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Evaluation of Soil Salinity Using Inductively Coupled Plasma-Mass Spectrometer (ICBMS)--Case Study of Al Qassim Region, Kingdom Saudi

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Abstract: Al Qassim region situated in the middle of the Kingdom of Saudi Arabia. It has a population of roughly 370,727 people and a 58,046-km^2 area. It is referred to as the "trophic basket" of the nation due to its agricultural resources. It is one of Saudi Arabia's most significant agricultural districts. Soil salinization is present as a global problem. Analyzing the impact of trace elements on soil salinization done. The concentrations of trace elements in three samples (Chlorine (Cl), Sodium (Na), Potassium (K), Magnesium (Mg), and Boron (B),), were taken from the western and eastern sides and 50cm depth, were testing using a COUPLED PLASMA-MASS SPECTROMETER (ICBMS), and they were found to be (152 µg/g, 5066 µg/g, 16022 µg/g, 4.2 µg/g, respectively) for the first sample. (185 µg/g, 4873 µg/g, 14876 µg/g, 2.6 µg/g, and respectively) for the second sample. (144µg/g, 5298 µg/g, 15080 µg/g, 3.8 µg/g, respectively) for the third sample. A pH meter used to determine the pH. The pH ranged from 5.98 on the east to 6.08 and 6.02 for 50cm depth, indicating somewhat acidic conditions. In addition, the concentrations of SO_4 and HCO_3, salty water-containing anions, which are common components, were tested. One of the main barriers to plant growth and development in acidic soils is aluminum (Al) toxicity. Magnesium and potassium values are higher than usual. At the plant root, a high potassium concentration prevents magnesium from being absorbed; a high magnesium content in the soil solution has no effect on potassium absorption.

Keywords: Soil Salinity, Trace Elements, COUPLED PLASMA-MASS SPECTROMETER (ICBMS), pH Meter, Al Qassim Region, Acidic Soils

1. Introduction

The study found that 97% of Saudi Arabia is very dry, while the remaining 3% is located in the elevated areas of the southwestern corner of the country. Desertification indicators that can be used to monitor desertification are changes in both groundwater and surface water resources, and the consequence changes in natural vegetation density and extend of agricultural areas. Classification, evaluation, and mapping of degraded land are a major issue throughout the world [1].

In addition to being a social and economic issue, soil erosion is also an environmental one. The planet is greatly threatened by it. Both biological and human-induced production are reduced because of soil deterioration. [2]. The government of the Kingdom of Saudi Arabia promotes agribusiness to improve sustainability and urban life. The amount of agricultural land increases significantly as a result of this support [3-6]. Salinization of soil refers to the buildup of salts on its surface, which has detrimental effects on both soil and plants [7]. One of the primary issues facing agriculture in the Qassim region is salinization of the soil. Surface water and groundwater are the primary sources of the salts in the soil.

The total area of the Kingdom of Saudi Arabia is 2,149,690 square kilometers. The two elements that restrict limit agricultural productivity are land and water. [8].

Chemical disintegration, namely salinization, is the main mechanism that causes an area to disintegrate when cultivated soils are present in the Qassim region. Mapping soils and land degradation at a reconnaissance level using multispectral imagery, such data from Landsat. A computer-aided technique can distinguish between two salinity levels. A computer-aided Multispectral data analysis method can be used to distinguish between two salinity levels [9]. Examples of manifestations are salt buildup, CaCO3 deposition, and gypsum material surface exposure. By examining the amounts of slots in the soil in the Qassim Region of Saudi Arabia, the current study **is** to analyze the impact of trace elements on soil salinization.

2. Materials and Methods

2.1. Study Area

The most significant agricultural region in the Kingdom of Saudi Arabia is the Al-Qassim region. The Al-Qassim region, with a size of approximately 14,142 km^2, is located between 24°25' and 27°10' N and 41°30' to 44°54' E. The Al-Qassim region experiences an arid climate with chilly winters and hot summers. In the summer, the temperature varies between 36 and 40°C, and in the winter, it varies between 18.2 and 24.9°C. Agriculture is the economic backbone of the area. Figure 1.

Figure 1. *Location of Qassim region in the Kingdom of Saudi Arabia.*

2.2. Method and Analysis

Three samples were taken from a senility farm in Alameda town (East direction -West direction and at depth of 50 cm in the middle) Figure 2. Using a coupled plasma-mass spectrometer, the samples were examined (ICBMS).

Results shown in Table 1. Soil pH readings at 50 cm depth are eastward and westward (6.08, 5.98 and 6.01, respectively). If each value exceeds 5, the soil is considered acidic [10]. At acidic pH values, aluminum (Al) and iron (Fe) react with phosphate ions to form new, less soluble compounds. Neutral soils defined as soils with a pH ranging from slightly acidic (6.5) to slightly alkaline (7.5) [11, 12]. Potassium helps plants activate enzymes, draw water into roots, build phosphate molecules and CO2, transport sugars, and absorb and assimilate N. Although not always available, most soils contain large amounts of potassium. Table 1 shows the K concentration in the soil test. Density value too high, and uptake and assimilate N. Most soils contain potassium in large quantities, although it is not always available. Soil test K concentrations listed in Table 1. The value of concentration is too high. [13, 14].

Sulfur concentrations were found (1088, 1248, and 1106) (µg/g) in the eastern and western depths of 50 cm, respectively. Sulfur is very important in metabolism and plant growth. Concentrations of 5–10 ppm are sufficient for plants. [15, 16]. Concentrations of magnesium found to be high in all samples. High concentrations lead to toxicity, which may occur on soils. [17]. High concentrations of chlorine may be toxic to plants. The concentrations for toxicity estimated to be 4–7 mg /g for Cl– [18]. The concentrations of samples are greater than the concentrations for toxicity estimated. Na+ is the primary toxic ion for Faba beans. High-concentration NaCl inhibits K+ uptake, resulting in less regulation of unproductive water loss [19].

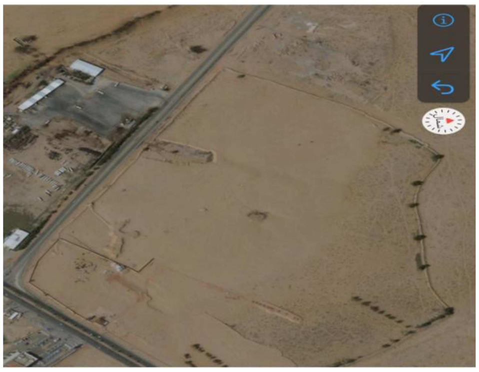

Figure 2. The location of study ground.

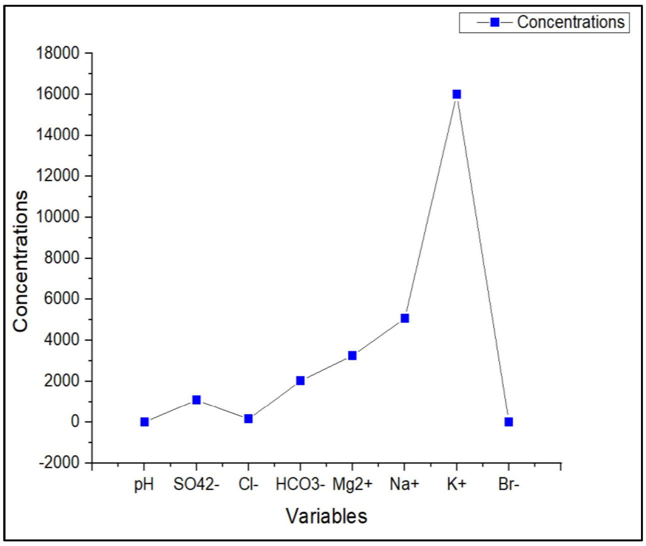

Figure 3. The concentrations of the element the earth. (Sample1- Eastern).

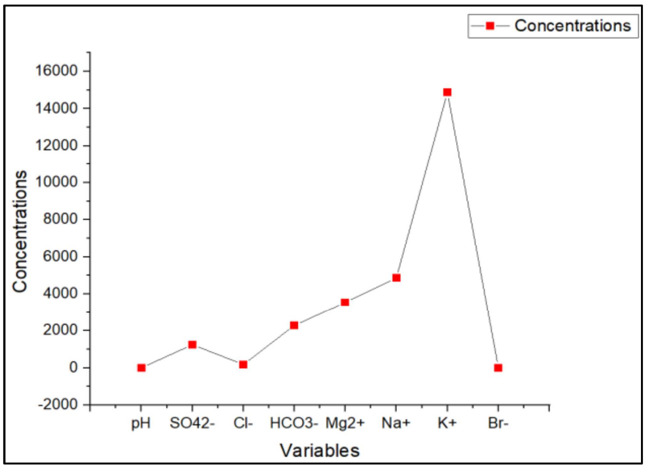

Figure 4. The concentrations of the element the earth. (Sample2- Western).

Table 1. The value of pH concentrations in (µg/g) for the samples.

Variables	Sample 1	Sample 2	Sample 3
	Eastern	Western	Depth At 50 cm
pH	6.08	5.98	6.01
SO_4^{2-} (µg/g)	1088	1248	1106
Cl^- (µg/g)	152	185	144
HCO_3^- (µg/g)	2036	2284	2133
Mg^{2+} (µg/g)	3268	3544	3426
Na^+ (µg/g)	5066	4873	5298
K^+ (µg/g)	16022	14876	15080
Total Iron (µg/g)	12374	6582	9476
Br^- (µg/g)	4.2	2.6	3.8

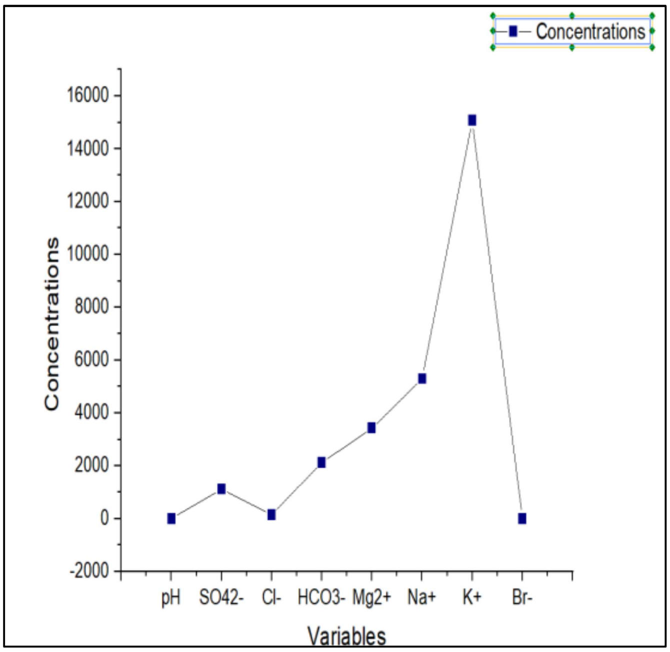

Figure 5. The concentrations of the element earth. (Sample3-Depth At 50 cm).

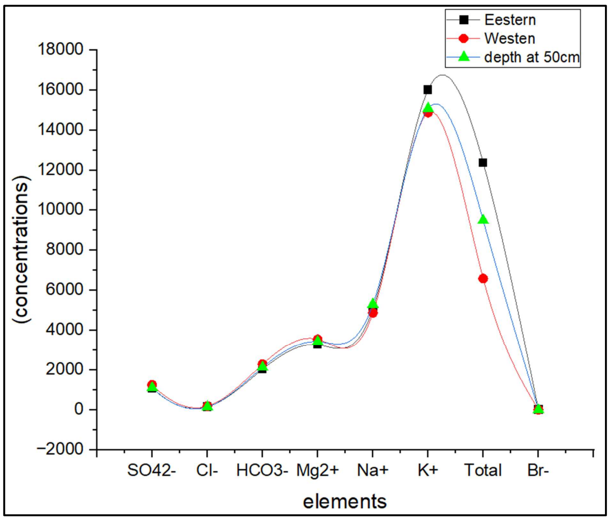

Figure 6. The concentrations of the element in deferent direction of the earth.

3. Discussion

Knowing the soil pH helps you figure out which chemical reactions are happening in the soil. We are most concerned with how pH affects the availability of toxic elements and essential nutrients. Acidic soils are difficult to grow in because the solid forms of some elements (like aluminum) are more soluble at lower pH levels. This means that more of the element will dissolve in water when the pH is lower, which can lead to crop failures. Figure 3, Figure 4, Figure 5 shows high concentrations of potassium, in spite of the soil pH being less than 6.5 (i.e., acidity), because pH has a direct effect on the availability of potassium [20]. The ideal soil pH for plants to absorb iron is in a slightly acidic range between 5.5 and 6.5. If a plant does not have enough iron, it will create an acidic environment around its roots, which can cause other nutrients to become unbalanced [21]. Soil pH affects how easily crops can extract essential nutrients like nitrogen, phosphorus, potassium, magnesium, and calcium from the soil. Higher soil pH can make it harder for plants to absorb these nutrients, which can result in reduced crop yields. To help crops take up these nutrients, it is important to address water and soil bicarbonates and to adjust irrigation water pH if necessary. Acidifying fertilizers or applying Ca and magnesium to the soil can also help improve crop yields.

4. Conclusions

Sampling taken from the ground in the Qassim area; there was a large area of the ground that was salty.

Three samples taken, two from the west and east, the third from a depth of 50cm. Soil Salinity evaluated using Inductively Coupled Plasma-Mass Spectrometer (ICBMS). The results show high concentrations of potassium. The pH range indicates acidic conditions. In figure 6, comparison of the concentrations of the elements in western, eastern, and 50cm depth. Cl has low concentration in 50cm depth, and iron concentration, and pH have law have in western direction.

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