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Analysis of Soil Chemical Properties to Application of Poultry and Cow Manure from Different Housing and Stacking Types Following *Telfairia occidentalis* (HOOK F.) Production

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study examines response of different housing and stacking types of poultry and cow manure on soil chemical properties. Soil chemical analysis were examined before and after manure application in order to assess whether manure from different housing and stacking types affected the soil chemical properties. The findings of the study shows manure from different housing and

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stacking types had significant effect on chemical properties of the soil. Poultry manure was observed to have more significant impact on the chemical properties of the soil than cow manure, and the housing and stacking type of the manure played a role in regulating the levels of nutrients produced as well as total organic carbon levels. The findings suggest that poultry and cow manure application from different housing and stacking types could significantly enhance the organic carbon, total nitrogen, available phosphorus, and potassium content in the soil. This study consequently conclude that manure from different housing and stacking types play significant role in affecting soil chemical properties which in turn improve soil fertility and sustain soil productivity.

Keywords: Analysis; properties; housing; stacking; production.

1. INTRODUCTION

Addition of organic materials such as animal manures to soils have a direct influence on soil organic matter content and improve soil fertility [1]. Soil quality is commonly enhanced with application of organic nutrient, but cautious management is essential to avoid environmental hazards of nitrate (NO_3) leaching and phosphorus buildup. The main component of organic production is providing organic sources of nutrients to increase plant growth as well as sustain soil quality.

The beneficial effects of organic matter on soil physical, chemical, and biological properties have been recognized for several years. Sustaining or increasing soil organic matter levels can help in aggregation of soil particles, which later improved drainage, infiltration, and tilth [2]. Organic matter helps as slow-release form of crop nutrients as well as source of energy and nutrients for soil microbes.

Organic manures can act as substitute to mineral fertilizers for improving soil structure [3]. Consequently, there is necessity for promoting dependence on the usage of organic materials such as farmyard manure, crop residues and poultry manure for crop production. In fact, poultry manure has been the best of all manures produced by livestock [4]. Furthermore, the nutrient contents of poultry manure is the best of all animal manures, and the usage of it as soil amendment for crops will provide significant amounts of all major plant nutrients. Poultry manure also increases biological activities, soil tilt and soil chemical properties [5].

Farmers in Nigeria realize the necessity for soil amendments by using available resources which include crop wastes, farmyard manure and poultry waste [6]. The need for organic amendment as reservoir of nutrients to crops has been acknowledge by Awodun [7] Akanbi et al. [8] and Ojetayo et al. [9]. This amendment improves soil physical, chemical and biological conditions, which later help crops growing environment thereby resulting in improved production of useful plant parts [8]. Organic amendments will stimulate and increase soil micro-organism, which will aid the breakdown process of organic matter and decompose into nutrients that plants can easily trap. Organic amendments reduce the needs of chemical fertilizer, which therefore, lead to reduced production amount, thereby increases income [10].

Manure is mostly derived from remains of plants and animals, animal feces, which can be of use as organic amendment in agriculture. Manures contribute significantly to the fertility status of the soil by providing organic matter and nutrients such as nitrogen. It is also a product obtained after decomposition of organic matter like cow dung which fortify the soil with necessary elements and provide humus to the soil. Manure from different animals have divers qualities and requires various amount when used as amendment. Animal manure, such as chicken manure and cow dung, enhance soil structure (aggregation) so that the soil holds more nutrients and water, and consequently becomes more fertile [6]. It also contains some nitrogen and other nutrients that assist the growth of plants [8].

The main objective of this study is to d etermine the influence of poultry manure and cow dung from various housing and stacking methods on some chemical properties of post planting soil following *Telfairia occidentalis* production.

2. MATERIALS AND METHODS

Experiment was conducted at the Organic Farm of the Federal University of Agriculture, Abeokuta (latitude 7° 13¹ N and longitude 3° 28¹ E). The annual mean minimum temperature is 22.2°C while the annual mean maximum temperature is 33.3°C.

Poultry manure was obtained from Isekolowo farm, Egbeda, along Alabata road, Abeokuta while cow dung was obtained at the cattle unit of College of Animal Sciences Farm, Federal University of Agriculture, Abeokuta.

Amendments were applied as guided by the native soil nitrogen and nitrogen requirement of *Telfairia occidentalis* (60 kg Nha^{-1}) (Akanbi et al., 2006). They were as follows: Zinc House Poultry Manure Bagged (ZPB) at 5.6 t ha^{-1}, Zinc House Poultry Manure Unbagged (ZPU) at 6.0 t ha^{-1}, Zinc House Cow dung Bagged (ZCB) at 6.5 t ha^{-1}, Zinc House Cow dung Unbagged (ZCU) at 5.6 t ha^{-1}, Palm Fronds House Poultry Manure Bagged (PPB) at 5.4 t ha^{-1}, Palm Fronds House Poultry Manure Unbagged (PPU) at 6.9 t ha^{-1}, Palm Fronds House Cow dung Bagged (PCB) at 5.1 t ha^{-1}, Palm Fronds House Cow dung Unbagged (PCU) at 5.5 t ha^{-1}, Open Space Poultry Manure Bagged (OPB) at 5.5 t ha^{-1}, Open Space Poultry Manure Unbagged (OPU) at 6.8 t ha^{-1}, Open Space Cow dung Bagged (OCB) at 5.3 t ha^{-1}, Open Space Cow dung Unbagged (OCU) at 5.9 t ha^{-1} and the Control (no amendment). These were laid out in a Randomized Complete Block Design (RCBD) with three replicates in 2017 and 2018. The amendments were applied two (2) weeks before planting.

2.1 Manure and Soil Analysis

Nitrogen was determined by modified micro Kjeldahl [11]. The organic carbon content was determined using wet oxidation method [12]. Phosphorus in manure was determined by using Vanado-molybdate method [13] while Phosphorus in soil was extracted using Bray-1 [14]. Potassium was determined by Flame Photometer and Soil pH was determined using pH glass electrode meter [15].

2.2 Statistical Analysis

Data collected were subjected to Analysis of Variance (ANOVA) using Statistical Analysis System. Significant means were separated using Duncan's Multiple Range Test (DMRT) at 5% level of probability.

2.3 Effect of Poultry Manure and Cow dung from Different Housing System and Stacking methods on Post - Planting Soil pH, Organic Carbon and Organic Matter in 2017 and 2018

Post planting soil pH in year 2017 shows that pH of unamended soil (control) had significantly highest pH (6.73) which was not significantly ($P \leq 0.05$) higher than the pH of soil amended with poultry manure bagged in palm fronds house at 5.4 tha^{-1} (PPB), poultry manure unbagged in palm fronds house at 6.9 tha^{-1} (PPU), cow dung bagged in palm fronds house at 5.1 tha^{-1} (PCB), cow dung unbagged in palm fronds house at 5.5 tha^{-1} (PCU), cow dung bagged in zinc house at 6.5 tha^{-1} (ZCB), poultry manure bagged in open space at 5.5 tha^{-1} (OPB), cow dung unbagged in open space at 5.9 tha^{-1} (OCU) and cow dung unbagged in open space at 5.3 tha^{-1} (OCB) but was significantly ($P \leq 0.05$) higher than the pH of plots amended with poultry manure unbagged in zinc house at 6.0 tha^{-1} (ZPU), cow dung unbagged in zinc house at 5.6 tha^{-1} (ZCU), poultry manure bagged in zinc house at 5.6 tha^{-1} (ZPB) and poultry manure unbagged in open space at 6.8 tha^{-1} (OPU) (Table1).

In year 2018, post planting soil pH was observed to be significantly ($P \leq 0.05$) higher on plots amended with PPB at 5.4 tha^{-1} (6.97) than the pH of post planting soils with other amendments. The lowest post planting soil pH was observed on unamended plots (6.40). Control (unamended) plots had the lowest pH which was significantly ($P \leq 0.05$) lower than the pH of plots amended with PPB at 5.4 tha^{-1}, ZPB at 5.6 tha^{-1}, OPB at 5.5 tha^{-1} and OCU at 5.9 tha^{-1}.

In year 2017, post planting soil organic matter content ranged from 8.70 g kg^{-1} (control) to 11.70 g kg^{-1} (ZCU). It was also observed that plots amended with ZCU at 5.6 tha^{-1} gave a significantly higher post planting soil organic matter content above the control plots (Table 1). The order of organic matter content increase relative to application of amendments goes thus: ZCU at 5.6 tha^{-1} > PPU at 6.9 tha^{-1} > OPB at 5.5 tha^{-1} > ZPU at 6.0 tha^{-1} > PCU at 5.5 tha^{-1} > PCB at 5.1 tha^{-1} > PPB at 5.4 tha^{-1} > ZCB at 5.6 tha^{-1} > OCU at 5.9 tha^{-1} > ZPB at 5.6 tha^{-1} > OCB at 5.3 tha^{-1} > OPU at 6.8 tha^{-1} > control. Also, in year 2018, it was observed that plots amended with PPB at 5.4 tha^{-1} had highest post planting soil organic matter content which was significantly ($P \leq 0.05$) higher than the post planting soil organic matter content of all other soil either amended or control. The order is as follows: PPB at 5.4 tha^{-1} > PCU at 5.5 tha^{-1} > OCU at 5.9 tha^{-1} > ZCU at 5.6 tha^{-1} > PPU at 6.9 tha^{-1} > ZPB at 5.6 tha^{-1} > PCB at 5.1 tha^{-1} > OPB at 5.5 tha^{-1} > ZPU at 6.0 tha^{-1} > ZCB at 6.5 tha^{-1} > OCB at 5.3 tha^{-1} > OPU at 6.8 tha^{-1} > control (Table 1).

2.4 Effect of Poultry Manure and Cow dung from Different Housing System and Stacking methods on Post - Planting Soil Total Nitrogen, Available Phosphorus and Potassium Content in 2017 and 2018

Total nitrogen of post planting soil (Table 2) was significantly (P ≤ 0.05) increased to the maximum with the application of cow dung unbagged in zinc house at 5.6 t/ha (ZCU) (2.27 g kg^{-1}) while unamended soil (control) had the least (1.77 g kg^{-1}) in year 2017. Although, application of ZCU at 5.6 tha^{-1} was observed to have highest post planting soil total nitrogen, it was not significantly (P ≤ 0.05) higher than the post planting soil total nitrogen of all amended plots except the post planting soil total nitrogen of plots amended with ZPB at5.6 tha^{-1}, OPU at 6.8 tha^{-1}, OCB at 5.3 tha^{-1} and unamended (control) plots. Lowest post planting soil total nitrogen was observed on unamended (control) plot which was not significantly (P ≤ 0.05) lower than the post planting soil total nitrogen of plots amended with ZPB at 5.6 tha^{-1}, OPU at6.8 tha^{-1} and OCB at 5.3 tha^{-1} (Table 2).

Likewise, in year 2018, application of amendments significantly (P ≤ 0.05) influenced post planting soil total nitrogen above the control. It was observed that post planting soil total nitrogen of plots amended with PPB at 5.4 tha^{-1} had the highest post planting soil total nitrogen content of 0.290 g kg^{-1} and it was not significantly (P ≤ 0.05) higher than the post planting soil total nitrogen of plots amended with PCU at 5.5 tha^{-1} (2.70 g kg^{-1}) and ZCU at 5.6 tha^{-1} (2.60 g kg^{-1}) whereas, it significantly (P ≤ 0.05) differ from the post planting soil total nitrogen content of OCU at 5.9 tha^{-1} (2.50 g kg^{-1}), PPU at 6.9 tha^{-1} (2.40 g kg^{-1}), PCB at 5.1 tha^{-1} (2.30 g kg^{-1}), OPB at 5.5 tha^{-1} (2.30 g kg^{-1}), ZPB at 5.6 tha^{-1} (2.30 g kg^{-1}), ZCB at 6.5 tha^{-1} (2.30 g kg^{-1}), OCB at 5.3 tha^{-1} (1.90 g kg^{-1}), ZPU at 6.0 tha^{-1} (1.90 g kg^{-1}), OPU at 6.8 tha^{-1} (1.80 g kg^{-1}) and control (1.50 g kg^{-1}) (Table 2).

In year 2017, highest post planting soil available phosphorus value (25.22 mg kg^{-1}) was given by soil amended with PPU at 6.9 (P ≤ 0.05), this was followed by soil amended with ZPU at 6.0 tha^{-1} (25.14 mg kg^{-1}), PCB at 5.1 tha^{-1} (24.46 mg kg^{-1}), ZPB at 5.6 tha^{-1} (24.37 mg kg^{-1}), OPB at 5.5 tha^{-1} (24.18 mg kg^{-1}), PCU at 5.5 tha^{-1} (23.96 mg kg^{-1}), ZCB at 6.5 tha^{-1} (23.84 mg kg^{-1}), OPU at 6.8 tha^{-1} (23.68 mg kg^{-1}), OCB at 5.3 tha^{-1} (23.20 mg kg^{-1}), ZCU at 5.6 tha^{-1} (23.16 mg kg^{-1}), PPB at 5.4 tha^{-1} (22.94 mg kg^{-1}), OCU at 5.9 tha^{-1} (22.67 mg kg^{-1}) and control (19.47 mg kg^{-1}). Likewise, in year 2018, application of amendments also significantly (P ≤ 0.05) influenced post planting soil available phosphorus above the control. It was also observed that highest post planting soil available phosphorus was given by plots amended with PPB at 5.4 tha^{-1} (27.54 mg kg^{-1}) while the least post planting soil available phosphorus was given by control (unamended) plots (18.78 mg kg^{-1}).

The potassium content of post planting soil in year 2017 was significantly (P ≤ 0.05) influenced by the application of amendments as highest post planting soil potassium content was observed on soil amended with PCU at 5.5 tha^{-1} (0.46 cmol kg^{-1}), this value did not significantly (P ≤ 0.05) differ from the post planting soil potassium content of plots amended with ZCU at 5.6 tha^{-1}, OCU at 5.9 tha^{-1}, PCB at 5.1 tha^{-1}, PPU at 6.9 tha^{-1}, ZCB at 6.5 tha^{-1}, ZPB at 5.6 tha^{-1}, ZPU at 6.0 tha^{-1} and PPB at 5.4 tha^{-1} while it significantly (P ≤ 0.05) differ from post planting soil potassium content of plots amended with OCB at 5.3 tha^{-1}, OPB at 5.5 tha^{-1}, OPU at 6.8 tha^{-1} and control.

It was also observed that unamended soil (control) had the least post planting soil potassium content which was significantly (P ≤ 0.05) lower than the post planting soil potassium content of all amended plots. Likewise, in year 2018, it was observed that the post planting soil potassium content of plots amended with PPB at 5.4 tha^{-1} was highest and the value was not significantly (P ≤ 0.05) higher than the post planting soil potassium content of plots amended with PCU at 5.5 tha^{-1} while it was significantly (P ≤ 0.05) higher than the post planting soil potassium content of all other plots either amended or control. Unamended plots had the lowest post planting soil potassium content which was not significantly (P ≤ 0.05) lower than the post planting soil potassium content of plots amended with OPU at 6.8 tha^{-1} but was significantly (P ≤ 0.05) lower than the post planting soil potassium content of all other amended plots (Table 2).

Table 1. Effect of Poultry Manure and Cowdung from Different Housing Systems and Stacking methods on Post Planting Soil pH, Organic Carbon and Organic Matter Content in 2017 and 2018

Amendments (tha^{-1})	pH		Organic Matter (g kg^{-1})	
	2017	**2018**	**2017**	**2018**
ZPB at 5.6	6.33c	6.67b	10.30bcd	10.00bcd
ZPU at 6.0	6.40bc	6.43d	11.20ab	9.20def
ZCB at 6.5	6.53abc	6.43d	10.50abcd	9.10def
ZCU at 5.6	6.33c	6.53bcd	11.70a	10.40bc
OPB at 5.5	6.53abc	6.60bc	11.30ab	9.40cde
OPU at 6.8	6.33c	6.43d	9.20de	8.50ef
OCB at 5.3	6.47abc	6.43d	9.80cde	8.80ef
OCU at 5.9	6.53abc	6.60bc	10.50abcd	10.40bc
PPB at 5.4	6.67ab	6.97a	10.90abc	12.00a
PPU at 6.9	6.67ab	6.47cd	11.50ab	10.10bcd
PCB at 5.1	6.60abc	6.50cd	11.00abc	9.40cde
PCU at 5.5	6.60abc	6.53bcd	11.20ab	10.60b
Control	6.73a	6.40d	8.70e	8.10f

Means with the same letter(s) in a column are not significantly different at P ≤ 0.05.

Key:

ZPB: Bagged poultry manure from zinc house
ZPU: Unbagged poultry manure from zinc house
ZCB: Bagged cowdung from zinc house
ZCU: Unbagged cowdung from zinc house
OPB: Bagged poultry manure from open space
OPU: Unbagged poultry manure from open space
OCB: Bagged cowdung from open space
OCU: Unbagged cowdung from open space
PPB: Bagged poultry manure from palm fronds house
PPU: Unbagged poultry manure from palm fronds house
PCB: Bagged cowdung from palm fronds house
PCU: Unbagged cowdung from palm fronds house

Table 2. Effect of Poultry Manure and Cowdung from Different Housing Systems and Stacking methods on Post Planting Soil Total Nitrogen, Available Phosphorus and Potassium in 2017 and 2018

Amendments (tha^{-1})	Total Nitrogen ($g\ kg^{-1}$)		Av. Phosphorus ($mg\ kg^{-1}$)		Potassium ($cmol\ kg^{-1}$)	
	2017	2018	2017	2018	2017	2018
ZPB at 5.6	1.970bcd	2.900d	24.370a	23.290ef	0.423abc	0.373cdef
ZPU at 6.0	2.170ab	1.900e	25.140a	23.283ef	0.423abc	0.353def
ZCB at 6.5	2.030abc	2.270d	23.840a	24.363cdef	0.427abc	0.343ef
ZCU at 5.6	2.770a	2.630abc	23.163a	26.037abc	0.453ab	0.403bcd
OPB at 5.5	2.200ab	2.300d	24.180a	24.403cdef	0.387c	0.400bcd
OPU at 6.8	1.900cd	1.830e	23.680a	23.617def	0.387c	0.376fg
OCB at 5.3	1.870cd	1.930e	23.203a	22.677f	0.407bc	0.367def
OCU at 5.9	2.030abc	2.530bcd	22.673ab	24.657bcde	0.450ab	0.397bcde
PPB at 5.4	2.100abc	2.900a	22.940ab	27.540a	0.417abc	0.500a
PPU at 6.9	2.230abc	2.400bcd	25.220a	25.447bcd	0.433abc	0.423bc
PCB at 5.1	2.100abc	2.330cd	24.463a	24.973bcde	0.437ab	0.377cdef
PCU at 5.5	2.170ab	2.700ab	23.957a	26.597ab	0.463a	0.447ab
Control	1.770d	1.500f	19.473b	18.780g	0.320d	0.273g

Means with the same letter(s) in a column are not significantly different at $P \leq 0.05$.

Key:

ZPB: Bagged poultry manure from zinc house
OCB: Bagged cowdung from open space
ZPU: Unbagged poultry manure from zinc house
OCU: Unbagged cowdung from open space
ZCB: Bagged cowdung from zinc house
PPB: Bagged poultry manure from palm fronds house
ZCU: Unbagged cowdung from zinc house
PPU: Unbagged poultry manure from palm fronds house
OPB: Bagged poultry manure from open space
PCB: Bagged cowdung from palm fronds house
OPU: Unbagged poultry manure from open space
PCU: Unbagged cowdung from palm fronds house

3. RESULT AND DISCUSSION

Poultry manure amended soil was observed to have higher post planting soil organic matter content, nitrogen, phosphorus and potassium content compared to their cow dung amended soil. This assertion is in support with the outcome of Aboutayeb et al. [16] who stated that poultry manure significantly improve post planting soil phosphorus content over control. It is also in agreement with the findings of Omisore et al. [4] who stated that chicken manure has been recognized to be the best of all manure derived from livestock. From this finding, it was deduced that bagged poultry manure amended soil had higher post planting soil phosphorus content than the unbagged poultry manure amended soil while cow dung unbagged amended soil had higher post planting soil phosphorus content than the bagged cow dung amended soil. This also support the findings of Inyang et al. [17] that agricultural soils amended with animal manure is likely to be high in organic matter which affect the extent of aggregation of soil particles, minimizes bulk density and heightens soil porosity. Also, the finding of Follett et al. (2007) confirmed this fact that application of organic residues heighten soil organic carbon level. It also supports another assertion that addition of organic manures regularly is the only method to increase soil organic carbon status [18,19,20]. Olowoake [5] also found that addition of manure improves soil properties.

4. CONCLUSION

Chemical properties of soil (pH, organic matter, Nitrogen, Phosphorus and Potassium) were significantly influenced with the application of poultry manure and cow dung from different housing and stacking types.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Escobar MEO, Hue NV. Temporal changes of selected chemical properties in three manure amended soils of hawaii. Bioresource Technology. 2008;99:8649-8654.
2. Rosen CJ, Allan DL. Exploring the benefit of organic nutrient sources for crop production and soil quality. HortTechnologyhottech.ashsppublication.org. 2007;17(4):422-430.
3. Dauda SN, Ajayi FA, Ndor E. Growth and yield of water melon (*Citrullus lanatus*) as Affected by poultry manure application. Journal of Agriculture and Social Science. 2008;4:121-124.
4. Omisore JK, Kasail MY, Chukwu UC. Determination of optimum poultry manure rate for maize production. proceedings of the 43rd Annual Conference of the Agricultural Society of Nigeria. Abuja. 2009;260-263.
5. Olowoake AA. Influence of organic, Mineral and organomineral fertilizers on growth, Yield and soil properties in grain amaranth (*Amaranthus cruentus* L.). Journal of Organics. 2014;1(1).
6. Adediran JA, De Baets N, Mnkeni PNS, Kiekens L, Muyiwa NYO, Thys A. Organic waste Materials for soil fertility improvement in the Border Region of the Eastern Cape, South Africa, Biological Agriculture and Horticulture. 2003;20:283-300.
7. Awodun MA. Effect of poultry manure on growth, Yield and nutrient content of fluted pumpkin (*Telfairia occidentalis* Hook F). Asian Journal of Agricultural Research. 2007;1:67-73.
8. Akanbi WB, Togun AO, Adediran JA, Ilupeju EAO. Growth, dry matter and fruit yield components of okra under organic and inorganic sources of nutrients. American Eurasian Journal of Sustainable Agriculture. 2010;4(1):1-13.
9. Ojetayo AE, Olaniyi JO, Akanbi WB, Olabiyi TI. Effect of fertilizer types on the nutritional quality of cabbage varieties before and after Storage. Journal of Applied Biosciences. 2011;48:3322-3330.
10. Pius BN. Learn how to make and use compost manure in farming. Friend of the book; 1998.
11. Jackson ML. Soil chemical analysis.P.86-92. Eaglewood cliffs, N. J: Prentice Hall Inc; 1964.
12. Nelson DW, Sommers LE. Total carbon, Organic carbon and organic matter. Methods of soil analysis. Part 2. Chemical and Microbiological properties. ASA, Madison. WI. 1996;359 – 580.
13. Aduayi EA, Gatitu GM. Routine soil and leaf analysis advisory service for Coffee growers at Coffee Research Station. Kenya Coffee. 1973;38:278-281.

14. Bray RH, Kurtz LT. Determination of total organic and available form of phosphorus in soils. Soil Science. 1945;59:39-48.
15. Mclean EO. Soil pH and lime requirement. In: Methods of soil analysis Part 2. Agronomy. A.L. Page (ed) Am. Soc. Agron. Madison, 101. USA. 1982;199 – 234.
16. Aboutayeb R, Elgharous M, Abali Z, Farouzi B, Koulali Y. Short term effects of chicken manure application on soil physicochemical properties cropped with silage maize. International Journal of Innovation and Applied studies. 2014;9(2): 662-671.
ISSN 2028-9324
17. Inyang M, Gao B, Yao Y, Xue Y, Zimmerman AR, Pullammanappallil P. Removal of heavy metals from aqueous solution by biochars derived from anaerobically digested biomass. Bioresource Technology. 2012;110:50-56.
18. Katyal JC, Rao NH, Reddy MN. Critical aspects of organic matter management in the tropics: The Example of India. Nutr. Cycl. Agro Ecosyst. 2001;61:77–88.
19. Ikeh AO. Ndaeyo NU, Uduak IG, Iwo GA, Ugbe LA, Udoh EI, Effiong GS. Growth and yield responses of pepper (*Capsicum frutescens* L.) to varied poultry manure rates in uyo, Southeastern Nigeria. ARPN Journal of Agricultural and Biological Science. 2012b;7:9:735-742.
20. Ikeh AO, Udoh EI, Uduak GI, Udounang PI. Response of cucumber (*Cucumis sativus* L) to different rates of goat and poultry manure on an ultisol. Journal of Agriculture and Social Research. 2012a; 12:2:132-139.

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