IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 10, Issue 8 Ver. I (August 2017), PP 21-25
www.iosrjournals.org

Soil Physical Properties and Yield of Cucumber as Influenced by Biochar, Wood Ash and Rice Husk Dust Application in Abakaliki Southeastern Nigeria

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Abstract: *Field experiment was carried out to evaluate the soil physical properties and yield of cucumber as influenced by biochar, wood ash and rice husk dust application in Abakaliki Southeastern Nigeria at the Teaching and Research Farm of Faculty of Agriculture and Natural Resources Management, Ebonyi State University, Abakaliki in 2016. The experiment was laid out in Randomized Complete Block Design (RCBD) with four treatments and five replications. The treatments used were as follows: T_0 = Control (0 t ha^{-1}), T_1 = Biochar (5 t ha^{-1}), T_2 = Wood Ash (5 t ha^{-1}), T_3 = Rice Husk Dust (5 t ha^{-1}). Data collected were subjected to Analysis of Variance and significant difference between mean dictated using F-LSD at 5% level of probability. The results showed significant improvement in soil bulk density, total porosity, aggregate stability and mean weight diameter and non-significant improvement in moisture content and dispersion ratio among the treated plots when compared to control. Also, number of pods, pod length, pod circumference, pod diameter and pod yield were significant higher in the treated plots while plant height, leaf area index and number of leaves showed non-significant improvement with respect to control. Biochar, woodash and rice husk dust is recommended to be used as soil amendment in crop production.*

Keywords: *Amendment, degradation, improvement, parameter*

Date of Submission: 08-05-2017 Date of acceptance: 05-08-2017

I. Introduction

Soil is widely acknowledged as a fundamental resource for production of crops and agriculture as a whole. Continuous farming activities such as long period of cropping without the addition of any soil improving materials can impoverish the soil and when the soil is unable to meet the requirements of plant, it is considered to be constrained and in which case serious attention is required to boost the fertility status. It is however known that soil has the substantial capacity to treat and assimilate wastes. Application of plant wastes be it for plant nutrient supply or purely for disposal purposes has been known to increase the carbon content of the soil (Njoku and Ibekwe, 2017; Mbah and Onweremmadu, 2009 and Gupta *et al*., 1977) thereby increases soil physical properties such as aggregation, increases water holding capacity and decrease bulk density.

Biochar as an organic waste is the carbon-rich product obtained by heating biomass in a closed system under limited or no supply of oxygen (Wei zheng *et al.,* 2010). Biochar rcan be added to the soil as a means of sequestering carbon and enhancing soil quality (Wei Zheng *et al*., 2010). When used as a soil amendment, biochar has been reported to boost soil fertility and improve soil physical quality increasing moisture holding capacity, total porosity, aggregate stability and reduce soil bulk density thereby improving and retaining nutrients in soil (Lehmann *et al*., 2006; Lehmann, 2007).

Ash is the substance that remains after any material has been burned (Nwite *et al*., 2011). Wood ash which is the inorganic and organic residue remaining after the combustion of wood had been confirmed to be a good source of potassium, calcium lime and micronutrients (Adekayode and Olujugba, 2009; Moyin-Jesu, 2014). Farmers used wood ash to prevent diseases and acidic soil pH of in a similar manner to agricultural lime (Moyin-Jesu, 2014). Applying ash to farm land after recycling has been one effective way to improve the physical, chemical and microbiological properties of soils (Nwite *et al*., 2011). Rice husk dusts are solid wastes from rice processing in an area and constitute environmental hazards if not properly disposed (Uguru *et al*., 2015). Rice husk contains a high content of silicon and potassium, nutrients which have great potential for amending soil (Varela *et al*., 2013). Rice husk dust can be used as soil amendment to provide nutrients to plant (Anikwe, 2000, Mbah and Onweremadu, 2009 and Njoku *et al.,* 2011). Equally, Nnabude and Mbagwu (1998) observed that application of fresh and burnt rice-mill waste at the rate of 25.0 and 50.0 Mgha-1 decreased soil bulk density and increased total porosity.

The study aimed at evaluating soil physical properties and yield of cucumber as influenced by biochar and wood ash application in Abakaliki Southeastern Nigeria

II. Materials And Methods

2.1 Study Area

The study was conducted during the cropping season of 2016 at the Teaching and Research Farm of the Soil Science and Environmental Management, Ebonyi State University, Abakaliki, Ebonyi state, Nigeria. This region geographically is located between latitude 06^0 45^1 N and- longitude 08^0 30^1 E and- at an elevation of 147m above the sea level. The experimental site is at the derived savannah zone of Southern Eastern Nigeria. The climate is characterized with daily temperature range of 22^0C to 32^0C. The area has a bimodal rainfall pattern from April to November with peak at August and September. The total rainfall ranges from 1700mm to 2000mm with a mean of 1800mm and in form of an intensive violent shower of short duration. The soil belongs to the order Utisol which is largely loamy and ranging from medium to high fertility, indicating suitability for agriculture.

2.2 Experimental Design and Layouts

The experiment was laid out in a Randomized Complete Block Design (RCBD) and the experimental field was measured 11m by 9.5m giving a total area of $104.5m^2$. Five replications were made from treatments giving a total of 20 plots in the whole experiment. Each plot contained the treatment according to their randomization. Each plot was measured 2m by 2m with 0.5m between adjacent plots and 1m between blocks. The seeds were sown at a plant spacing of 50cm by 50cm giving a total of 25 holes in each plot and 2 seeds per hole.

The treatment combinations were as follows:

T_0 = control
T_1 = 5 tonnes of biochar per ha
T_2 = 5 tonnes of wood ash per ha
T_3 = 5 tonnes of rice husk dust per ha.

2.3 Soil sampling

Prior to land clearing, both soil auger and core sampler were used to collect soil samples randomly for pre-planting soil analysis. After harvesting, post-harvest soil samples were collected for the determination of some selected soil physical properties.

2.4 Source of experimental materials

The cucumber seeds were sourced from Abakpa main market Abakaliki, Ebonyi State and the particular variety used is named POINT SET. The biochar used was sourced from a local bakery in Abakaliki and grinded into powder before application. Also wood ash was gotten from the same source as the biochar and sieved to remove debris while rice husk dust was gotten from the rice mill industry at Abakaliki.

2.5 Plant wastes Application

The plant wastes were measured 2kg per treatment and broadcasted in the beds before incorporating into the soil according to randomization after raising the beds using hoe.

2.6 Cultural practices

Plots were made weed-free manually using hoes, cutlass, and hand pulling and harvesting was done as soon as plants reached its physiological maturity (8 WAP).

2.7 Agronomic Measurements

Five plants were picked at random from each plot and tagged and assessments of the following crop parameters were carried out on the tagged plants. After harvest, pods collected from the tagged plants were counted to determine the yield. Pod length was determined by measuring the pod with a meter rule also the plant height was taken from the soil surface to the apical tip of the plant using meter rule. The length and breadth of the plant leaf was measured to obtain the leaf area index which was estimated as its length multiplied by its maximum width and number of leaves determined by counting the number of leaves on each of the tagged plant.

2.8 Laboratory Methods and Procedure

Bulk density was determined by the method described by Blake and Hartage (1986). Total porosity was determined according to the method described by Obi (2002) and moisture content was determined using the method described by Obi and Ebo (1995). Aggregate stability and Mean weight diameter were determined as

described by Kemper and Rosenau (1986) and dispersion ratio was also determined as described by Kemper and Rosenau (1986) while particle size distribution was measured using the method described by Gee and Baunder (1979).

2.9 Statistical and Data Analysis

Data collected from these parameters were subjected to statistical analysis of variance (ANOVA) for Randomized Complete Block Design (RCBD) according to Obi (2002). Treatment means were separated using Fisher's Least Significant Difference (F-LSD) according to Obi (2002).

III. Results And Discussion

3.1 Initial Soil Properties

Table 1 showed the initial properties of the soil studied. The soil was a sandy loam comprising of sand, silt and clay at 528, 264 and 208gkg^{-1} respectively. It also contain bulk density, total porosity, moisture content, mean weight diameter, dispersion ratio and aggregate stability of 14.92%, 1.40gcm^{-3}, 31.12%, 2.25mm, 0.70 and 7.34%, respectively.

3.2 Soil Physical Properties as Influenced by Biochar, Wood Ash and Rice Husk Dust Application

Soil physical properties as influenced by biochar, woodash and rice husk dust application were as shown in Table 2. There was a significant ($p<0.05$) changes in the values of bulk density, total porosity, aggregate stability and mean weight diameter among the various treatment studied while moisture and dispersion ratio showed non-significant changes with respect to amendment applied. This agreed with Njoku *et al.* (2015) which showed that the influence of wastes on soil depends on the type of wastes added to soil. The highest bulk density of 1.7 gcm^{-3} was observed in control (T_0). This observed bulk density in control was higher than bulk density in T_1, T_2 and T_3 by 14%, 5% and 12% respectively. This in agreement with works of Atkinson *et al.* (2010); Major *et al.* (2009); Sohi *et al*. (2010); Zwieten *et al*. (2012) who proposed that the application of biochar to soil is considered to improve a range of soil physical properties including soil bulk density, total porosity and other soil physical properties. It also agrees with the work of Mbah *et al*. (2011) who obtained lower bulk density and higher total porosity due to rice husk dust application. The order of increase in mean weight diameter was $T_1 < T_0 = T_2 < T_3$. Rice husk dust recorded the highest aggregate stability value of 9.14% while that of other treatments ranged between 5.12% to 7.89% with the exception of wood ash that decrease aggregate stability. The decrease of aggregate stability in wood ash plots may have been as a result of tillage that disrupted the existing soil aggregates.

3.3 Yields of Cucumber as Influenced by Biochar, Woodash and Rice Husk Dust Application

Table 3 showed yields of cucumber as influenced by biochar, woodash and rice husk dust application. There was a significant ($p<0.05$) changes in number of pods of cucumber, pod length, pod circumference, pod diameter and pod yield with respect to biochar, woodash and rice husk dust application among the treatment studied while plant height, leaf area index and number of leaves showed non-significant changes among the treatment. However, control recorded the lowest values of plant height, leaf area index and number of leaves, than T_1, T_0, T_2 and T_3. This result agreed with the works of Eifediyi and Remison (2010); Adenawoola and Adejoro (2005) who observed that waste can improve the growth and yield of cucumber.

IV. Conclusion

This work showed that application of biochar, woodash and rice husk dust improved soil bulk density, total porosity, aggregate stability and mean weight diameter as well as the cucumber yields. However, with the exception of moisture content and dispersion ratio, soil physical properties (bulk density, total porosity, aggregate stability and mean weight diameter) studied showed significant improvement in among the different treatment when compared to control. Similarly, number of pods, pod length, pod circumference, pod diameter and pod yield were significant higher in the treated plots while plant height, leaf area index and number of leaves showed non-significant improvement with respect to control. Biochar, woodash and rice husk dust is recommended to be used as soil amendment in crop production

Table 1: Initial Physical Properties of the Soil Studied

Parameter	Value	Unit
Sand	528	gkg^{-1}
Silt	264	gkg^{-1}
Clay	208	gkg^{-1}
Texture	Sandy loam	-
Total porosity	47.17	%
Bulk density	1.40	gcm^{-3}

Moisture content	31.12	%
Mean weight diameter	2.25	Mm
Dispersion ratio	0.70	
Aggregate stability	7.34	%

Table 2: Soil Physical Properties as Influenced by Biochar, Wood Ash and Rice Husk Dust Application

Treatment	**Bulk density g/cm^3**	**Total porosity (%)**	**Miosture (%)**	**Aggregate stabibility (%)**	**Mean weight diameter (mm)**	**Dispersion ratio**
T_0	1.79	32.55	14.18	5.19	2.20	0.77
T_1	1.53	42.46	32.18	7.89	2.10	0.78
T_2	1.70	35.76	40.11	5.12	2.20	0.78
T_3	1.56	41.13	34.60	9.14	2.44	0.79
FLSD≤0.05	0.16	6.14	NS	0.22	0.09	NS

Where: T_0 = 0 t h^{-1} (control), T_1 = 5 t h^{-1} Biochar, T_2= 5 t h^{-1} Wood ash, T_3 = t h^{-1} Rice husk dust, NS =Non significant

Table 3: Yield of Cucumber as Influenced by Biochar, Wood Ash and Rice Husk Dust Application

Treatment	Plant height (cm)	Leaf area index	Number of leaves	Pod length (cm)	Number of pods	pod circumference (cm)	Pod diameter (cm)	Pod yield (t/ha)
T_0	60.38	71.05	12.75	10.05	1.88	11.05	3.50	3.65
T_1	69.73	80.78	18.05	15.50	3.50	15.40	4.90	8.00
T_2	85.68	82.38	18.70	15.28	2.13	16.18	5.15	5.20
T_3	67.43	80.88	15.20	15.08	3.13	16.23	5.18	7.50
FLSD≤0.05	NS	NS	NS	3.61	1.46	4.62	0.44	1.38

Where: T_0 = 0 t h^{-1} (control), T_1 = 5 t h^{-1} Biochar, T_2= 5 t h^{-1} Wood ash, T_3 = t h^{-1} Rice husk dust, NS =Non significant

References

[1]. Adekayode, F.O. and Olojugba, M.R. (2010). The utilization of wood ash as manure to reduce the use of mineral fertilizer to improve performance of maize (zea mays L.) as measured in the chlorophyll content and grain yield. *Journal of soil science and Environmental management*, vol. 1(3): pp 40-45.

[2]. Adenawonuola, A.R. and Adejoro, S.A. (2005). Residual effect of poultry manure and NPK fertilizer residues on soil nutrient and performance of Jute (Corchorusohtorus). Nigerian Journal of soil sciences, 15: 133 – 135.

[3]. Atkinson, C.J., Fitzgerald, J.D. and Hipps, N.A. (2010). Potential mechanisms for achieving agricultural benefits from biochar application to temperate soils: a Review. Plant and soil 337: 1-18.

[4]. Anikwe , M. A.N. (2000). Amelioration of a heavy clay loam with rice husk dust and its effect on soil physical properties and maize yield.*Bioresourse Technology*. 74:169 – 173.

[5]. Blake, G.R. and Hartage, K. H. (1986). Bulk Density In: Klute (ED). Methods of soil Analysis part 1; *American Society of Agronomy* Vol. 9: 365 – 375.

[6]. Eifediyi, E.K. and Remison, S.U. (2010). Growth and yield of cucumber (Cucumis sativuis L.) as influenced by farmyard manure and inorganic fertilizer. Journal of plant breeding and crop sciences, vol. 2(7): 216 – 220.

[7]. Gee, G.W. and Bauder, J.W.(1986). Particle Size Analysis by Hydrometer Method; Simplified Method for Routine Textural Analysis and Sensitivity a Test of Mineral Parameters; *Soil Sc. Soc. Am. J.*43:1004 – 1007.

[8]. Gupta, S.C., R.H. Downy and W.E. Larson (1977). Hydraulic and thermal properties of a sandy soil as influenced by incorporation of sewage sludge soil science,Am. Proc.

[9]. Kemper, W.D. and Rosenau, R. C. (1986). Aggregate and Size Distribution In: Klute (ed) Methods of Soil Analysis; part 1; Physical and Mineralogical Methods, ASA, SSSA, Madison,W.I. USA, 425-442 pp.

[10]. Lehmann, J. (2007). Bioenergy in the black, Frontiers Ecol. Environ., 5: 381-387.

[11]. Lehmann, J., Gaunt, J., Randon, M. (2006).Biochar sequestration in terrestrial ecosystems.A review.Mitadapt.strat.global change 11: 403-427.

[12]. Major, J., Steiner, C., Downie, A., Lehmann, J. (2009) Biochar effects on nutrient leaching. In: J. Lehmann, S. Joseph (eds) Biochar for Environmental management: Science and Technology. Earthscan.

[13]. Mbah, C.N. and Idike, F.I. (2011). Carbon storage in tropical Agicultural soils of South Eastern Nigeria under different management practices. *International research journal of Agricultural science and soil science.* Vol. 1(2): pp 053-057.

[14]. Mbah, C.N. and Onweremadu, E.U. (2009). Effect of organic and mineral fertilizer inputs on soil and maize grain yield in an acid ultisol in Abakaliki – South Eastern Nigeria; *American Eurasian journal of Agronomy*. 2(1): 07-12.

[15]. Moyin-Jesu, E.I. (2014). Effects of water extracts of Neem leaf, wood ash and their mixture on soil chemical composition and growth and yield of plantain. *American Journal of Experimental Agriculture*, 4(7): 837-846.

[16]. **Njoku, C.** and Ibekwe, I. (2017). Response Of Selected Soil Chemical Properties And Maize Yields as Affected By Animal Wastes Application In Abakaliki, Southeastern Nigeria, *International Research Journal of Agricultural Science,* vol. 1(1), pp 1 – 6.

[17]. **Njoku, C**., Mbah, C.N., Igboji, P.O., Nwite, J.N. and Chibuike, C.C. (2015). Effect of Biochar on Selected Soil Physical Properties and Maize Yield in an Ultisol in Abakaliki Southeastern Nigeria, *Global Advanced Research Journal of Agricultural Science* Vol. 4(12) pp. 864 – 870.

[18]. Njoku, C., Mbah, C.N., Okonkwo, C.I. (2011). Effect of rice mill wastes application on selected soil physical properties and maize yield (Zea mays L.) on an ultisol in Abakaliki South Eastern Nigeria; *journal of soil science and Environmental management*, vol. 2(11): pp. 375 – 383.

[19]. Nnabude, P. C. and Mbagwu J. S. C. (1998). Soil water relation of Nigeria typic haplustult amended with fresh and burnt rice mill wastes. *Soil Tillage Res. 50:207–214*.

[20]. Nwite, J.C., Igwe, C.A., Obalum, S.E. (2011).The contributions of different ash sources to the improvement in properties of a degraded Ultisol and maize production in southeastern Nigeria. *American-Eurasian Journal of sustainable Agriculture*, 5(1): 34 – 35.
[21]. Obi, I. U. (2002). Statistical method of detecting differences between treatment meant and research methodology issues in laboratory and filed experiment.Ap express publishers limited,3 Obollo Road Nsukka –Nigeria Pp117.
[22]. Obi, M.E. and Ebo, P.O. (1995). The effect of organic and inorganic amendments on soil physical properties and maize production in a severely degraded sandy soil in southern Nigeria. *Bioresource Technology* 51: 117-123.
[23]. Sohi, S.P., Krull, E., Lopez-Capel, E. Bol, R., Donald, L.S. (2010). Review of biochar and its use and function in soil. Advances in Agronomy. Academic press.
[24]. Uguru, B.N., Mbah C.N. and **Njoku C.** (2015).Effect of Rice Husk Dust on Selected Soil Physical Properties and Maize Grain Yield in Abakaliki, South Eastern Nigeria , *Global Advanced Research Journal of Agricultural Science* Vol. 4(12) pp. 878 – 886.
[25]. Varela, M.O., Rivera, E.B., Huang, W.J., Chien,C.C., Wang, Y.M. (2013). Agronomic properties and characterization of rice husk and wood biochars and their effect on the growth of water spinach in a field test. *Journal of soil science and plant nutrition*, 13(2): 252-254.
[26]. Wei, Z., Sharma, B.K., Rajagopalan, N. (2010).Using biochar as a soil amendment for sustainable Agriculture. *Sustainable Agriculture Grant Program.*
[27]. Zwieten, L.V., Sing, B.P. and Cox, J. (2012). Biochar effects on soil properties. In: J. Cox (ed) Biochar in Horticulture: Prospects for the use of biochar in Australian Horticulture. Horticulture Australia.

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