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THE EVALUATION OF SOIL SALINIZATION WITH THE METHOD OF ELECTRIC VERTICAL SOUNDING

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Abstract:

The studies carried out on maroon and grey salt soils show the dependence of the electrical resistance of soils not only on the degree of salinisation, but also on soil moisture and temperature, which determine the change in VES parameters over soil horizons and micro-relief elements.

It has been proven that the value of VES also depends on the type of soil salinity, soil density and organic matter content. This should be taken into account when evaluating data from the electrical vertical sounding of soils.

Keywords: soil salinization, electrical vertical sounding, resistance dependence of W, t^0.

RESEARCH OBJECT

Maroon salt soils from Dagestan and Iran as well as grey soils from the Karaulbazar district of the Bukhara region in Uzbekistan were selected as research objects [3, 4, 7, 9].

The research methodology consisted in the evaluation of the electrical properties of soils by electric vertical sounding in the field in seasonal dynamics and under laboratory conditions in the determination of the water physical and agrochemical properties of soils [4, 5, 6].

Experimental

AIM AND TASKS OF RESEARCH

The determination of the salinity of the soil is of great agroecological importance, and in addition to physico-chemical methods of investigation, the method of electric vertical sounding is used to determine the salinity. However, the results of this method depend not only on the salinity in soils, but also on their ratio, humidity, temperature, density and humus content of the soils. They differ during the growing season on individual elements of the micro-relief in the structure of the land cover. Our work is dedicated to clarifying these questions.

Data consumption of electrical vertical sounding to characterize the formation and fertility of soils

The method of electric vertical sounding is one of the geophysical methods for the rapid determination of soil properties and in particular the salinity of soils [7].

According to Pozdnyakova A.D. [4], the apparent electrical resistance of soils reflects their formation and fertility. Depending on the shape of the resistance curve and size, the intensity and type of soil-forming processes taking place in the soil profile can be assessed. According to the author, the resistance of Neuland podsol soils reached several hundred and even thousands of ohms. In peat soils, this value (ρK) was no more than 40-60 ohms/m. The ρK curves of Neuland Soda Podsol soils reflected their three-layer structure: $\rho A\pi < \rho A2 > \rho B$. An exponential dependence of the electrical resistance on the sum of the absorbed bases, uptake capacity and humus content was observed.

Kopikova L.P. [2] established patterns of changes in the electrical conductivity of soils due to their salinity. The study of the electrical conductivity of natural solutions of soils of chloride-sulfate salinity

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with a concentration of 1-25 g/l made it possible to determine high correlation coefficients with mineralization (r = 0.91; for n = 90) and with the sodium adsorption ratio - SAR (r = 0, 79; n = 90).

The author proposes one of the toxicity classification of solutions for salinity type by sulfate-calcium-magnesium (at humidity from HB to 0.7 HB). Non-toxic and moderately toxic salts have an electrical conductivity S/m of 10-1 at 180 °C and 4-7 and 10-13 respectively; the content of easily soluble salts C at HB is 6–9 and 13–18 g/l respectively [2].

According to our data, there was a general tendency in the change in electrical resistance in the soils of the coastal plain of Dagestan: it decreased in the direction of the elevated part to the coastal part [3].

In addition, according to our data, the electrical resistance of the salt soils was zero. This corresponded to a content of water-soluble salts above 4% (4-30%). In slightly saline soils where the content of water-soluble salts was below 1 %, the electrical resistance fluctuated in the range of 20 to 160 ohms/m [3].

As can be seen from the data presented in Table 1, an acidic suspension effect is evident in soils: the pH of the suspension is lower than the pH (H2O) of the filtrate. To a greater extent it is shown for soil No. 3, to a lesser extent for soil No. 4. pH(KC1) deviates from the pH(H2O) of the extract, to a greater extent this difference is shown in soil No. 3. The highest resistance U (ohm) is typical for soil No. 2, where the overall alkalinity is higher, the loss of ignition is higher, the density is lower and the humidity is higher. The lowest resistance U (ohms) is typical for soil #3, where EL (MS), TDS ppm are higher, soil density is higher, and pH (H2O) is higher.

Table 1
Relationship of indicators of electrical vertical sounding with soil properties (Ap)

Indicator	Soil			
	1	2	3	4
W, %				
	0,3	3,1	0,7	0,2
pH (H2O) extract				
rNCS1 - Aufschlämmung	8,0	7,9	8,3	7,9
pH(H2O) - Aufschlämmung				
	7,6	7,6	7,6	7,4
RF g/cm3				
Festphasendichte, g/cm3	6,6	6,6	6,4	6,7
Loss during calcination				
	1,7	1,2	1,6	1,4
Gesamtalkalität *				
Gesammtmineralisierung (ppm)	2,3	2,2	2,7	2,3
THE (ms) **	29,6	35,3	29,0	26,8
U (Ohm) ***				
In	0,7	1,4	1,1	0,2
K, %	203	291	456	298
	309	414	686	443
	6,9	11,2	4,7	5,1
	18,2	34,8	18,7	16,7
	25,8	7,4	16,7	16,8

*) salt concentration in ppm; **) electrical conductivity;) resistance in the VES process; V - Voltage in the method of electric vertical sounding of soils: 1, 3 – brown salty semi-desert salt soil, Iran; 2 – brown semi-desert salt soil, Iran; 4 - Grey floor, Uzbekistan

INFLUENCE OF SOIL MOISTURE ON VES PARAMETERS

Kotenko M.E. It has been found that the electrical conductivity of maroon salt soils depends not only on salinity, but also on moisture content and degree of soil humus content, which must be taken into account when interpreting vertical electrical sounding data [3].

From a theoretical point of view, with a temperature change from ^{00} to 200, the CO2 content in the soil changes from 171 to 27.8 mg/100 g of water, which also affects the solubility of CaCO3, MgCO3. At different temperatures, the solubility of individual precipitation varies unequally. At 20 °C, the solubility of MgCl2 is therefore 54.6 mg/l; MgSO4 - 18; MgCO3 H2O - 0.13. With increasing temperature, the absorption of polyvalent cations by the soil and with lower entropy increases with higher hydration energy. With increasing humidity, the absorption of cations with lower hydration energy and with higher solution entropy is preferred.

According to our data, with a temperature increase from ^{200} to 400, the absorption of Ca by soils

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was 204%, Mg - 55%, Na - 21% [6]. Also, according to our data, the electrical resistance of Soda Podsol soils was 60-300 ohms/m; for loamy soils - 40-180 ohms/m; for the rock - 60-80 ohms/m.

As can be seen from the data presented, in alkaline soils from the analyzed soils, the density of the solid phase is higher, the electrical conductivity is higher, the electrical resistance of the soils is lower, the content of water-soluble salts is higher, the pH KCl of the slurry and the pH(H2O) of the extract are higher. In grey soils, compared to other comparative soils, there is less loss during calcination, less soil moisture, lower pH (KC1) of the slurry and pH (H2O) of the extract.

The size of the slurry effect (pH (H2O) of the extract minus pH(H2O) of the slurry) is higher in alkaline salt soil (1.4) and lower in brown salt soil (1.3) and in gray soil (1.2).

Seasonal changes in temperature and soil moisture and their influence on the electrical conductivity of soils

The electrical resistance of soils changes in seasonal dynamics. However, these laws differ for individual soil groups, horizons and for soils developed on different elements of meso- and micro-reliefs.

Gyulaliyev Ch.G. [1] established patterns of changes in the electrochemical properties of soils depending on temperature and humidity. The author has shown that an increase in the specific surface area and volumetric mass of soils causes a linear increase in electrophysical coefficients. With increasing temperature from ^{50} to 400, the electrophysical coefficients increased almost linearly. With increasing humidity, they initially increased intensively. Then the specific electrical conductivity continued its growth, but less intensely.

According to our data, the seasonal dynamics of easily soluble salts in the profile of the maroon soils in Dagestan also indicate a change in the type of salinity over the course of the year. The change from the sulfate-chloride salinization type to the sulfate or chloride-sulfate salinization type has become established.

It is shown that the electrical conductivity of soils increases with increasing soil salinity and the ionic strength of the solution. However, the effect of sodium and calcium salts, carbonates and sulfates on it is different. The solubility of salts depends on pH, pCO2, temperature, humidity, complexing ability of soil solutions.

According to the data obtained by us for maroon salt soils of Dagestan, a large dispersion of the values of electrical resistance over the surface and along the soil profile was detected. At the same time, the specific electrical resistance at the soil surface was 71–82 ohms/m, although the soils differed in the typical height and degree of salinization and alkalinity, which is apparently due to the low moisture content of the upper layer of the soil. Thus, in the upper layer of the salt soils, the moisture content was < 5-7%, and already in the 12 cm layer it fluctuated in the range of 12-18%. With a content of water-soluble salts of 4-30% in the salt soil, the electrical resistance was close to zero, and in slightly saline soils with a salinity of less than 1%, the electrical resistance fluctuated in the range of 20-160 ohms/m.

Influence of the course and extent of soil salinization on the condition of the seeds of individual cultivated plants

The influence of salinity on the individual crops is very different. For example, a decrease in yield of 25 % is observed for soybeans at 5.7 mmhos/cm and for barley at 13.0; a yield reduction of 10 % is observed for soybeans at 3,8 mmhos/cm and for barley at 10,0.

For the soils of Libya on moderately saline soils with a salinity of 0.2-0.4% in Ap and a content of toxic salts of 0.1-0.35%; at a chlorine content of 0.03-0.10% at TB mmol / cm, at ^{250C} - 0.75-1.5, olives and date palms showed good growth, while potatoes, peas, almonds showed a decrease in yield of 50-80% [5]. At the same time, salinity gradations for soils of different granulometric composition, humus content, depending on the mineralogical composition of the soils, absorption capacity, etc. also differ.

Individual plants and varieties are also more resistant to different types of salinity: to C1 and SO4, Na and Ca, etc. [5]. The toxic effect of salinity on plants largely depends on the composition and ratio of salts and salt tolerance of plants.

Due to the preponderance of less harmful salts in the soil solution, the plants are mainly exposed to osmotic pressure; with the predominance of more harmful salts, plant intoxication increases and salts have a specific inhibitory effect on individual enzymes [8]. At the same time, some plants are resistant to chlorine, others to sulfates. Plants that grow in conditions with chloride salinity have a higher salt tolerance, but at the same time are less resistant to drought and cold than plants that grow in conditions with sulfate salinity.

RESULT

The method of electric vertical sounding (VES), which is used to determine the salinity of the soil, is fast and convenient for use in the field. However, when interpreting the data, it should be borne in mind that the results obtained depend not only on the content of water-soluble salts in the soil, but also on

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their composition, soil moisture, density, temperature, humus content, pH, and EL. This determines the change in soil salinity in the seasonal dynamics and structure of land cover and should be taken into account when interpreting VES data in the agroecological assessment of land.

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