization in West Africa. *Plant and Soil*, 171(2), 245-253.
- Makinde, E. A., Agboola, A. A. & Oluwatoyinbo, F. I. (2001). The effects of organic and inorganic fertilizer on growth and yield of maize / melon inter crop, Ibadan Nigeria. *Moor Journal of Agriculture Research*, 2(11), 15-19.
- Mehra, N. O., Legg, J. C, Goring, C. A. I., & Black, C. A. (1954). Determination of organic phosphorus in soil:1. Extraction methods. *Soil science society of America proceedings*, 18, 443-449.
- National Bureau of Statistics (NBS) (2017). Demographic statistics bulleting. August, 2018.
- Pavan, Y., Singh, P., Yadav, R. L., & Ram, L. (2004). Organic manures and nitrogen levels on okra cv. Varsha Uphar. *Haryana Journal of Horticultural Sciences*, 33(1/2), 124-126.
- Shahriazzaman, M. C., Mazed, H. E. M. K., Pulok, M. A. I., Mehraj, H., & Uddin, A. F. M. (2014). Response of organic manures on growth and yield of okra (*Abelmoschus esculentus* L.). *Journal of Science, Technology & Environment Informatics*, 1(2), 60-67.
- Vanlauwe, B., Tiftonell, P., & Mukalama, J. (2007). Within-farm soil fertility gradients affect response of maize to fertiliser application in western Kenya. In *Advances in integrated soil fertility management in sub-Saharan Africa: Challenges and opportunities* (pp. 121-132). Springer, Dordrecht.
- Vanlauwe, B., Wendt, J., & Diels, J. (2001), 'Combined application of organic matter and fertilizer. In: Tian, G., Ishida, F., and Keatinge, J. D. H. (eds.). *Sustaining soil fertility in West-Africa*. SSSA Special Publication Number 58, Madison, WI. Pp. 247-280.