Int.J.Curr.Res.Aca.Rev.2021; 9(11): 23-30

International Journal of Current Research and Academic Review

ISSN: 2347-3215 (Online) Volume 9 Number 11 (November-2021)

Journal homepage: http://www.ijcrar.com

doi: https://doi.org/10.20546/ijcrar.2021.911.004

Influence of Biochar and Compost on the Fertility of Acid Sandy Soils in Gabon

Allogho Mve Janvier*, Ondo Jean Aubin, Mefouet Abessolo Daniel Datch, Abogo Mebale Aimé Jhustelin and Zue Mve Mexent

Laboratoire Pluridisciplinaire des Sciences (LAPLUS), Ecole Normale Supérieure, BP.17009 Libreville, Gabon

**Corresponding author*

Abstract

The use of biochar to improve soil fertility is gaining popularity because of its potential to improve soil quality, increase crop yield and sequester carbon in the soil. A 60-day pot incubation experiment was conducted to study the effects of *Pentaclethra macrophylla* pod biochar and green waste compost applied alone or in combination (5% of soil weight) on the physicochemical properties of two acidic sandy soils in Gabon. Biochar and compost applied alone or in combination significantly increased pH, electrical conductivity, available phosphorus, nitrate ions and drastically reduced available aluminium in the soil solution. The effect of compost was greater than that of biochar on soil properties.

Article Info

Accepted: 15 October 2021
Available Online: 20 November 2021

Keywords

Biochar, Compost, Amendment, Acidic sandy soil, Physicochemical properties.

Introduction

Climate change is a hot topic this century, and there are many causes of global warming, including industrialization and agriculture. One of the major challenges of this century is the implementation of techniques that can mitigate climate change through a new way of managing agricultural soils.

According to Koy (2010) and Lele (2016), sandy acid soils are characterized by low nutrient reserves and cannot sustainably support agricultural production. Agricultural intensification remains a major challenge for the economic diversification of our country Gabon; however, to date, shifting cultivation on bushland remains the most common method practiced by farmers. It is a source of human/wildlife conflict and contributes to environmental degradation (Vosti *et al.*, 2001). This problem can be solved by improving and maintaining long-term soil fertility through the application of soil amendments. In Gabon, gardeners often use NPK (nitrogen, phosphorus and potassium fertilizers) and urea as mineral fertilizers to increase their agricultural yields. Soils grown with mineral fertilizers become more acidic over time (Ondo *et al.*, 2014). Studies in Africa have also shown a negative trend regarding soil nutrient balance due to the use of mineral fertilizers (Cobo *et al.*, 2010). This trend can be reversed with the use of environmentally friendly organic fertilizers including biochar and compost (Schulz and Glaser, 2012).

Biochar, charcoal produced from biomass by pyrolysis (in an oxygen-poor environment), is used as a soil amendment or carbon sequestration. It is being studied as an alternative/complementary amendment to compost in agricultural soils (Jatav *et al.*, 2017). Its interest has increased rapidly in the last two decades due to its potential benefits in carbon sequestration Lehmann and Joseph (2009), improving crop yields (Jeffery *et al.*, 2011; Spokas *et al.*, 2012), reducing greenhouse gas (GHG) emissions Cayuela *et al.*, (2013) and reducing nutrient leaching (Singh *et al.*, 2010).

Compost has been widely studied as an organic amendment to improve soil quality and increase crop production. In general, studies have shown significant yield improvements when compost is added to soil Amlinger *et al.*, (2007) resulting from reduced bulk density, increased soil pore volume and water conductivity Carter *et al.*, (2004), improved water retention and reduced soil erosion (Bass *et al.*, 2018). However, compost is generally not stable over medium to long term time scales for which regular reapplication is required.

The combined application of biochar and compost has been little explored to date, although it has the potential to synergistically improve soil properties, enhance agronomic production and increase soil organic carbon content. Liu *et al.*, (2012) showed that the application of biochar and compost under field conditions provided synergistic benefits to the amount of SOM, nutrient content and water holding capacity of the soil, but further studies, especially in tropical systems, are still scarce.

In order to broaden the understanding of the influence of organic amendments on tropical agricultural systems, an incubation test was conducted on two sandy soils with different combined amendments. Also, the objective of this work is to evaluate the impact of biochar, compost and biochar/compost mixtures additions on soil properties.

Materials and Methods

Sampling

Two sandy soils were collected in two regions of Gabon, one at Gamba (2°40'43 "S 9°56'18 "E) in Ogooué Maritime Province, southwestern region of Gabon and the other at Akanda (0°33'02.7 N 9°21'04.2 E) in Estuaire Province, northwestern. Soil samples were taken from the top 30 cm of soil. They were taken to the laboratory, dried at room temperature, crushed and passed through a 2 mm mesh sieve and stored in plastic bags.

The biochar used in this study was produced by pyrolysis of *Pentaclethra macrophylla* pods at a temperature of 450±25ºC. The compost was produced at the Vembo landfill, owned by the ASSALA oil company, from a windrow of green waste (60 m long, 1.5 m high and 4 m wide).

Physico-chemical analysis of soils, biochar and compost

A series of analyses of physico-chemical properties were carried out on the two sandy soils, the biochar and the compost. Hydrogen potential (pH) and electrical conductivity (EC) were analyzed using a Consort C561 multi-parameter, a pH electrode and a conductivity probe. The analysis was performed by introducing 10 g of soil into 25 mL of demineralized water according to the NF X 31-103 protocol for pH and NF X 02-107 for electrical conductivity. Aluminum was determined by the chromazurol S spectrophotometric method (Palkans, 1965). Phosphorus, in the form of available phosphate (PO 43-) was quantified by complexation with ammonium molybdate using the method of (Olsen *et al.*, 1954). The cation exchange capacity (CEC) was obtained by the METSON method at pH 7 (Metson, 1956). Ammonium ions (NH4+-N) were analyzed using the method of (Searle, 1984). Nitrate ions (NO-N) in the soil were extracted with a 2 mol/L KCl solution, and the concentration of nitrate in the extract was analyzed using an ultraviolet spectrophotometer at wavelengths of 220 and 275 nm (Huang *et al.*, 2004).

Incubation experience

Soils were placed in 200 mL plastic jars and thoroughly mixed with biochar and compost. Treatments were made with a combination of biochar and compost at 5% (w/w) to soil. Amendments were prepared and soils amended with the biochar:compost mixtures at 0:0, 100:0, 80:20, 50:50, 20:80 and 0:100 (% w/w). Incubations of the biochar-compost-soil combinations were conducted at 60% moisture content, 25°C in the dark for 60 days. The incubation times selected were 1, 15, 30, 45 and 60 days. Once an incubation time was reached, the samples were dried and the pH, EC, Al 3+, PO 43-, NH4+ and NO3- properties analyzed.

Statistical analysis

Statistical analyses were performed with XLSTAT, Version 2010 (Addinsoft, Paris, France). Each treatment was repeated three times. The significance of the differences between the means of the values of the physicochemical parameters of the analyzed soils was evaluated by Tukey's test ($p < 0.05$). Regression analyses were performed to find out how the amendment and incubation time influenced the analyzed properties in the soil solution.

Results and Discussion

The analytical results of the physicochemical properties of the two soils, biochar and compost are presented in Table 1.

The sandy texture of the experimental soils suggests easy root penetration. However, the retention of water and mineral elements would be a constraint for sustained agricultural production in this case. The two soils tested were very acidic (pH 4.5 for the Gamba soil and 4.2 for the Akanda soil) while the compost was neutral (pH = 6.5) and the biochar alkaline (pH = 8.7). The available phosphorus in the soil solution is very low (6.6 mg. kg -1for the Gamba soil and 2.4 mg. kg -1for the Akanda soil). The acid character of these soils implies a high retention of phosphorus, because phosphate combines with iron and aluminium to form compounds that are not very soluble and therefore not very available for plants (Dabin, 1963; Kadiata *et al.,* 2003). This would be the main cause of the low phosphorus content available in the experimental soils. The phosphate content of the biochar (151.1 mg. kg-1) and compost (110.6 mg. kg) -1amendments, combined with their pH, would improve phosphorus availability in Gamba and Akanda soils.

Nutrient contents (N, Ca^{2+} and Mg^{2+}), and CEC are very low compared to the values proposed by Landon (1991) for tropical agricultural soils. The low CEC is an indication that these soils contain low nutrient reserves. On the other hand, biochar and compost have physico-chemical potentialities that can improve the physico-chemical fertility of both soils through their action on pH adjustment of acid soils (Lehmann and Joseph, 2009; Schulz and Glaser, 2012).

After the diagnosis of the four matrices (the two soils, the biochar and the compost), the soils were amended with biochar and compost, alone or mixed with different combinations, to see if these mixtures would effectively improve the physico-chemical parameters of fertility of the two acid sandy soils and maintain these modifications long enough in time as predicted in the literature, to hope for a sustainable agricultural development. The results of this monitoring of the physico-chemical parameters of the amended soils are presented below:

There was no significant difference between the pH of the Akanda soil and the Gamba soil. The pH increased in all amended soils compared to the control in both soils. This increase was correlated with the increase of compost in the soil. Significant changes in pH were observed, from 6.4 in the control soil to 7.6 in the Akanda soils amended with compost, and from 5.9 to 7.6 in the Gamba soils amended with compost. The pH increased slightly and significantly in the soils amended with biochar alone, to 6.6 in the Akanda soil and to 6.8 in the Gamba soil. This increase it could be related to the rapid exchange of proton H^+ between the soils and the organic amendments used in this study (Ch'ng *et al.,* 2014). It could also be related to the high content of calcium and magnesium in the biochar compared to that in the soils. Several studies attribute the increase in pH, in organically amended soils, to the high contents of calcium and magnesium in these organic amendments (Ch'ng *et al.,* 2014). These nutrients are related to carbonates in the biochar which are the main cause of its pH increase (Yuan *et al.,* 2011). This is in agreement with the study, as compost and biochar have higher calcium and magnesium contents than both soils (Table 1). The increase in pH in the amended soils remained significant for all amendments throughout the incubation period.

Electrical conductivity (EC) increased in all samples compared to the controls except for the 100-0 amendment in Akanda soil throughout the incubation period (Figure 2). It could be thought that ions in the Akanda soil solution are adsorbed by the biochar. This observation was also made by (Esmaeelnejad *et al.*, 2016; El-Naggar *et al.*, 2019) who stated that biochar may reduce soil nutrient availability and crop productivity due to reduced plant nutrient uptake and/or reduced soil carbon mineralization.

EC was significantly higher in the Akanda soil than in the Gamba soil ($p < 0.05$). EC was higher in soils containing large amounts of compost, showing that compost influences EC more than biochar. Several authors also observed that compost improved soil electrical conductivity while biochar had little effect on this property (Carmo *et al.*, 2016).

The exchangeable aluminium content is 9 mg. kg-1 in the Gamba control soil, and 145.2 mg. kg-1 in the Akanda control soil. It undergoes a drastic decrease from the first day of incubation for all the amended soils. The problem of aluminium toxicity in tropical acidic soils and observed in the Akanda soil (with contents > 50 mg.

kg-1) is solved with soil amendment by biochar and compost alone or combined (Edou Minko *et al.*, 2003). This reduction of Aluminium could be attributed to the reduction of H+ and the increase of pH. The increase in soil pH had an effect on the reduction of exchangeable aluminium content. This confirms the experiments of Lehmann *et al.*, (2009) and Schulz *et al.*, (2013) that show that biochar reduces bioavailable aluminium and acidity in tropical soils.

The phosphorus content (P-PO4) available to plants is 6.6 mg. kg-1 in the Gamba control soil and 2.4 mg. kg-1 in the Akanda soil. It does not vary significantly when the soil is amended with biochar alone. For all other amended soils, it is significantly higher throughout the incubation process, reaching 189.0 mg. kg-1 in the Akanda soil (20-80 and 0-100 amendments) and 146.2 mg. kg-1 in the Gamba soil (0-100 amendment). Thus, we go from soils very poor in available phosphorus (with contents < 15 mg. kg-1) to soils rich in this element (with contents > 50 mg. kg-1), according to the classification of (Landon, 1991). Increases are greater in combinations with high amounts of compost. They could be attributed to a reduction in the activity of exchangeable aluminium and the increase in soil pH (Ondo *et al.*, 2017). These results on phosphorus are similar to those found by Sasmita *et al.*, (2017) in a similar study on an Indonesian acid soil. The availability of P is not regular over time. There is an increase at the beginning of incubation followed by a decrease in available phosphorus content between 30 d and 45 d for soils amended with biochar alone and biochar-compost mixture. This in agreement with several studies that attribute this variability to P sorption (Sample *et al.*, 1980.; Sharpley, 1983.). Nest *et al.*, (2016) explain this decrease by competition for adsorption sites between the phosphate anion and the organic matter anions produced during its decomposition in the soil. Sharpley (1983) and Sample *et al.*, (1980) also attribute these variations to one of the activation properties of biochar, which would consist of sorption in the first stage and then release in the second stage. The increase in available phosphorus in the amended soil followed the order 0-100 > 20-80 > 50-50 > 80-20 > 100-0 > Control for the Akanda soil and 0-100 ≈ 20-80 > 50-50 > 80- 20 > 100-0 > Control for the Gamba soil.

The amount of NO3--N did not vary significantly between the two soils. The addition of biochar and compost influenced the amount of NO3--N and NH4+-N in the soil solution (Figures 5 and 6). The amount of NH4+-N was higher in the Akanda soil compared to the Gamba soil. It was above 15 mg. kg-1 in all Akanda soils up to day 30th while this value was the upper limit in Gamba soils (Figure 6). Nitric nitrogen content NO3--N decreased at the beginning of incubation before increasing in all soils except the Gamba soil amended 20-80 which shows an increase before a significant decrease at day 45th, and the amended soil 0-100 which shows a significant decrease after 60 days of incubation. During NO3--N reduction, NH4+-N concentration increased to a maximum of 44 mg.kg–1 in the Akanda soil amended 100-0, and 15 mg. kg-1 in the Gamba control soil. It should be noted that NO3--N depletion over the same period was greater than NH4+-N accumulation. A reasonable interpretation of this disparity is that NO3--N was lost through denitrification. Another possibility is that biochar tends to adsorb nitrate into the soil solution, especially in the presence of limited compost. Thus, substantial NH4+-N accumulation would not be expected when both processes occur simultaneously (Abbasi *et al.*, 2013). The low concentration of NH4+-N with the high amount of NO3--N indicates that nitrification was not a rate-limited process in soil N mineralization (Abbasi *et al.*, 2013).

The addition of compost and biochar significantly influenced the nitrogen cycle with higher nitrate levels in amended Akanda soils at day 45th and in most amended Gamba soils compared to controls. This mineralization of organic matter, through nitrification, is effective thanks to nitrifying bacteria that are intolerant to acidic conditions (Burger and Jackson, 2003).

Table.1 Physicochemical properties of soils, biochar and compost

Paramètres	pH	CE	Mg^{2+}	Ca^{2+}	Al^{3+}	NH_4^+	NO_3^-	PO_4^{3-}	CEC
		mS/cm	mg/kg						cmol/kg
Soil of Gamba	4,5	979	41,3	50,1	9	18,86	1,90	6,6	1,3
Soil of Akanda	4,2	1065	49,3	50,8	145,2	35,30	1,90	2,4	3,2
Biochar	8,7	2734,3	606	664	< ld	0,47	3,34	151,1	15,18
Compost	6,5	2182,3	1068	10405	< ld	38,06	11,48	110,65	123,4

Fig.1 Variation in pH in the control and amended soils of Akanda and Gamba

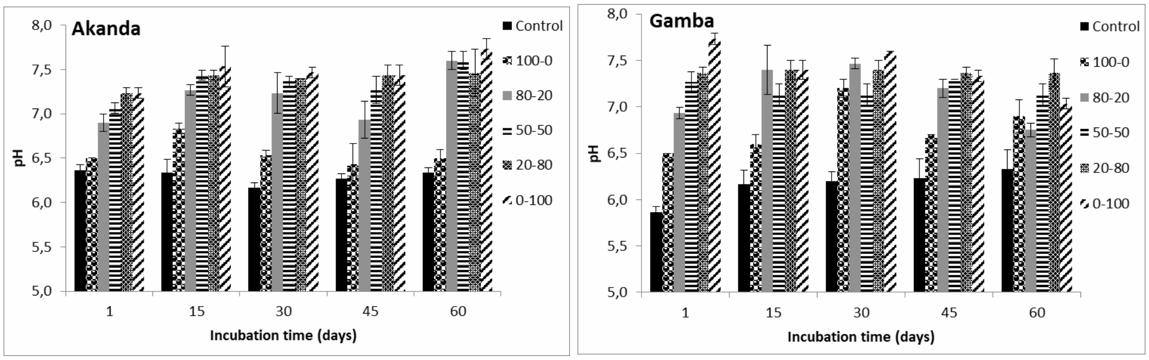


Fig.2 Variation in electrical conductivity in the control and amended soils of Akanda and Gamba

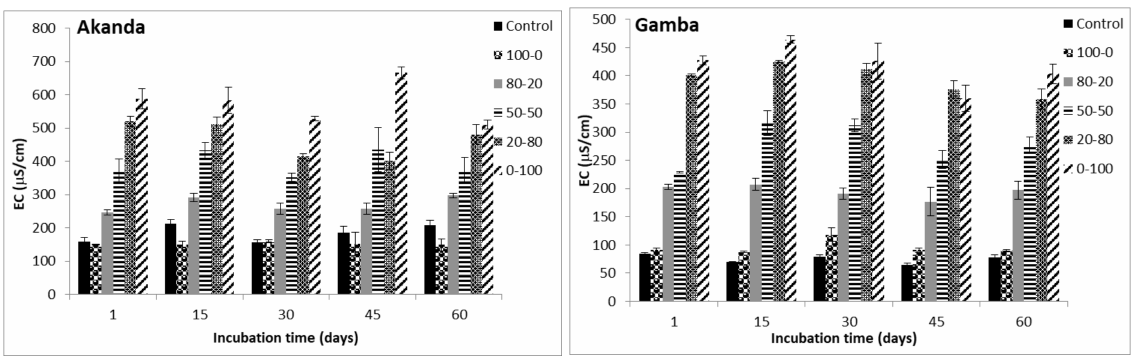


Fig.3 Variation in exchangeable aluminium content in the control and amended soils of Akanda and Gamba

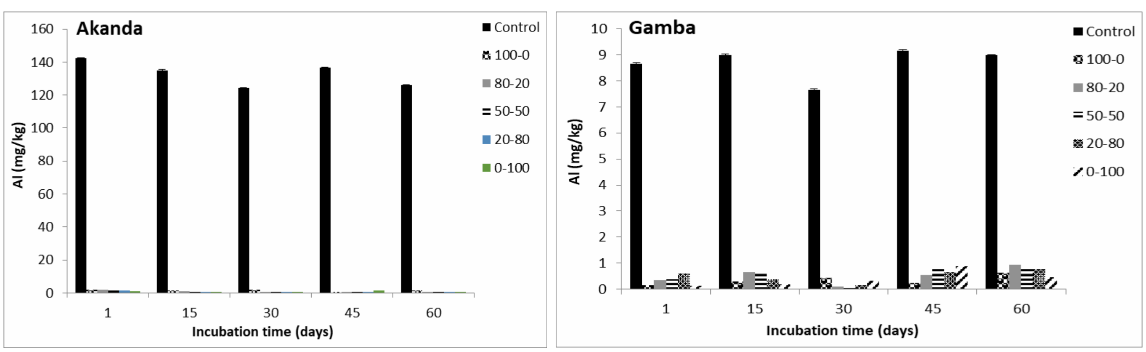


Fig.4 Variation in available phosphorus content in control and amended soils of Akanda and Gamba during the incubation period

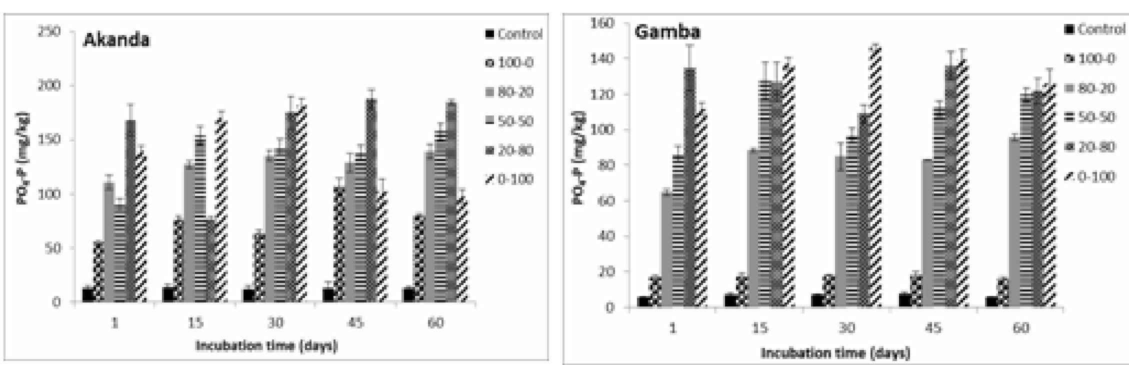


Fig.5 Variation in nitrate ion content in control and amended soils of Akanda and Gamba during the incubation period

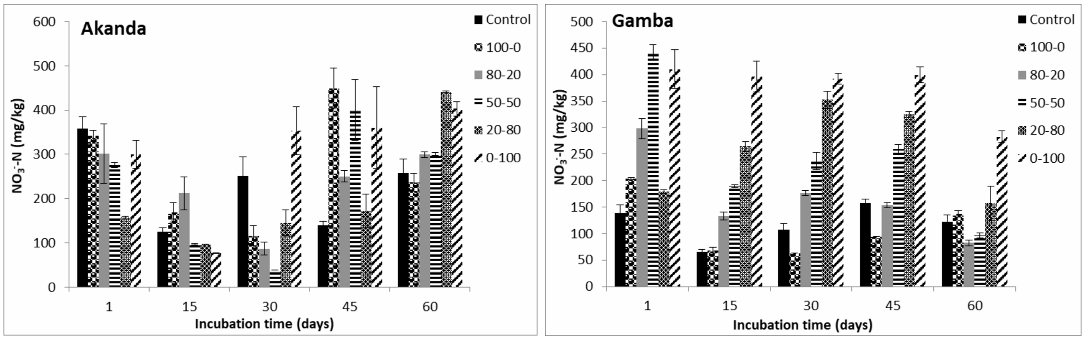
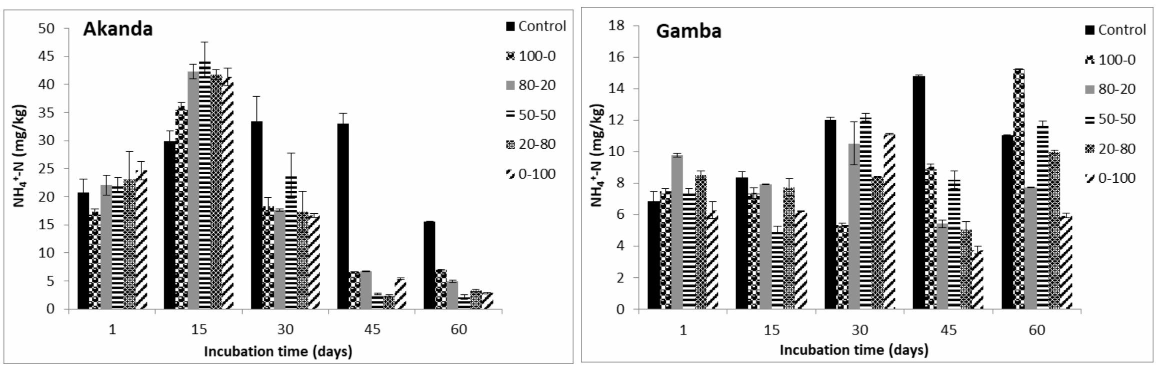


Fig.6 Variation in ammonium ion content in control and amended soils of Akanda and Gamba during the incubation period



The study showed that amendment with biochar and compost applied alone or in combination significantly increased pH, electrical conductivity, available phosphorus and nitrate ions, and drastically reduced available aluminium in the soil solution. The compost input was more beneficial to the soils than the biochar input during the incubation period. Therefore, the study demonstrated that compost applied alone or in combination with biochar has the potential to improve soil quality. A longer-term incubation study in the laboratory and field would examine the long-term effects of biochar treatments, either combined or not with compost, on soil physicochemical properties and crop yield responses.

References

Abbasi, M. K., N. Afsar, and Rahim N. 2013. Effect of Wood Ash and Compost Application on Nitrogen Transformations and Availability in Soil-Plant Systems. Soil Science Society of America Journal. 77(2) : 558-567.

Amlinger, F., Peyr, S., Geszti, J., Dreher, P., Karlheinz, W., Nortcliff, S. 2007. Beneficial Effects of Compost Application on Fertility and Productivity of Soils. Literature Study. Federal Ministry for Agriculture and Forestry, Environmental and Water Management, Austria, retrieved from www.bmlfuw.gv.at/dms/lmat/greentec/abfallressourcen/behandlung- verwertung/behandlung-biotechnisch/kompost_studien/CompBenefits-1-/CompBenefits%5B1%5D.pdf.

Bass A M, MI Bird, G Kay, B Muirhead. 2018. Soil properties, greenhouse gas emissions and crop yield under compost, biochar and co-composted biochar in two tropical agronomic systems. Science of the Total Environment. 550, 459–470.

Burger, M., Jackson, L. E. 2003. Microbial immobilization of ammonium and nitrate in relation to ammonification and nitrification rates in organic and conventional cropping systems. *Soil Biol. Biochem.* 35, 29–36

Carmo D L D, de Lima L B, Silva C A. 2016. Soil fertility and electrical conductivity affected by organic waste rates and nutrient inputs. Revista Brasileira Ciência Solo 40, 40-560. ;

Carter, M. R., Sanderson, J. B., MacLeod, J. A. 2004. Influence of compost on the physical properties and organic matter fractions of a fine sandy loam throughout the cycle of a potato rotation. Can. J. Soil Sci. 84, 211–218.

Cayuela, M. L., Sanchez-Monedero, M. A., Roig, A., Hanley, K., Enders, A., Lehmann, J. 2013. Biochar and denitrification in soils: when, how much and why does biochar reduce N2O emissions? Sci. Rep. 3, 1732–1739.

Ch’ng, H. Y., O. H. Ahmed and N. M. A. Majid. 2014. Biochar and compost influence the phosphorus availability, nutrients uptake, and growth of maize (*Zea mays* L.) in tropical acid soil Pak. J. Agri. Sci., Vol. 51(4), 797-806.

Cobo, J. G., Dercon. G., Cadisch G. 2010. Nutrient balances in African land use systems across different spatial scales: A review of approaches, challenges and progress, Agr Ecosyst Environ 136: 1- 15

Dabin, B. 1963. Appréciation des besoins en phosphore dans les sols de Côte d’Ivoire. Cah.ORSTROM, 3, 27-42.

Edou Minko, A., Emane Mba, S. et Eba, F, 2003. L’état de fertilité du complexe absorbant des sols du plateau manganésifère d’Okouma. Revue Cames, série A vol.02

El-Naggar, A., El-Naggar. A. H., Shaheen, S. M., Sarkar, B., Chang, S. X., Tsang, D. C. W.,… Ok, Y. S. 2019. Biochar composition-dependent impacts on soil nutrient release, carbon mineralization, and potential environmental risk: A review. Journal of Environmental Management. 241, 458-467.

Esmaeelnejad L, Shorafa. M, Gorji. M, Hosseini, S. M. 2016. Enhancement of physical and hydrological properties of a sandy loam soil via application of different biochar particle sizes during incubation period. Spanish Journal of Agricultural Research. 14(2), e1103.

Huang, S. W., Jin. J. Y., Yang L. P., Bai Y. L., Li. C. H. 2004. Spatial variability of nitrate in cabbage and nitrate-N in soil. Soil Science 169(9), 640-649.

Jatav, H. S., Jayant. H, Kumar. S, Kumar. V, Chattopadhya. A, Dhawal. S. K, Singh. Y. V. 2017. Rôle du biochar : Dans le secteur agricole, son implication et sa perspective. International Journal of Chemical Studies 5(2), 14-18.

Jeffery, S., Verheijen, F. G. A., van der Welde, M., Bastos, A. C. 2011. A quantitative review of the effects of biochar application to soils on crop productivity using meta-analysis. Agriculture Ecosystems & Environment 144, 175–187.

Kadiata, B. D. & Lumpungu K. 2003. Differential phosphorus uptake and use efficiency among selected nitrogen-fixing tree legumes over time. J. Plant Nutr., 26, 1009-1022.

Koy, R. 2010. Amélioration de la qualité des sols sableux du plateau des Batéké (RD Congo) par application des matériels géologiques et des déchets organiques industriels locaux. Thèse de doctorat. Sciences de la Terre, Université de Gent (Belgique).

Landon. J. R., ed. 1991. Booker tropical soil manual, Harlow, UK, Longman. 474 p. Lehmann. J., Joseph S. 2009. Biochar for environmental management: an introduction. In:

Lehmann, J., Joseph, S. (Eds.), Biochar for Environmental Management: Science and Technology. Earthscan, London.

Lehmann, J., Czimczik, C., Laird, D., Sohi, S. 2009. Stability of Biochar in the Soil. Dans

Lehmann, J., Stephen, J. (Eds): Biochar for environmental management. Science and technology. Earthscan Washington. pp : 183–205.

Lele, N. B. 2016. Potentiel d’amélioration de la fertilité des sols sableux et acides de Kinshasa (RDC) par l’usage du charbon des bois (biochar), de la biomasse végétale et des engrais minéraux. Thèse de doctorat :de l’école régionale post-universitaire d’aménagement et de gestion intégré des forêts et territoire tropicaux

Liu, J., Schulz, H., Brandl, S., Miehtke, H., Huwe, B., Glaser, B. 2012. Short-term effect of biochar and compost on soil fertility and water status of a dystric cambisol in NE Germany under field conditions. J. Plant Nutr. Soil Sci. 175, 698–707.

Metson, A. J., 1956. Methods of chemical analysis for soil survey samples. *Soil Bureau Bulletin - New.*

Nest, T. V., Ruysschaert, G., Vandecasteele, B., Houot, S., Baken, S., Smolders, E., Cougnon, M., Reheul, D. and Merckx, R. 2016. The Long Term Use of Farmyard Manure and Compost: Effects on P Availability, Orthophosphate Sorption Strength and P Leaching. Agriculture, Ecosystems and Environment. 201, 23-33.

Olsen, S. R., Cole. C. V., Watanabe. F. S., Dean. L. A. 1954. Estimation of available phosphorus in soils by extraction with sodium bi-carbonate. USDA Circular 939. Washington (DC): U.S. Department of Agriculture ; 1–19. *Zealand, Department of Scientific and Industrial Research* No. 12.

Ondo J A, F Eba, H Z Moussambi Membetsi, R Menye Biyogo, D Ndzoungou. 2017. Soil Solution

Aluminum, and Nutrient and Aluminum Uptake in Hibiscus Sabdariffa Under Nitrogen and Phosphorous Fertilizers, Communications in Soil Science and Plant Analysis 48,1636-1645. DOI: 10.1080/00103624.2017.1373795

Ondo J A., Prudent P., Massiani C., Höhener P., Renault P., 2014. Effects of agricultural practices on properties and metal content in urban garden soils in a tropical metropolitan area. J. Serb. Chem. Soc. doi: 102298/JSC130121068O

Palkans. P. 1965. Spetrometric determination of aluminium with chromazurol S, Anal. Chim. Acta., 32, pp 57-63

Sample E. C., R. J. Soper. and G. J. Racz., 1980. Reactions of phosphate fertilizers in soils. American Society of Agronomy: Madison, WI, USA.

Sasmita, K D., A. Iswandi, A. Syaiful, Y. Sudirman et D. Gunawan., 2017. « Application de biochar et d'engrais organique sur un sol acide comme milieu de culture pour les plants de *cacao* (*Theobroma cacao* L.) », *International Journal of Sciences Basic et Recherche appliquée*, vol. 36, non. 5, pp. 261-273.

Schulz, H., Dunst, G. and Glaser, B. 2013. Positive effects of composted biochar on plant growth and soil fertility. Agronomy for Sustainable Development, 33(4): 817-827

Schulz H., Glaser B., 2012. Effects of biochar compared to organic and inorganic fertilizers on soil quality and plant growth in a greenhouse experiment. J Plant Nutr Soil Sci 175 :410–422. doi :10.1002/jpln.201100143

Searle P. L. 1984. The Berthelot or Indophenol reaction and its use in the analytical chemistry of nitrogen. A review. Analyst 109, 549 568

Sharpley A. N. 1983. Effect of soil properties on the kinetics of phosphorus desorption. Soil Sci. Soc. Am. J. 47 : 462-467.

Singh, B. P., Hatton, B. J., Singh, B., Cowie, A. L., Kathuria, A. 2010. Influence of biochars on nitrous oxide emissions and nitrogen leaching from two contrasting soils. J. Environ. Qual. 39, 1224–1235.

Spokas, K. A., Cantrell, K. B., Novak, J. M., Archer, D. A., Ippolito, J. A., Collins, H. P.,

Boateng, A. A., Lima, I. M., Lamb, M. C., McAloon, A. J., Lentz, R. D., Nichols, K. A. 2012. Biochar: a synthesis of its agronomic impact beyond carbon sequestration. J. Environ. Qual. 41, 973–989.

Vosti, S., Carpentier, C., Witcover, J. Valentin, J. 2001. Systems in the Western Brazilian Amazon. Agricultural technologies and tropical deforestation 127

Yuan J-H, Xu R-K, Zhang H. 2011. The forms of alkalis in the biochar produced from crop residues at different temperatures. Bioresour Technol. 102(3) :3488–3497.

How to cite this article:

Allogho Mve Janvier, Ondo Jean Aubin, Mefouet Abessolo Daniel Datch, Abogo Mebale Aimé-Jhustelin and Zue Mve Mexent. 2021. Influence of Biochar and Compost on the Fertility of Acid Sandy Soils in Gabon. *Int.J.Curr.Res.Aca.Rev.* 9(11), 23-30. doi: https://doi.org/10.20546/ijcrar.2021.911.004