

**Research Article**
**Open Access**

## Assessment of Soil Nutrients Enhancement by organic NPK® (compost) and Urea under Sesame (*Sesamum indicum* L.) Cultivation in Makurdi, Nigeria

T.S. Ter\*, E.T. Ali and O.F. Olatunji

Department of Soil Science, Federal University of Agriculture, P.M.B.2373, Makurdi, Nigeria

### ABSTRACT

In Nigeria, soil nutrient losses occasioned by inappropriate land uses are negatively impacting on food security for the growing population. The escalating cost of mineral fertilizers has limited the use of the commodity by smallholder farmers who produces most of the food consumed in the country. In this context, the use of organic materials as a soil amendment is critical to optimized crop yield per unit area of land. This experiment examined soil nutrient enhancement using organic NPK® and urea under sesame cultivation in Makurdi, Nigeria. The result from the study showed that, application of organic NPK® improves soil organic matter content and raises soil pH, total Nitrogen, available Phosphorus, and exchangeable cations. Similarly, seed weight of sesame positively correlated with manure and urea. It was deduced that yield obtained by addition of organic NPK® at 400kg/ha was statistically the same with yield obtained from urea at 150 kg/ha. This result implies that organic NPK® is a suitable substitute for fertilizer urea for sustainable cultivation of sesame.

### \*Corresponding author

TS TER, Department of Soil Science, Federal University of Agriculture, P.M.B.2373, Makurdi, Nigeria. E-mail: terterhide@gmail.com

**Received:** February 26, 2022; **Accepted:** March 10, 2022; **Published:** March 15, 2022

**Keywords:** Soil pH, Organic Amendment, Nutrient Loss, Sesame

### Introduction

The gradual decline in yield per unit area of land as witnessed in some major food such as sweet potatoes, cocoyam, maize, soybeans, sorghum, millet, sesame etc has been a major concern to many governments in the sub-Saharan countries. This condition has been attributed to; low level of irrigation farming, environmental constraints, and low farm inputs, low adaptation of modern farming techniques among other socio-economic challenges [1]. According to FAO report, Nigeria's agricultural import stood at N3.35 trillion as against import of N803 billion

This report was affirmed by the National Bureau of Statistics report of 2014 which indicated that crop productivity in Nigeria is inefficient and poor performing because a unit input employed in the production process does not yield its highest possible level of output. Unfortunately, Nigerian agriculture is characterised by peasant farming with low level of technology, poor infrastructure, low fertilizer inputs etc. [2]. stated that modern farming technology are either not accessible or simply not economical to adopt by peasant farmers. The management of soil fertility is also, a limitation to crop productivity in the sub Saharan region.

[3]. alluded that the inability of farmers to replenish nutrients lost in the intensive cultivation which has replaced the traditional bush fallow system remains a major limitation to soil fertility improvement and crop yield. Continuous cropping of cereals using chemical fertilizers as the main source of nutrients can lead to significant decline in yields after only a few years of cropping due to soil acidification, compaction and loss of soil organic matter [4].

Improving the physical, chemical and biological properties of the soil require incorporation of nutrients resource from traditional and modern sources. The options could be by incorporation of organic materials in a cropping system that responds to low soil fertility and other environmental stresses. Organic manures have been proven to enhance efficiency and reduce the need for chemical fertilizers, to improve the soil fertility and soil health [5]. Because organic matter contributes to improve soil properties, addition of organic matter generally results to increase soil productivity.

The use of organic manure as a nutrient source by farmers is at a low rate as most farmers still prefers chemical fertilizer; the resultant effect is undesirable soil structure. This has been attributed to several factors; handling of the organic manure, the quantity required by specific crops, etc. Generally, there is paucity of information to peasant farmers on the efficacy of manure in the production of some arable crops. This study was thus carried out to assess the efficiency of organic manure to replenish nutrient loss under sesame cropping system in Makurdi, Nigeria.

### Material and Methods

The field trials were conducted at the Teaching and Research Farm, University of Agriculture, Makurdi, in 2018 and 2019 cropping seasons under rain-fed condition. The area falls within latitude 7° 41' N and longitude 8° 37' E, at an elevation of about 97 meters above sea level in the Southern Guinea Savanna Agro- Ecological Zone of Nigeria. The area has two distinct seasons; wet and dry; the wet season starts from April and ends in October with mean annual rainfall of 1250 mm and mean temperature of 32°C. The soil at the site of the experiment classified as Alfisols.

## Treatments and Experimental Design

The treatments were:

- I. Control
- II. Compost at 0.2 t/ha
- III. Compost at 0.3 t/ha
- IV. Compost at 0.4 t/ha
- V. Urea at 150 Kg/ha

The treatments were laid in Randomized Complete Block Design (RCBD) and replicated three times.

## Routine Soil Analysis

Before commencement of land preparation, surface (0-15 cm) soil samples were collected at eight different points with the aid of a soil auger using random sampling method. The samples were bulked for analysis. The soil samples were air dried, ground and pass through 2 mm sieve and taken for routine soil analysis in the laboratory as follows; Soil pH was determined in a 1:1 soil-water suspension by the glass electrode method, particle size analysis by the hydrometer method of [6]. In which sodium hexametaphosphate (calgon solution) was used as dispersing agent. Total organic carbon was by chromic acid oxidation procedure of Walkley and [7]. Total nitrogen was determined using the procedure described by Anderson and [8]. The Molybdenum-blue method as described by was used to determine available phosphorus. Exchangeable bases were determined by the neutral ammonium acetate saturation. Na and K in the extracts were determined by the flame photometer while Ca and Mg were determined using Atomic Absorption Spectrophotometer (AAS), exchange acidity by the 1 M KCl extraction and 0.01M NaOH titration. Effective cation exchange capacity was determined by summation of exchangeable bases and acidity. This procedure was repeated after harvest with soil sample obtained in each treatment and analysed independently.

## Land preparation and planting

The land preparation was carried out by conventional method. Thereafter, manure was ploughed into the soil before sesame (local variety) was planted by broadcasting the seed at the seed rate of 10Kg/ha.

## Crop Data and Analysis

The number of pods per plant and weight of grain yield was measured at harvest. These data collected were subjected to analysis of variance (ANOVA) and the means that were statistically different were separated using Fisher's least significant difference (F-LSD) at 5% level of probability [9].

## Results and Discussion

### Properties of the Soil at the Experimental Site

Some selected properties of the soil at the experimental site are presented in Table 1. pH values were 6.01 and 5.98 in 2018 and 2019 cropping seasons respectively, indicating that the soil was slightly acidic and would require amendment if crop production will be sustained. Clay content was 13.60% and 13.37% for 2018 and 2019 respectively. The soils at the experimental site were sandy loam. Organic matter content varied from 0.90% and 0.89% in the two cropping seasons. The total nitrogen (N) was 0.02% and 0.04. Phosphorus (P) was 2.30 mg/kg and 2.31 mg/kg. The soil was generally low in both nitrogen and phosphorus content as with most soils in sub Saharan countries.

This may be due to nutrient loss experienced as a result of leaching or erosion arising from poor farm practice without correspondence nutrients inputs to replace the nutrient loss. The result agree with

several authors [10,12,5,13]. Who observed that most soils in the sub Saharan countries are low in essential plants nutrients. The exchangeable cations were; K (0.24 and 0.26 Cmol/kg), Ca (3.01 and 3.60 Cmol/kg), Mg (0.80 and 1.06 Cmol/kg), Na (0.27 and 0.28) during the two cropping seasons respectively. The results also indicated that effective cation exchange capacity (ECEC) of the soils were low 6.42 Cmol/kg and 5.25 Cmol/kg in 2018 and 2019 respectively indicating that soil amendment was needed to optimized yield per unit area of land.

**Table 1: Soil Properties of the Experimental Site before Planting**

Soil parameters 0-15 cm	2018	2019
Sand (%)	75.90	77.50
Silt (%)	10.50	09.53
Clay (%)	13.60	12.97
Textural class	SL	SL
pH (H <sub>2</sub> O)	6.11	5.98
pH(KCl)	5.67	5.03
Organic matter (%)	0.90	0.89
Total nitrogen (%)	0.02	0.04
Phosphorus (mg/kg)	2.73	4.01
K (cmol kg <sup>-1</sup> )	0.24	0.26
Ca (cmol/kg <sup>-1</sup> )	3.01	3.60
Mg (cmol kg <sup>-1</sup> )	0.80	1.02
Na (cmol kg <sup>-1</sup> )	0.27	0.28
EA	1.01	0.09
ECEC (cmol kg <sup>-1</sup> )	6.42	5.25

SL= sandy loam, EA= effective acidity

### Properties of Compost

The nutrient composition of compost used in the experiment is presented in Table 2. The results indicate that pH of compost is neutral and has reasonable amount of organic matter and nutrient content. These values are indicators that compost when use as soil amendment will reasonably enhance the fertility status of the soil.

**Table 2: Chemical Composition of Organic NPK® (Compost) Used For the Experiment**

Parameters	Compost
Organic matter (%)	48.65
Total nitrogen (%)	8.20
Phosphorus (mg/kg)	6.12
K (cmol kg <sup>-1</sup> )	3.80
Ca (cmol kg <sup>-1</sup> )	13.28
Mg (cmol/kg <sup>-1</sup> )	8.13
Na(cmol/kg <sup>-1</sup> )	0.98

### Effects of Compost and Urea of Soil Properties

Tables 3 and 4 shows the properties of soil as affected by compost during the two cropping seasons; the soil pH was lowest (6.01 and 5.85 in 2018 and 2019 respectively) in zero manure plots in the two cropping seasons. Similarly, urea application lowered soil pH (6.10 and 5.6) as can be deduced from the Tables. Compost manure application increased soil pH levels with compost at 400 kg/ha returning the highest soil pH (6.38 and 6.90). This could be attributed to the displacement of Al<sup>3+</sup> and H<sup>+</sup> by Ca<sup>2+</sup> content

in the compost used in the experiment. Previous studies revealed that decomposition of manure OH<sup>-</sup> ions and Mg<sup>2+</sup> ions are released this ions tend to reduce the activities of Al<sup>3+</sup> and H<sup>+</sup> ions in the soil thus raising the soil pH as can be deduced from the experiment [14,15]. Similar observations were made by Tipping and [16,17]. who observed that compost lowered the solubility of Al<sup>3+</sup> ions by binding them to the negatively charged exchange sites and hence raising the soil pH. A similar pattern was observed in OM, total N, available P, exchangeable cations as can be observed from Tables 3 and 4. [18]. stated that addition of manure in soil often leads to increase of total microbial activities and enhance net N mineralization and release of labile organic matter. Also, [13]. noted that soil OM can be maintained through incorporation of organic manure in the form of crop residues, mulching, green and animal manure application.

The concentration of exchangeable cations had a positive correlation with compost in the two cropping seasons as observed from the tables of result. This observation was consistent with and [19].who stated that higher soil pH due to manure and lime application enhances CEC of soil [23]. also alluded that exchangeable cations are often increased through addition of fertilizer which releases these cations in available forms in some minerals and mostly in plant residues and animal manure. Soil organic matter, total N and available P, was lowered in all zero fertilizer and manure treatment. A similar scenario was observed with respect to exchangeable cations. This could be attributed to low pH arising probably from depletion of OM and subsequent leaching of cations.

**Table 3: Effect of Organic NPK® (Compost) and Urea on Soil Properties (2018)**

Treatment	pH	OM (%)	N (%)	P (mg/kg)	K Ca Mg			Na (cmol/kg)	EA ECEC	
					→				←	
Control	6.01	0.88	0.01	2.07	0.23	2.96	0.70	0.22	1.01	5.12
200kg/ha CP	6.20	1.05	0.08	2.77	0.28	2.88	1.09	0.27	0.90	5.42
300kg/ha CP	6.22	2.86	0.13	3.00	0.28	3.09	1.43	0.27	1.13	6.20
400kg/ha CP	6.38	3.17	0.17	4.02	0.31	3.31	1.52	0.34	1.22	6.70
150kg N/ha	6.10	0.88	0.02	2.31	0.24	2.99	0.76	0.20	0.83	5.02

CP=compost

**Table 4: Effect of Organic Npk® (Compost) and Urea on Soil Properties (2019)**

Treatment	pH	OM (%)	N (%)	P (mg/kg)	K Ca Mg			Mg (cmol/kg)	EA ECEC	
					→				←	
Control	5.85	0.76	0.05	3.15	0.23	2.91	0.98	0.27	1.00	5.30
200kg/ha CP	5.67	1.73	0.13	3.15	0.27	3.60	1.02	0.27	1.01	5.90
300kg/ha CP	6.10	2.08	0.20	4.19	0.31	3.63	1.02	0.30	1.02	6.28
400kg/ha CP	6.90	3.15	0.20	4.21	0.33	3.75	1.05	0.30	1.09	6.52
150kgN/ha	5.60	0.76	0.17	3.18	0.27	3.61	1.01	0.27	1.00	6.16

**Table 5: Mean Effect of Organic NPK® (Compost) and Urea on Number of Pods and Seed Weight of Sesame**

Treatment	Number of pods/plant		Seed weight (kg/ha)	
	2018	2019	2018	2019
Control	20.0	33.0	109.1a	188.7a
200kg/ha CP	20.0	36.0	112.2a	193.0a
300kg/ha CP	23.0	36.0	178.1b	257.1b
400kg/ha CP	23.0	36.0	198.0bc	266.3bc
150kgN/ha	25.0	38.0	248.7c	272.9c
LSD (0.05)	NS	NS	54.86	11.30

CP= compost, NS= not significant. Means with same alphabet are statistically the same

The result obtained shows that fertilizer and manure did not have any significant impact on pods yield per plant. Nonetheless, there was marginal increment in the number of pods per plant with increasing level of compost. This is an indication that manure and mineral fertilizer have the potential to optimize pods yield of sesame. This result was at variance with finding by [20]. Who observed that pods yield of sesame was significantly affected by manure addition in the soils of Keffi, Nigeria. The finding was attributed to low fertility status of the soil in the area which triggered plant respond to fertilizer application. Compost and urea application had significant impact on sesame yield during the two cropping seasons (Table 5).

The highest seed yield (248.3kg/ha and 272 kg/ha in 2018 and 2019 respectively) was obtained from application of urea at 150 kg/ha. Compost at 400kg/ha gave seed yield of 198 kg/ha and 248 kg/ha in 2018 and 2019 respectively. The yield obtained from application compost at 400kg/ha was statistically the same with yield obtained from urea. This suggests that compost at 400kg/ha can be a suitable substitute for mineral fertilizer. The lowest seed yield was obtained from zero fertilizer application (109.1 kg/ha and 188.7 in the two cropping seasons). The result attest to the fact that fertilizer application was essential ingredient in the cultivation of sesame as in most crops in the savannah region [12,5,21,22]. The positive correlation of sesame seed yield and fertilizer application as observed from this study agreed with similar studies conducted by other researchers.

### Conclusion

This study has highlighted the relevance of organic materials as a soil amendment for sustainable crop productivity in the study area. Furthermore, the study has also, demonstrated that sesame yield can be optimized by incorporation of organic inputs in the soil.

### References

1. Food and Agriculture Organization (FAO) (2004). Use of Phosphate Rocks for Sustainable Agriculture in: Fertilizer and Plant Nutrition Bulletin, 13 (Zepata F and Roy RN.) Eds., FAO Land and water Development Division and International Atomic Energy Agency.
2. Hazell P (2005) Is Agriculture still Important for Economic Development and Poverty Reduction? International Food Policy Research Institute Forum, Washington.
3. Duguma BJ, Gockowski J, Bakala (2000). Smallholder Cacao (*Theobroma cacao* Linn.) Cultivation in i. Agroforestry Systems of West and Central Africa: Challenges and Opportunities Agroforestry
4. Juo ASR, J Caldwell, BT Kang (1994). Place of alley cropping in sustainable agriculture in the tropics. Transaction of the 15<sup>th</sup> International Soil Science Congress, 7: 98-109.
5. Ayoola OT, Adeniyani ON (2006). Influence of Poultry Manure and NPK Fertilizer on Yield and Yield Components of Crops under Different Cropping Systems in South West Nigeria. Afr. J. Biotechnol, 5:1386-1393.
6. Bouyoucos GH (1951). Recalibration of the Hydrometer for making Mechanical Analysis of Soils. Agronomy Journal 43: 434-438.
7. Walkley A, Black IA (1934). An Examination of the digestion Method for determining Soil Organic Matter and Proposed Modification of the Chronic Acid Titration Method. Soil Science 37: 29-38.
8. Anderson JM, Ingram JSI (1996) Tropical Soil Biology and Fertility. A Hand Book of Methods, 2nd edition. CAB International pp57-74.
9. Obi UI (2001). Introduction to Factorial Experiment for Agricultural, Biological and Social Science Research. 2nd ed. Optimal Computer Solution Ltd. Enugu, Nigeria 63-75.
10. Lar R (1989). Agroforestry Systems and Soil Surface Management of a Tropical Alfisol. Agroforestry Systems 8: 9711.
11. Ojeniyi SO (2000). Effect of Goat Manure on Soil Nutrients and Okra Yield in a Rain Forest area of Nigeria. Applied Tropical Agriculture 5: 20-23.
12. Aduayi EA, Chude VO, Adebuseyi BA, Olayiwola SO (2002) Fertilizer use and management practices for crops in Nigeria. 3rd ed. S.B. Garko international limited 67-70.
13. Agbede OO (2009) Understanding Soil and Plant Nutrition 1<sup>st</sup> ed. Salman Press Nassarawa. Pp 42-86.
14. Brady NC, Weil RR (2007). The Nature and Properties of Soils. 13th ed. Prentice – Hall, New Jersey, 650.
15. Adepetu JA, Adetunji MT, Ife DV (2014) Soil Fertility and Crop Nutrition. 1st ed. Jumak Publishers, Ring road, Ibadan, 153-159.
16. Tipping E, Woof C (1991) The Distribution of Humic Substances between the Solid and Aqueous Phases of Acid Organic Soils: A Description based on Heterogeneity and Charge-Dependent Sorption Equilibria. J. Soil Sci. 42: 437-448.
17. Islam MR, Rashid MB, Siddique AB, Afroz H (2014) Integrated Effects of Manures and Fertilizers on the Yield and Nutrient Uptake by BRRI dhan49. J. Bangladesh Agric. Univ, 12: 67-72.
18. Andersson S (1999) Influence of Liming Substances and Temperature on Microbial Activity and Leaching of Soil Organic Matter in Coniferous Forest Ecosystem. Doctoral Thesis. Swedish University of Agricultural Sciences.
19. Yagi R, Ferreira ME, Cruz M, Barbosa J (2003) Organic Matter Fractions and Soil Fertility under the Influence of Liming, Vermicompost and Cattle Manure. Sci. Agric 60: 549-557.
20. Haruna IM, Ibrahim H, Rahman SA (2009). The Yield and Profitability of Roselle. (*Hibiscus sabdariffa*) at varying Poultry Manure and Nitrogen Fertilizer Rates in the Northern Guinea Savanna of Nigeria. Electronic Journal of Environmental and Food Chemistry 8: 1136-1139.
21. Bill W (2008). Planting Date Effects on Corn Yield. J. New Agric. Sci, 19: 28.
22. Ogbonna PE, Obi IU (2000) Effect of Poultry Manure and Planting Date on the Growth and Yield of ‘Egusi’ Melon (*Colocynthis Citrullus* L.) in the Nsukka Plains of South Eastern Nigeria. Samaru J. Agric. Res. Vol. 16: 63-74.
23. Juo ASR, R Lal (1977). The Effect of Fallow and Continuous Cultivation on the Chemical and Physical Properties of an Alfisol in Western Nigeria.

**Copyright:** ©2022 TS TER, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.