MOLYBDENUM DISTRIBUTION IN RELATION TO PHYSIC-CHEMICAL PROPERTIES IN THE SOIL OF OIL PALM PLANTATIONS IN EDO STATE

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Abstract

Crop production has been increased on many soil throughout the world by small amount of molybdenum, Mo salts. The element is essential in nitrogen symbiotic and free living soil organism. The purpose of this study is to determine the relationship between physic chemical properties and molybdenum distribution in the soil of oil palm plantations in Edo State. Soil samples from oil palm plantation were collected from Nigerian Institute for Oil Palm Research (NIFOR) Ovia North East Local Government in Edo State. The results obtained showed that P^H, O. C, N, P Ca^{2+}, $Mg^{2+}Na^+$, K^+, ECEC and Mo concentrations decreases from the top soil to the bottom. The relationship between P^H, O. C, N, P Ca^{2+}, $Mg^{2+}Na^+$, K^+, ECEC and Mo concentration are directly proportional down the depth of the soil i.e. as PH is decreasing all other parameters mentioned above, incluing Mo concentration are also decreasing down the soil depth, with the exception of the clay particles.

Soil testing is well recognized as a sound scientific tool to assess inherent power of soil to supply plant nutrients.

Soil may be defined as a thin layer of earths crust which serves as a natural medium for the growth of plant. This is the unconsolidated mineral matter that has been subjected to, and influenced by genetic and environmental factors-parent material, climate, organisms and topography all acting over a period of time. Thus some soils are red, some are black, some are deep and some are shallow, some are coarse-textured and some are fine-textured. They serve in varying degree as a reservoir of nutrient and water for crop growth.

There is increasing interest in plantations which could be attributed to advantages of the plantation system of agriculture, such as environmental conservation and protection, and economic and social benefits. Tree crops are commonly grown in plantations in the tropics. Some of these include coffee (Coffea arabica), cocoa (Theobroma cacao), rubber (Hevea braziliensis), oil palm (Elaeis guineensis), eucalypts (Eucalyptus spp), teak (Tectona grandis), gmelina (Gmelina arborea) and pines (Pinus spp.). Several studies have examined the ecological requirements and environmental impact of oil palm on soil (Irvine 1969, Onwueme & Sinha 1991).

Plants require small amount of molybdenum for normal growth. The element is essential in nitrogen symbiotic and free living soil organism and is the metal constituent of nitrate reeducates in higher plant. Intervenal chlorosis, leaf cupping and leaf malformation are symptoms of Mo deficiency in plant. Data from several hundred soil analysis indicate an average Mo content of approximately 2ppm. Mo deficiency in crop result when available Mo supply is exhausted by plants or fixed in unavailable state at low soil pH and is corrected by application of a few ounces of Mo salt to the acre. Crop production has been increased on many soils throughout the world by applications of small amount of Mo salts. A preliminary survey to determine the extent of Mo deficient soils have been conducted in most agricultural areas, the element will probably assume increasing importance when more thorough surveys are completed (Ernest and Purvis 2010).

Soil pH, organic matter, Clay, Drainage, crops sensitivity and nutrients interaction are factors that can affect availability of Molybdenum (Mo).

1. Soil pH: This is one of the most important factors affecting the availability of Mo to plant. (Gupta and Lipset, 2003). The MoO_4^{2-} anion exists in exchangeable form in the soil. Thus, the fact that Mo availability to plants increases with increasing pH may be explained by an anion exchange of this equation shown below (Greg, 2005).

$$2OH \rightleftharpoons MoO_4^{2-}$$

2. Organic Matter: The level of available Mo has been found to be closely related to soil organic matter (Karimian &Cox, 2007). It is conceivable that Mo tied up in organic matter will be released for plant use through mineralization. It is also possible that Fe oxide bound to organic matter may be responsible for organic matter adsorption.

3. Clay: The role of clay in the micronutrient status of soil is well documented and the extractable Mo was significantly correlated with clay fraction (krauskopf, 2009).
4. Drainage: Soil wetness seem to be one of the main factors affecting the availability of Mo. Wet soil tend to have high organic matter content and large amount of Mo that may be readily available (Davies Q and Anastas, P.T., 2007). Poorly drained soil accumulates so much MoO_4^{2-} that the plant grown on them is toxic to animals (Kubota J, Lazar V.A. Longman L.N. and Beeson K.C., 2004).

Effective Cation Exchange Capacity (ECEC) is the total capacity of a soil to hold positively exchangeable cautions. It influences the soil ability to hold unto essential nutrients and provides a buffer against soil acidification.

Caution exchange capacity (CEC), is a measure of the soil ability to hold positively charged ions. It is a very important soil property influencing soil structures stability, nutrient availability, soil pH and soil reaction to fertilizer and other ameliorate. (Hazleton and Murphy, 2007). A component of soil has negatively charged sites on their surface which absorbs and holds positively charged ions (caution) by electrostatic force. The electrical charge is critical to supply of nutrients to plants because many nutrients exist as cautions (e.g Magnesium, potassium and calcium). In general terms, soil with large quantities of negative charge are more fertile because they retained more caution. (Mc Kenzie N.J. Jacquier D.J. Isbell R.F., Brown K.L, 2004). The main ion associated with CEC in soil are the exchangeable cautions calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{2+}) and potassium (K^{+}). (Rayment and Higginson 1992). Soil with low CEC are more likely to develop deficiency in potassium (K^{+}), Magnesium (Mg^{2+}) and other cautions, while high CEC soil are less susceptible to leaching of those cautions (Cornell University Cooperative Extension, CUCE, 2007).

Materials and Methods

Sample Collection

Soil sample of oil palm plants were collected from Nigerian Institute for Oil Palm Research (NIFOR) in Benin, Ovia North East Local Government Area in Edo State. Soil samples were collected from:

1. Three different sites A,B,C, were marked randomly and samples from each was collected from (0 – 15)cm, (15 – 30)cm, (30 – 45)cm and (45 – 60)cm depths.
2. An auger was used to the dig the soil at four horizons from 0 to 60cm depth of the soil.
3. A meter rule was used to measure the horizon as soil samples were collected from 0-15cm, 15-30cm, 30-45cm and 45-60cm for site A. Same was done for site B and C respectively. Hence, for each site, we had four samples.

Materials

The following materials were used in collecting sample and data for this project work.

i. Auger
ii. Hand glove
iii. Polythene bags
iv. Masking tape
v. Meter rule
vi. Cutlass

Apparatus

i. Hot plate
ii. Distilled water
iii. Conical flask
iv. Volumetric flask
v. Spectrophotometer

Methods

The soil samples were air-dried, passed through a 2mm mesh sieve, prior to soil physical and chemical analysis. Soil particles size composition was determined using the hydrometer method (Bouyoucos, 1951) and organic carbon by the method of Walkley &Black (1934). Kjeldahl method was used for determining total nitrogen while available phosphorus was measured calorimetrically after extraction with Bray P-1 solution (Bray &Kurtz 1945). Soil extracts used for determination of exchangeable bases were obtained by leaching the soil using neutral 1M ammonium acetate solution. Calcium, potassium and sodium were determined by flame photometry and magnesium was determined using atomic absorption spectrophotometer. Soil pH was determined potentiometrically in 1 N KCL using 1:1 soil to solution ratio. Exchangeable acidity was determined by barium chloride-triethanolamine method while caution exchange capacity was determined by the summation method (Chapman 1965). Extractable micronutrients were leached from the soil using 0.1 M HCL. Molybdenum in the leachate was determined on the atomic absorption spectrophotometer.

Results and Discussions

Table 1.0: Results of the Physico-Chemical Parameters of Soil Samples From Oil Palm Plantation

S/NO	Sample Description	pH	% O.C	% N	Mg/ Kg P	Meq/100g soil							% Clay	% Silt	% Sand	Mg/Kg Mo
						Ca	Mg	Na	K	H^+	Al^{3+}	ECEC				
1	OPA 0-15	5.70	1.60	0.098	21.57	6.72	1.68	0.35	0.18	0.40	-	9.33	5.4	2.2	92.4	10.74
2	OPA 15-30	5.50	0.70	0.049	14.59	3.60	0.64	0.32	0.12	0.30	-	4.98	7.9	2.0	90.1	7.95
3	OPA 30-45	5.30	0.54	0.031	8.86	3.36	0.40	0.29	0.18	0.20	-	4.33	9.4	1.4	89.2	5.64
4	OPA 45-60	5.10	0.16	0.011	3.67	2.72	0.24	0.26	0.15	0.10	-	3.37	16.4	0.8	82.8	3.99
5	OPB 0-15	5.80	1.06	0.087	27.77	4.88	1.52	0.34	0.17	0.30	-	7.21	4.9	2.5	92.6	9.87
6	OPB 15-30	5.60	0.64	0.041	16.16	3.84	0.64	0.28	0.11	0.30	-	5.17	5.9	2.1	92.0	6.38
7	OPB 30-45	5.40	0.53	0.032	9.41	3.12	0.32	0.26	0.09	0.2O	-	3.99	8.4	1.8	89.8	4.77
8	OPB 45-60	5.20	0.45	0.029	4.32	2.96	0.16	0.24	0.05	0.20	-	3.61	12.9	1.0	86.1	4.09
9	OPC 0-15	5.70	1.44	0.093	18.15	5.15	1.52	0.36	0.19	0.30	-	7.52	5.4	2.3	92.3	12.31
10	OPC 15-30	5.60	0.74	0.052	11.73	3.12	1.04	0.35	0.13	0.20	-	4.84	6.9	1.9	91.2	9.42
11	OPC 30-45	5.40	0.48	0.027	7.26	3.04	0.64	0.30	0.08	0.20	-	4.26	9.4	1.4	89.2	6.54
12	OPC 45-60	5.20	0.38	0.019	3.86	2.40	0.40	0.29	0.05	0.20	-	3.34	15.9	0.7	83.4	4.23

Discussion

From the table 1.0 above in Oil Palm, Site A (OPA) in oil palm plantation, the pH values ranges from 5.10 -5.70 (moderately acidic) while that of Effective Cation Exchange Capacity (ECEC) values ranges from 3.37 -9.33meq/100g soil and Mo concentration ranges from 3.99 -10.74 Mg/kg.

For Oil Palm Site B (OPB) in oil palm plantation, the pH values ranges from 5.20 – 5.80 (moderately acidic) while that of Effective Cation Exchange Capacity (ECEC) values ranges from 3.61-4.071 Meq/100g soil and Mo concentration values ranges from 4.09-9.87mg/kg.

For Oil Palm Site C (OPC) in oil palm plantation the pH values ranges from 5.20-5.70 while that of Effective Cation Exchange Capacity (ECEC) values ranges from 3.34–7.52Meq/100g soil and Mo concentration ranges from 4.23–12.3 1Mg/kg.

Through close observation of the three sites, Mo concentration was found to be highest at the top soil (0-15cm) and lowest at the bottom soil (45-60cm) while for other physico-chemical parameters e.g. P^H, O.C, N, P, Ca^{2+} , Mg^{2+}, Na^+, K^+, ECEC same was observed, with the exception of clay particles.

Conclusion

Conclusively, the relationship between P^H, O.C, N, P, Ca^{2+} , Mg^{2+}, Na^+, K^+, ECEC and Mo concentration are directly proportional down the depth of the soil i.e. as the physico-chemical parameters are decreasing down the soil depth (0-60cm), Mo concentration is also decreasing down the depth with the exception of the clay particles. This research has reveled that, through the soil pH, organic matter, clay particles, Mo availability in the soil could be monitored and appropriate treatment applied.

Recommendation

The soil pH, Organic Matter, Clay and drainage should be closely monitored. Since the knowledge of their status will reveal the appropriate soil treatment. Thus guide against deficiencies and toxicity levels.

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