Effect of Selected Organic Soil Amendments on Soil Physico-Chemical Properties, Growth and Yield Of yellow Pepper (*Capsicum annum*)

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ABSTRACT

A field experiment to investigate the effects of different forms of organic manure on physico-chemical properties of clayey loam ultisol, growth and yield performance of yellow pepper plants, Capsicum annum (L.) var. was carried out at the Research Farm of the Agricultural and Bioresources Engineering, Faculty of Engineering, Nnamdi Azikiwe University Awka, Anambra State, Nigeria. The experiment was laid out in a Randomized Completely Block Design (RCBD) with three (3) replications. Treatments used were 10t/ha cassava peel biochar (CPBC), 10t/ha poultry manure (PM), 10t/ha cow dung (CD) and 5t/ha+5t/ha of their various combinations with one control. Morphological data were collected at two weeks interval after transplanting. Data collected were subjected to ANOVA. Significant mean differences were separated using LSD(0.05). At 12WAP, plants that received a combination of PM and CP had significantly higher heights, while the widest leaf area (116.6cm^2) was obtained from those that had CD.Highest fruit weight per plant was recorded with cow dung (0.63kg), while cow dung + poultry had the highest number of fruit (170.3). The pH of the amended plot ranged from 4.73-4.99. The exchangeable bases (Ca^{2+} and Mg^{2+}) were significantly higher in the plot amended with cassava peel biochar with values of 1.76cmol/kg and 1.44cmol/kg, compared to other amendments. There was also, significantly higher Organic Carbon values in the plots amended with Poultry manure. Based on the results, it could be deduced that the plot amended with cow dung + poultry manure significantly improved the soil fertility. Therefore, should be recommended for yellow pepper production in the study area.

INTRODUCTION

Food crisis is a global challenge and a great threat to the existence of human race. According to Akinrinde (2006), the soil is a very crucial factor in food production, and unproductive and infertility on soil can result in food insecurity. Nigeria soils have a high potential for crop production, but the yield levels obtained are usually low due to poor soil management. It is pertinent to improve soil quality and consequently, crop production without damage to the environment in areas with low crop production due to low soil quality. This problem could be solved through the use of soil organic or inorganic amendments Eleduma *et al*., (2016).

Davis and Wilson (2005), defined soil amendment as any material added to a soil to improve its physico-chemical properties. These materials include biocharwith high surface area and porosity which has major impact on soil physical properties by its feedstock. Many studies have found that soils treated with Biochar has the potential characteristic of increasing water retention and nutrient capacity especially in depleted tropical soils (Bakewell-Stone, 2011). In addition to this, Poultry manure (PM) contains nutrient elements that can support crop production and enhance the physico-chemical properties of the soil (Omisore *et al.,* 2009). Like other soil organic amendments, cassava peels are potential source of organic matter and plant nutrients. Its management includes direct incorporation into the soil, burning or processing them into a more stable organic amendment called Biochar. Similarly, cow dung is an important source of organic matter. It increases the soil buffering capacity, thus help regulating soil acidity, increase water holding capacity and infiltration rate.

Yellow Pepper (*Capsicum annuum L.*) is an important agricultural crop that belongs to Solanaceae family. It is a spice crop in high demand which commands a high price in the South Eastern parts of Nigeria because of its bright yellow colour, aroma, nutritional and medicinal value which distinguishes it from other pepper varieties.

The aim of this study was to evaluate the effects of cassava peels biochar, poultry manure cow dung and their combinations on growth and yield of yellow pepper.

Specific objectives:

i. To determine the effect of the soil selected organic amendments on the physical and chemical properties of the soil.

ii. To determine the effect of the combination of two of the applied treatments on the growth and yield of yellow pepper.

MATERIAL AND METHODS

The study was conducted at the Teaching and Research Farm of the Department of Soil Science and Land Resources Management, Faculty of Agriculture, Nnamdi Azikiwe University, Awka. Awka is located in the South-Eastern part of Nigeria. It lies within Latitude 62488^{o}N and Longitude 7.18289^{o}E. The area is characterized by a mean annual rainfall of 1828mm, maximum and minimum temperature of 32^{o}C and 24^{o}C respectively, and a relative humidity of 75-85% on the average of the dry season and raining season with general lower evapotranspiration. The soil is well drained and mostly sandy-loam to loamy in plains and Hydromorphic along the flood plains. The soils in the area are rich in mineral content and therefore support the high agricultural productivity in the area.

10t/ha Poultry Manure (PM), 10t/ha Cow Dung (CD), 10t/ha Cassava peel biochar (CP),5t/ha+5t/ha Poultry Manure and Cow Dung, 5t/ha+5t/ha Poultry Manure and Cassava Peel (PM+CP), 5t/ha+5t/ha Cow Dung and Cassava Peel Biochar (CD+CP), (5t/ha+5t/ha) Cow Dung and Poultry Manure (CD+PM) and Control (C) (zero treatment) were applied on the experimental plots by incorporating them into the soil and left for 7days to equilibrate/cure before planting. The experiment was laid out in a Randomized Complete Block Design (RCBD) with seven treatments and three replications.

The seedlings were transplanted 6weeks after planting to their allocated plots at a spacing of 45cm×75cm. Organic manures were incorporated into the beds at three weeks prior to planting. Weeding was done manually at every two weeks interval using hoe and hand.

Data Collection and Statistics

Prior to the commencement and at the end of the experiment, soil samples were collected randomly at a depth of 0-15cm with the aid of soil auger from the experimental plots after which they were mixed together to form a composite sample. They were later air dried, crushed and passed through a 2mm mesh sieve and taken to laboratory to determine the routine soil chemical properties using standard procedures.

Particle size distribution was determined using the Bouycous Hydrometer Method of Gee and Or (2002). pH was determined in glass electrode using 1:2.5 soils:water ratio (IITA, 1989). Total Exchangeable acidity (Al^{3+} and H^{+}) was determined by titration method using 1N KCl (IITA,1989). Exchangeable (Ca^{2+} and Mg^{2+}) were determined in 0.25N ammonium acetate (NH_4OAC) at pH 7. EDTA titration method was used to determine $Ca^{2+}$and Mg^{2+} (Thomas, 1982). Exchangeable K^{+} and Na^{+} were extracted using 1N neutral ammonium acetate (NH_40AC) and determined photo-metrically using flame photometer (Thomas, 1982). Soil organic carbon content was quantified by Walkey-Black wet oxidation method as described by Nelson and Sommers (1982).Total Nitrogen was determined by kjehdahl digestion method using concentrated H_2SO_4 and a Sodium copper sulphate catalyst mixture (Bremner, 1996). Plant morphological data collected were plant height (cm) using measuring tape to measure the height of four (4) plants per plot from the soil surface to the tip of the plant where the youngest leaf branches and the average value was recorded, number of leaf per plant obtained by visual observation. All the data were collected at two weeks interval after transplanting (WAT) and Number of fruit and its weight in kg at 10 to 12 weeks growth stage.

The data collected were subjected to Analysis of variance (ANOVA) and means were separated using Fishers Least Significant Different (F-LSD) at $P<0.05$.

RESULTS AND DISCUSSION

Physico-chemical properties of soil before planting

The physico-chemical properties of the soil before planting were presented in table 1. The results showed that the soil texture was sandy loam with pH of 5.23 which shows moderate acidity and contain moderate organic carbon, total nitrogen and high in exchangeable acidity. The soil also contained high phosphorus indicating high fertility status.

The organic amendments used shows moderate acidity with pH of 5.3, 5.5 and 5.8 (table 1) respectively. It also shows good amount of chemical nutrients as measured which is an indication that the pepper thrives when the organic amendments was applied.

Table 1: Physico-chemial properties of soil before planting and the chemical properties of cassava peel, cow dung, poultry manure used.

SOIL PROPERTIES		**Nutrient content**		
	VALUE	Cassava Peel Biochar	Cow Dung	Poultry Manure
Textural class	SL	-	-	-
%Sand	54.40	-	-	-
%Silt	27.00	-	-	-
%Clay	18.60	-	-	-
pH in H_2O	5.23	5.3	5.5	5.8
TN(%)	0.11	0.89	1.08	1.58
Av.P(mg/kg)	11.20	17.8	13.9	18.8
OC(%)	1.32	10.37	12.45	18.35
Ca^{2+}(cmol/kg)	3.20	1.93	1.48	6.00
Mg^{2+}(cmol/kg)	1.00	1.58	1.90	1.50
K^{+}(cmol/kg)	0.27	0.02	0.07	0.03
Na^{+}(cmol/kg)	0.20	0.02	0.03	0.02
Al^{3+}(cmol/kg)	0.44	-	-	-
H^{+}(cmol/kg)	2.6	-	-	-

SL = Sandy Loam

Effect of cassava selected soil organic amendments and their combinations on selected chemical properties of the soil

Effects of the treatments on the soil chemical properties (0-15cm) were shown in table 2. Apart from the Exchangeable Base Cations which differed significantly. The treatments effects on the soil total N, organic carbon, pH, available phosphorus and exchangeable acid cations did not differ significantly. However, these parameters were consistently higher in the plot that received any of the organic manure relative to control. This may imply that the treatment resulted to priming action (when organic materials were applied). This is in agreement with Eleduma *et al*., (2016), who reported that the application of different rates of cow dung at different rates slightly increased the soil pH value, percentage T.N, OC, Ca and Mg.

Table 2: Effect of selected organic soil amendments and their combinations on selected chemical properties of the soil .

SAMPLE	pH (H_2O)	% OC	% T.N	Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}	Al^{3+}	H^{+}	P
				($Cmolkg^{-1}$)				($mgkg^{-1}$)		
CP	4.730	0.42	0.333	1.764	1.436	0.035	0.347	0.093	1.387	0.327
CD	4.96	0.37	0.333	1.759	1.349	0.039	0.344	o.480	1.4 33	0.454
CD+CP	4.90	0.35	0.030	1.623	1.391	0.037	0.332	0.360	1.633	0.226
CD+PM	4.81	0.34	0.026	1.483	1.458	0.039	0.409	0.213	1.933	0.354
PM	4.99	0.82	0.066	1.698	1.474	0.049	0.345	0.347	1.787	0.357
PM+CP	4.96	0.57	0.049	1.298	1.278	0.001	0.341	0.449	2.268	0.357
Control	4.76	0.43	0.035	1.398	1.316	0.019	0.332	0.480	1.613	0.349
$LSD_{0.05}$	Ns	Ns	Ns	0.06	0.102	0.006	0.011	Ns	Ns	Ns

Effect of cassava peel biochar, cow dung, poultry manure and their combination on plant height and number of leaves

The response of yellow pepper to the selected treatments on the vegetative growth (plant height and number of leaves is presented in table 3. The response shows that significant effect ($p<0.5$) was observed with the treatment means at 8 WAP compared to other treatments.At 12 WAP, the highest plant height was recorded on the plots that received PM+CP, though, this was not statistically different from other treatments as there mean values differed.

Also, the effects of treatment on the number of leaves were recorded (table 3) and it was observed that there was significant difference among the treatment meansat 4WAP unlike other growth stages measured which did not show any statistical significance among the means, though there difference was clearly stated, but statistically, they were not significant. The highest number of leave (61.6) was produced from application of PM + CP at 12 WAP, while the least value (31.2) was recorded on the plot that received CD+CP. This is in agreement with Eleduma *et al*., (2016), who reported that nutrient availability determines plant vegetative growth. The consistent poor performance of control plots and those with low level of nutrient showed that plants tents to thrive at their optimum level when nutrients are available in adequate amount.

Table 3: Effect of cassava peel biochar, cow dung, poutry manure and their combination on plant height.

	Plant Height (cm)					No. of Leaves				
SAMPLE	4WAP	6WAP	8WAP	10WAP	12WAP	4WAP	6WAP	8WAP	10WAP	12WAP
CP	15.42	20.3	21.8	39.8	36.2	6.92	11.7	24.1	39.6	46.4
CD	25.83	25.6	34.1	41.8	40.5	10.58	14.4	37.7	42.3	49.7
CD+PM	21.79	23.6	25.2	34.3	41.0	12.33	22.2	37.5	97.4	36.8
CD+CP	20.89	17.2	22.0	30.4	32.2	6.83	13.2	26.6	26.4	31.2
PM	21.75	18.6	28.2	44.4	37.7	8.25	20.2	32.0	86.0	58.3
PM+CP	24.67	21.5	27.1	41.3	48.0	10.42	18.7	37.3	76.0	61.6
Control	19.44	26.6	20.3	32.9	30.2	5.50	12.5	29.5	36.0	43.4
LSD0.05	NS	NS	8.23	NS	NS	2.963	NS	NS	NS	NS

Effect of the selected organic amendments and their combination on fruit weight and number of fruit.

The response of the crop to application of the selected soil amendments on fruit weight per plant was shown in table 4. Relatively, it could be observed that plots treated with CP biochar and CD have the highest fruit weight than other plots that received other treatments. The values obtained from all the treatment were significantly different from each other.

Similarly, it was shown that highest number of fruit (170.3) was recorded on the plots treated with the combination of CD+PM, while the lowest value (40.0) was recorded against the plots treated with the combination of CD+CP.

Table 4: Effect of selected organic amendments and their combination on fruit weight and Number of fruit.

Type of organic amendments	Weight Of fruit (kg)	Number of fruit
CP	0.60	88.7
CD	0.63	63.3
CD+PM	0.16	170.3
CD+CP	0.52	40.0
PM	0.31	72.0
PM+CP	0.25	129.3
Control	0.57	57.3
LSD0.05	0.09	7.76

CONCLUSION

Cassava peel biochar and poultry treatments gave high Ca^{2+} and Mg^{2+} whereas Al^{3+} and H^{+} were relatively low. The exchangeable bases and acidity were at good level thereby improving and sustaining the soil fertility, while the percentage OC and N where low in all the plant. Based on growth parameter of the test crop it was seen that poultry manure + cassava peel biochar had highest height at 12WAP and cow dung + poultry had the highest number of leave. In terms of fruit yield, cow dung + poultry produce the highest fruit yield while cow dung +cassava peel biochar had the least number of fruits. From all indication, cow dung + poultry manure could be considered more suitable for yellow pepper production in the studied soil.

REFERENCES

Akinrinde,A. E. (2006). Soils:Nature, Fertility,Conservation and Management. Agronomy Department, University of Ibadan, Ibadan, Nigeria. Page 1.

Bakewell-Stone, .P. (2011).Introduction to Biochar in Tropical Agriculture. ProNatura International, Paris, France, pg 51.

Bremner, J.M. (1996). Nitrogen-total. In methods of Soil Analysis. Chemical Mathods, part 3. 2nd edn, 1085-1121. (Ed. D.L. Sparks) SSSA Book Series No. 5,ASA and SSSA: Madison, WI, USA.

Davis,J. G.andWilson,C. R. (2005). Choosing a Soil Amendment. Colorado State University Extension, USA.

Eleduma, A.F., Aderibigbe, A.T.B., and Obabire, S.O., (2020). Effect of cattle manure on the performance of Maize (Zea mays L.) grown in savannah transition zone Southwest Nigeria. International Journal of Agricultural Science and Food Technology. ISSN: 2455-815X.

Gee, G.W., and Or, D., (2002). Particle-size analysis. In: Dane, J.H., Topp, G.C. (Eds.), Methods of Soil Analysis. Part 4. Physical Methods. Soil Science Society of America, Madison, Winsconsin, USA, pp. 255-293. No.5.

IITA, (1989). Automated and semi-automated methods of soil and plant analysis. Manual series, No 7, IITA, Ibadan, Nigeria.

Nelson, D. W. and Sommers, L.W (1982). Total Carbon, Organic Carbon and Organic Matter. In:Page, A. L., R. H. Millller, and D. R. Keeney (Eds). Methods of Soil Analysis. 2. Chemical and Microbiological Properties. *Agronomy* 9: 301-312.

Omisore, J.K., Kasail, M.Y., and Chukwu, U.C. (2009). Determination of optimum poultry manure rate for maize production. Proc. 43rd Annual Conference of the Agricultural Society of Nigeria, Abuja, pp. 260-263.

Thomas, G.W. (1982). Exchangeable Cations. In: page AI, Miler R.H. Keeney DR (eds) Methods of Soil Analysis Part. ASA-SSSA. Madison, pp 159-166.