GLOBAL SYMPOSIUM ON SOIL ORGANIC CARBON, Rome, Italy, 21-23 March 2017

Carbon Sequestration by an Accelerated compost in an Alfisol

AyanfeOluwa O. E.[1], O. O. AdeOluwa[2] and V. O. Aduramigba-Modupe[3]*

[1]ayanfeoluwaolufemi@gmail.com, Federal College of Agriculture, Ibadan, Nigeria
[2]Department of Agronomy, University of Ibadan, Ibadan, Nigeria
[3] Institute of Agricultural Research and Training, Moor Plantation, Ibadan.

Abstract
Compost has the potential to trap carbon in the soil while supplying nutrients needed for the crop. This study investigated the carbon sequestration potential of different rates of a commercial accelerated compost (Gateway Organic Fertilizer) in an Alfisol in two years. The treatments laid out in Randomized Complete Block Design with three replications were accelerated compost (AC) at the rates of 0, 60, 90, 120, 150 and 180 kgN/ha. Mineral fertilizer (NPK 15-15-15) and conventional compost (CC), both at 60 kgN/ha, were checks. Post residual cropping soil samples (6 months after application) were analysed for organic carbon and data analysed using standard error of means. In 2013, the carbon sequestered was in the order of 90 kgN/ha AC;111%) > 150 kgN/ha AC;102% > 60 kgN/ha CC;66% > 180 kgN/ha AC;55% > 60 kgN/ha AC;45% > 120 kgN/ha AC;38% > 60 kgN/ha NPK;24%. In 2014; 60 kgN/ha AC;58% > 180 kgN/ha AC;53% > 90 kgN/ha AC;34%) > 120 kgN/ha AC;22% > 150 kgN/ha AC;13% > 60 kgN/ha CC;9% > 60 kgN/ha NPK;2%). It could therefore be concluded that the shortness in maturity of the AC used for this study does not limit its carbon sequestration potential.
Key words: Accelerated compost, organic wastes, carbon sequestration, climate change, mitigation strategies, Alfisol

Introduction, scope and main objectives

Agriculture has a great potential to reduce the build-up of greenhouse gases in the atmosphere thereby mitigating climate change (Keith *et al*., 2006). This is possible by promoting the use of organic wastes into organic fertilizer for crop production, thereby facilitating the composting of organic materials that would have been burnt, thus, storing the carbon that have being trapped from the atmosphere during photosynthesis into the soil (Lal, 2004; UNFCCC/CCNUCC, 2007; Fliessbach *et al*, 2009).

Recent development had shown that composting process could be accelerated by speeding up the rate of the biological decomposition of organic material through the artificial introduction of some microorganisms, or by manipulating the temperature. Compost made within a relatively short period of about three weeks instead of the conventional three month period of maturity are referred to as accelerated compost (Rotor, 2008). This technology; acceleration of composting, therefore, has the tendency to increase the availability of compost for farmers while encouraging the trapping of more carbon in the soil and mitigate the effect of climate change. It will also accelerate the handling of high volume of waste being generated thereby enhance the management of waste and promote healthy environment (Laine-Ylijoki, 2005).

However, the concern is what will be the implication of reduced composting time on the carbon sequestration ability of the compost. Alfisols constitutes 9.7% of the global soil, based on soil order (Blum and Eswaran, 2004). This work therefore investigated the carbon sequestration by an accelerated compost on an Alfisol using maize as the test crop.

Methodology

The experiment was carried out on an Alfisol at the experimental site of the Federal College of Agriculture, Ibadan, Nigeria, 7˚22.5′ N and 3˚50.3′ E in both year 2013 and 2014. The total land area for the experiment each year was 360 m^2. The experiment was made up of a total of 24 experimental units with plot size of 3.3

m^2, a spacing of 0.5 m between plots and 1 m between the blocks. The pre planting/pre-applied soil analysis showed that the Alfisol was very low in N (0.4, 0.9 g/kg), P (8, 4 mg/kg) and organic carbon (7.2, 9.1 g/kg), and marginal in K (0.4, 0.4 cmol / kg) in both 2013 and 2014 trials, respectively, while the textural class was loamy sand. The chemical composition of the accelerated compost (AC) and conventional compost (CC) used for this study is shown in the Table.

The treatments laid out in Randomized Complete Block Design with three replications were AC at the rates of 0 60, 90, 120, 150 and 180 kgN/ha. Mineral fertilizer (NPK 15-15-15) and CC, both at 60 kgN/ha, were checks. Soil samples were collected from treated plots after the residual cropping and analysed for organic carbon using the dichromate wet oxidation method (Nelson and Sommers, 1996), and the data analysed using standard error of means. The amount of carbon sequestered in the soil by each treatments was calculated as the surplus of the soil organic carbon (SOC) relative to the control (no soil additive) treatment.

Table. Chemical composition of the compost used for the study

Parameter	pH (H_2O)	Total Carbon	N	P	K	Ca	Na	C:N ratio	Fe	Cu	Mn	Zn
		---------- (g / kg) ----------							---------- mg / kg ----------			
AC	5.9	150	10.9	10	3	140	1	14	1321	61	405	146
CC	9.7	170	12	8	17	240	4	14	6053	11	393	1.5

AC; accelerated compost, CC; conventional compost

Results

The result of the soil organic carbon and the carbon sequestration in the two years of trials is shown in the Figure. In 2013 trial, the result showed that 90 kgN/ha AC treated soil resulted into the highest mean value of SOC (37.2 t/ha), which was not significantly ($p<0.05$) different from the 150 kgN/ha AC (35.6 t/ha). Ranked next was the 60 kgN/ha CC (29.2 t/ha), followed by the180 kgN/ha AC (27.2 t/ha) which was not significantly different from the 60 kgN/ha AC (25.6 t/ha). The next in the rank was the 120 kgN/ha AC (23.8 t/ha), followed by the 60 kgN/ha NPK (21.8 g t/ha) while the control treatment gave the lowest significant value (17.6 t/ha). The carbon sequestered in the treated soils was in the order of 90 kgN/ha AC (111 %) > 150 kgN/ha AC (102 %) > 60 kgN/ha CC (66 %) > 180 kgN/ha AC (55 %) > 60 kgN/ha AC (45 %) > 120 kgN/ha AC (38 %) > 60 kgN/ha NPK (24 %). It could be noted that the organic carbon sequestered in the 60 kgN/ha AC treated soil (45 %) was almost double that of the 60 kgN/ha NPK (24 %).

In 2014 trial, the result showed that 60 kgN/ha AC treated soil (29.0 t/ha) resulted into the highest mean value of SOC, which was not significantly ($p<0.05$) different from the 180 kgN/ha AC (28.2 t/ha). Ranked next was the 90, 120 and 150 kgN/ha AC (24.6, 22.4 and 20.8 t/ha respectively) followed by the 60 kgN/ha CC (20 t/ha). The 60 kgN/ha NPK and the control treatment resulted into the least significant mean value of 18.8 and 18.4 t/ha respectively. The carbon sequestered was in the order of 60 kgN/ha AC (58 %) > 180 kgN/ha AC (53 %) > 90 kgN/ha AC (34 %) > 120 kgN/ha AC (22 %) > 150 kgN/ha AC (13 %) > 60 kgN/ha CC (9 %) > 60 kgN/ha NPK (2 %). It could be noted that the highest organic carbon sequestered in 60 kgN/ha AC treated soil (58 %) was about 6.5 fold that of the 60 kgN/ha CC (9 %).

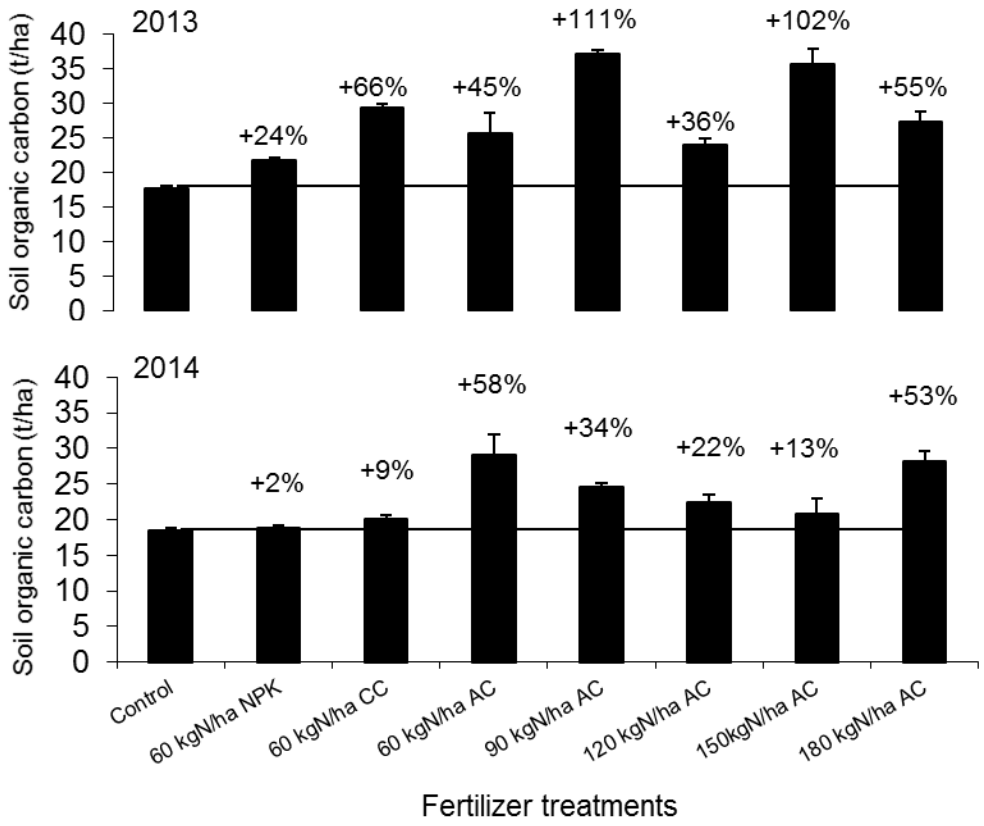

Figure. Effects of the application rates of accelerated compost on the soil organic carbon and carbon sequestration after the residual cropping

NPK, NPK 15-15-15; AC, Accelerated Compost; CC, Conventional Compost

Bar is Standard error of mean

The line across bars indicates the surplus SOC in all treatments relative to the Control

Discussion

This result showed that both the accelerated and conventional composts treated plots in this study sequestered more carbon than the NPK 15-15-15 mineral fertilizer plot. This concur with the reports of Adeyemo and Agele (2010); Šimon and Czakó (2014) that composts improved the soil organic carbon. This result substantiates the submission of Luske and Van der Kamp (2009) as well as Rees (2009) that the organic carbon contained in composts will be sequestered into the soil when applied as a fertilizer. The result further substantiates the reason while UNFCCC has included composting as an official method for greenhouse gas emission reduction projects (UNFCCC/CCNUCC, 2007). It also confirmed the position of Lal (2004) that agricultural soils are a major potential carbon sink that may be used to mitigate climate change.

The result also showed that the AC at (60 kgN) sequestered more carbon than the CC at the same rate in the 2014 trial. This showed that the shortness in the duration of composting for accelerated compost does not pose limitation to its carbon sequestration ability.

Conclusions

This result of this finding revealed that the accelerated compost used for this study sequestered carbon comparable to the conventional compost in the two years of trials. It could therefore be concluded that while accelerated compost increased the chances of availability of compost for crop production, the shortness in its maturity does not limit its carbon sequestration potential.

References

Adeyemo, A. J. and Agele, S. O. 2010. Effects of tillage and manure application on soil physicochemical properties and yield of maize grown on a degraded intensively tilled Alfisol in southwestern Nigeria. *Journal of Soil Science and Environmental Management*. 1.8: 205 - 216.

Blum, W.E.H. and Eswaran, H. 2004. Soils for sustaining global food production. *Journal of Food Science* 69: 38-42.

Diacono, M. and Montemurro, F. 2010. Long-term effects of organic amendments on soil fertility. A review. *Agronomy for Sustainable Development*. 30.2: 401 - 422.

Fliessbach, A., Maeder, P., Diop, A., Luttikholt, L. W. M., Scialabba, N., Niggli, U., Hepperly, P. and LaSalle, T. 2009. Climate change: Global risks, challenges and decisions. *Mitigation and adaptation strategies – organic agriculture*. IOPConf. Series: *Earth and Environmental Science* 6: 2420 - 25.

Keith Paustian, John M. Antle, John Sheehan and Eldor A. Paul, 2006. Agriculture's Role in Greenhouse Gas Mitigation Prepared for the Pew Center on Global Climate Change.

Laine-Ylijoki, J. 2005. Test for DOC-leaching from materials. Nordic Innovation Centre, NT Technical Report 582. ISSN 0283-7234.

Lal, E., 2004. Soil Carbon Sequestration Impacts on Global Climate Change and Food Security. *Science* 304.5677: 1623 – 1627.

Luske B. and Van der Kamp J. 2009. Carbon sequestration potential of reclaimed desert soils in Egypt. Louis Bolk Institute & Soil and More International. The Netherlands.

Nelson, D. W. and Sommers, L. E. 1996. Total carbon, organic carbon and organic matter. *Methods of soil analysis.* Sparks, D. L. Ed. Part 3. 5. 2nd ed. Madison, Wisconsin: Soil Science Society of America. 961 - 1010.

Rees, E. 2009. "Change farming to cut CO_2 emissions by 25 per cent". The Ecologist.http://www.theecologist.org/News/news_analysis/280491/change_farming_to_cut_CO2_emissions_by_25_per_cent.html. Retrieved 2 February 2014.Rotor, A. V. 2008. *The hiring with nature handbook*. http://naturalismavrotor.blogspot .com /2013/02/ust-ab-assignment-therapeutic-effect of.html?m=1

Šimon T. and Czakó, A. 2014. Influence of long-term application of organic and inorganic fertilizers on soil properties. *Plant Soil Environment* 60.7: 314 - 319.

UNFCCC/CCNUCC 2007. Approved baseline and monitoring methodology AM0039. "Methane emissions reduction from organic waste water and bioorganic solid waste using co-composting". AM0039 / Version 02, Sectoral Scope 13, EB 35.