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Effect of different Cropping Practices on Mn and Fe Sequestration in Lagos Nigeria

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Abstract: *The quantity of organic carbon (OC), Mn and Cu released by different cropping systems into the soil were studied in Lagos southwestern Nigeria in 2012. The cropping practices were Organic Farm Plots (A), Manually Continuous Cropping (B), Agroforestry (C) and Convetional Tilled Farmers Plot (D) with the use of machineries. There was no fertilizer application except organic plots. Three soil depths were sampled at 0-15, 15 -30 and 30 – 45 cm and replicated three times. The soil samples were transferred to the laboratory for analysis. The design was completely randomized (CRD). Agroforest plots absorbed more OC than other farming practices. There were significant (p<0.05) differences in the amount of Mn and Cu released by different cropping methods. Among the cropping practices, agroforestry and organically manured soil recorded the highest sequestration of organic carbon. Different cropping patterns sequestrate OC, Mn and Cu at different rates and at different depths, therefore good cropping practices could be used to stock organic carbon.Micronutrients contents were found to decrease down with depth in all the study sites.*

Keywords: *Micronutrients, carbon stock , and Soil*

Agricultural soils play a key role in global biogeochemical cycles and food productivity. In recent years, the desire to manage the level of carbon dioxide (CO_2) in the atmosphere has encouraged research into using agricultural soil to soak up CO_2 in the atmosphere. The options of sequestering in the soil some of the carbon presently dumped in the atmosphere have a lot of advantages for both the farmers and the environment.

Soil organic carbon sequestration is the process of transferring carbon dioxide from the atmosphere into the soil through crop residues and other organic solids, and in a form that is not immediately re-emitted. Alan (2012) noted that the transfer or sequestering of carbon helps off-set emissions from fossil fuel combustion and other carbon-emitting activities while enhancing soil quality and long-term agronomic productivity. Soil carbon sequestration can be accomplished by management systems that add high amounts of biomass to the soil, cause minimal soil disturbance, conserve soil and water, improve soil structure, and enhance soil fauna activity.

Jina *et al*., (2008) stated that carbon is a key ingredient in soil organic matter (57% by weight). Plants produce organic compounds by using sunlight energy and combining carbon dioxide from the atmosphere with water from the soil. Soil organic matter is created by the cycling of these organic compounds in plants, animals, and microorganisms into the soil. Well-decomposed organic matter forms humus, a dark brown, porous, spongy material that provides a carbon and energy source for soil microbes and plants. When soils are tilled, organic matter previously protected from microbial action is decomposed rapidly because of changes in water, air, and temperature conditions, and the breakdown of soil aggregates accelerates erosion. A soil with high organic matter is more productive than the same soil where much of the organic matter has been burnt through tillage and poor management practices and transported by surface runoff and erosion. However, organic matter can be restored to about 60 to 70% of natural levels with best farming practices (2011).

Organic matter is known to have effect on soil micronutrients such as Zinc and Mn release to the soil for plant uptake. In most cases, the higher the amount of organic manure presents in the soil, the higher the amount of Zn and Mn such soil is likely to contain.(Samuel et al. 2003). Zinc is known to participate in chlorophyll formation and activates many enzymes especially for protein synthesis, growth hormone production and seed development. Manganese also activates some important enzymes that are involved in chlorophyll formation and also involved in nitrogen fixation.

Different farming practices such as organic farming; convectional agricultural practices, continuous cropping and agroforestry are likely to have effect on CO_2 sequestration since they influence organic matter and soil micronutrients. The amount of OC present in the soil without adding organic residues is likely to determine the amount of CO_2 sequestered to the soil. There is scanty of information that compares various farming practices on soil micronutrients as well as organic carbon sequestration in Lagos southwestern Nigeria where this experiment was carried out. Hence, the objective of this study was to compare the effect of common farming practices on soil OC, Zn and Mn sequestration in southwestern Nigeria,

I. Materials And Methods

Study sites

Four study sites were used for this experiment. The sites were selected based on the farming history pattern, the sites were Organic Farm Plots (Site A), which is located at Ikorodu farm settlement. There were continuous application of organic manures (ii) Manually Continuously Tilled Farm Plot (B) which is adjacent to farm settlement with continuous arable crop production within the past five years without the use of organic manures. (iii) Agroforestry (C) situated at Lekki Penninsula. (iv) Conventionally Tilled Plot (D) with the use of machineries. This site was adjacent to agroforestry in Lekki Penninsula. All the four sites were located in Lagos. Lagos is situated in the southwestern corner of Nigeria; this elongated state spans the Guinea coast of west to its boundary with Ogun state in the east. It extends approximately from latitude 6°27′11″N 3°23′45″E/ 6.45306°N. Of its total area of 3, 577sq.km, about 787sq km or 22 percent is water.

Samples Collection

A reconnaissance survey was carried out at the 4 selected sites for the study to establish sampling points. Three sampling depths i.e. single, double and triple diggings (0-15, 15-30 and 30- 45 cm) were used for the study. Five core soil samples were randomly collected and bulked at about 50m apart from three locations within each site to make three replicates. At each depth, samples were collected for laboratory analysis.

Samples were collected as stated under method of sample collected above. The samples were air-dried for 72 hours. Air dried soil samples were packed in drug dispenser envelopes. The dispenser envelopes were labelled on the white side accordingly

Samples Analysis

Samples were analyzed in the Environmental Laboratory (EMT Lab) of the College of Environmental Resource Management, Federal University of Agriculture-Abeokuta. Organic carbon content, soil pH and Mn and Cu contents were determined. Organic carbon was determined by the Walkley-Black procedure. The micronutrients were determined using dilute acid extraction whereas soil pH on a saturated sample was determined in soil electrolyte (0.01 M $CaCl_2$) suspension using a glass electrode pH meter (Digital pH meter, Accumet Model AR15, Fisher Scientific).

Data Analysis

The data obtained from the laboratory analysis was analysed using Statistical Package for Analysis of variance (ANOVA). Further analysis of Tukey HSD was employed to determine significant ($P<0.05$) difference between and among treatments means.

II. Results And Discussion

The pH of all the study sites was favourable for some microbial activities and adequate for the release of soil nutrients. According to Sobulo and Osiname (1987), compared with plot A, all the treatments significantly reduced soil pH (Table 1). It was observed that all farm plots A, B, C and D were reduced in soil pH as the soil depth increased. This finding agreed with the findings of Anikwe (2010)

Site C (Agro-forest farm plot) had the highest percentage of organic carbon per soil sample followed by site A (conservation/organic farm plot) in the 0-15cm cm soil layers as against the OC found in Sites B and D (the manual continuously cropped and conventionally tilled farm plots). The better performance of agro forest might be as a result of litter that covers the soil and their decomposition to form organic matter. The beneficial effects of organic matter include reduction in soil temperature, water conservation and buffering capacity. The presence of organic matter might prevent the volatilization of soil nutrients and encourage stocking of OC. At 15-30cm layer of the soil, the highest percentage of the organic carbon sequestered was found in site C followed by site A while sites B and D had very low percentage organic carbon stock. For 15.1-30.0 cm depth, highest OC was found in site C while sites B and D recorded the lowest OC (Table 2). The low OC stock recorded by sites B and D might be as a result of their low organic matter.

Site A had the lowest Mn and Cu compared with sites B, C and D in the three layers but was high in soil OC. The high organic matter might have encouraged chelation of Mn and Cu. This is in agreement with the findings of Makinde *et al.* (2000) that organic matter encouraged chelation. At the third layer (30-45) available Mn contents at the conservation/organic farm plot was lower than the available Mn of the conventionally tilled farm plot. This also occurred in agro-forestry and the adjacent farmer's plot that was conventionally tilled and continuously cropped. Manganese content of the soil in agro-forestry was lower than the one in adjacent conventionally tilled farm plot.

The table shows that the available Cu was significantly ($p<0.05$) different across the three depths in each farm plot. Available Cu at the organic farm plot was found lower compared to the farmer's plot that was manually tilled and continuously cropped. The same situation was found in agro-forestry (site C) and the conventionally tilled farm plot D.

Compared with plot A, all the farming practices significantly increased soil Mn and across all the profiles. This is in agreement with the findings of Offiong and Iwara (2012). Highest value of Mn was found at site D while the lowest Mn content was found in site A. The highest available Cu content was found in Site D while the lowest Cu was found in sites A and C. The pH values of the study sites influenced the absorption of soil nutrients by plants, which vary in the pH ranges they can tolerate.

Sites with low micronutrient had high percentage of organic carbon stock. This shows that available Cu and Mn content significantly ($P<0.05$) enhanced efficiency of organic carbon sequestration.

Table 1: Effect of cropping systems on pH and organic carbon sequestration at different depth in Lagos Nigeria

site	pH			OC		
	0 -15cm	15 -30cm	30 -45cm	0 -15cm	15 -30cm	30 -45cm
A	6.92a	8.34a	8.34a	4.98ab	4.59b	3.39ab
B	6.24b	7.83bc	7.83c	2.57c	2.56a	2.09c
C	6.34b	7.94b	7.94b	5.59a	5.39a	3.59a
D	6.48ab	7.34c	7.34d	2.79c	2.79c	2.79b
SE	0.01	0.07	0.07	0.004	0.004	0.05

Means with the same letters are not significantly different at 5% level using Tukey HSD

A= organic farm plots
B= .manually continuously tilled plots
C=Agro-forest.
D= conventional Agricultural Practice with the use of machineries.

Table 2: Effect of cropping systems on Mn and organic Cu sequestration at different depth in Lagos Nigeria

site	Mn (mg kg^{-1})			Cu($mgkg^{-1}$)		
	0 -15cm	15 -30cm	30 -45cm	0 -15cm	15 -30cm	30 -45cm
A	327d	289d	216d	6.56d	6.42d	5.77c
B	411c	312c	248c	7.74c	6.68c	5.12d
C	479b	456b	392b	9.76b	9.74b	9.64b
D	488b	476a	468a	14.15a	11.21a	9.67a
SE	0.85	0.84	0.7	0.007	0.007	0.0007

Means with the same letters are not significantly different at 5% level using Tukey HSD

A= organic farm plots
B= .manually continuously tilled plots
C=Agro-forest.
D= conventional Agricultural Practice with the use of machineries.

Table 3: Effect of cropping systems pH, Mn ,Cu and organic carbon sequestration at different depth in Lagos Nigeria

site	OC	pH	Mn	Cu
	%		______mg kg^{-1}____	
A	4.31a	7.87a	277.33c	6.25c
B	2.40b	7.30a	323.67b	6.53b
C	4.86a	7.41a	442.33a	9.71a
D	2.79b	7.05a	477.33a	11.68a
SE	0.35	0.22	28.25	0.76

Means with the same letters are not significantly different at 5% level using Tukey HSD

A= organic farm plots
B= .manually continuously tilled plots
C=Agro-forest.
D= conventional Agricultural Practices with the use of fertilizers, pesticides and machineries

In table 3, cumulative effect of pH, Mn, Cu and organic carbon at the plough layer as affected by different cropping practices that plot C had the highest cumulative soil pH, A had the highest Cu, D had the highest Mn and Cu showing that different agronomic practices had different rate of sequestrating OC. It was also found that soil depth affect OC sequestration, availability of Mn and Cu.

III. Conclusion

Experiment was conducted to determine the effect of cropping system on organic carbon sequestration as well as the release of soil Cu and Mn. The cropping practices were Organic Farm Plots, manually continuously tilled plots which is adjacent to farm settlement and continuous cropping of the farm at various time within the past ten years, Agroforest and Convetional Tilled Farmers Plot (D) with the use of machineries. Agroforest plots absorbed more OC than other farming practices. Different cropping pattern sequestrates OC, Mn and Cu at different rate and at different depth, therefore cropping practices has significant effect in stocking organic carbon

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