Analysis of Physico-chemical and Macro Element Concentration in Soils of Six Farmlands in Khartoum State, Central Sudan

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Abstract

Analysis of some selected physico-chemical parameters and macro-elements in soil samples collected from six farmlands (Agricultural schemes) in Khartoum State, Central Sudan : EL-Gomouya, Wad Ramli, Umm Arda, EL-Waha, EL-Silait and EL-Shaab schemes) were carried out The soil characterization was carried out for parameters like pH, organic carbon, moisture content, electrical conductivity , soil texture , potassium, sodium, magnesium, calcium and phosphorus in the soil samples. The physicochemical analysis of soil samples understudy showed different concentrations of various parameters at different farmlands. Correlation analysis was employed to examine the relationship between the various parameters in the soil samples.

Keywords: Physico-chemical properties; Farmland soils; Khartoum State; Central Sudan

Introduction

The physicochemical study of soil parameters is important for plant growth and soil management. These studies give information about nature of soil nutrient status of soil. According to this information farmers arranged the amount of which fertilizers and

nutrients, needed to soil for increase the percentage yield of crops (Addis and Abebaw, 2014).

The productivity of Agricultural soil depends on its physico-chemical properties. The soil conditions are important, because it is a universal medium for plant growth , which supplies essential nutrients to the plants.

This study was undertaken to provide a general assessment of the levels of macro- elements of the selected soil samples obtained from six farmlands in Khartoum State, Central Sudan.

The objective of this study is to evaluate the chemical concentrations of selected macro – elements in studied soils and to make correlations between macro elements levels of the soils with the other soil physico-chemical properties.

Materials and Methods

Materials:

The soil samples were collected from six farmlands, Agricultural schemes, in Khartoum State, Central Sudan. Six samples from each sites (two different depths (0-30 cm and 30-60 cm) , these six samples were mixed together giving a representative samples to all the schemes (EL-Gomouya, Wad Ramli, Umm Arda, AL-Waha, AL-Silait and AL-Shaab). Samples were collected by hand in polythene bags and given the appropriate numbers before transporting to the laboratory and was prepared for analysis.

Methods:

The soil physical and chemical analyses were performed according to standard procedure (Piper , 1950; Richards , 1954 and Allen, 1974).

Physical Analysis of the soil:

The physical character of the soil was determined by the analysis of the particle size using the Hydrometer method. Soil textural types were assigned by using standard Table (Forest Service Handbook , Washington DC, 1960).

Chemical Analysis of the Soil:

The pH of the soil was measured in a soil water suspension (1 : 2, soil : water). Organic carbon content (%) of the soil was determined by Black method (1965) using 1g soil. Organic matter (%) was determined by multiplying the value of organic carbon by 1.724 (van bemmelen factor). pH and Electrical conductivity (EC) were determined from saturated soil extract (Piper, 1950). Determination of sodium and potassium were by using flame photometer. Determination of calcium and magnesium. Phosphorus was analyzed colorimetrically by Molybdenum blue method using Spectrophotometer.

Soil moisture content was determined by oven drying method (Allen,1974). The soil organic carbon analysis was performed according to standard procedure (Richards, 1954).

Results and Discussion

This research work provides documentation of the relationship between physico –chemical properties and macro-elements in soils of farmland soils in Khartoum State , Central Sudan.

The results of physico-chemical analysis (viz. pH, EC, OC, MC, soil texture : clay , silt and sand) and selected macro- element concentrations of randomly selected soil samples collected from farmlands soils in Khartoum State are provided in Table 1.

Moisture content: The moisture content (MC) ranged from 0.45 ± 0.30 to 6.92 ± 1.77 .

pH : pH is a very important property of soil as it determines the availability of nutrients , microbial activity and physical condition of soil. Soil pH values in the six farmlands ranges from 7.07 ± 0.48 to 8.19 ± 0.37 . The lower pH observed was in EL-Gomouya soil sample and the higher pH in AL-Waha soil sample. The soils studied from the cultivated lands were neutral except AL-Waha soil which was slightly alkaline.

Electrical Conductivity (EC): EC value ranges from 0.43 ± 0.24 to 1.86 ± 1.42 mS/Cm. The EC of AL-Waha soil is high as compared to the other sites which may be due to excess use of fertilizers like P and K . EC is used as a measure of salinity. AL-Silait soil is a non-saline according to Wagh *et al.*, 2013).

Organic Carbon (OC): OC ranges from 0.28 ± 0.13 to 0.49 ± 0.08 %.

Sodium (Na): The results obtained revealed that highest concentration of sodium in the soil studied was found in EL-Gomouya $57.95 + 33.87$, followed by AL-Waha $53.05 + 20.91$. The sodium content is very important to decide its quality for irrigation. Salts ultimately affect the soil quality and plant growth (Mahajan and Billore (2014).

Potassium (K): The highest concentration of K in the soil studied was found in AL-Silait $19.97 + 16.91$ and the lowest concentration was found in AL-Waha $1.81 + 1.49$.

Calcium (Ca): As can be seen from Table 1 , the highest concentration of Ca was found in the Umm Arda $15.33 + 11.63$, followed by EL-Gomouya $12.58 + 8.03$ and Wad Ramli $12.42 + 5.29$.

Magnesium (Mg): AL-Waha $2.67 + 1.03$ and EL-Gomouya $9.17 + 5.82$ have the lowest and highest Mg values , respectively.

Phosphorus (P): P ranges from $0.94 + 0.20$ to $1.32 + 0.41$. The lowest and highest P values were found in AL-Silait and Wad Ramli , respectively.

Silt: The highest content of silt in the soil studied was found in AL-Shaab $54.42 + 7.04$, followed by Wad Ramli $52.18 + 6.31$ and EL-Gomouya $51.5 + 10.0$.

Clay: The highest content of clay in the soil studied was found in Wad Ramli $34.91 + 4.84$, followed by Umm Arda $34.81 + 2.39$ and AL-Shaab $32.44 + 6.24$.

Sand : The highest content of sand in the soil studied was found in AL-Waha $30.02 + 2.12$, followed by AL-Silait $27.78 + 10.64$ and Umm Arda $16.11 + 7.70$.

Table 1. Results of physicochemical parameters of the studied soils
(mean + SD , n =5)

Parameters Sites	MC (%)	pH	EC (mS/ Cm)	OC (%)	Na	K	Ca	Mg	P	Silt	Clay	Sand	Textural Type
EL- Gomouya	6.59 ±2.3 4	7.07 ± 0.48	1.52 ± 1.40	0.29 ± 0.09	57.95 ± 33.87	7.45 ± 2.20	12.5 8 ± 8.03	9.17 ± 5.82	0.96 ± 0.16	51.5 ± 10.0	31.7 4 ± 3.33	13.4 ± 1.33	Sandy clay loam
Wad Ramli	6.92 ± 1.77	7.20 ± 0.62	1.13 ± 0.78	0.38 ± 0.16	49.28 ±25.91	9.95 ± 8.37	12.4 2 ± 5.29	7.82 ± 5.28	1.32 ± 0.41	52.1 8 ± 6.31	34.9 1 ± 4.84	15.7 6 ± 11.5 2	Sandy clay loam
Umm Arda	0.45 ± 0.30	7.48 ± 0.36	1.09 ± 0.78	0.41 ± 0.16	18.14 ± 2.1	8.18 ± 6.55	15.3 3 ± 11.6 3	4.42 ± 2.01	1.05 ± 0.17	49.0 8 ± 5.76	34.8 1 ± 2.39	16.1 1 ± 7.70	Sandy clay loam
AL-Waha	2.66 ± 1.61	8.19 ± 0.37	1.86 ± 1.42	0.44 ± 0.12	53.05 ± 20.91	1.81 ± 1.49	6.57 ± 0.87	2.67 ± 1.03	1.25 ± 0.25	33.5 2 ± 10.3 2	29.8 7 ± 1.90	30.0 2 ± 2.12	Clay loam
AL-Silait	1.67 ± 0.88	7.25 ± 0.67	0.43 ± 0.24	0.28 ± 0.13	29.93 ± 19.69	19.9 7 ± 16.9 1	6.6 ± 2.2	3.58 ± 1.20	0.94 ± 0.20	44.5 8 ± 9.92	27.6 4 ± 3.28	27.7 8 ± 10.6 4	Clay loam
AL-Shaab	5.59 ± 2.78	7.32 ± 0.33	0.56 ± 0.21	0.49 ± 0.08	5.15 ± 3.67	6.81 ± 3.75	5.33 ± 3.09	3.25 ± 4.10	0.97 ± 0.17	54.4 2 ± 7.04	32.4 4 ± 6.24	13.1 6 ± 4.04	Sandy clay loam

Correlation Analysis :

The relationships between the concentrations of different physicochemical parameters were analyzed by Pearson s correlation coefficient and the results are shown in Table 2.

The high correlation coefficient (near +1) means a good relation between two variables , it can be strongly correlated , if $r > 0.7$, whereas r values between 0.5 to 0.7 shows moderate correlation between two parameters (Rakesh and Raju, 2013).

From Table 2 , we can observe that strong positive correlations were noticed for the parameters between EC with Na; clay with Ca and P. The strong positive correlation shows that the parameters are closely associated.

Moderate positive correlations were observed between pH with OC , EC, sand and K; OC with MC ; MC with silt and Mg ; EC with P ; silt with clay and Mg; Na with Mg. A strong negative correlation was found between pH with silt ; EC with K; Silt with sand. There

was also moderately negative correlation between pH with MC and Mg; OC with K and Mg ; MC with sand ; EC with silt ; silt with Na ; clay with sand ; sand with Mg. The other correlations are weak.

Conclusion:

The physicochemical parameters of farmlands soil in Khartoum State, Central Sudan were analyzed. The results indicate that the soil pH is neutral to slightly alkaline. Electrical conductivity values of the soils were slaine (except AL-Silait soil). Soil type is slightly clay loam (except AL-Waha and AL-Silait are clay loam).

Further study should be done to investigate the levels of heavy metals and other soil physico-chemical parameters of the soils in the studied farmlands

Table 2. Pearson s correlations coefficients for selected physico-chemical parameters of studied soils:

	pH	OC	MC	EC	Silt	Clay	Sand	K	Na	Mg	Ca	P
pH	1	0.5147	- 0.4683	0.5469	- 0.8657	- 0.2344	0.6686	0.4921	0.126	- 0.6514	- 0.3277	0.4644
OC		1	0.6603	0.087	- 0.0295	0.3256	- 0.1535	- 0.6764	- 0.4845	- 0.5196	- 0.2506	- 0.308
MC			1	0.1152	0.5243	- 0.2653	- 0.5646	- 0.2147	0.3479	0.6728	- 0.0019	0.1947
EC				1	- 0.5121	0.1197	0.157	- 0.7915	0.746	0.2621	0.2874	0.36
Silt					1	0.5782	- 0.9123	0.2184	-0.6467	0.5218	0.352	- 0.3413
Clay						1	I. 0.5158	II. 0.2365	III. 0.3295	0.1231	0.777	0.9188
Sand							1	0.1676	0.2525	- 0.5858	- 0.4994	- 0.167
K								1	0.2007	0.0215	0.0275	- 0.1428
Na									1	0.5701	0.2254	0.4737
Mg										1	0.6409	0.0825
Ca											1	0.1438
P												1

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