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Assessment of Fertilizer Blended Waste on Soil and Water at Fertilizer Blending Company in Bokkos, Plateau State, Nigeria

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Abstract

The volume of waste generated from fertilizer blending company in Bokkos call for concerned due to environmental and human risk. Therefore assessing the concentration of soil and water parameters forms the basis for this research. Soil and water samples were collected within the vicinity of the company and analysed using standard techniques. The results obtained, for water samples in mg/L showed; pH (8.3±0.1), EC (226±28µS/cm), TSS (0.50±0.2), free chloride (0.04±0.04), PO_4^{3-} (2.1±1.0), SO_4^{2-}(1.7±3.0), NO_3^- (19.1±3.0), Hardness (43.3±6.4), P (0.70±0.3), P_2O_5 (1.5±0.8). The results for soil samples in mg/L, showed; pH in water (6.84±0.1), EC (204±54.1µS/cm), OC (0.80±0.2), OM (1.4±0.3), N (28.7±9.3), P (2.11±0.3), CEC (7.07±0.3), K (1.77±0.84) and moisture content of (9.07±0.14%). The results statistically correlate at 95% confidence level. This study has revealed that the water and soil within the environs of the company is ideal for human consumption and agricultural purpose. However, sustained monitoring of heavy metals in the environs of the company is hereby recommended to avert environmental and human hazard.

Keywords: Physicochemical; Fertilizer; Waste; Pearson correlation matrix; Soil; Water; Bokkos.

1. Introduction

One of the objectives of the millennium development goals (MDGs) is to ensure environmental sustainability while the target are to integrate the principles of sustainable waste management into the country policies and programs; reverse loss of environmental resources and to reduce biodiversity loss, achieving by 2020, a significant reduction in the rate of loss, etc [1].

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Rapid industrialization in Nigerian agricultural sector has often been associated with large scale ecological damage largely due to unscientific and unsystematic disposal of industrial effluents [1]. Fertilizers are integral part of current agricultural practice as they provide essential mineral elements for positive growth and blossoming harvest. Even high yielding varieties of crop plants possibly do not reach to their full potential without getting a balance dose of fertilizer [2]. Globally, fertilizer consumption has over the past few decades increasingly shifted towards developing countries. The main force responsible for the shift are the introduction of environmental legislation restricting the use of fertilizer in many developed countries and significant growth in fertilizer demand in developing regions as a result of an unprecedented growth in population [2]. Bejafta chemical and agro allied services is a fertilizer blending company situated in Bokkos Local Government, Plateau State, Nigeria. The blending plant is one of the largest in Nigeria and has the capacity to produce 50 metric tons (MT) of fertilizer per hour and over 900 tons in one day. This then brings us to a total of about 330,000 MT in a year [3]. The company is cited along the bank of River Basin, opposite the express high way to Jos, the capital city of Plateau state. Due to high demand of water; River Basin serves as a source of water supply to the entire Bokkos Local Government Area, Plateau State. Other minor rivers within the vicinity of the company are River Mabang and River Mavel. Apart from source of water to the community, River Basin also been used for irrigation purposes during dry season farming. Almost every type of industrial process involves the release of trace quantities of half a dozen or more inorganic compounds in one form or the other. The polluting ability of these compounds depends on their intrinsic properties determined by their structure and none chemical factors like production and pattern of use [4]. Once soil is contaminated, it is difficult and expensive to decontaminate it [5]. Therefore, the activities of the Fertilizer blending plant may impact positively or negatively on agricultural activities and aquatic lives as discharge of waste may reduce the water quality there by makes it unfit for usage.

In view of the forgoing, this study was aimed at assessing the fertilizer blending waste concentration on soil and water within the vicinity of the blending company.

2. Materials and Methods

2.1 Description of Experimental site

As earlier stated, the Fertilizer Blending Company is located opposite Jos express high way, along the bank of River Basin; in Bokkos Local Government Area (LGA), Plateau state, Nigeria. The Company main activity is the blending of Nitrogen, Phosphorous, and Potassium (NPK) grade fertilizer, which has capacity of producing 330,000 [3] metric tons per annum. By the side of the River, farming activities is carried out in raining and drying season. The River serves as the main source of water supply to the entire Local Government. Bokkos LGA has an area of 1,682 km^2 and a population of 178,454 according to 2006 census [6]. The geographic data on figures 1 and 2 below is obtained from the Geographic information System of the Plateau State University Bokkos.

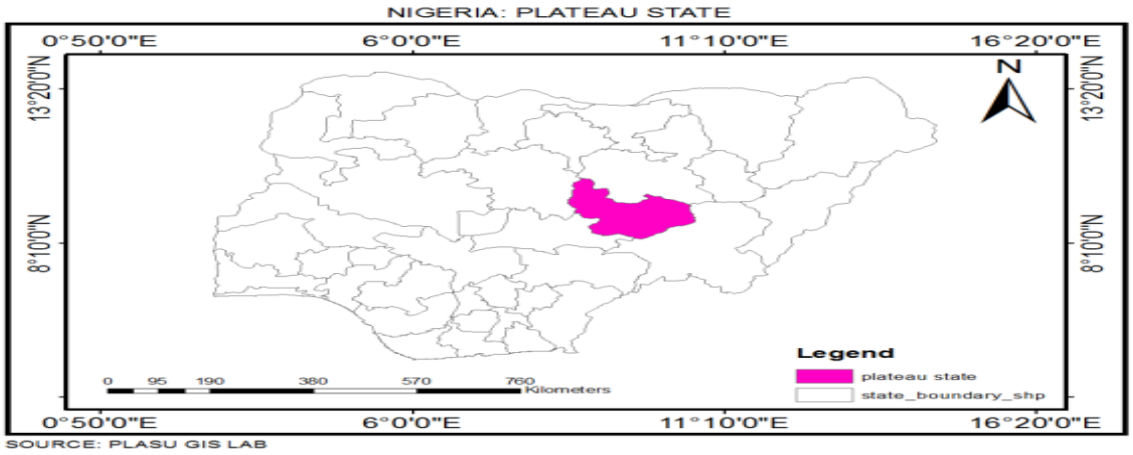

Figure1: Map of Nigeria showing Plateau State.

Source: PLASU GIS LAB, 2019 [6].

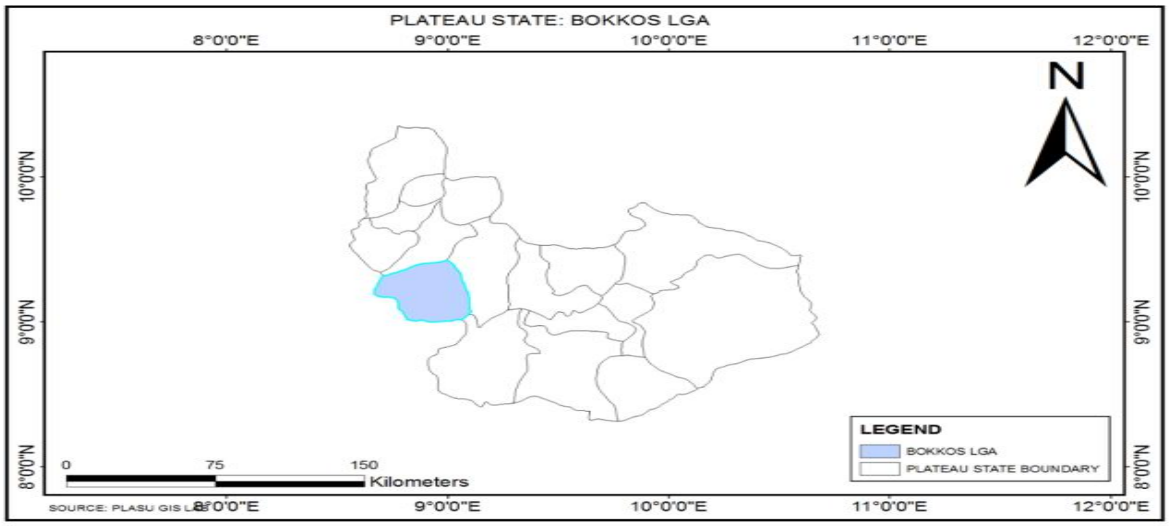

Figure 2: Map of Plateau State showing Bokkos LGA.

Source: PLASU GIS LAB, 2019 [6]

2.2 Sampling

Three soil samples (SS 1), (SS 2), and (SS 3), of about 150g were collected at random within the vicinity of the blending company, (0 to 10) cm from the soil surface. Water Samples were obtained from the River and Streams at sampling stations 4(SS 4), 5(SS 5) and 6(SS 6). Samples were collected with 500mL plastic container at about 5 to 10cm below the water surface. The water samples were digested according to standard procedure described by Eneji and his colleagues [7]. Exactly 100 mL of acidified sample was measured in a 250 mL conical flask and 5 mL of Concentrated HNO_3 was added to the conical flask and covered with watch glass. The flask was heated on hot plate at 60^{o}C for 20 minutes until the solution appears light colour and then cooled to ambient

temperature. Flask and watch glass was rinsed with distilled water and filtered into a 250mL clean conical flask. Filtrate was transferred to a 100 mL volumetric flask and the conical flask was rinsed with 5 mL distilled de-ionized water and poured into the volumetric flask. The sample was made up to 100 mL mark with distilled water, agitated to mix thoroughly and stored for analysis. About 10g of the soil sample was weight and transferred in HANNA cylindrical apparatus, 30 mL of de-ionized water was added to the soil sample, three drops of 0.01M $CaCl_2$ was added to the mixture and properly shaken for three minutes and allowed to settle after which the clear solution is filtered. The filtrate obtained during preparation was used for various tests. Only distilled water was used in the instrument as describe by Justina [8]. And de-ionized water was used as blank for soil analysis.

3. Results and Discussion

The summary of physicochemical properties of water and physicochemical properties of soil (mean ($\overline{X}$)), are presented in Tables 1 and 3 respectively.

Table 1: Physicochemical properties of water within the vicinity of Bokkos Fertilizer blending company.

SP	**Mean ($\overline{X}$)**	**Standard Deviation ± (S)**	**Standard (SON)**	**Remark (Health Impact)**
pH	8.3	0.1	6.5 – 8.5	None
EC (µS/cm)	226	28.2		
TSS (mg/L)	0.50	0.2	-	
Free residual Cl^-(mg/L)	0.04	0.04	0.2 – 0.25	None
PO_4^{3-}(mg/L)	2.1	1.0	-	
SO_4^{2-}(mg/L)	1.7	3.0	100	None
NO_3^-(mg/L)	19.1	3.0	50	Cyanosis, and asphyxia (blu-baby syndrome) in infants under 3 months
Hardness (mg/L)	43.3	6.4	150	None
P (mg/L)	0.70	0.3		
P_2O_5 (mg/L)	1.5	0.8		

Table 2: Pearson correlation matrix of physicochemical properties of water.

WATER PROPERTIES		Ph	EC	TSS	Free Chloride	PO_4^{3+}	SO_4^{2-}	NO_3^-	Hardness	P	P_2O_5
Ph	Pearson Correlation	1									
EC	Pearson Correlation	-.924	1								
	Sig. (2-tailed)	.249									
TSS	Pearson Correlation	-.971	.989	1							
	Sig. (2-tailed)	.154	.095								
Free Chloride	Pearson Correlation	.610	-.866	-.782	1						
	Sig. (2-tailed)	.582	.333	.428							
PO_4^{3+}	Pearson Correlation	-.500	.132	.277	.381	1					
	Sig. (2-tailed)	.667	.916	.821	.751						
SO_4^{2-}	Pearson Correlation	-.500	.132	.277	.381	1.000	1				
	Sig. (2-tailed)	.667	.916	.821	.751	.000					
NO_3^-	Pearson Correlation	.038	.345	.203	-.768	-.885	-.885	1			
	Sig. (2-tailed)	.976	.775	.870	.442	.309	.309				
Hardness	Pearson Correlation	-.954	.996	.998	-.820	.217	.217	.263	1		
	Sig. (2-tailed)	.194	.055	.040	.388	.861	.861	.830			
P	Pearson Correlation	-.803	.515	.636	-.017	.918	.918	-.626	.587	1	
	Sig. (2-tailed)	.407	.656	.561	.989	.260	.260	.569	.601		
P_2O_5	Pearson Correlation	-.500	.132	.277	.381	1.000	1.000	-.885	.217	.918	1
	Sig. (2-tailed)	.667	.916	.821	.751	.000	.000	.309	.861	.260	

Table 3: Physicochemical properties of soil within the vicinity of Bokkos Fertilizer blending company.

SAMPLE		Mean ($\bar{X}$)	Standard Deviation ± (S)
pH		6.84	0.1
EC (µS/cm)		204	54
Organic Carbon (ppm)		0.80	0.2
Organic Matter (ppm)		1.4	0.3
Nitrogen (N) (ppm)		28.70	9.3
Phosphorus (P) (ppm)		2.11	0.3
Exchangeable bases	Potassium (K) (mMol/100g)	1.77	0.84
	Sodium (Na) (mMol/100g)	2.18	0.32
	Calcium (Ca) (mMol/100g)	0.68	0.53
	Magnesium (Mg) (mMol/100g)	0.40	0.22
Exchange acidity (mMol/100g)		2.03	0.11
CEC (mMol/100g)		7.07	0.3
Sand (%)		60.73	8.145
Clay (%)		18.65	2.08
Silt (%)		19.28	11.28
Textural Class (%)		-	-
Moisture Content (%)		9.07	0.14

Table 4: Pearson correlation matrix of physicochemical properties of soil.

SOIL PROPERTIES		EC	pH	Org. c	Org. M	N	P	K	Na	Ca	Mg	Exchange Acidity	CEC	Sand	Silt	Clay	Moisture
EC	Pearson Correlation	1															
pH	Pearson Correlation	-0.814	1														
	Sig. (2-tailed)	0.394															
Org. c	Pearson Correlation	0.96	-0.618	1													
	Sig. (2-tailed)	0.182	0.576														
Org. M	Pearson Correlation	0.957	-0.612	1	1												
	Sig. (2-tailed)	0.187	0.581	0.005													
N	Pearson Correlation	0.147	-0.694	-0.137	-0.145	1											
	Sig. (2-tailed)	0.906	0.512	0.913	0.907												
P	Pearson Correlation	0.998	-0.778	0.975	0.973	0.087	1										
	Sig. (2-tailed)	0.039	0.433	0.143	0.148	0.944											
K	Pearson Correlation	0.677	-0.978	0.442	0.435	0.828	0.631	1									
	Sig. (2-tailed)	0.527	0.133	0.708	0.714	0.379	0.565										
Na	Pearson Correlation	0.5	0.096	0.723	0.729	-0.783	0.551	-0.3	1								
	Sig. (2-tailed)	0.667	0.939	0.485	0.48	0.427	0.628	0.806									
Ca	Pearson Correlation	-0.811	1	-0.613	-0.606	0.699	-0.774	0.98	0.102	1							
	Sig. (2-tailed)	0.398	0.004	0.585	0.585	0.507	0.437	0.128	0.935								
Mg	Pearson Correlation	-0.665	0.975	-0.428	-0.42	-0.837	0.619	-1	0.315	0.976	1						
	Sig. (2-tailed)	0.537	0.143	0.718	0.724	0.369	0.575	0.01	0.796	0.139							
Exch. acidity	Pearson Correlation	-0.06	0.629	0.223	0.231	-0.996	0	-0.776	0.834	0.634	0.786	1					
	Sig. (2-tailed)	0.961	0.567	0.857	0.852	0.056	1	0.435	0.372	0.563	0.425						
CEC	Pearson Correlation	0.485	0.112	0.712	0.718	-0.793	0.537	-0.315	1	0.119	0.33	0.843	1				

	Sig. (2-tailed)	0.677	0.928	0.496	0.497	0.417	0.639	0.796	0.01	0.924	0.786	0.361					
Sand	Pearson Correlation	0.268	-0.777	-0.014	-0.023	0.992	0.209	0.89	-0.701	-0.781	-0.9	-0.978	-0.71	1			
	Sig. (2-tailed)	0.828	0.433	0.991	0.986	0.078	0.866	0.301	0.506	0.429	0.291	0.124	0.495				
Silt	Pearson Correlation	-0.424	0.871	-0.153	-0.144	-0.95	0.369	0.954	0.572	0.874	-0.959	0.929	0.586	-0.986	1		
	Sig. (2-tailed)	0.721	0.327	0.902	0.908	0.185	0.759	0.194	0.612	0.323	0.184	0.241	0.602	0.107			
Clay	Pearson Correlation	0.151	-0.697	-0.133	-0.142	1	0.091	0.83	0.781	0.701	-0.84	-0.996	-0.79	0.993	-0.96	1	
	Sig. (2-tailed)	0.904	0.509	0.915	0.91	0.002	0.942	0.377	0.429	0.505	0.367	0.058	0.419	0.076	0.18		
Moisture	Pearson Correlation	0.834	-0.359	0.956	0.958	-0.422	0.866	0.159	0.895	-0.353	-0.14	0.5	0.887	-0.308	0.15	-0.4	1
	Sig. (2-tailed)	0.372	0.766	0.19	0.185	0.722	0.333	0.899	0.295	0.77	0.909	0.667	0.305	0.801	0.91	0.7	

The results obtained for the water test showed a mean pH of (8.30±0.1). This value is within the pH range of 7.76 – 8.89 reported by Hyeladi and Nwagilari [9] for Alau Dam, North East, Nigeria. The total suspended solids of 0.50±0.2 mg/L recorded in this work agrees with a range of 0 – 2.5mg/L given by Ehigiator and Jimoh [10]. A range of 73 at 0 m depth to 119 at 20 – 30 m was also reported by Akindele and his colleagues [11].

A hardness of 43.3 ± 6.4 mg/L was obtained in this study. According to Wright and his colleagues [12], water with hardness above 200 mg/L may cause scale deposition in the distribution system and result in excessive soap consumption and subsequent scum formation. Studies further revealed an electrical conductivity (EC) of 226± 28 μS/cm for water. Discharge of exchangeable bases by plants could be attributed for the high values of electrical conductivity. The concentration of hardness in water was recorded as (43.3±6.4 mg/L). The National Guidelines and Standards for Water Quality in Nigeria recommended a value of 200mg/L [13]. Results further revealed a nitrates concentration of 19.1±3.0 mg/L. Ehigiator and Jimoh [10], reported much lower values ranging from 1.3 – 10 mg/L for Bosso Lake, North Central Nigeria. Wright and his colleagues [12], gave a maximum acceptable concentration (MAC) for nitrate in drinking water as 45 mg/L. The concentration of free chloride in water was 0.04±0.04 mg/L. Eneji and his colleagues [7] reported chloride range of 1.06 mg/L to 155 mg/L for River Benue, Nigeria. The concentration of phosphate in water was 2.1±1.0 mg/L. Phosphate complements nitrate in the ageing process of water body. Akindele and his colleagues [11] reported values of 0.18mg/L at 0 m, 0.22 mg/L at 5 m and 0.21 mg/L at 20 – 30 m for Tiga Lake, North Western Nigeria. Result of phosphorous in water showed 0.70 ± 0.3 mg/L. The low phosphorous value is an indication that the contribution of this parameter from the company to the water bodies is insignificant. A low water sulphate value of 2.1± 1.0 mg/L was measured in this study. Trevett and his colleagues [14] reported that Sulphate ion if present in excess amount produces cathartic effect upon human beings.

Results were also obtained for the physicochemical studies of the soils in the plant environs. A pH value of 6.84 ± 0.1 recorded in this studies concurred with a range of 6.0 to 7.0 reported by Le and his colleagues [15]. A soil moisture content of (9.07±0.14 %) was recorded. Furthermore, soil (EC) was recorded as 204 ± 54 μS/cm. According to Samouelian and his colleagues [16], Soil (EC) is the measure of how much electrical current soil can conduct. The concentration of organic carbon (OC) in the soil was (0.80 ± 0.12 ppm). This value is far below a value of 34% reported by Geetha and his colleagues [17] for soil of Panchythi. Studies also revealed that the soil organic matter (OM) was 1.4 ± 0.3 ppm. According to Nuh [18], Knowledge of soil organic matter content is important in herbicide applications, pH maintenance, and general soil quality and productivity assessments. The concentration of nitrogen, phosphorous, potassium, sodium, calcium and Magnesium investigated were; 28.70 ± 9.3ppm, 2.11± 0.3 ppm, 1.77 ± 0.8 mM/100g, 2.18 ± 0.32 mM/100g, 0.68 ± 0.53 mM/100g and 0.40 ± 0.22 mM/100g respectively. The cation exchange capacity in the soil was (7.07 ± 0.28 mMol/100g). A standard deviation of ± 0.28 mMol/100g shows how far the content of organic carbon spread from the mean.

3. Conclusion

It can be inferred from this study that the water physicochemical parameters investigated were within literature and Standard for water quality. Thus, the water in the River and stream within the environs of the fertilizer blending company Bokkos, is considered good for human consumption. Although organic carbon is a limiting parameter in the soil physicochemical parameters, the surrounding soil is ideal for Agricultural activities due to the presence among others of nitrogen, phosphorus, potassium, calcium, magnesium and organic matter. However, continuous monitoring of the water and soil within the environs of the fertilizer blending company is hereby recommended in order to avert any environmental and human catastrophe.

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