EVALUATION OF NICKEL CONCENTRATION IN RELATION TO THE PHYSICO-CHEMICAL PROPERTIES OF SOIL CULTIVATED WITH OIL PALM

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Abstract

The objective of this study is to evaluate the relationship between nickel concentration and the physicochemical properties of soil cropped to oil palm. Soil samples were collected from three (3) different location/ four soil depts- (0-15) cm; (30-45/ cm; (45-60) cm, using plastic spade. Soil samples were analyzed via standard methods, using the spectrophotometer and pH meter. The values for pH range from 5.7-6.1; 5.0-6.00; and 5.40 -6.40; for site 1, 2 and 3 respectively. Generally, the four soil sites were slightly acidic. Organic carbon (O.C) values range from 0.44-2. 08; 0.60-2.68; and 0.44-2.54; Nickel values range from, 4.81-13.06; 3.11-13.54-15.76; 12.85-15.30; and 11.24-11-15.10; for sites 1, 2 and 3, respectively. The result shows that as Nickel concentration decreases down the soil dept, all the physic-chemical parameters' concentration also decreases down the dept, except, clay and hydrogen ion concentration. This implies that the relationship between Nickel concentration and the physic-chemical parameters is directly proportional.

Keywords: Evaluate, nickel, concentration, physic-chemical, cultivated, soil, oil palm.

Oil palm (*Elasis guineensis*) is tropical tree crop which is mainly grown for its industrial production of vegetative oil. It is a typical estate crop, grown and harvested over large uniform areas (3,000 to 5,000 ha around a central oil mill to allow rapid industrial handling after harvesting. Palm trees can also be observed in village gardens where they provide oil for local consumption, but in that case both yield and oil quality are much lower. Oil palm is a typical crop of the rainy tropical lowlands. The tree requires a deep soil, a relatively stable high temperature and continuous moisture throughout the year. Soil fertility is less important than physical soil properties. The origin of oil palm points to Africa in particular to West Africa. Fossil pollen, similar to the oil palm as it grows today, has been found in Miocene and more recent strata in the Niger Delta. (MPOC, 2008). Portuguese explorers of the Guinea coast mentioned the existence of tree appearing to be oil palms as early as 1434. In 1508 already reference has been made to palm groves in Liberia, and to palm oil trade near the Forcados River in Nigeria. Later, Portuguese, Dutch and English travelers refer to palm wine and palm oil in the area.

Oil palm requires deep and easily penetrable soils with a good moisture retention and free drainage. The primary taproot depends deeply from the base of the tank, but remains short when the water table is high. Most finer secondary roots are in the top 1m of soil. The crop supports water logging only for short periods. Oil palm establishes fairly well on relatively poor soils, through the fertility level in the root zone always affects yield. In chemically poor soils the crop is sensitive to the equilibrium between the various elements. (FAO, 2006) .Hence, the C/N ratio should be near 10 on the soil surface; exchangeable K^+ should be at least 0.15 – 0.20 me/100g soil; available P should be at least 3-5mg/kg soil; Mg/K and Ca/K should be above 2; and pH should be higher than 4.5. The most significant nickel ore are pentlandite; nickel – iron sulphide and garnierite as well as, nickel – magnesium silicate. Nickel is a relatively abundant and naturally occurring metal, widely distributed in the earth's crust. Its status in soils is highly dependent on the nickel concentration of the parent rocks, but in surface soils, its content is also a refection of soil-forming process and pollution (Kabata-Pendias and Pendias, 1992; McGrath, 1995). The lowest contents are found in sedimentary rocks that comprise of clays, limestones, sandstones and shales, while the highest concentration exist in basic igneous rocks (Kabata- Pendias and Mukherjee, 2007).

Nickel content in soils the brand range between 0.2 and 450 ppm, while the grand mean is calculated to be 22 ppm (Kabata – Pendias and Pendias, 1992; Cempel and Nickel, 2005; Bencko, 1983; Scott-Fordsmand, 1997). Duke (1980a) also reported an average concentration if 86 ppm for the natural nickel content in the earth's crust. Values representing the contamination level of nickel in rural soils of the world for various countries have been reported by FAO (2006) as follows: Australia (60 ppm), Canada (150 ppm), China (20 ppm), France (50 ppm), Germany (200 ppm), Japan (100 ppm) Netherland (210 ppm), South Afica (15 ppm), United Kingdom (60 ppm), and United State of American (420 ppm). However, SHacklette and Boerngen (1984) in their soil survey of the United State reported Nickel concentration range of less than 5 to 700 ppm, with a geometric mean of 13 ± 2.31 ppm.

Industrial waste materials, lime, fertilizer and sewage sludge constitute the major sources of nickel into soils (mcllveen and Negusanti, 1994). Moreover, nickel is apparently a heavy metal of environmental concern only in urban cities, but could become a problem resulting from decreased soil pH, due to reduced use of soil liming in agricultural soils and mobilization arising from increased acid rain in industrialized areas (Bencko, 1982; Cempel and Nickel, 2005). With decreasing pH, the solubility and mobility of nickel increases, hence, soil pH is the major factor controlling nickel solubility, mobility and sorption, while clay content, iron –manganese mineral and soil organic being of secondary importance (Anderson and Christensen, 1988; Ge , Murray , and Hendershot ,2000; Suave, Hendershot, and Allen ,2000 ; Tye, Young , Crout, Zhang, Preston, Zhao, and Megrath ,2004). Generally, the distribution of nickel in soil profile is uniform, with typical accumulation at the surface soil due to deposition through anthropogenic activities (Cempel and Nickel, 2005).

Material and Methods

Study Area

Soil samples were collected from Nigeria Institution for Oil Palm Reserch (NIFOR) plantation, located along Akure Owo Road, in Edo State.

Sample Collection/Treatment

Soil samples was collected from Nigeria Institution for Oil Palm (NIFOR) plantation located along Akure – Owo Road, in Edo State. Soil samples were sent to the laboratory foe treatment such as air dying and sieving.

Apparatus

i. Spectrophotometer
ii. Polypropylene test tube, 10-ml capacity. (Borosilicate glassware should not be used).
iii. Hand gloves, Nose mask, laboratory coat etc.

Methods

Treated samples were analyzed using standard methods –Soil pH was deremined on 2:2.5 soil to water ratio by glass electrode. Other analysis included organic carbon (Walkley & Black, 1934), calcium, magnesium were determined by using Atomic Absorption Spectriphotometer after extracting it with 1 M ammonium acetate (pH 7.0. soil B was exteacted by the hot water method of Berger & Trong (1944). Particle size distribution was determined by the Bouyoucos (1962) hydrometer method. All laboratory analyses were carried out on the four dept of soils, that is (015, 15-30, 30-45, 45-60) cm.

Result of the Distribution of Nickel in Relation to Soil Phisico-Chemical Properties in Soil of Oil Palm Plantation

Table 1a

Dept(cm) Palm I	pH	us/cm EC	% OC	% OM	% N	mg/kg P	cmol/kg					
							Ca	Mg	K	Na	H^+	Al^+
0-15	6.1	1600	2.08	4.50	0.17	10.63	11.92	2.64	0.15	0.45	0.6	ND
15-30	5.9	70	2.08	4.00	0.15	8.92	10.08	2.08	0.11	0.77	0.7	ND
30-45	5.7	50	0.92	3.56	0.07	11.31	11.52	1.20	0.08	0.46	0.7	ND
45-60	5.7	50	0.44	3.08	0.03	22.11	11.76	0.48	0.07	0.43	0.8	ND
Dept(cm) Palm I	ECEC	% Clay	% Silt	% Sand	% Ni							
0-15	15.76	3.0	4.7	92.3	13.06							
15-30	13.74	4.0	6.7	89.3	3.79							
30-45	13.96	5.1	6.1	88.8	3.78							
45-60	13.54	10.5	4.7	84.2	4.81							

Table 1b

Dept(cm) Palm II	pH	us/cm EC	% OC	% OM	% N	mg/kg P	cmol/kg					
							Ca	Mg	K	Na	H^+	Al^+
0-15	6.0	1001	2.68	4.63	0.16	9.53	11.83	2.61	0.13	0.43	0.3	ND
15-30	5.8	50	2.07	3.58	0.14	7.72	10.01	2.04	0.12	0.74	0.4	ND
30-45	5.5	50	1.04	1.80	0.07	10.32	9.23	2.38	0.06	0.48	0.6	0.1
45-60	5.0	40	0.60	1.04	0.04	20.30	12.06	0.40	0.05	0.40	0.8	0.2
Dept(cm) Palm II	ECEC	% Clay	% Silt	% Sand	% Ni							
0-15	15.30	3.0	4.7	92.3	13.02							
15-30	13.31	4.0	6.6	89.4	3.07							
30-45	12.85	5.2	6.0	88.8	3.51							
45-60	14.51	10.5	4.7	88.4	3.11							

Table 1c

Dept(cm) Palm III	pH	us/cm EC	% OC	% OM	% N	mg/kg P	cmol/kg					
							Ca	Mg	K	Na	H^+	Al^+
0-15	6.4	1300	2.54	4.39	0.18	10.24	11.72	2.54	0.11	0.43	0.3	ND
15-30	6.2	50	2.09	3.61	0.15	15.47	10.06	2.01	0.09	0.71	0.4	ND
30-45	5.7	40	0.92	1.59	0.06	10.20	8.32	2.49	0.06	0.44	0.9	0.1
45-60	5.4	30	0.44	0.76	0.02	7.29	9.07	0.32	0.03	0.32	1.0	0.5
Dept(cm) Palm III	ECEC	% Clay	% Silt	% Sand	% Ni							
0-15	15.10	3.0	6.6	90.4	13.0							
15-30	13.27	4.0	6.3	89.7	3.01							
30-45	12.32	5.2	6.0	88.8	3.30							
45-60	11.24	10.0	4.7	85.3	3.14							

Table 1A, Palm I- First location of site A in oil palm plantation
Table 1B, Palm II- Second location of site B in oil palm plantation
Table 1C, Palm III- Third location of site C in oil palm plantation

Discussion

Tables 1A, 1B and 1C show the physical and chemical properties of the soils under study. The soils from the various locations vary in properties. At all three oil palm growing areas studied, organic carbon content was greater in the surface soils than in the other depts. The percent OC ranged from 2.08 to 2.68% for the surface soils than in the subsurface. The availability of nickel is related to soil pH with the element being most available is acid soils. Thus, the moderately acid condition of the soil suggest that nickel content of the soils would be low, as confirmed by the results in tables 1A, 1B and 1C. The available nickel levels in the soils from the various locations are shown in tables 1A, 1B and 1C. Available nickel levels in the surface soils were higher than those in the other depts.

The phytoavailability of nickel has been correlated with free nickel ion activity in soil solution; hence, plant uptake is also dependent on soil pH, organic matter content and iron- manganese oxide (Massoura, Echevaria, Becquer, Ghanbaja, Leclerc- cessac, and Morel, 2006; Rooney, Zhao, and McGrath ,2007; Ge, Murray, and Hendershot, 2000). Environment Agency (2009e) documented that nickel from anthropogenic source is more readily taken up by plants than that from natural occurring sources, and that plant species also differ in the their tolerance and ability to take up nickel from soils.

Conclusion

The amounts of nickel in the three sites were within the range for normal growth of oil palm. Organic matter content and pH of the soils greatly inclucenced the concentrations of nickel in the soils. Nickel's concentration is directly proportional to that of the physco-chemical parameters, with the exception of, H^+, Al^{3+} and clay respective concentrations.

Recommendation

Since creating acid condition in soils for optimum growth of crops is not hr norm, the options for increased oil palm production in the country would be proper management of soil organic matter and application of nickel fertilizers to the oil palm plantations.

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