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Changes in Selected Soil Physical Properties and Maize Yields as Affected by Animal Wastes Application in Abakaliki Southeastern Nigeria

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Abstract— *The study was conducted at Abakaliki to determine the changes in selected soil physical properties and maize yields as affected by animal wastes application in Abakaliki southeastern Nigeria in 2014 and 2015 cropping seasons. The experiment was laid out in Randomized Complete Block Design with four treatment replicated five times. The treatments were poultry droppings at 5 tha^{-1} (PD), cow dung at 5 tha^{-1} (CD), mixture of PD + CD at 5 tha^{-1} and control (C) – non application of amendment. Bulk density, total porosity, moisture content, aggregate stability and mean weight diameter were determine in the laboratory using appropriate procedure while plant height, leaf area index and grain yield were also, measured in the field using recommended methods. The results showed positive changes in selected soil physical properties and maize yield in the two cropping seasons with the application of animal wastes. Also, improvement in soil physical properties and maize yields were higher in the second cropping season when compared to the first cropping season. Poultry dropping is recommended for farmers to use as fertilizer in maize production because plots treated with poultry droppings recorded the highest maize grain yield in the two cropping season than other treatments.*

Keywords — Animal wastes, improvement, physical properties, treatment, yield.

I. INTRODUCTION

Turning agricultural wastes into organic fertilizers is one of the waste recycling technologies. Organic fertilizers are used as a supplement particularly in some parts of Africa where nutrients availability in the soil is low and is a serious challenge for production of food [1]. The use of agricultural wastes as soil amendment can be used to improve soil productivity and increase crop yield thereby ensuring food security [2]; Njoku and [3]. Application of animal wastes on soil as amendments reduces the accumulation of the waste in the environment, reduces odour, bulk density and increase total porosity [4]. Using poultry droppings and cow dung as soil amendment have been reported by many researchers to give significant improvement in crop growth and yield. Parameters such as leaf area index, plant height, grain yield etc increased with the application of animal wastes. According to [5] and [6] poultry dropping improved soil properties which translated to higher crop yield. [7] observed that there was significant increase in yield of corn grains under the treatments of ploughing with composts as compared to the treatment of ploughing only, regardless the level of ploughing. Addition of individual residues with manures had resulted in higher dry matter weight of fodder sorghum compared to the control treatment [1]. In order to achieve a global trend towards organic farming we have to use poultry manure as a substitute for inorganic fertilizer [8]. Waste utilization in agriculture is a common phenomenon; it is a means of enhancing soil quality, creating livelihood for farmers and providing nutrients for plants [9]. Recent studies have shown that waste utilization in crop production has a positive effect on social, economic and environment.

The objective of the study was to determine the changes in selected soil physical properties and maize yields as affected by animal wastes application in Abakaliki southeastern Nigeria.

II. MATERIALS AND METHODS

2.1 Study area

The experiment was carried out at Abakaliki southeastern Nigeria. Abakaliki lies in latitude and longitude of $04^{0}6^{'}$ N and $08^{0}65'$ E, respectively in the derived savannah of the Southeastern agro-ecological zone of Nigeria. The yearly rainfall ranges between 1700 -2000 mm. The rainfall pattern is bimodal which normally start at April – July and September – November and there is short break in

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August generally referred to as August break. January – March were normally known as dry season while the minimum and maximum temperatures of the area were 27°C and 31°C, respectively [10]. The relative humidity of the area during the dry season and rainy season are 55 - 60% and 75 - 80%, respectively. The soil of the area belongs to the order Ultisol.

2.2 Sources of materials

Animal wastes and maize (Oba super II) were purchased from animal unit of Ebonyi State University and Ebonyi State Agric Development Programme, respectively.

2.3 Land preparation and experimental design

The experiment was laid out in Randomized Complete Block Design with four treatment replicated five times. Cutlass was used in clearing the vegetation and debris was removed and the beds were made using hoe. Treatments were incorporated into the plots immediately after cultivation using hoe. Two maize seed were planted per hole. The maize seed was planted at the depth was 3 cm while spacing of 75 cm between rows and 25 cm within rows were also used. Two weeks after germination (WAG) the young plant was thinned down to one plant per stand and lost stands were replaced. The crop population was 48 seedlings per plot. Weeding was done manually at three weeks interval till harvest period. The same procedure was repeated in 2015 cropping season. Treatments used for the experiments are as follows:

i. C – 0 t ha^{-1} (Control)
ii. PD – 5t ha^{-1} of Poultry droppings = (4.5kg/plot)
iii. CD – 5t ha^{-1} of Cow dung = (4.5kg/plot)
iv. MX– 5 t ha^{-1} of Mixture (2.5t $ha^{-1}$of Poultry droppings + 2.5t ha^{-1} of Cow dung)

2.4 Soil Sampling

Initial auger soil samples and core soil samples of 170.9cm^{-3} were collected from 5 different places from the site before cultivation and used for the determination of initial soil properties. Also, undisturbed core soil samples of 170.9 cm^{-3} and auger soil samples were collected from each plot at 90 days after planting (DAP).

2.5 Laboratory Analyses

The following soil physical properties were determined:

Bulk density and total porosity were determined as described by [11]. Moisture content was determined using the procedure outlined by [12]. Aggregate stability and mean weight diameter were also determined using the method described by [13]. Bouyoucous hydrometer method was used to determine particle size distribution as described by [14]. Textural triangle was used to determine textural class of the soil.

2.6 Crop Parameters Determined

At 90 DAP, ten maize plants per plot were selected and tagged [3]. The tagged plants were used for the determination of the following crop parameters:

i. Plant height: Plant height was measured from the ground surface to the tip of the plant using a meter rule.
ii. Leaf area index: Leaf area index was determined by calculation – using the formular: Length X Width X 0.905 – where 0.905 is a correction factor.
iii. Grain yield: Grain yield was determined by shelling the cobs of harvested plants and dried to 14 % moisture content. Dried grain yield per plot was weighed and then converted to its hectare equivalent.

2.7 Data Analyses

Statistical analysis of the data was carried out using the General Linear Model of SAS software for Randomized Complete Block Design [15] while differences between treatments means were determined using the Fisher's Least Significant Difference (F-LSD)

III. RESULTS

3.1 Initial properties of the soil

Table 1 shows the initial properties of the soil studies. The soil studied was a sandy loam recording the values of sand, silt and clay of 480gkg^{-1}, 402gkg^{-1} and 118gkg^{-1}, respectively. Similarly, the bulk density, total porosity, moisture content, aggregate stability and mean weight diameter of the soil before planting were 1.2gcm^{-3}, 51.32%, 11.98%. 6.8% and 1.34mm, respectively.

Table.1: Initial Properties of the Soil Studied

Parameters	**Value**
Sand	480 gkg^{-1}
Silt	402 gkg^{-1}
Clay	118 gkg^{-1}
Textural	Sandy loam
Bulk Density1.2gcm^{-3}	
Total Porosity	51.32%
Moisture Content	11.98%
Aggregate Stability	6.8%
Mean weight diameter	1.34mm

3.2 The Effect of Animal Waste on Soil Physical Properties

The effect of animal waste on soil physical properties is shown in Table 2. There was a significant ($P<0.05$) differences in the values of bulk density, total porosity, moisture content and mean weight diameter observed in all the plots in the two cropping seasons. Higher bulk

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density of 1.28gcm^{-3} was recorded by control in 2014 cropping season. This observed bulk density in control was higher than bulk density in PD, CD, and MX by 2%, 1%, and 1%, respectively. Similarly, in 2015 cropping season higher bulk density of 1.36 gcm-3 in control while that of animal waste treated plots ranged between 1.23 – 1.25 gcm^{-3}. The order of total porosity increase in 2014 cropping season was MX>PD=CD>C while the order of total porosity increase in 2015 cropping season was CD>PD>MX>C. The lowest moisture content of 11.23% was observed in control in 2014 cropping season moisture content animal wastes amended plots ranged between 12.94 – 14.38%. Also, in 2015 cropping season lowest moisture content of 9.68% was recorded in control and moisture content in plots treated with animal wastes ranged between 13.24 – 14.26%. The order of increase in aggregate stability in 2014 cropping season was PD>MX>CD>C whereas the order of aggregate stability increase in 2015 cropping season was CD>MX>PD>C. In 2014 cropping season, the lowest mean weight diameter value of 0.95mm was observed in control. This observed mean weight diameter value in control was lower than mean weight diameter in PD, CD and MX by 75%, 56% and 68%, respectively. Whereas, in 2015 cropping season the lowest mean weight diameter of 0.86 mm was observed in control while that of animal wastes treated plots ranged 1.51 – 1.68 mm.

Table.2: Effect of Animal Waste on Soil Physical Properties

Treatments	BD (gcm^{-3})		TP (%)		MC (%)		AS (%)		MWD (mm)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
C	1.28	1.36	51.70	48.68	11.23	9.68	8.00	6.38	0.95	0.86
PD	1.26	1.24	52.08	53.21	13.93	14.26	10.64	11.31	1.66	1.68
CD	1.27	1.23	52.18	53.59	12.94	13.24	9.23	12.41	1.48	1.51
MX	1.27	1.25	52.45	52.83	14.38	13.56	10.45	12.01	1.60	1.54
F–LSD	0.02	0.11	0.03	0.25	0.02	0.36	0.03	0.28	0.03	0.10

Where C = Control (Non-application of amendment; PD = 5tha^{-1} of Poultry droppings; CD = 5tha^{-1} of Cow dung; MX = 2.5t ha^{-1} of Poultry droppings + 2.5tha^{-1} of Cow dung; BD = Bulk density; TP = Total porosity; MC = Moisture content; AS = Aggregate stability and MWD = Mean weight diameter

3.3 Effect of Animal Wastes on Agronomic Parameters

The effect of animal wastes on plant growth, leaf area index and maize grain yield is shown in Table 3. There was a significant ($p < 0.05$) differences in the values of leaf area index, plant growth, and grain yield in all the plots studied. The lowest value of plant height of 100.96cm was observed in control and the highest value of 118.40cm was recorded in PD in 2014 cropping season. Similarly, in 2015 cropping season control recorded the lowest plant height of 98.68 cm while that of animal wastes treated plots ranged between 110.24 cm – 135.65 cm. The lowest leaf area index of 203.31 cm was recorded in the control in 2014 cropping season. This observed leaf area index in control in 2014 cropping season was lower than that of PD, CD and MX by 10, 6 and 2%, respectively. In 2015 cropping season, lowest leaf area index of 198.23 was observed in control and leaf area index recorded in animal wastes treated plots ranged between 211.36 in MX – 228.51 in PD. The order of increase in maize grain yield in 2014 and 2015 cropping season was PD>CD>MX>C.

Table.3: Effect of Animal Waste on Plant Growth, Leaf Area Index and Maize Grain Yield

Treatments	Plant height (cm)		Leaf area index		Grain yield (t ha^{-1})	
	2014	2015	2014	2015	2014	2015
C	100.96	98.68	203.31	198.23	2.10	1.86
PD	118.40	120.63	224.73	228.51	2.87	3.01
CD	108.60	110.24	216.95	221.13	2.44	2.98
MX	133.59	135.65	207.42	211.36	2.24	2.56
F–LSD	2.809	3.697	0.032	0.086	0.276	0.309

Where C = Control (Non-application of amendment; PD = 5tha^{-1} of Poultry droppings;
CD = 5tha^{-1} of Cow dung; MX = 2.5t ha-1 of Poultry droppings + 2.5tha^{-1} of Cow dung

IV. DISCUSSION

4.1 Soil Physical Properties

The results indicated that the bulk density in plots treated with animal wastes reduced more than the bulk density in control during the two cropping seasons studied. In the second season of the experiment the bulk density in control increased when compared to first season of the experiment. On the other hand, total porosity was higher in plots treated with animal wastes than control. Total porosity unlike bulk density decreased in control and increased in treated plots in second season of the experiment more than first season of the experiment. This indicated that the application of animal wastes in soils reduce soil bulk density and increase total porosity. This agrees with the work of [5] who noted that addition of

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animal wastes to soil reduced soil bulk density and increased total porosity. They also recorded that annual addition of poultry wastes to soil had beneficial value on soil physical properties. [9] also observed reduction in soil bulk density and increase in total porosity with increase in different levels of poultry droppings application.

Plots treated with animal wastes gives higher moisture content when compared with control in the two cropping seasons. Control had lower moisture content in second cropping season than first cropping season whereas plots treated with animal wastes recorded higher moisture content in second cropping season than control. This showed that animal wastes have the capacity to increase the water content of the soil. The positive effect in soil water accumulation could be ascribed to greater quantity of poultry manure added to the soil. This is in supports of the earlier work of [16] who reported that addition of poultry manure to soil enhance organic matter content of the soil thereby improved the moisture absorption in the soil. The improvement in the moisture absorption of soil might be due to the positive development in the soil structure which was associated with poultry manure application [17]. [9] reported that poultry additions of poultry manure up to 50 tha^{-1} increases moisture content of the soil. Moisture content therefore can be improved by adding animal wastes which helps to improve soil quality.

Application of animal wastes to soil improved the aggregate stability in the two cropping season when compared to control. Aggregate stability in control reduced in the second cropping season while aggregate stability in the animal wastes treated plots increased in the second cropping season more than the aggregate stability observed in the first cropping season. Plots treated with animal wastes recorded higher mean weight diameter than control in the two cropping seasons when compared with control. Also, in the second year of the experiment control and animal wastes treated plots recorded lower and higher mean weight diameter, respectively than the first year of the experiment. [18] reported that the beneficial effects on physico-chemical properties of soil were as a result of compost added to the soil which is in support of this study.

4.2 Effect of Animal Wastes on Maize Yield

Plant heights were significantly higher in animal wastes treated plots than control in the two cropping seasons. Animal wastes treated plots had higher plant height in the second cropping season than first cropping season while that was lower in the second cropping season than first cropping season. Similarly, leaf area index was higher in animal wastes treated plots than control in the two cropping seasons. Leaf area index decreased in control and increased in animal wastes treated plots in the second cropping season than first cropping season. [6] showed that poultry droppings are made up of important elements that are related with high photosynthetic actions which enhance vegetative and roots growth. [19] reported earlier that development of maize leaf, vigorous and healthy growth of the crop is as a result of poultry droppings added to the soil. [8] noted that poultry manure helps in vigorous growth, physiological activities and also increased meristematic tissues in the plant due to the content of plant nutrient in the soil. Also, grain yields were higher in animal wastes treated plots than control in the two cropping seasons. Plots treated with poultry droppings recorded the highest maize grain yield in both cropping seasons. Maize grain yield in animal wastes treated plots were higher in the second cropping season while maize grain yield in the control decreased in the second cropping season. This showed that animal waste treatment is important for sustainable maize production. [6] in their own view also reported that poultry manure had effects positively on the physical attributes of water melon which they said could be due to the fact that poultry manure contained important elements that is good for high photosynthetic activities that promote vegetative growth and prolific root. [19] reported earlier that, different types of manure application rates leads to significant response in grain yield which are in the support of this study.

V. CONCLUSION

The results indicated that animal wastes added to the soil at 5tha^{-1} improved soil physical properties and maize yield. The improvement was higher in the second cropping season than that of first cropping season which proved that animal wastes application to soil promotes sustainability. Poultry dropping is recommended for farmers to use as fertilizer in maize production because plots treated with poultry droppings recorded the highest maize grain yield in the two cropping season than other treatments.

REFERENCES

[1] Mubarak, A. R., Omaima, E. R., Amal, A. A. and Nemat, E. H. (2009). Short-term Studies on use of organic amendments for amelioration of a sandy soil. *African Journal of Agricultural Research* Vol. 4 (7): 621- 627.

[2] Njoku C., Mbah C.N. and Okonkwo, C.I. (2011). Effect of rice mill wastes application on selected soil physical properties and maize yield (*Zea mays l.*) on an Ultisols in Abakaliki Southeastern Nigeria. *Journal of Soil Science and Environmental Management* 2(11) 375 – 383.

[3] Njoku, C. and Mbah, C.N. (2012). Effect of burnt and unburnt rice husk dust on maiz yield and soil physico-chemical properties of an Ultisoil in Nigeria. *Biol. Agric & Horti.* Vol. 1.1-12.

[4] Zebarth, B.J., Neilsen, G.H., Hogue E., and Neilsen, D. (1999). Influence of organic waste amendments on selected soil physical and chemical properties. *Can. J. Sci.* 79: 501- 504.

[5] Agbede, T.M., Ojeniyi, S.O. and Adeyemo, A.J. (2008). Effect of Poultry Manure on Soil physical and chemical properties, growth and grain yield of sorghum in Southwest,Nigeria, *Am.-Eurasian J. Sustain. Agric.* 2(1): 72 – 77.

[6] John, L.W., Jamer, D.B. Samuel, L.T. and Warner, L.W. (2004). Soil Fertility and Fertilizers: An Introduction to Nutrient Management, Pearson Education, India.

[7] Wanas, Sh. A. (2006). Towards Proper Management of Clayey Soils: Combined Effects of Plowing and Compost on Soil Physical Properties and Corn Production. *Egypt Journal of Applied Sciences Research* 2(3): 123 – 128.

[8] Dauda, S.N., Ajayi, F.A. and Ndor E. (2008). Growth and Yield of Watermelon (*Citrullus lanatus*) as Affected by Poultry Manure Application. *Journal of Agriculture & Social Sciences;* 121–124.

[9] Ewulo, B. S. Ojeniyi, S. O. and Akanni, D. A. (2008). Effect of poultry manure on selected soil physical and chemical properties, growth, yield and nutrient status of tomato. *African Journal of Agricultural Research* Vol. 3 (9): 612 – 616.

[10] Federal Department of Agriculture and Land Resources (1985). Reconnaissance Soil Survey of Anambra State, Nigeria Soil Report, Kaduna.

[11] 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.

[12] 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.

[13] 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, 425-442pp.

[14] 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.

[15] SAS Institute Inc. (1999). SAS/STATS users guide, Version 6, 4th ed. SAS Institute., Cary, NC.

[16] Adesodun, J.K., Mbagwu, J.S.C. and Oti N (2005). Distribution of carbon nitrogen and phosphorus in water stable aggregates of an organic waste amended Ultisol in southern Nigeria. *Bioresource Technol.* 96: 509 – 516.

[17] Aluko, O.B. and Oyedele, D.J. (2005). Influence of organic incorporation on changes in selected soil physical properties during drying of a Nigerian Alfisols. *J. of Applied Sci.*5:357-362.

[18] Wanas, Sh.A.(2002). The role of organic compost in alleviating soil compaction. *Egypt. J. Appl. Sci.* 17 (6): 363 – 372.

[19] Aliyu, L. (2000). The effects of organic and mineral fertilizer on growth, yield and composition of pepper (*Capsicum annum L*). *Biol. Agric. Hort.* 18: 29–36.