EFFECT OF NATURAL GAS FLARING ON MICRONUTRIENTS STATUS IN SOILS OF THE NIGER DELTA CULTIVATED TO THE OIL PALM.

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ABSTRACT
A study was conducted to determine the effect of gas flaring on the micronutrients status of soils around a gas flare site near Ubiaruku in Ukwani Local Government Area of Delta State. Fifteen soil samples were collected from 0-15 cm in a manner to fully and adequately represent the area covering the gas flare site. The samples were air dried and passed through a 2mm sieved. They were analyzed for micronutrients (Zn, Cu, Mn and Fe) and some physico-chemical properties following standards laboratory methods. Result showed that Zinc (Zn) range between 0.00 to 0.14 mg kg^{-1}, copper 0.00 to 1.64 mg kg^{-1}, manganese (Mn) 0.00 to 4.02 mg kg^{-1} and Iron (Fe) 110.60 to 204.3 mg kg^{-1}. Their mean values were Zn (0.04 mg kg^{-1}), Cu (1.15 mg kg^{-1}), Mn (1.58 mg kg^{-1}) and Fe (122.4 mg kg^{-1}). Generally, the micronutrient status (Zn, Cu, Mn) except Fe were low as compared with their critical limits as observed in the study. The low mean values of these micronutrients imply that soil amendments of Zn, Cu, Mn and/or application of appropriate quantities of key nutrient elements would enhance their availability for optimum oil palm growth and productivity in the study area.
Keywords: Micronutrients, physico-chemical properties, gas flaring, oil palm

INTRODUCTION

Oil production has continued to play a dominate role in the Nigeria economy, ranging from generation of foreign exchange to serving as a source of energy to run the nation economy. Production of other necessary needs of man derived from crude oil would not have been possible if crude oil was not discovered and exploited. The above mentioned benefits and lots of others have shown that crude oil has been a blessing to man and the nation in general. On the other hand, the process of employing modern technology in the exploration, product processing and storage of this natural resource has resulted in the abuse of man's environment direct or indirectly. There are reports that suggest low fertility status caused by crude oil exploration activities (Oyem and Oyem, 2013). Phil-Eze and Okoro (2009) reported that oil exploration gives rise to the degradation of arable soil in the Niger Delta region through spillage, drilling waste and gas flaring which creates negative impact on soil chemical, physical and biological properties. Reduction of soil fertility can be observed in the immediate vicinities of the flow station where intense heat is generated by the burning of natural gas. This triggers off the volatilization of plant nutrient from the top soil and evaporation of soil moisture (Amadi *et al*, 1993). Similarly, Alakpodia (2000) and Ejuwa (2005) stated that the constant heat being emitted from the flare sites make the soil of the adjacent farmland hard and unproductive. Oluwatimilehin (1987) studied the effect of gas flaring on Okro, palm trees and cassava. He observed a depression in flowering and fruiting in these crops. He equally found out that the tubers decreased in length and weight with decreasing distances from the flare sites. Ukegbu and Okeke (1987) examined the effect of gas flare on the growth, productivity and yield of selected farm crops in Izombe flow station located in Izombe Ohagi/Egbema/Oguta Local Government Area of Imo state. They found out that the impact was about 100% loss in yield in all the crops cultivated about 200 meters away, 45% loss for those about 600 meters and 10% loss in yield for crops about 1000 meters away from the flare. The effects were reduced with increasing distances from the flare. The sustainable production of a soil mainly depends upon its ability to supply essential nutrients to the growing plants (Kumar and Nabel, 2011). Zinc (Zn), cupper (Cu), manganese (Mn), Iron (Fe) are essential micronutrients for plant growth. Although needed by plants in very small amounts, they play important role in gene expression, biosynthesis of proteins, nucleic acids, growth substances, chlorophyll and secondary metabolites etc (Singh, 2004 Rengel, 2007 and (Gao*et al.*, 2008). Although the effects of oil and gas exploration activities on soil physico-chemical properties have been studied extensively, (Nkwopara *et al.*, 2012; Udo and Fayemi, 1975; Rowell, 1977; Okpokwasili and Odokuna, 1990; Ladousse and Tramies, 1991) information is scarce on the level of soil micronutrients around gas flare sites in the Oil Rich Niger Delta Region of Nigeria. Therefore this study was initiated to investigate the baseline level of soil micronutrient status in a gas flare site cropped to the oil palm near Ubiaruku, Delta State of Nigeria.

MATERIALS AND METHODS

Location of Study Area: The study was conducted in an existing oil and gas facility located in Ukwani Local Government Area of Delta State. The study area is in the rainforest agro-ecological zone of Nigeria and lies at Latitudes 7º 36'N and Longitude 4º 59' E. Humid tropical climate prevails with average annual rainfall of 1500 - 3000 mm. In the raining season, the rainfall pattern is bimodal and falls between April and October, while the dry

season is between November and April. Mean minimum and maximum daily temperatures are 24°C and 33°C. The soils of the area has been classified as ultisols, low in water holding capacity, organic matter, highly drained and usually have multiple nutrient deficiencies. The vegetation is characterized by scanty grasses, shrubs and scattered crops such as oil palm, maize, cassava and melon etc.

Soil Sampling and Handling: Sampling was randomized to fully and adequately represent the gas flare site. At specific locations, soil sample were obtained with the aid of stainless steel auger at 0-15cm depths respectively. The samples were transferred into properly labeled polyethylene bags and aluminum foil wrappers for storage processing, and analyses of their physico-chemical and micronutrient status (Fe, Cu, Mn, Zn).

Laboratory Analyses: Particle size distribution was determined by the hydrometer method as described by Gee and Bauder (1986). Soil pH was determined in 0.1 mol/L KCl suspension using a soil: liquid ratio of 1: 2.5 and values were read off electrometrically using the pH meter. Soil organic carbon was analyzed by Walkley and Black method as described by Nelson and Sommers (1982). Percent total nitrogen was measured by micro - kjeldahl digestion method (Bremner and Muilvaney, 1982). Available phosphorus was determined using Bray (II) method (Olsen and Sommers, 1982). The available Fe, Mn, Cu and Zn in soil samples were extracted with a DTPA solution (0.005M DTPA + 0.01 M $CaC1_2$ + 0.1 Mtriethanolamine, pH 7.3) as outlined by Lindsayand Norvell(1978). The concentration of micronutrients in the extract was determined by atomic absorption-spectrophotometer (ECIL, AAS-4129).

Data analysis
The results were statistically analyzed, using simple statistics, and compared with standard.

Results and Discussion
Table 1 shows the different sampling points with their associated physicio-chemical and micronutrient characteristic in the studied soil. While Table 2 shows the range and mean values of selected physico-chemical characteristic of soils in the study area. The mean value of sand, silt and clay fractions were 91.12%, 1.57% and 7.30% respectively. The high percentage of sand suggests that the soil may be prone to leaching due to high presence of macro-pores of the dominating sand fractions. This may adversely affect the growth of crops because of probable low water and nutrient retention capacity. The pH shows a range of 4.8 – 5.5 with mean value of 5.0. The acidic nature of the soil shows increase leaching of basic cations which characterized the tropical areas (Parnes, 1990; Gordon *et al.,* 1993). The soil also displays low mean values of total nitrogen (0.12%) organic carbon (1.90%) exchangeable magnesium ($0.45 mgkg^{-1}$) and potassium ($0.47 mgkg^{-1}$). Ibeawuchi *et al.*(2006) recommended that such soils are low in fertility. The observed low fertility may be attributed to the high temperature which may have resulted from the intense heat generated by burning of natural gas by the oil and gas facilities. This may probably be responsible for the low organic carbon as it accelerates organic carbon mineralization (Onweremadu *et al.,* 2008). Similarly, Ogidiolu (2003) observed that organic carbon and total nitrogen decline around gas flaring site. In addition, the acidic nature of the site may have been induced by the gas flaring activities observed within the location of the study. In such case soil are render unproductive agriculturally, because solubility and hence the uptake of nutrients from such soil are reduced (Finnveden and Ekvall, 1999).

Sampling points	Soil Dept. (cm)	Sand (%)	Silt (%)	Clay (%)	pH	EC (µS/cm)	Org. C. (%)	Total N (%)	Ex. Mg (mg/kg)	Ex. K (mg/kg)	Fe (mg/kg)	Mn (mg/kg)	Cu (mg/kg)	Zn (mg/kg)
1	0-15	89.2	0.4	10.4	4.8	117	1.32	0.04	0.33	0.30	112.2	4.10	1.00	0.02
2	0-15	86.40	1.5	12.1	4.9	179	2.03	0.07	0.69	0.10	111.3	2.11	ND	0.01
3	0-15	90.70	1.7	7.6	5.5	109	0.21	0.02	0.46	0.02	112.2	3.02	1.34	0.01
4	0-15	93.40	2.4	4.2	5.0	170	3.01	0.03	0.36	1.00	117.0	1.12	1.45	ND
5	0-15	93.90	2.5	3.6	5.4	160	2.90	0.09	0.44	0.09	114.2	ND	1.17	ND
6	0-15	91.20	1.4	7.4	5.4	134	2.50	0.13	0.39	1.39	114.0	0.42	1.12	0.2
7	0-15	89.90	1.7	8.4	5.1	110	1.30	0.17	0.38	0.23	110.9	1.34	1.22	0.03
8	0-15	96.40	1.2	2.4	4.8	110	2.01	0.05	0.69	0.09	111.2	ND	1.23	ND
9	0-15	88.90	0.9	10.2	5.0	110	1.30	0.01	0.71	0.02	204.3	ND	ND	0.01
10	0-15	90.10	0.5	9.4	4.9	120	2.60	0.04	0.61	1.33	110.6	4.02	1.52	ND
11	0-15	88.30	1.8	9.9	5.2	117	2.61	0.05	0.91	0.22	111.3	3.03	ND	0.10
12	0-15	91.10	1.9	7.0	5.1	100	1.93	0.03	0.13	0.16	112.1	3.02	1.64	0.01
13	0-15	92.40	2.6	5.0	5.0	121	2.01	0.07	0.31	1.00	117.0	1.12	1.35	ND
14	0-15	88.70	1.6	9.7	4.9	112	2.21	0.19	0.12	0.08	114.2	ND	1.56	ND
15	0-15	96.20	1.5	2.3	5.1	122	2.11	0.09	0.25	1.09	165.1	0.42	1.25	0.13

Table 1: Selected physico-chemical and micronutrients characteristic of the studied soil

EC= electrical conductivity, Org C= organic carbon, N= nitrogen, Mg= magnesium, K= potassium, Fe= iron, Mn =manganese, Cu= cupper, Zn =Zinc.

Table 2: Range and mean values of selected physico-chemical properties of soils in the oil and gas installation

Soil characteristics	Range	Mean
Sand (%)	86.40 – 96.40	91.12
Silt (%)	0.40 – 2.60	1.57
Clay (%)	2.30 – 12.10	7.30
pH	4.8 –5.50	5.0
Total N (%)	0.01–0.19	0.12
Org. C (%)	0.21 – 3.90	1.90
K (mg kg^{-1})	0.01 – 1.32	0.47
Mg (mg kg-^{1})	0.02 – 4.32	0.45

N = Nitrogen, C= carbon, K = p Potassium, Mg = Magnesium

Micronutrient status of soils of the flare site

Table 2 shows the range and mean values of available soil micronutrient status within the study area. It was observed that available Fe contents in the surface soil ranged from 110.00 to 204.3 mg kg^{-1} with a mean value of 122.4 mg kg^{-1}. The mean value of the Fe was generally high according to the ratings of Esu (1991). Available cupper content ranged from 0.00 to 1.64 mg kg^{-1} with a mean value of 1.15 mg kg^{-1}.The study also showed that available Zn in the surface soil varied from 0.00 to 0.14 mg kg^{-1} with mean value of 0.04mg kg^{-1}.Available Mn varied from 0.00 to 4.02 mg kg^{-1} with a mean value of 1.58 mg kg^{-1}. Generally, it was observed that the mean values of available Cu, Zn and Mn, were low according to the ratings of Esu (1991).These phenomena may have been resulted from the burning of natural gas as observed in the study area. The high temperature emanating from the burning of natural gas may have triggered the volatilization of most of the micronutrients element studied (Amadu *et al.,* 1993). In the same vein, the poor micronutrients status may also be attributed to the high leaching losses associated with the sandy textures prevailing in the study area (Gordon *et al.,* 1993)

Table 3: Range and mean values of micronutrient status of soils around the oil and gas operational facilities

Micronutrients	Range	Mean
Fe (mg kg^{-1})	112.00 – 204.3	122.4
Cu (mg kg^{-1})	0.00 – 1.64	1.15
Mn (mg kg^{-1})	0.00 – 4.02	1.58
Zn (mg kg^{-1})	0.00 – 0.14	0.04

CONCLUSION

The study has revealed that the status of the micronutrients (Cu, Zn and Mn) studied were low as affected the flaring of natural gas. For long term improvement of these micronutrients sustainable soil management practice like organic and inorganic amendments should be introduced for optimum oil palm yield and productivity in the study area.

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APPENDIX
Ratings for soil fertility classes

Parameters	Very low	Low	Medium	High	Units
Zn	< 1.0	1.0-1.5	1.6 - 3.0	3.1 - 5.0	mg/kg^{-1}
Cu	< 1.0	1.0-2.0			mg/kg^{-1}
Fe		< 2.5	2.5 - 5.0	> 5.0	mg/kg^{-1}
Mn	<1.0	1.0-2.0	2.1- 3.0	3.1-5.0	mg/kg^{-1}
N		<1.5	1.5 - 2.0	>2.0	(%)
P		< 10	10 - 20	>20	mg/kg^{-1}
K		<0.15	0.15 - 0.30	>0.30	mg/kg^{-1}
Ca		< 2	2 - 5	>5.0	mg/kg^{-1}
Mg		<0.3	0.3-1.0	>1.0	mg/kg^{-1}
Na		<0.2	0.2-0.3	>0.3	mg/kg^{-1}
Org. carbon		<10	10 - 15	>15	(%)
CEC	< 6.0	6.0 - 11	12 - 25	26 - 40	Meg/100g

Source: Esu (1991)
Zn = zinc, Cu= cupper, CEC = Cation exchange capacity., Na= Sodium