



Effect of Soil pH and Total Sulfur on Microbial Biomass Carbon along River Getsi, Kano State, Nigeria

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Abstract

The study aimed at assessing the effect of soil pH and sulfur on microbial biomass carbon. In pursuit of the field investigation, the study area was divided into two locations: contaminated and control location. Each of the two locations (1 km² in area) was divided into 10 grid squares within which 10 samples were collected using composite sampling techniques from a depth 0-30cm whereby physicochemical properties of soil such pH, total sulfur, electrical conductivity, Cd, Cr and Pb were determined using standard laboratory procedures. The results of the analyses were subjected to statistical analyses using SPSS software and Microsoft excel to undertake standard deviation, correlation and regression at 95% confident limit. The results revealed that all the physicochemical properties were found to be higher in the contaminated location and also organic carbon and cadmium were negatively correlated with microbial biomass carbon, while EC, pH, S, Cr and Pb were positively correlated with microbial biomass carbon in the study location. However total sulfur, Cr, Cd and Pb were significantly correlated with microbial biomass carbon at 0.05 level of significant difference. The physicochemical properties explain the variation of microbial biomass carbon in the study location to 64% leaving the remaining percentage for other factors to explain.

Keywords: *Soil; Contamination; Effect, Sulfur; Microbes.*

1.0 INTRODUCTION

Soil quality is considered as the capacity of a specific kind of soil to function, within natural ecosystem boundaries, to sustain plant and animal productivity, water, air quality and support human health and habitation (Arshad and Martin, 2002). Soil type and properties were usually found to be interrelated and in combination, could be used to define the state of a soil system (Tan, 2009). In more recent years,

due to concerns with soil degradation and the need for sustainable soil management in agro-ecosystems, there has been a renewal scientific attention to soil variables couples with this is the idea of soil use which has emphasized the values of soil and soil preparation for a specific function. However, these soil preparation often change with time which is very long for management purpose, therefore some soil properties based on biological and biochemical activities such as microbial biomass carbon,

organic matter decomposition and enzymes have shown a respond to small changes in soil condition.

Soil pH is the simple and direct measures of the overall chemical condition of the soil and regarded as master variable because of its influence on the chemical and biological reaction in soil (Haney *et al.*, 2001). It has been found that soil pH correlated with solubility of soil nutrient compound and hence their availability to the plant. Soil microbial biomass carbon is initially linked to nutrient transformations in soil acting as both a sink and source of nutrient. The changes in soil microbial biomass carbon are important in controlling the turnover of carbon and associated nutrient which in turn regulate nutrient availability for plant uptake (Chen *et al.*, 2003). This studies aimed at assessing the effect of some physicochemical properties of soil on microbial biomass carbon using various methods of evaluating physicochemical properties, while the objectives are, to: evaluate some selected physicochemical properties of soil and microbial biomass carbon and also determine the effect of some selected physicochemical properties of soil on microbial biomass carbon.

2.0 MATERIALS AND METHODS

2.1 Study area

The study was carried out along river Getsi irrigated land located between latitude 12° 10' N to 12° 21' N and longitude 8° 46' E to 8° 53' E and the area is situated in Ungogo local government area Kano state of Nigeria. The farmers in the area normally used water from the stream which is contaminated from Bompai industrial area as well as hand dug wells and bores hole to extract their irrigation water using generator and the crops grown in the area include cabbage, lettuce, onion, carrot, cucumber and tomatoes.

2.2 Materials

The materials used in this study include soil auger and spade for sampling the soil, global navigation system (GNS) for recording the coordinate of the sampling point, spectrophotometer for analyses of microbial

biomass carbon, pH meter and electrical conductivity meter for measuring soil pH and electrical conductivity respectively.

2.3 Sampling Techniques

The study location was selected randomly whereby 1km² was measured and then divided in to 10 grids squares from which the soil samples were collected at the intersection of each grid using composite sampling method. The samples were collected within the 0 – 30cm depth this is because it's the zone of maximum biological and chemical activities in soils. The samples collected were placed into polythene bags labelled appropriate, air dried, homogenized, sieve and then taken to the laboratory for further analyses.

2.4 LABORATORY PROCEDURES

Soil pH was determine electrometrically by soil water ratio (1: 2.5) in CaCl₂, electrical conductivity of soil saturation was assessed using conductometer, organic carbon was assessed using wet digestion method as describe by Walkley and Black (1934), the total sulfur was determined using turbidometric method as described by Sarkar and Haldar (2005). The microbial biomass carbon was determined by fumigation-extraction methods as described by Vance *et al* (1987) in the modification described by Nannipieri *et al* (2003). 15g of fresh soil sample was placed in to two 50ml beakers and the beakers were placed in to two paired desiccators (control and Fumigated). In the fumigated desiccator, 100ml beaker containing 25ml chloroform (alcohol free) was placed in the centre. The second desiccator contain non-fumigated (control) samples in which the desiccator was closed and the sealants were uniformly distributed. Vacuum was applied to the fumigated treatment up till chloroform boiled. The desiccators were closed and stored in dark condition for 72 hours at room temperature. The soil samples were transferred in to the shaking bottle and 50ml of 0.5M K₂ SO₄ were added and shake on a wrist action shaker for 25 minutes and the suspension were filtered. The samples were digested and the

microbial biomass carbon was analyzed with calorimeter.

For the assessment of heavy metals (Cd, Cr and Pb) the soil was digested through wet digestion method as described by Anderson (1974) 10g of soil was placed in a clean 300ml calibrated digestion tube and 5ml of concentrated sulphuric acid (H_2SO_4) was added in the fume hood and swirled carefully and then placed in the block-digester. Gradually, the temperature setting was increased from 60°C to 145°C for one hour. Five milliliter (5ml) of tri-acid mixtures (HNO_3 , H_2SO_4 and HCL) were added and then heated to 240°C for further one hour and kept overnight to avoid excessive foaming. The tubes racks were removed out of the block-digester and allowed to cool at room temperature and then filtered through Whatman No. 42 filter papers and stored in pre-cleaned polythene bottles for further analysis. The digested and filtered samples were aspirated and the results were dispensed on the read out unit of Atomic Absorption Spectrophotometer.

3.0 RESULTS AND DISCUSSION

The physicochemical properties of soil under investigation were presented and discussed (Table 1) which shows that the study locations have high mean values of pH 7.65 and 7.11 for contaminated and control locations respectively. The high mean values of pH indicates that the exchange complex of the soil in the study locations is dominated by exchangeable base cations which replace or exchanged the Hydrogen and Aluminum ions in the soil. This is explained by Brady and Weil (1999) that high pH soil tend to be dominated by exchangeable bases which were normally exchanged or replace the Hydrogen and Aluminum ions in the soil. The high mean values of electrical conductivity in contaminated location indicates that the location have higher concentration of soluble salts which resulted to high electrical conductivity (table 1).

Table 1: Mean values of physicochemical properties of soil in Getsi irrigated land

locations	Physicochemical properties of soil								
	EC (ds/m)	pH (Cacl)	S (ppm)	OC (%)	Cr (mg/kg)	Cd (mg/kg)	Pb (mg/kg)	MBC (Mg C/kg)	Temp (°C)
Contaminated	1.38	7.65	43	1.37	64.8	4.37	43.6	0.29	24.7
Control	0.48	7.11	32	1.86	18.72	3.9	32.05	0.17	21.6

Source: Field (2015).

The mean values all the physicochemical properties were found to be higher in contaminated location than the control location with exception of organic carbon which is found to be higher in control location than the respective contamination location. High mean values of the physicochemical properties in contaminated location is probably attributed to the high pH and temperature in the location in which temperature influence the population and activities of soil microbe, while pH influence the availability, solubility and toxicity of nutrient element to soil which in turn reduce the toxicity effect of soil pollutant to soil microbes. This

indicates that the soil microbes in the study location resist the toxicity effect of some soil pollutants which led to the high mean values of some physicochemical properties in contaminated location. This is adduced by Brady and Weil (1999) who explained that soil microbial activities virtually ceases below 5°C and increase more than double for every 10°C rise in temperature. Also Lal (2006) reported that availability, solubility and toxicity of soil pollutants decreases as soil pH increases, this is due to the increase in negative charges on variable charge surface in soil and the propensity for these pollutants to precipitate as springily soluble compound as soil pH increases.

The electrical conductivity and organic carbon obtained in this work is in line with the values obtained by Chukulobe and Saeed (2014), while the values of pH is higher than the values obtained by Adamu and Yusuf (2014) this indicates that there is gradual reduction of Hydrogen and Aluminum ions by base cation which is responsible for the high pH in the soil. The mean values of Cr and Pb obtained in this work is higher than the mean values obtained by Bichi and Bello (2013). This indicates that there is gradual accumulation of Cr and Pb in the study location, while the mean values of Cd is lower than the values obtained by Uzairu *et al* (2013). This indicates that there is reduction of Cd in the study location which is probably due to leaching, runoff and or low pollutant containing Cd in the location.

3.2 EFFECT OF SOIL pH AND SULFUR ON MICROBIAL BIOMASS CARBON

The soil pH and sulfur have significant effect on soil microbial biomass, it was observed that contaminated location recorded high mean value of soil pH and sulfur than the control location which is indicates the effect of pH and sulfur in

the study location. Soil pH affected the microbial biomass in various ways: as soil pH change is highly dependent on some soil properties like organic matter which directly affect the microbial biomass carbon. Sulfur and soil pH affect the activity of soil microbes and availability, solubility and toxicity of pollutant in the soil which affect the population and activity of soil microbes whose are responsible for the microbial biomass production in soil.

Table 2 show the relationship between some physicochemical properties and microbial biomass carbon in the study location. It was observed that organic carbon and cadmium were negatively correlated with microbial biomass carbon, while EC, pH, S, Cr and Pb were positively correlated with microbial biomass carbon in the study location. However total sulfur, Cr, Cd and Pb were significantly correlated with microbial biomass carbon at 0.05 level of significant difference. This implies that total sulfur, Cr, Cd and Pb significantly affect the microbial activity in the soil of the study location.

Table 2: Relationship between physicochemical properties and soil microbial biomass

Physicochemical properties	Coefficient of correlation (r)
Electrical conductivity (ds/M3)	0.1
soil pH (CaCl)	0.23
Total sulfur (ppm)	0.66*
Organic carbon (%)	-0.43
Chromium (mg/kg)	0.58*
Cadmium (mg/kg)	-0.54*
Lead (mg/kg)	0.37*
Source: Field (2015)	* Significant at 0.05

The coefficient of determination (r^2) value between physicochemical properties and microbial biomass carbon is 0.64, this show that the physicochemical properties under investigation explain the variation of microbial biomass carbon in the study location to 64% leaving the remaining percentage for other

factors to explain, this indicates that physicochemical properties of soil significantly affected the microbial biomass carbon.

The relationship between heavy metals and some soil properties (Table 3) shows that Cr is positively correlated with electrical conductivity and pH and was negatively correlated with

organic carbon, Cd is negatively correlated with Ec, OC and soil pH, while Pb was positively correlated with Ec and pH and was negatively correlated with OC. This indicates that there is

relationship between physicochemical properties of soil under studies and heavy metals in the study locations.

Table 3: Relationship between Heavy metals and some soil properties

	EC		pH		OC	
	<i>r</i>	p-values	<i>r</i>	p-values	<i>r</i>	p-values
Cr	0.32	0.09	-0.16	0.28	0.6	0.48
Cd	-0.15	0.9	-0.35	0.1	-0.19	0.06
Pb	0.38	0.06	-0.03	0.16	0.66	0.99

Source: Field (2015)

4.0 CONCLUSION AND RECOMMENDATIONS

From the findings it was revealed that industrial activities from Bompai industrial area and domestic activities from Sabon Gari, Brigade quarters and airport road have significant influence on the amount of pollutants in the study area because contaminated location recorded high mean values of some pollutants. The soil pH, total sulfur and temperature

significantly affect the activities of soil microbes and consequently affect some physicochemical properties of soil in the area. From the findings it was concluded that microbial activity is influenced by some physicochemical properties of soil which affect some biological (microbial biomass carbon) and chemical properties of soil and are considered as sensitive biological indicator of soil pollutant and could be considered as soil quality indicator.

5.0 REFERENCES

- Adamu, G.K. and Yusuf, M. A. (2014). A comparative Study of Changes in Soil Fertility Under Two Farming Practices in the Kano Close Settle Zone. *European Scientific Journals* 10(2): 1857 – 7881.
- Anderson, J. (1974). *Wet Digestion Versus Dry for the Analysis of Fish Tissue for Trace Metals*; Afon Absorption Newsletter.
- Arshad, M. A. and Martin, S. (2002). Identifying critical limits for soil quality indicators in Agro-ecosystems. *Agriculture, Ecosystems and Environment* (88): 153–160.
- Brady, N. C. and Weil, R. R. (1999). *Nature and Properties of Soils*; Fourteenth Edition, Pearson Education Inc; Upper Saddle River New Jersey
- Chen, Y. and Chen, M. (2001). Heavy Metal Concentrations in Nine Species of Fishes Caught in Coastal Waters of Ann-ping SW. Taiwan. *Journal of Food Drug Anal.* (9): 107-114.
- Chukulobe, E. E. and Saeed, M. D. (2014). Assessment of Some Physicochemical Properties And Level of Pb, Cu, and Zn in Soil of Selected Dump site in Kano Metropolis, North West Nigeria. *Int. J. boil. Chem. Scie.* 8 (2): 717 – 726.
- Haney, R. L., Franzluebbers, A.J. Hons, F.M. Hossner, L.R and Zuberer, D.A. (2001). Molar Concentration of K₂SO₄ and soil pH effect estimation of extractable C with chloroform fumigation extraction. *Soil Biol. Biochem.* (33): 1501–1507.
- Lal, R. (2006). *Encyclopedia of Soil Science*. The Ohio State University Columbus,

- Ohio, U.S.A. New York London. 817 – 1813. Taylor and Francis group. 2nd Edition (1 & 2).
- Mohammed, M.A. (2010). An Assessment of Heavy Metals Pollution in Soils Under urban and Peri- Urban Irrigation in Kano Metropolis. *Unpublished M.Sc Thesis*, Geography Department, Bayero University Kano- Nigeria. 45 – 58.
- Nannipieri, P., Ascher, J., Ceccherini, M.T, Landi, L., Pietramellara, G. and Renella, G. (2003). Microbial diversity and soil function. *Eur. J. soil Scie.* (54): 655-670
- Sarkar, D and Haldar, A. (2005). *Physical and Chemical Methods in Soil Analysis*. Fundamental Concepts of Analytical Chemistry and Instrumental Technique. New age International, Publishers, 4835/24, Ansari Road, Daryaganji, New Delhi-India
- Tan, K. H., (2009). *Environmental Soil science*. (3rd edition). C .R.C Press. Francis and Tailor Group. 93 – 430.
- Uzairu, A., Uba S., Sallau M. S., Abba H. and Ounola O. J. (2013). Seasonal chemical fraction of metals in some dumpsites soil in Zaria metropolis, Nigeria . *Journal of environmental earth science*. 3(2): 2224-3216
- Vance, E.D, Brook, J. C. and Jenkinson, D.S (1987). An Extraction Method for Measuring Soil Microbial Biomass. *C. Soil Bio. Bio. Biochem.* (19):703 – 703
- Walkley, A. and Black, C.A. (1934). An Examination of the Djetgareff Method for Determining Organic Matter and Proposed Modification of the Chromic Acid Titration Method. *Soil Sci.* (37): 29–38.