Salient Visionary
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Test Measurements of Salinity in Irrigation Water and Soil and Classification of Salinity

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ABSTRACT/ANNOTATION

The aim of the study is to determine the linear relationship between the methods of implementing operational test measurements of salinity in mobile laboratories and the existing methods. considered the classification of salinization according to this method. I want to note that the analysis of salinization by chemical methods requires hard work and a long time.

Key words: Electrical conductivity, Sodium adsorption, Soil salinization, Irrigation water, Soil sodicity, Saturated soil solution.

INTRODUCTION

Salinization of soil and water resources creates serious environmental problems in agriculture and natural ecosystems. This is mainly related to the high salt concentration of sodium, sulfate, boron, fluorine, selenium, arsenic and some elements with radioactivity in underground water. Due to the decrease of water resources, the flow of groundwater has increased. Therefore, researches in the direction of solving the problem of salinization are becoming relevant.

N.M. Tulaykov developed the methods of collecting and preserving soil moisture in arid climate conditions and argued against the use of field farming systems in those conditions and showed the necessity of using autumn grains and inter-row cultivated plants. [1]

In the application of flood irrigation, leakages cause the level of underground water to rise. As a result of the use of water from the earth's surface by plants and evaporation, salts accumulate in the crop layer and make the soil salty. The washing of saline soil and the cultivation of salt-resistant plants, the use of clean irrigation water and the application of an innovative irrigation system are considered to be the main methods of combating salinization.

In the modern agricultural system, it is necessary to assess salinization with operational methods and take necessary measures against it.

Those accumulated salts develop salinity in the soil and have a negative effect on the growth of plants. These salts contain anions chloride (Cl^-), sulfate (SO_4^{2-}), nitrate (NO_3^-), bicarbonate (HCO_3) along with sodium (Na^+), potassium (K^+), calcium (Ca^{2+}) and magnesium (Mg^{2+}) have cations such as [2]
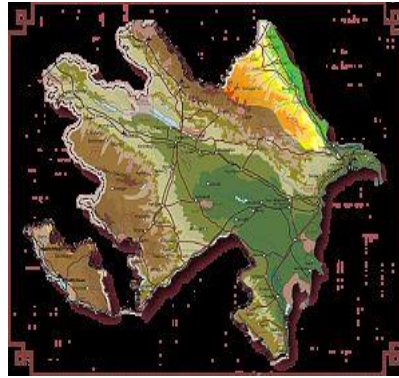
Table 1: Anions (negatively charged ions), cations (positively charged ions) that cause salinization in soil and water

Salts				Characteristic test methods	
Anions		**Cations**			
Bicarbonate	HCO_3^-	**Calcium**	Ca^{2+}	**Total dissolved solids or electrical conductivity**	**TDE or ,EC**
Boron	**B**	**Magnesium**	Mg^{2+}	**Residual sodium carbonate**	**RSC**
Carbonate	CO_3^{2-}	**Potassium**	K^+	**Lime precipitation potential**	**LDR**
Chloride	**Cl-**	**Sodium**	Na^+	**Sodium adsorption ratio or sodium hazard**	**SAR**
Nitrate	NO_3	**Manganese**	Mn^{+2}	**Acidity / alkalinity**	**PH**
Sulfate	SO_4^{2-}	**Iron**	Fe^{+2}	-	-

Accumulation of salinity-producing salts in the planting layer of the soil can be due to various reasons. Salts, which are brought mainly in the irrigation water and rise to the planting layer through water from the salty mother rocks in their deep layers, are more dangerous. Salt water flows also cause salinization in coastal areas. Apart from that, as a result of decomposition of mineral fertilizers, composts and other reasons, salt accumulation occurs in the soil. [2]

METHODOLOGY AND OBJECT

It is possible to quickly determine soil salinity with some verification tests in multifunctional and mobile laboratories. Methods of determining salinity in a short time with the use of modern mobile tools without conducting chemical analyzes in laboratories were considered.

Total dissolved solids (TDS), electrical conductivity (EC), residual sodium carbonate in soil extract (RSC), lime precipitation potential (LDP), soda absorption ratio (SAR) or soda hazard calculation methods for soil and water salinity tests were conducted.

The sodium, calcium and magnesium contained in the irrigation water compact the soil structure and make it difficult for water and air to penetrate the soil. Hardening of the soil has a negative effect on the development of

plant roots as well as making planting difficult. The sodium adsorption ratio (SAR) equation is used to estimate the potential hazard of soil soda hardening and to predict sodium. [3]

Since the considered measurements of salinity in soil and water are mainly carried out at aqueous concentrations, water chemistry technology is widely used. In water chemistry applications, pH and electrical conductivity are not considered quantities of concentration, while the expression of total dissolved solids (TDS) concentration in water is an approximation.

Here, the mass concentration (ρ) is determined by dividing the mass of the solute by the volume of the solvent. In water chemistry, the amount of dissolved substance is expressed in units of measurement, mostly mg/l = mg/dm³ = g/m³. higher concnin case of use (for example, in waste water treatment) it is expressed in g / l. [4]

Although some concentration quantity is formally expressed as mass concentration, in reality no direct information about any true mass concentration can be obtained without further conversion. In water chemistry, parts per million (ppm = mg/kg) and parts per billion (ppb = µg/kg) are the most commonly used units. Since the standard density of liquid water is about 1 kg / dm³, for most applications the mass fraction is converted to the corresponding mass concentration by a factor of 1 ppm-1 mg / l and 1 ppb-1 µg / l, respectively[5]

Molar concentration (c) is determined by dividing the amount of solute by the volume of solvent. A more commonly used unit is mmol/l =mol/dm³ = mol/m³, expressed in mol/l if the solute has very high concentrations.

To convert one molar concentration (c) to the corresponding mass concentration, (M) c · M = ρ, and to convert the mass concentration (ρ) to the corresponding molar concentration (c), the formulas ρ / M = c are used.

One molar concentration (c) When converted to the appropriate equivalent concentration (ceq), the molar concentration (z) is multiplied by the valency.

Here, c·z = ceq.Mol/z, the conversion factor between eq,val and g equivalent units is 1 mmol/l · 1/z = 1 meq / l = 1 mval / l = 1 mg-eq / л = 1 mg-eq/l.

It is expressed as And to convert an equivalent concentration (ceq) to the corresponding molar concentration (c), divide the equivalent concentration (z) by the valency. Here, ceq / z = c.[4]

DISCUSSIONS AND ANALYSIS

Electrical Conductivity (EC) – Since pure water is a poor electrical conductor, the presence of dissolved salts increases the electrical conductivity relatively.

Therefore, the electrical conductivity of salt electrolytes in an aqueous soil solution is measured and expressed in dS/m or mmhos/cm. The soil is considered highly saline when the EC is greater than 4 dS/m in a mostly saturated soil paste. This is equivalent to about 40 mmol of salt per liter.

Electrolytic conductivity (as opposed to metallic conductivity) increases by about 1.9% per centigrade increase in temperature.

Therefore, EC needs to be expressed at a reference temperature for comparison and accurate salinity expression; In this regard, 25 ° C is used the most[2].

Different plants show varying degrees of salt tolerance. Therefore, the degree of soil salinization is classified as follows based on electrical conductivity.

Table 2: Classification of soil salinization degrees based on electrical conductivity (EC)

s.s.	Elektrik keçiriciliyi (mmhos / cm)	Dərəcə	Təfsir
1	0 - 0.15	Çox zəif	Bitkilər qida maddələri ilə zəif təmin oluna bilər.
2	0.15 - 0.50	Zəif	Torpaqda üzvi maddələr çoxdursa, qənaətbəxşdir.
3	0.51 - 1.25	Orta	Bir sıra bitkilərin xarakterinə uyğundur.
4	1.26 - 1.75	Yüksək	Gövdəsi qurulmuş bitkilər üçün yaxş yeni əkilər və ya çökəklər üçün çox yüksəkdir.
5	1.76 - 2.00	Çox yüksək	Bitkilər ümumiyyətlə inkişafdan qalır və ya soluxur.
6	>2.00	Həddindən artıq yüksəkdir	Bitkilər ciddi dərəcədə cılızlaşır; yeni çoxillik əkmələr və çökəkliyə düçən toxumlar məhv olur.

etc. Electrical conductivity (mmhos / cm) Degree Interpretation

1 0 - 0.15 Very poor Plants may be poorly supplied with nutrients.

2 0.15 - 0.50 Poor Soil is satisfactory if there is a lot of organic matter.

3 0.51 - 1.25 Medium Corresponds to the character of a number of plants.

4 1.26 - 1.75 High Stem good for established plants too high for new plants or stumps.

5 1.76 - 2.00 Very high Plants generally stunt or wilt.

6 >2.00 Extremely high Plants severely stunted; new perennial plantings and pitted seeds are destroyed.

2. Amount of total dissolved salts (TSS) – indicates the amount of salts in 1 liter of saturated soil solution in milligrams. There is a linear relationship between TSS and EC values of dissolved salts in certain soil extracts.

Various brines have conductivity values of 1 dS/m from 550 to 700 ppm equivalent to dry salt residues. The value of 1 dS/m of the amount of total soluble salts in the most common sodium chloride salt is equal to 640 ppm.

If the EC value is known, the dissolved salts in soil or water are estimated using the formula TSS (meq/l or ppm) = EC (mmhos/cm or dS/m) x 640.

Sodium adsorption ratio (SAR) is a widely accepted index that characterizes the ratio of soda to calcium and magnesium in dissolved soil. Sodium-containing salts are in the first place among harmful salts.

The harmfulness of salts in the soil depends on the type and age of the plant, the properties of the soil and the degree of humidity.

If we conditionally accept the level of harmfulness of Na_2SO_4 salt as one, then $NaCO_3$ – 3, $MgCl_2$ and $MgSO_4$ – 3 – 5, $NaCl$ – 3 – 6 and Na_2CO_3 – 10.

From this it can be seen that Na_2SO_4 is the weakest and Na_2CO_3 is the most harmful salt.

The formation of NOH during the hydrolysis of normal soda is the main reason why it is so harmful. Therefore, the accumulation of carbonate salts in the soil is very harmful.

The accumulation of salts in soil and groundwater is related to their degree of dissolution [6]

The sodium adsorption ratio is expressed in millivivivalents (mg/l) by calculating SAR $=(Na+)/\sqrt{(1/2\ ([Ca2+]+[Mg2+]))}$ in one liter of saturated soil extract

In irrigation water quality monitoring, it is important to assess sodium hazard along with determination of electrical conductivity. So, both electrical conductivity (EC) and sodium adsorbs

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Sodium adsorption rate in one liter of saturated soil extract

$$SAR = (Na+)/\sqrt{(1/2\ ([Ca2+]+ [Mg2+]))}$$ **and expressed in millivivivalents (mg/l)**

In irrigation water quality monitoring, it is important to assess sodium hazard along with determination of electrical conductivity.

Thus, both electrical conductivity (EC) and sodium adsorption ratio (SAR) affect water infiltration. The effect of sodium adsorption ratio (SAR) on water infiltration is classified as follows.

Table 3: Risk of water leakage

N₀	SAR	Weak	Medium	High
1	0 - 3	>0.7	0.7 - 0.2	<0.2
2	3 - 6	>1.2	1.2 - 0.3	<0.3
3	6 - 12	>1.9	1.9 - 0.5	<0.5
4	12 - 20	>2.9	2.9 - 1.3	<1.3
5	20 - 40	>5.0	5.0 - 2.9	<2.9

When evaluating soil types, the tendency of increasing sodium hazard should be taken into account as a rule, the weakening of electrical conductivity.

If the ratio of calcium and magnesium to sodium (SAR) in the soil is more than 13, the soil is called soda soil. High sodium in sodic soils causes soil particles to repel each other, which prevents the formation of soil aggregates.

It creates a solid soil structure on the surface of the soil that is impermeable to water and poorly aerated, which makes cultivation difficult.

Reclamation of saline and brackish soils is carried out by plastering. The goal is to remove the sodium cation from the absorbent complex of the soil and replace it with calcium cation.

Due to plastering of the soil, it is possible to increase the percentage of large particles that make up the mechanical composition and improve the microaggregate content [5].

Variable sodium percentage (ESP) - Another index that characterizes the sodicity of the soil. As mentioned above, excess sodium weakens the movement of water and air in the soil. Exchangeable sodium (ESP) can take values of more than 15 in soil. The relationship between variable sodium percentage (ESP) and cation exchange capacity (CEC) is as follows.

ESP= ([Na+])/CEC x 100

Cation exchange capacity is the sum of the exchangeable cations of hydrogen that often enter the soil. The relationship with both cations and varying sodium percentage is defined as ESP=([Na+])/([Ca2+ + Mg2+ + Na+ + K+]) x 100 dist. and is expressed in meq / 100g.[7]

RESULT

While the variable sodium percentage is used only to characterize the sodicity of soils, the sodium adsorption ratio (SAR) is applicable to soil, soil solution, and irrigation water.

Thus, the following classification can be made on the relationship of Electrical Conductivity (EC), Variable Sodium Percentage (ESP) and Sodium Adsorption Ratio (SAR) in soil salinization in saturated soil solution:

Table 4: Classification according to the relationship of electrical conductivity (EC), sodium percentage change (ESP) and sodium adsorption ratio (SAR) in soil salinization

s.s.	Siniflər	EC (mmhos/cm)	SAR	ESP	Torpağın ipik quruluşu
1	Şorlaşmamış	< 4.0	< 13.0	< 15.0	Duza meylli strukturlu
2	şoran	>4.0	< 13.0	< 15.0	Duzlu strukturlu
3	sodalı	< 4.0	>13.0	>15.0	Dağınıq və struktursuz
4	Sodalı-şoran	>4.0	>13.0	>15.0	Duzlu strukturlu

etc. Classes EC (mmhos/cm) SAR ESP Soil texture

1 Unsalted < 4.0 < 13.0 < 15.0 Salt-prone structure

2 saline >4.0 < 13.0 < 15.0 Saline structure

3 soda < 4.0 >13.0 >15.0 Scattered and unstructured

4 Soda-saline >4.0 >13.0 >15.0 Saline structure

Salinity is determined mainly by the salt level of the soil from which plant roots extract water. Therefore, soil samples should be collected from a minimum depth of 0-40 cm or from the root depth of cultivated plants, according to the root characteristics of cultivated plants. When determining the degree of salinity resulting from irrigation within the soil profile, deeper samples should be collected.

The comparison of soil samples from the affected area with similar appearance based on the results of remote sensing is important in the diagnosis of salinization. In this case, eight to 10 core samples can be collected from a similar-looking area.

Sometimes, because the methods of obtaining soil solution samples with more typical saturated water content under field conditions are not practical, there are differences in the results of aqueous extracts of soil samples with higher than normal water content for soil in the laboratory. That's why it's salty In the diagnosis and characterization of q, the following parameters can be included in the basic soil salinity test:

5. Calculation of predicting the effect of irrigation water on the soil. Residual sodium carbonate (RSC) is another calculation that predicts sodium hazard. This calculation represents the sum of carbonates (bicarbonate + carbonate) minus the sum of divalent cations (calcium and magnesium): [7]

(HCO3 - + CO3 2-) – (Ca2+ + Mg2+) = RSC

Table 5: Proposed limits for irrigation water based on residual sodium carbonate (RSC)

	Classification RSC	RSC Total (meg/l)	RSC Irrigation Hazard
1	Weak	<0	No problem with RSC
2	Medium	0-1,0	Monitor seepage and soil pH; correction may or may not be necessary; Check the SAR
3	High	1,0-2,5	Monitor seepage and soil pH; need correction with acid.
4	Very high	>2,5	Monitor seepage and soil pH; correction with acid is necessary.

Residual sodium carbonate (RSC) values indicate that the loss of calcium in the chemical reaction resulting in the formation of calcium carbonate will increase soil pH.

There are some suggested limits to increasing residual sodium carbonate (RSC) calculations above zero. In general, in water with an RSC value above 1.0, water seepage and soil pH monitoring may require corrective action. There are two methods for this, by adding acid or gypsum to the irrigation water.

Lime deposition potential (LDP). This is observed as calcium or magnesium carbonates in irrigation water, or as a white residue of lime scale in the presence of lime.

Factors affecting lime scale are increased temperature, increased pH, loss of carbon dioxide in the water, and evaporation. The water used in the irrigation system produces sediment in the equipment. In this case, lime deposits accumulate in irrigation systems and cause problems. Lime accumulates inside the components and causes clogging of drip holes in particular.

Drip or micro irrigation systems are also prone to clogging problems.

When irrigation is carried out with the above-ground system, the lime residue creates white spots on the fruits and creates the impression of pesticide residues, which lowers the value of the product in its sale [8].

If necessary, suitable precipitants should be applied to remove lime residues from the system. Irrigation water with a high concentration of lime has the effect of increasing or decreasing the pH level in the presence of phosphorus, zinc and iron compounds in the soil. The following equation is used to calculate the lime deposition potential of irrigation water.

$(HCO_3^- + CO_3^{2-})$ or $(Ca^{2+} + Mg^{2+})$ = LDP in mg/l:

For example, HCO_3^- = 4 mg/l, CO_3 = 1 mg/l, Ca^{2+} = 2 mg/l, Mg^{2+} = 1 mg/l, where (4 + 1) or (2 +1) LDP = 3 will be.

Removing lime from irrigation water causes a lowering of pH and alkalinity. Alkalinity is a measure of the concentration of negatively charged anions, or alkalis, in a solution, which is proportional to the level at which water can neutralize one unit of acid capable of neutralizing acids.

In general, most of the alkalinity in water drawn from aquifers or natural sources consists of bicarbonates (> 90%; HCO_3^-); Other anions such as carbonates, hydroxides, phosphates, borates and silicates affect the total alkalinity level.

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