Effect of Oil Spill on Some Soil Physicochemical Properties and Agriculture In Esit Eket Onna Areas, Akwa Ibom State, Nigeria

Wokocha C.C. and Aniebet B.
Faculty of Agriculture
Department of Crop andf Soil Science
University of Port Harcourt
Rivers state

DOI: 10.56201/ijaes.v8.no2.2022.pg51.56

ABSTRACT

The study was conducted to determine the level of concentration of heavy metals and physicochemical properties of the soils of the study area. The levels of pH varied slightly between 5.30 (ETAK IDIM) and 5.44(OKPSON 1).The concentration of the available Phosphorus varied from 2.08ppm(OKPSON 1) to 2.81ppm (ATAI 1). The Total Hydrocarbon Content varied from 4034.12 mg/kg (ITAK IDIM UKPA) to 4904.71 mg/kg (NEW BARRACK). The textural class of the soils was generally sand. The silt particles had range from 0.56% (ETAK IDIM and ATAI 11) to 2.00% (ITAK IBANG), The clay minimum value (1.00%) was obtained from ATAI 1 and maximum value of 3.00% was obtained from ITAK IBANG, OKPSON 1 and ATAI 11. The sand particles ranged from 95% (ITAK IBANG) to 98% (ATAI 1). While the concentration of Ammonium ion varied from 14.65ppmN (OKPSON 1) to 32.50ppmN (NEW BARRACK). The concentration of heavy metals showed that Pb varied between 12.41mg/kg (ETO ESEK) and 23.24mg/kg (NEW BARRACK); Cu ranged from 5.10mg/kg (ETO ESEK) to 18.12mg/kg (OKPSON 1);Cr levels ranged from 15.17mg/kg (OKPSON 1) to 23.00mg/kg (ETO ESEK); Ni varied from 1.00mg/kg (ETO ESEK) to 26.14mg/kg (ATAI 1).

Key words: *oil spill, physicochemical properties, sustainable agriculture, livelihood*

INTRODUCTION

An oil spill is the release of a liquid petroleum hydrocarbon into the environment due to human activities. The oil is often released into the ocean, land or coastal waters which constitute serious form of environmental pollution.

In Nigeria, the major source of energy is crude oil and the processes of crude oil production often results in environmental pollution. Nnaji and Egwu (2020) noted that oil spills are one of the most widespread forms of pollution on agricultural lands and water bodies in Nigeria. Oil spills impacts on the ecosystem can be severe. Many plants and animals suffer or are killed within a short time after the spill occurs (Asthana and Asthana, 2003).

This study aimed to determined the effect of oil spill on soil physicochemical parameters (pH, organic carbon, CEC, N,P,K, Exchangeable acidity, ECEC, THC and soil texture) and its impact on agriculture as

well as how this problem can be averted for sustainable agriculture in the affected areas of which Esit Eket and Onna areas of Akwa Ibom State is a case study.

MATERIALS AND METHOD:

Site Description:

The study was conducted in ten communities (Eto Esek, Itak Idim Ekpe, New Barrack, Itak Ifia, Itak Ibang, Okposon 1, Atia 1, Itak Udim Ukpa, Ine Akpautong and Atai II) of Esit Eket and Onna Areas, Akwa Ibom State.

Sample Collection and Preparation:

Soil samples were collected with soil auger from four locations within each community in the study areas at depth of 0 – 20cm into polyethene bags, labeled and taken to the laboratory for preparation and analyses. The samples were air-dried, ground to pass through a 2mm sieve.

Soil Samples Analyses:

The pH was determined in the laboratory using glass electrode pH meter. 1:2.5 soil to water ratio was used (Loganathan, 1984). Available Phosphorus was determined using Bray No.1 method as modified by Olsen and Sommer (1982). Macro-Kjeldahl digestion method (Bremner, 1996 and Mulvaney, 1996) was used to determine Total Nitrogen. Total Hydrocarbon Content (THC) was determined using spectrophotometer after extracting 1g of soil sample with 10ml of toluene. Exchangeable Cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}). Total organic carbon was determined by the wet combustion method of Walkley and Black (1934) as modified by Juo (1979). Exchangeable acidity of the soil sample was determined. 5 drop of phenolphthalein indicator was titrated with 0.05M NaoH solution. Particle size analysis was done by hydrometer method modified by Juo (1979).

RESULTS AND DISCUSSION:

The results of the heavy metals concentrations and physicochemical properties of the soil in the study areas are presented in Table1. The levels of pH varied slightly between 5.30 (ETAK IDIM) and 5.44(OKPSON 1). The organic carbon ranged from 1.61% (ETO ESEK) to 2.62(OKPSON 1). The concentration of the available Phosphorus varied from 2.08ppm(OKPSON 1) to 2.81ppm (ATAI 1). The exchangeable acidity had values ranging from 0.24cmol/kg (ATAI 1) to 0.72cmol/kg (ETAK IDIM). The ECEC values ranged from 4.17cmol/kg(ETO ESEK) to 6.85cmol/kg (OKPSON 1). The Total Hydrocarbon Content varied from 4034.12 mg/kg (ITAK IDIM UKPA) to 4904.71 mg/kg (NEW BARRACK). The textural class of the soils was generally sand. The silt particles had range from 0.56% (ETAK IDIM and ATAI 11) to 2.00% (ITAK IBANG), The clay minimum value (1.00%) was obtained from ATAI 1 and maximum value of 3.00% was obtained from ITAK IBANG, OKPSON 1 and ATAI 11. The sand particles ranged from 95% (ITAK IBANG) to 98% (ATAI 1). Sulphate concentration varied between 90.63ppm (ETO ESEK) to 937.5ppm (ATAI 1), While the concentration of Ammonium ion varied from 14.65ppmN (OKPSON 1) to 32.50ppmN (NEW BARRACK). The levels of EC ranged between 405 us/cm (ETAK IDIM) and 633 us/cm (ATAI 1). The concentration of heavy metals showed that Pb varied between 12.41mg/kg (ETO ESEK) and 23.24mg/kg (NEW BARRACK); Cu ranged from 5.10mg/kg (ETO ESEK) to 18.12mg/kg (OKPSON 1);Cr levels ranged from 15.17mg/kg (OKPSON 1) to 23.00mg/kg (ETO ESEK); Ni varied from 1.00mg/kg (ETO ESEK) to 26.14mg/ kg (ATAI 1).

Table 1
Concentration of Physico-Chemical Properties in the study area:

PARAMETERS	ETOESEK	ETAKIDIM	NEWBARRACK	ITAKIFIA	ITAKIBANG	OKPSON 1	ATAI 1	ITAKUDIMUKPA	INENKPAUTONG	ATAII
pH	5.3	5.3	5.3	5.3	5.3	5.44	5.33	5.33	5.32	5.30
Organic carbon (%)	1.61	2.30	2.26	2.41	2.48	2.62	2.20	2.30	2.31	2.10
Available P (PPM)	2.11	2.11	2.14	2.15	2.11	2.08	2.81	2.11	2.10	2.12
Total Nitrogen (%)	0.40	0.02	0.16	0.06	0.03	0.01	0.01	0.01	0.03	0.04
Exch. Acidity (cmol/kg)	0.48	0.72	0.56	0.68	0.32	0.45	0.24	0.25	0.24	0.25
CEC (Cmol/kg)	4.17	6.46	5.58	6.62	6.60	6.85	6.68	5.58	5.58	5.62
ECEC (Cmol/kg)	4.79	7.43	6.41	7.61	7.59	7.87	7.68	6.41	7.87	7.43
THC (mg/kg)	4634.12	4528.24	4904.71	4292.94	4034.12	4516.47	4388.24	4034.12	4346.14	4526.16
Silt (%)	1.00	0.56	1.00	0.88	2.00	1.54	1.00	1.54	1.00	0.56
Clay (%)	2.00	1.92	2.00	1.84	3.00	3.00	1.00	1.92	2.00	3.00
Sand (%)	97.00	97.52	97.00	97.28	95.00	95.46	98.00	96.64	97.00	96.54
Texture	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand
SO_4^{2-} (PPM)	90.63	140.63	112.56	189.14	140.63	215.98	937.50	112.56	140.13	215.98
NO_3^-(ppm N)	21.70	4.90	8.80	3.60	7.00	3.42	4.20	8.80	20.17	3.42
NH_4^+(ppm N)	31.00	28.00	32.50	31.20	28.00	14.65	28.00	31.00	28.00	31.00
Electrical conductivity (us/cm)	583	405	597	451	434	428	633	583	428	402
Pb (mg/kg)	20.02	23.24	12.41	12.86	14.32	16.41	18.04	16.42	16.41	16.42
Cu (mg/kg)	5.10	6.42	10.10	12.20	11.24	18.12	15.41	10.11	10.10	12.20

Cr (mg/kg)	23.00	21.00	18.40	21.08	12.22	15.17	26.14	15.17	15.00	18.42
Ni (mg/kg)	24.82	24.85	24.32	26.14	21.64	23.48	22.64	26.00	26.00	26.00

Discussion;

The soils of Esit Eket and Onna areas are generally sandy (Table 1). This sandy nature can be attributed to the parent materials of the area, Coastal Plain Sands, (Akamigbo, 2000). This indicates that the ground water in the area is susceptible to contamination by surface pollutants.

Soil reaction affects nutrient availability and toxicity, microbial activity, and root growth. Thus, it is one of the most important chemical characteristics of the soil solution because both higher plants and microorganisms respond so markedly to their chemical environment. The pH of the soils in the area are all slightly acid with range 5.30 – 5.44. Hence, soil nutrients especially Phosphorus, Nitrogen, sulphur and some micronutrients are affected (Agbede, 2009). Similarly, Brady (1974), reported that at pH of about 5.0, iron, manganese, zinc and copper become less available for plant nutrient.

Total organic carbon is the amount of carbon stored in the soil as a component of soil organic matter- plants and animal materials in the soil that are at various stages of decay. Total organic carbon is the basis of soil fertility. The TOC of the contaminated areas were high when compared with the critical limits of Metson (1961) which states that TOC above 2% is very high. Although the organic carbon contents of the area were high, both oil and grease make the soils on the spillage site unfit for crop farming. This coincides with the findings of Nnaji and Egwu (2020).

The Electrical Conductivity (EC) of soil expresses its total ionic strength and low total ionic strength of a soil solution indicates low dissolved salt contents and vice-versa. Crude oil is not a very good conductor of electricity, therefore, it is not likely that the oil spilled was directly responsible for the increasing values of the electrical conductivity. However, the high levels of the EC indicate the presence of soluble salts in the soil which could adversely affect plant growth (Ideriah and Ideriah, 2006).

Cation exchange capacity (CEC) defined as the capacity of soil to adsorb exchangeable cations (Brady and Weil, 2012). CEC is an important index of soil quality because the chemical activity of the soil depends on it. It influences soil structure stability, nutrient availability, soil pH and the soil's reaction to fertilizers and other ameliorants (Hazleton and Murphy, 2007). The clay mineral and organic matter components of soil have negatively charged sites on their surfaces which adsorb and hold positively charged ions (cations) by electrostatic force. This electrical charge is critical to the supply of nutrients to plants because many nutrients exist as cations (e.g. magnesium, potassium and calcium). Generally, soils with large quantities of negative charge are more fertile because they retain more cations (McKenzie *et al.*, 2004). The CEC of the contaminated soils ranged from 4.17 – 6.68cmol/kg and falls within low to medium according to the critical levels of Esu(1991). These soils are more likely to develop deficiencies of potassium, magnesium as well as other basic cations.

The Total Hydrocarbon Content (THC) levels were high indicating oil contamination, since the levels were above permissible limit of 4000 us/cm. The increase could be attributed to mobilization of the contaminated

sediments by the oil spill. This high level of THC has a devastating impact on the living organisms in the ecosystem which is a major long term concern.

The most noticeable soil quality deterioration in the study areas is the high level of heavy metals. The contamination of soil is a serious environmental problem (NRC1989, USEPA 1994). Thus the soil in the ten communities has been rendered a store house for heavy metal contaminants.

Lead (Pb) is toxic to most of the living things including man. Lead(Pb) contaminated soils may lead to its absorption by plants roots. Plants in the ten communities studied possess higher Lead(Pb) concentration as compared to the control and are passed to the higher trophic levels that include the people of these fishing communities(Asthana and Asthana, 1998).

Nickel exposure is very toxic as large amount can cause dermatitis and respiratory disorders. Nickel inhibits the activity of a number of enzymes such as malefic dehydrogenises, cytochrome oxidase and isocitrate dehydrogenase. It is a carcinogen and the exposure of about 30ppm could be lethal to humans (Sundermanu 1981).

Acute Chromium toxicity causes serious renal tubular necrosis. Exposure to hexavalent chromium has been found to cause dermatitis, allergic skin reactions, chronic ulceration and gastrointestinal ulcers (Langard and Norseth, 1979).

Copper(Cu) is the most toxic element to plants after mercury in plants. Inhibition of plants growth occur at the concentration less than 10ppm (Asthana Asthana, 1998). A higher concentration of Cu is injurious to blue green algae since the metal tends to suppress nitrogen fixation, which is an important phenomenon to plants.

REFERENCES

Akamigbo, F. O. R. (2000). Nigerian Agriculture and Challenges of the 21st Century: Nigerian Soils. *Agro. Sci. J. of Trop.* Vol.1(1).

Agbede, O. O. (2009). Understanding Soil and Plant Nutrition. 1st Edition, Keffi-Nasarawa State, Salman Press & Co. Nigeria Ltd. 260pp.

Asthana, D. K. and Asthana, M. (2003). Environmental problems and solutions. S. Chand and Company Ltd. New Uelhi. Indian.

Brady, R.H and Weil, R. (2012). The Nature and Properties of Soils. 13th edition, Singapore, Pearson Education, 976.

Brady, N. C.(1974): The natural and properties of soils 8th Edition. Macmillan publishing CO., INC., New York. U.S.A.

Bremner, J.M.(1996). Analysis of total nitrogen. Method of soil analysis part 3. Chemical methods. SSA Book Series No. 5, U.S.A.

Esu, I. E. (1991). Detailed Soil Survey of NIHORT Farm at Bunkure, Kano State, Nigeria. Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria.

Ideriah, T. J. and Ideriah B. J.(2006). Effect of crude oil spillage on physic-chemical and heavy metal

concentration in soils from Ablagada, Nigeria. *Global Journal Of Pure and Applied Science* 12(4)pp 539 -543.

Hazleton, P. and Murphy, B. (2007). Interpreting Soil Test Results: What to do all the numbers mean? Published by CSIRO Publishing. Collingwood Victoria- Australia. http://www.publish.CSIRO.

Juo, A. S. R. (1979). Selected Methods of Soil and Plant Analysis. IITA, Manual Series No.1, 70p.

Langard S. and Norseth, T. (1979). Chromium. In Handbook on the toxicology of metals(Eds) Friberg L. and Norberg G. F., Vouk V. B. Elsvier N. Y.

McKenzie, N. J., Jacquier D. J., Isbell, R. F. and Brown K. L. (2004). Australian Soils and Landscapes; An Illustrated Compendium. CSIRO Publishing; Collingwood, Victoria.

Metson, A.J. (1961). Methods of Chemical Analysis of Soil Survey Samples. Govt., Printers Wellington, New Zealand. *Journal of Soil Science and Environment*. Pp. 64.

Mulvaney, R. L. (1996). Mineral nitrogen determination. Method of soil Analysis Part 3. Chemical Methods. SSSA book Xeries No.5 U.S.A.

Nnaji, J. C and Egwu, A. C. (2020). Physiochemical characteristics of oil spill impacted agricultural soils in three areas of the Niger Delta. Singapore Journal of Scientific Research, 10(2):137-144.

Norseth T.(1981). The Carcinogenicity of Chromium. Environmental Health Prospect 40:121

NRC (1989). Contaminated marine sediments assessments and remediation. National Academic Press Washington, D.C.

Sunderman, F.W.J.(1981). Nickel. In Disorders of Mineral Metabolism Volume 1. (Eds) Binner F. Coburn J.W, Academic Press. New York.

Walkley, A. and Black. I. A. (1934). An Examination of Degtjareff Method of Determining Soil Organic Matter and a proposed Modification of the Chromic Acid Titration Method. *Soil Science*, 37, 29-37.