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ORIGINAL ARTICLE

Evaluation of Some Soil Properties on Dehydrogenase Activity in River Getsi Kano State, Nigeria

Mansur Abdul Mohammed [a], Tasiu Rilwanu Yalwa [a] and Sunisi Abdu Yusuf [b]

[a] Department of Geography, Bayero University Kano-Nigeria,
[b] Department of Soil Science and Agricultural Engineering, Usmanu Danfodiyo University, Sokoto-Nigeria

*Corresponding Author: mamohammed.geog@buk.edu.ng

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Abstract

The study aimed at evaluating some soil physicochemical properties of soil on dehydrogenase activity in the soil of the area which was achieved by assessing some selected physicochemical properties of soil and dehydrogenase activities, and determine the relationship between some selected physicochemical properties of soil and dehydrogenase activities of soil in the area. One square kilometer of irrigated land was selected randomly and then divided in to 10 grids square and samples were collected in each grid using composite method and analyzed using standard laboratory procedures. The results shows that, clay recorded mean values of 3.8 cmol/kg ±0.84, EC 1385 dSm-1 ±760, pH 7.66±0.46, OC 1.37%±125, total nitrogen 0.15%±0.04, CEC 2.8 cmol/kg±0.06 and DHA 0.005±0.06. The findings shows that, there is no significant relationship between clay, EC, pH, Oc, nitrogen and dehydrogenase activities using correlation analyses at p <0.05 probability level, while the regression analyses show that the coefficient of determination (r2) values obtained are 0.05, 0.44, 0.001, 0.03, 0.006 and 0.09 for clay, EC, pH, Oc, TN and CEC respectively. From the findings it was concluded that Ec, pH, OC, N and CEC have no significant effect on DHA of the soil in the area. It is therefore recommended that appropriate soil management practice should be encourage more to enhance microbial activity in the soil of the area.

Keywords: Soil; Enzymes; Dehydrogenase; Soil properties; River Getsi

Introduction

Soil enzymes and soil microbes are sensitive biological indicators for soil quality evaluation and play an active role in biochemical function in the overall process of organic matter decomposition. In the soil system, soil fertility as a result of their involvement in the cycle of nutrients such as nitrogen, carbon and phosphorus which are required for plant growth which can sensitively reflect changes of the soil environment (Bruce, 2004). Soil enzymes are direct expression of the soil community to metabolic requirements and available nutrients and are important in catalyzing several important reactions necessary for the life processes of micro-organism in soils and the stabilization of soil structure, decomposition of organic wastes, organic matter formation and

nutrient cycling (Bruce, 2004). The activity of dehydrogenase enzyme in the soils undergoes complex biochemical processes consisting of integrated and ecologically-connected synthesis processes, and in the immobilization and enzyme stability. The dehydrogenase enzyme levels in soil systems varies in amount primarily due to the fact that each soil type has different amounts of organic matter content, composition and activity of its living organisms and intensity of the biological processes.

The dehydrogenase enzyme activity is commonly used as an indicator of biological activities in soil and considered to exist as an integral part of intact cells but does not accumulate extracellularly in the soil. Dehydrogenase enzyme is known to oxidise soil organic matter by transferring protons and electrons from substrates to acceptors. These processes are part of respiration pathways of soil micro-organisms and are closely related to the type of soil and soil air-water conditions. Since these processes are part of respiration pathways of soil microorganisms (Bruce, 2004).

The most important soil factor stimulating soil dehydrogenase activity is organic matter content, pH, temperature and soil moisture. These factors have important effect not only on soil enzymes activities but first of all on microorganisms' activities. Soil organic matter has been considered as an indicator of soil quality similarly like dehydrogenase because of its character of nutrient sink and source that can enhance soil physical, chemical and promote biological activity (Salazar et al., 2011). Soil moisture is another soil factor stimulating dehydrogenase activity because water availability strongly effect soil microbial activity, community composition and consequently on soil enzymatic activity. As the soil dry, the water potential increases, and as well microbial activity as intracellular enzyme activity slow down in the case of wet soil, increased moisture could bring into soil solution soluble organic matter, this might be responsible for increase of bacterial population (Geisser et al., 2011)

Temperature and seasons of the year are other factors, the rate of enzymes catalyses generally increase with increasing temperature until the unfavorable temperature at which enzymes become denaturized and hence its activity reduce (Wolinska and Stepnieireska, 2012). The soil reaction (pH) also stimulate dehydrogenase activity in the soil, generally enzymes activities tend to increase with soil pH. It was demonstrated that acidic condition in the pH range between 1.5 – 4.5 result with strong inhibition of dehydrogenase activity in relation to the alkaline soil. Soil pH can affect the dehydrogenase activity by change in ionic form of the active site of enzyme which consequently affect the activity and hence the rate of reaction, affecting the affinity of the substrate to enzymes and altering the three-dimension shape of enzyme (Quilihanomand and Moranon, 2002; Moeskops et al., 2010).

Some of the previous studies such as Mohammed (2004); Adamu (2014) investigated some soil properties, however, these studies are limited in scope because they did not assess the relationship between soil properties and dehydrogenase activities in the soil of the river site. The study of soil properties on dehydrogenase activities in soil is very pertinent as it give indications of the potential of the soil to support biochemical processes which are essential for maintaining soil fertility.

Materials and Methods

The materials used in this study are soil augar for sampling the soil, global positioning system for recording the coordinate of the sampling point, spectrophotometer for analyses of DHA, pH meter and electrical conductivity meter for measuring soil pH and electrical conductivity.

Study Area

The study was carried out in Jaba irrigated land along river Getsi which is situated in Ungogo local government Kano state of Nigeria which lies between latitude 12o 02ˈ and 12o 10ˈ N and longitude 8o 34ˈ and 8o 44ˈE (Figure 1). The farmers in the area normally used contaminated water emanated from Bompai industrial area and domestic activities from city centre, Brigade and Sabon Gari quarters, and open well and bore hole for their irrigation and the crops grown in the area include cabbage, lettuce, onion, carrot, cucumber and tomatoes

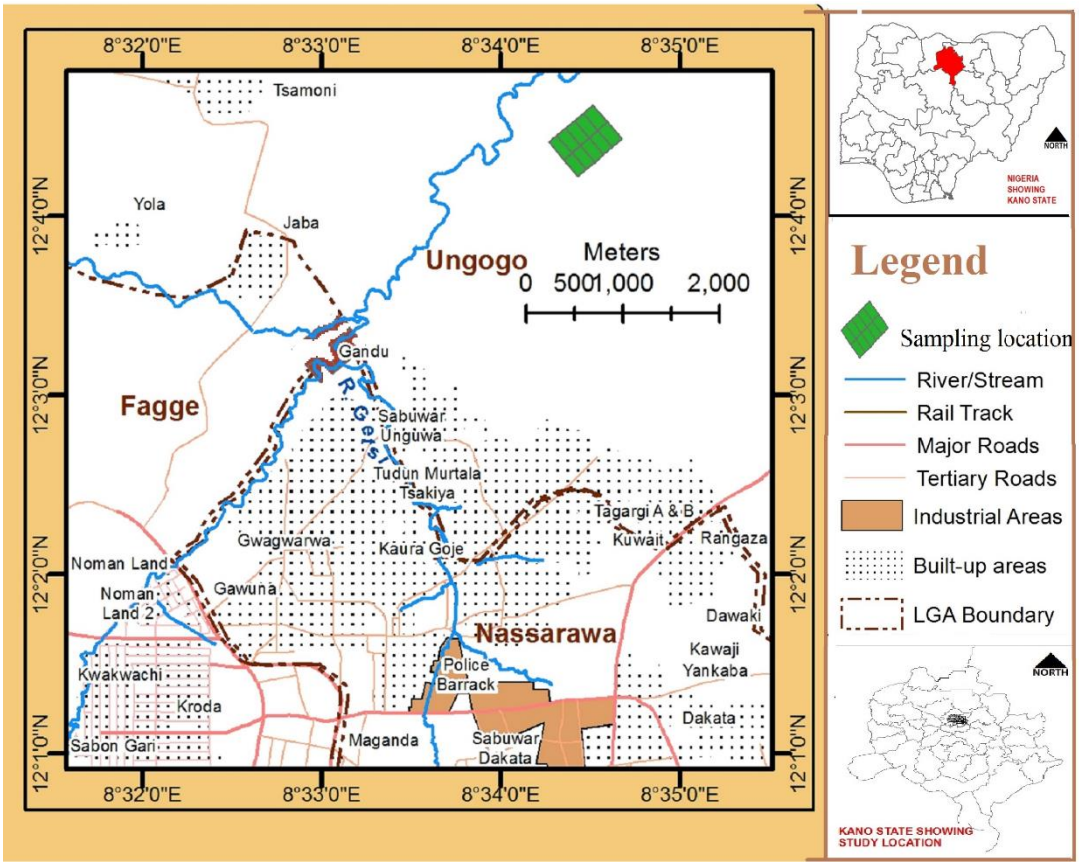

Figure 1. Study location and sampling grids

Sampling Methods

The study location is selected randomly and then 1km2 was measured and then divided in to 10 grids square where soil samples were collected at the intersection of each grid using composite sampling method. The samples were collected within 0 – 15cm depth this is because it is a zone of maximum biological activities in soils. The samples collected were placed into polythene bags labelled appropriately, air dried, sieve through 2mm mesh and then taken to the laboratory analyses of some selected soil properties and dehydrogenase activities.

Laboratory Analyses

The selected soil properties were determined using standard laboratory procedures: pH determined by using pH meter, electrical conductivity of soil saturation with conductometer,

organic carbon is measured following the wet digestion method as describe by Walkley and Black (1934), cation exchange capacity by Bower method, particle size distribution by the hydrometer method, total nitrogen was determined by the Kjeldahl method as describe by.

The dehydrogenase activity analysed using tryphynyl tetrazolium chloride as a subtrate as described by Thalman (1968) in the modification described by Alef and Nannipieri (1995); Nannipieri et al. (2003). 20g of air dried soil was mixed with 0.2 g of CaCO3 and 6 g of the mixture was placed in each of three test tubes set. 1 ml of 3 % aqueous solution of TTC (Triphenyl tetrazolium chloride) and 2.5 ml of deionized water were added and the samples was incubated at 36oC for 24 hours. 10 ml of methanol was added and filtered after shaking. The red color intensity was measured by using a spectrophotometer (CECIL model no. 2010) at a wavelength of 485nm and the result being expressed in microgram TPF kg-1 d-1.

Results

The results for some selected soil properties show that the soil properties under studies varied widely with respect to the distribution of soil's total nitrogen, organic carbon, clay, cation exchange capacity, electrical conductivity and pH (Table 1).

Table 1. Descriptive statistic for selected soil property (n= 10)

Parameters	**Mean**	**Range**	**SD**
Clay%	3.8	2.32- 4.43	0.84
Electrical conductivity (dSm-1)	1385	536 - 2630	760
pH (Kcl)	7.66	7.0 - 8.2	0.46
Organic Carbon (%)	1.37	0.07 - 3.16	1.25
Total Nitrogen (%)	0.15	0.09 -0.19	0.04
Cation Exchange Capacity (Cmol/kg)	2.8	2.7 - 2.9	0.06
Dehydrogenase activity ($TPFmg^{-1}$)	0.0051	0.003 - 0.008	0.0016

Source: Field & Laboratory (2015)

The mean value of clay in the study location is 3.8cmol/kg and ranges from 2.32 to 4.43cmol/kg, the mean value of Ec is 1385 dSm-1 and ranges from 536 to 2630 dSm-1. The mean values of EC obtained is higher than the values obtained by Haliru et al. (2014). This indicates that there is continuous accumulation of soluble salt in the soil of the area. This is explained by Brady and Weil (1999), who described that increases in soluble salt in soil lead to increases in EC.

Discussion

The pH value shows that the soil of the area is slightly alkaline (7.6) and ranges from 7.0 to 8.2. However, the mean value of pH obtained in this work is higher than the value obtained by Binns *et al.* (2003) this implies that there is gradual accumulation of basic soluble salt. The mean value of organic carbon is 1.37% and ranged from 0.07 to 3.16% and therefore ranked low based on rating of London (1991). The value of organic carbon obtained is in consistent with the values obtained by Adamu and Yusuf (2014) this indicates that there is low removal of organic carbon in

the area through crops uptake, this is explained by Brady and Weil (1999) that, the major cause of organic carbon loss in cultivated soil. The total nitrogen is 0.15% and ranges from 0.09 to 0.19 and ranked high based on fertility assessment manual described by Chude *et al*. (2011). The mean CEC value is 2.8 Cmol/kg and ranges from 2.7 to 2.9 Cmol/kg and ranked low based on the fertility assessment manual described by Chude *et al*. (2011).

Effect of Some Soil Properties on DHA

The correlation analyses was used in determine the effect of soil properties under investigation and DHA in which the regression is used in determined the extent of the relationship (Figure 2-7).

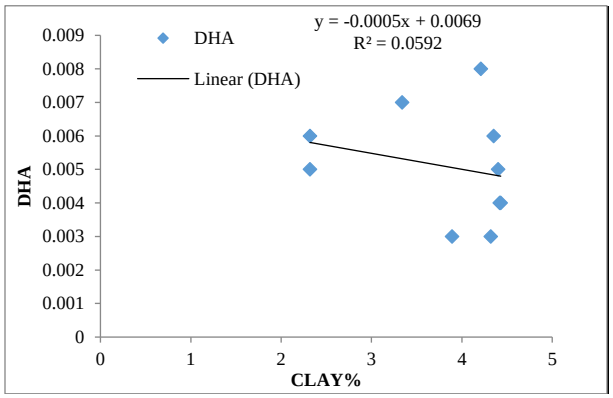

Figure 2. Relationship between DHA and Clay

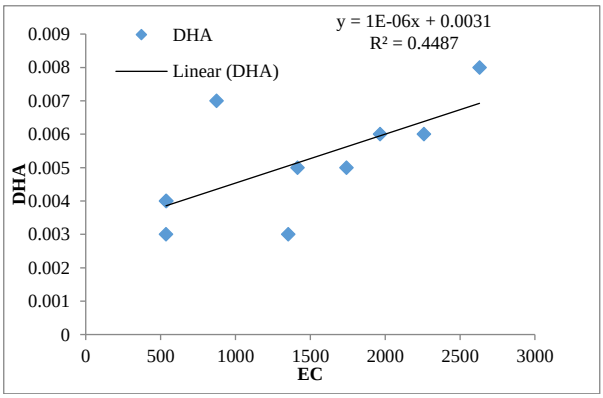

Figure 3. Relationship between DHA and EC

The correlation analyses show that there is no significant relationship between clay, pH, organic carbon, total nitrogen, and dehydrogenase activities at $p<0.05$ probability level. This indicates that change in dehydrogenase activity in the soil of the area is not associated with changes in clay, pH, organic carbon and nitrogen. The coefficient of determination ($r^2 = 0.059$) values for clay (Figure 2) show that clay can explained the variation of DHA in the soil of the area to 5.9% leaving the remaining percentage to other factors to explain. However, significant relationship between electrical conductivity and DHA was observed at $p<0.05$ probability level which implies that changes in dehydrogenase activity is associated with changes of electrical conductivity of the soil of the area. This also implies that EC level in the soil is highly related to soluble salt content as described by Brady and Weil (1999). However, coefficient of determination (r^2) values (Figure 3) shows that variation of dehydrogenase activity can be explained by electrical conductivity to 44% leaving the remaining 56% for other factors to explain.

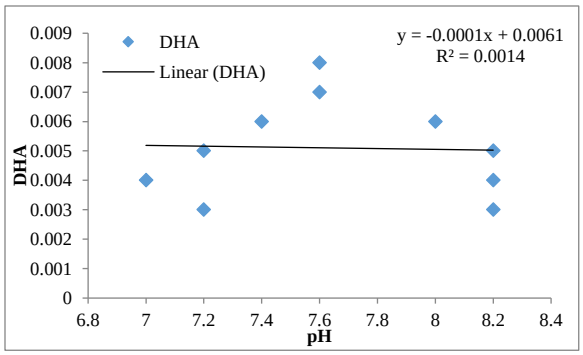

Figure 4. DHA and soil pH

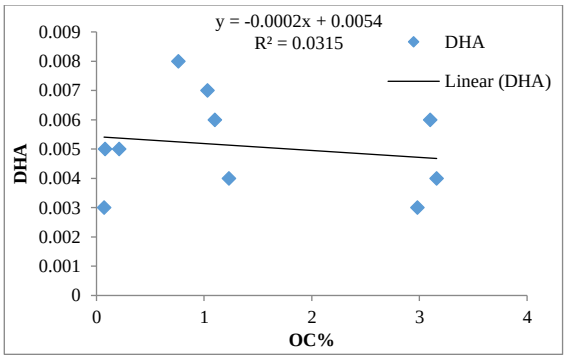

Figure 5. DHA and %OC and OC

The regression analyses shows that soil pH and organic carbon (Figure 4 and 5) can explain the variation of DHA to 0.014% (r^2 =0.0014) and 3% (r^2 = 0.031) respectively leaving the remaning 99.086% and 97% for other factors to explain. This indicates that pH and OC have less significant effect on the DHA in the soil of the area.

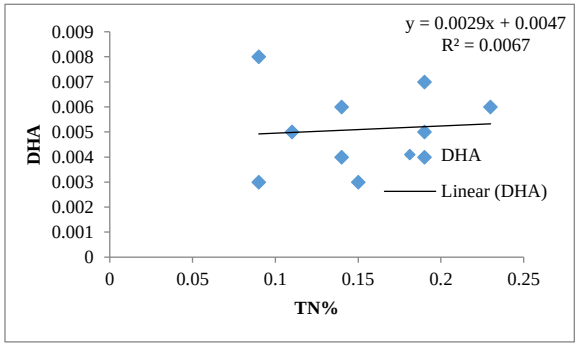

Figure 6. DHA and soil TN

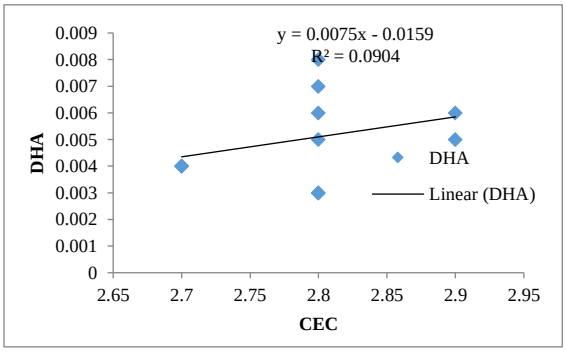

Figure 7. DHA and CEC

The coefficient of determination of total nitrogen (r2 =0.006) and cation exchange capacity (r2 =0.09) show that the variation of dehydrogenase activity in the study area can be explained by nitrogen and CEC to 0.06% and 9% respectively leaving the remaining 99.04% and 91% to other factors to explain, this indicates that nitrogen and CEC have no less significant effect on DHA than other factors (Figure 6 and 7). This result contradicts the results obtained by Moeskops et al (2010); Romero et al. (2010) who explained the significant correlation between organic carbon, pH and DHA. However, the results is line with results obtained by Wolinska and Stepnieirska (2012) who reported high values of DHA at lower pH value between 5.5 – 7.73 and significant inhibition of DHA was reported on pH above 5.75. This trend may be attributed to the fact that high pH usually from 6.6 – 7.2 inhabit the DHA in the soil. This is contended by Brzezinska et al. (2011) who reported that the best pH condition for DHA range between 6.6 – 7.

Conclusion

From the findings it was concluded that clay, pH, organic carbon and nitrogen have no significant effect on dehydrogenase activity of the soil of the area and the dehydrogenase activity can be considered as soil quality indicator. However, appropriate soil management practices like minimum tillage, crop rotation, cover crops should be encourage more to enhance the microbial population and activities in the soil of the area and also further study is recommended to assess other factors affecting the DHA of the soil in the area.

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