



Chemical Analysis of the Salt Composition of Saline Soils of Mirzachul

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ABSTRACT: In this article, the concentration of cations such as Na^+ , Ca^{2+} , Mg^{2+} , and K^+ and Cl^- anions in soil samples taken from Mirzachul district was determined by titrimetric analysis. Also, the CO_3^{2-} anion was determined by the acidimetric method, and the SO_4^{2-} anion was precipitated with a barium chloride (BaCl_2) solution in the form of barium sulfate (BaSO_4). In the obtained results, the change in the percentage concentration of ions is depicted using diagrams, arranged in accordance with the soil horizons (in the range from 0 cm to 100 cm).

KEYWORDS: Calcium, magnesium, chloride, carbonate and sulfate ions, soil salinity.

I. INTRODUCTION

Soil salinization has been one of the most important ecologically hazardous factors for 100 years, as more than 25% of the total cultivated area and 33% of irrigated land worldwide are affected by salinization [1]. Today, soil salinization is observed in many irrigated lands. Soil salinization has emerged as one of the main environmental problems that poses a serious threat to soil quality and agricultural crop areas. The human factor and climate change are the main causes of soil salinization, which leads to the erosion of irrigated agricultural land. An increase in salt content disrupts the structural composition of the soil, the properties of microbiological activity, and this can lead to a disruption of the balance of harmful ions, which limits the normal growth and development of the plant, and a sharp decrease in plant yield occurs [2]. Magnesium, calcium, iron, and other cations can be found as sources of salinization, but sodium salts are the main cause of soil salinization [3]. Saline soils contain cations such as sodium (Na^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), and potassium (K^+), and the main anions are chlorides (Cl^-), sulfates (SO_4^{2-}), carbonates (CO_3^{2-}), and bicarbonates (HCO_3^-). However, depending on the concentration of sodium ions and salts, the degree of soil salinity can be divided into three types: 1) saline, 2) solonetzic, 3) saline-solonetzic [4]. These mentioned soil samples, except for salt-tolerant plants, negatively affect the physiological, biochemical, and genetic development of plants (5-6). The negative consequences of accumulated salts in the soil can lead to shortening of the surface part of the plant leaf, a decrease in the amount of chlorophyll pigments, a decrease in water absorption, and a decrease in the efficiency of photosynthesis [7]. The accumulation of sodium (Na^+) and chloride (Cl^-) ions limits the assimilation of potassium (K^+) ions and other beneficial nutrients by the plant [8]. An increase in the concentration of sodium (Na^+) and chloride (Cl^-) ions disrupts ion balance in the plant organism and negatively affects metabolism. As a result, the plant's appearance and biochemical processes change negatively. However, some plants can adapt to such conditions and reduce the negative effects of salts by storing Na^+ ions in vacuoles to protect the cell [9].

II. SIGNIFICANCE OF THE SYSTEM

This research is aimed at a detailed and systematic study of the chemical composition of saline soils of the eastern territories of the Mirzachul district of the Jizzakh region based on modern scientific methods.

III. METHODOLOGY

This study is devoted to the study of saline soils located in the Mirzachul district of the Jizzakh region and actively used for agricultural purposes. In the eastern part of the district, the high level of salinity of sown areas, the occupancy of a large part of irrigated land, and agroecological significance are important objects of

research. Soil samples taken from the land plots of farms located in the Yangidala M.F.Y. area of Mirzachul district were selected as the object of research. During the sampling process, soil layers were separated at depths from 0-5 cm to 80-100 cm, and the quantitative characteristics of soluble salts, including calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), potassium (K^+) cations, as well as chloride (Cl^-), carbonate (CO_3^{2-}), and sulfate (SO_4^{2-}) anions, were analyzed.

IV. THE EXPERIMENTAL RESULTS

Research work was carried out on irrigated agricultural lands in the Yangidala M.F.Y. area of the Mirzachul district of the Jizzakh region. The soils of this region differ from other soils by a high degree of salinity and the width of irrigated land areas. Soil samples were taken from layers at depths of 0-5 cm, 5-10 cm, 10-20 cm, 20-30 cm, 30-40 cm, 40-60 cm, 60-80 cm, and 80-100 cm in accordance with standard requirements. Samples taken from each layer were marked under a separate number and analyzed in accordance with laboratory requirements.

After bringing the saline soil samples to the laboratory, they were dried at room temperature for 48 hours, the soil was cleaned of mechanical impurities, and passed through three-layer special laboratory sieves with sizes of 1, 0.5, 0.25 mm. For the purpose of determining soluble salts and ions in the soil, the water extraction method was used. This method is one of the widely used laboratory methods for analyzing the chemical composition of saline soils [10, 11]. Sieved and mechanically cleaned soil samples were mixed with distilled water in a mass ratio of 1:5. The mixture was stirred with a magnetic stirrer for 30-40 minutes. The purpose of this is to ensure the complete transfer of soluble salts from the soil to the aquatic environment. The resulting suspension was then filtered using filter paper intended for laboratory analysis, and the aqueous extract solution was prepared for chemical analyses [12].

V. CHEMICAL ANALYSIS METHODS

The concentrations of Ca^{2+} and Mg^{2+} ions in aqueous extracts of the collected soil samples were determined by the complexometric titration method. A 0.1 N standard solution of Trilon B was used as the titrant. Murexide powder was applied as an indicator for Ca^{2+} , while an Eriochrome solution was used for Mg^{2+} determination [13, 14]. The concentration of chloride (Cl^-) ions was determined by the argentometric titration method using a 0.1 N silver nitrate solution. Potassium chromate served as the indicator [15]. All chemical analyses were performed in triplicate, and the average values were calculated.

Data processing: The obtained experimental results were calculated using mathematical methods (Table 1). The distribution patterns of ions according to soil depth were illustrated in the form of graphs and diagrams.

Table 1. Percentage contents of ions in the aqueous extracts of soil samples collected from the Mirzachul district.

№	Soil layer (cm)	Ca^{2+}(%)	Mg^{2+}(%)	Cl^-(%)	CO_3^{2-}(%)	SO_4^{2-}(%)
1	0—5	0.5000	0.20	0.046	0.1598	0.2600
2	5—10	0.3665	0.17	0.038	0.1580	0.2254
3	10—20	0.2833	0.14	0.024	0.1569	0.2173
4	20—40	0.1835	0.12	0.017	0.1556	0.2163
5	40—60	0.1835	0.09	0.016	0.1535	0.2036
6	60—80	0.1800	0.06	0.014	0.1520	0.1844
7	80—100	0.1330	0.02	0.010	0.1506	0.1759

Based on the obtained results, the degree of soil salinity was evaluated, and the variation in ion concentrations with depth was analyzed. The following diagrams illustrate the percentage concentrations of ions

in the soil according to the corresponding soil layers. The content of calcium (Ca^{2+}) ions in aqueous extracts prepared from different soil layers is presented in Figure 1. It was revealed that the concentration of calcium (Ca^{2+}) ions is higher than the rest of the soil layer in the 0 - 5 cm range. About 0.5%. As the depth increased downward, calcium (Ca^{2+}) ions began to decrease in stages, forming at a rate of 0.28 – 18% at a depth of 10 - 20 cm. In addition, it was found that the concentration of calcium (Ca^{2+}) ions decreases further at depths below 40 cm, reaching about 0.13% at depths of 80-100 cm. According to the conclusion of the resulting result, it was known that the surface layer of the soil accumulates more calcium ions than the lower layers.

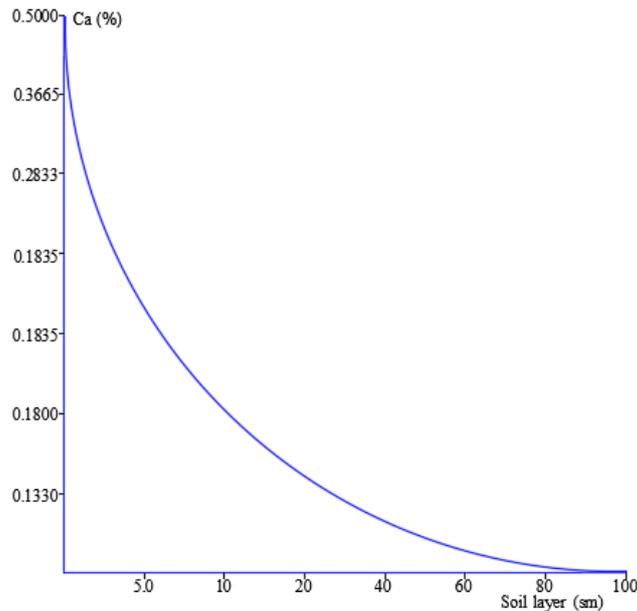


Figure 1. Graph of the percentage dependence of Ca^{2+} ions in different layers of soil.

The composition of magnesium ions in aqueous solutions made from different layers of soil is shown in Figure 2. According to the results of the resulting study, it was shown that the amount of magnesium (Mg^{2+}) ions in the 5 cm – 100 cm section of the soil is unevenly distributed. The graph describes the data as follows: While the concentration of magnesium (Mg^{2+}) ions consists of 0.20% at a depth of 5 cm, at a depth of 10 cm this indicator decreased slightly (0.16 %), but after a depth of 20 cm, the percentage of magnesium (Mg^{2+}) ions decreased sharply, the highest value was 0.20%. In later layers, results consisting of 0.12% at 40 cm, 0.09% at 60 cm, 0.06% at 80 cm, and 0.02% at 100 cm were recorded.

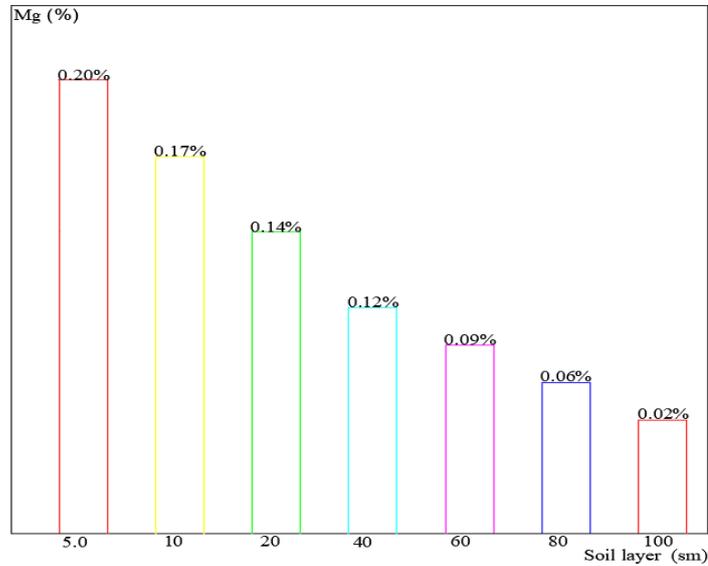


Figure 2. Diagram of the dependence on the percentage of Mg^{2+} ions in different layers of the soil.

Figure 3. The composition of chloride ions in aqueous solutions made from different layers of soil is researched and the results are shown in Figure 3. The content of chloride (Cl^{-}) ions in the soil was found to be high in percentage concentration in layers ranging from 0-5 CM to 5-10 cm. From the results it became known that chloride (Cl^{-}) ions were mainly concentrated more in the upper layers of the soil, while at depths of 80-100 CM their concentration was observed to be much lower.

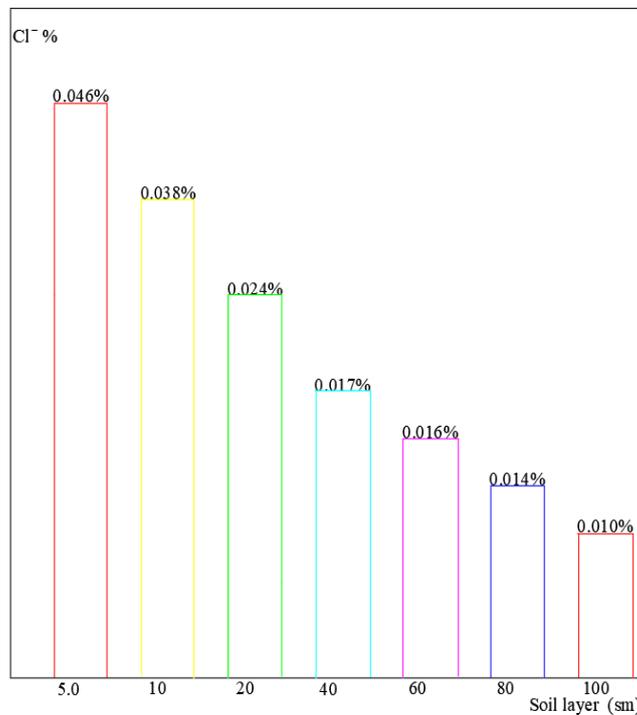


Figure 3. Diagram of the dependence on the percentage of Cl^{-} ions in different layers of the soil.

The content of carbonate ions in aqueous solutions prepared from different layers of saline soil is shown in Figure 4. From the data in the diagram, it was revealed that the amount of carbonate (CO_3^{2-}) ions is greater in the parts of the soil between 0 and 5 cm, and that the carbonate ions located between 80 and 100 cm are less.

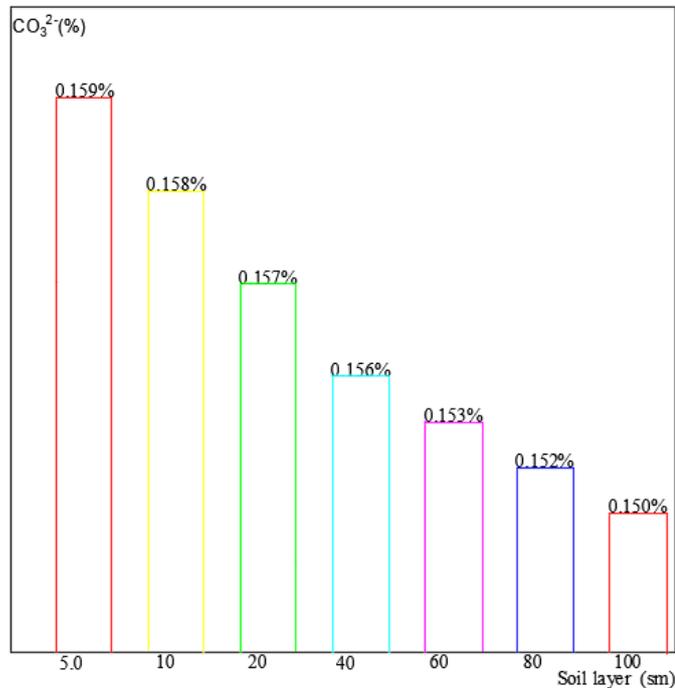


Figure 4. Diagram of the dependence on the percentage of CO_3^{2-} ions in different layers of the soil.

The data obtained on the distribution of sulfate ions in aqueous solutions of different layers of the soil is shown in Figure 5. From the diagram it is seen that 0.5-100 cm layers in the data obtained from the buoyant water absorption, it was observed that the amount of sulfate ions decreases from top to bottom.

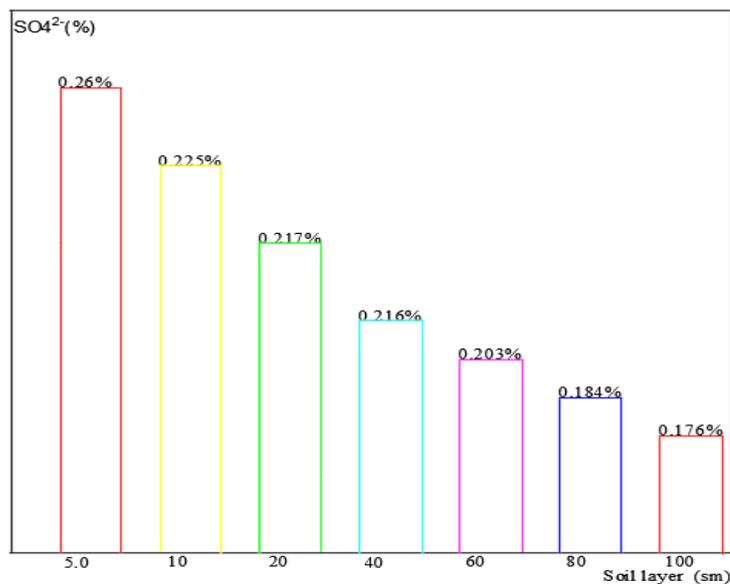


Figure 5. Diagram of the dependence on the percentage of SO_4^{2-} ions in different layers of the soil.



VI. CONCLUSION AND FUTURE WORK

The results of this study made it possible to determine the laws of vertical distribution of soluble salts in irrigated soils located on the territory of the Mirzachul District of the Jizzakh region. According to the experimental data obtained, calcium (Ca^{2+}), magnesium (Mg^{2+}), chloride (Cl^-), carbonate (CO_3^{2-}) and sulfate (SO_4^{2-}) ions were unevenly distributed over the soil layers, the bulk of which was observed to accumulate more in the upper layers. It was found that the gradual decrease in the amount of calcium and magnesium cations with increasing depth is associated with soil leaching processes and capillary rise phenomena. The relatively high accumulation of chloride and sulfate anions in the upper layers indicates the presence of secondary salinization processes caused by irrigation water. The higher occurrence of carbonate ions in the upper layers also confirms the soil's tendency towards an alkaline environment. The results obtained showed that salinity processes in soils in the Mirzachul region are strongly manifested mainly in superficial layers, and justified the need to strengthen reclamation activities from an agroecological point of view. In particular, the implementation of deep washing irrigation, the modernization of drainage systems and the selection of saline-resistant crop varieties are important in restoring soil fertility.

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