European Journal of Agricultural and Rural Education (EJARE)
Available Online at: https://www.scholarzest.com
Vol. 2 No. 5, May 2021,
ISSN: 2660-5643

ASSESSMENT OF SOIL SALINITY USING THE VERTICAL ELECTRIC SOUNDING METHOD

Vitaly Igorevich Savich
Doctor Of Agricultural Sciences, Professor Department
Of Soil Science, Geology And Landscape Science Rsau-Moscow
Agricultural Academy Named After K.A. Timiryazeva (Россия)
+8905 501-14-46, Savich.mail@gmail.com
Hafiza Tuymurodovna Artikova
Candidate Of Biological Sciences, Associate Professor
Department Of Soil Science, Bukhara State University (Uzbekistan)
Tel: +99891-442-88-11, artikova-76 @ mail.ru
Shavkatullo Shukurovich Nafetdinov
Candidate Of Biological Sciences, Associate Professor
Department Of Soil Science, Bukhara State University (Uzbekistan)
+99890 711-97-30, shavkat-56@mail.ru
Khilola Salimova
Lecturer Department Of Soil Science, Bukhara State University (Uzbekistan)
+99893 620-73-81, x.salimova@inbox.ru
Khamroev Feruz Kamdamovich
Independent researcher at Bukhara state university (Uzbekistan). khamrayevferuz@gmail.com

Article history:
Received April 1th 2021
Accepted: April 17th 2021
Published: May 14th 2021

Abstract:
Researches in the vertical study method of salinity in saline brown and grey soils using electric current have shown that the electrical resistance of soil depends not only on its salinity but also on its humidity and temperature. It was also studied that vertical study using electric current depends on the microrelief horizons and its constituent elements. It was proved that the magnitude results of vertical research using electric current depends on the soil salinity type under research, the soil density and the organic matter content.

Keywords: Soil salinization, vertical electric sounding, resistance dependence on W, t^0.

RESEARCH OBJECTS

The research objects were the chestnut saline soils of Dagestan, Iran and serozem of Uzbekistan [3, 4, 7, 9].

Research methodology consisted in assessing the soils electrical properties by vertical electrical sensing in the field in seasonal dynamics and in laboratory conditions in determining the water-physical and agrochemical properties of soils [4, 5, 6].

Experimental part

The research purpose and objectives

Soil salinity assessment has a great agroecological importance and, along with physical and chemical research methods, to assess the salinity degree the vertical electrical sounding method is used. However, this method results depend not only on the salt content in the soils, but also on their ratio, humidity, temperature, density, humus content of soils. They differ during the growing season, on individual elements of microrelief in the soil cover structure. The work we have done is dedicated to clarifying these issues.

Using vertical electrical sounding data to characterize the soils genesis and fertility

Vertical electrical sounding method is one of the geophysical methods for the rapid determination of soil properties and, in particular, the soil salinity degree [7].

According to A.D. Pozdnyakova [4] apparent electrical resistivity of soils reflects their genesis and fertility. According to the resistance curve shape and the value it is possible to judge the intensity and type of soil-forming processes occurring in the soil profile. According to the author, resistance of virgin sod-podzolic soils reached several hundred and even thousands of Ohms. In peat soils, this value (ρ_K) was no more than 40-60 Ohm/m. The ρ_K curves of virgin soddy-podzolic soils reflected their three-layer structure: $\rho_{Ап} < \rho_{A2} > \rho_B$. An exponential dependence of the electrical resistance on the sum of absorbed bases, absorption capacity, and humus content has been established.

Kopikova L.P. [2] established the changes regularities in the electrical conductivity of soils from their salinity. The electrical conductivity research of natural solutions of the chloride-sulfate soils type of salinity with 1-25 g/l concentration made it possible to establish high coefficients of its correlation with mineralization (r = 0,91; for n = 90) and with sodium adsorption ratio - SAR (r = 0,79; n = 90).

The author proposes a toxicity classification of solutions for the sulphate-calcium-magnesium type of salinization (with humidity from HB to 0,7 HB). Non-toxic and moderately toxic salts have electrical conductivity Cm/m $\cdot 10^{-1}$ at18^0C relatively 4-7 and 10-13; the easily soluble salts content C at HB, respectively 6-9 and 13-18 g/l [2].

According to our data, a general tendency for the change in electrical resistance in the submontane -coastal plains soils of Dagestan was revealed: it decreased in the direction from the elevated part to the coastal one. [3].

Also, according to our data, the electrical resistance of the salt marsh was zero. This corresponded to the water-soluble salts content above 4% (4-30%). In slightly saline soils, where the water-soluble salts content was less than 1%, the electrical resistivity varied in the range from 20 to 160 Ohm/m. [3].

As can be seen from the data presented in Table 1, an acidic suspension effect is manifested in the soils: pH suspension below, than pH(H_2O) filtrate. B to a greater extent, it manifests itself for soil №3, to a lesser extent - for soil №4. pH(KC1) differs from pH(H_2O) hoods, to a greater extent, this difference is manifested for soil №3. The greatest resistance U (Ohm) is typical for soil №2, where the total alkalinity is greater, the loss on ignition is greater, the density is lower, and the moisture content is higher. The smallest resistance U (Ohm) is typical for soil №3, where the EC (MS), TDS ppм is higher, higher soil density, higher pH(H_2O).

Table 1

Relationship of vertical electrical sounding indicators with soil properties (Ап)

Indicator	Soil			
	1	2	3	4
W, %	0,3	3,1	0,7	0,2
pH(H_2O) – hood	8,0	7,9	8,3	7,9
pH_{KC1} – suspension	7,6	7,6	7,6	7,4
pH(H_2O) – suspension	6,6	6,6	6,4	6,7
OB g/cm^3	1,7	1,2	1,6	1,4
solid phase density, g/cm^3	2,3	2,2	2,7	2,3
loss on ignition, total alkalinity *	29,6	35,3	29,0	26,8
TDS ppм	0,7	1,4	1,1	0,2
EC (мs) **	203	291	456	298
U (Ом) ***	309	414	686	443
V	6,9	11,2	4,7	5,1
K, %	18,2	34,8	18,7	16,7
	25,8	7,4	16,7	16,8

*) concentration of salts in ppм; **) electrical conductivity; ***) resistance in the VES method; V – voltage in the soil vertical electric sounding method: 1, 3 – brown semi-desert solonetzic saline, Iran; 2 – brown semi-desert saline, Iran; 4 – serozem, Uzbekistan

Influence of soil moisture on VES indicators

M.E. Kotenko it was found that the electrical conductivity of saline chestnut soils depends not only on the salinity degree, but also on the moisture content and the humus degree content of the soils, which must be taken into account when interpreting the vertical electrical sounding data [3].

From a theoretical point of view, when the temperature changes from 0^0 to 20^0, the content CO_2 in soils varies from 171 to 27.8 mg/100 g of water which also affects $CaCO_3$, $MgCO_3$ solubility. At different temperatures, individual precipitates solubility changes unevenly. So, at 2^0C, the $MgC1_2$ solubility is 54.6 mg/l; $MgSO_4$ - 18; $MgCO_3 \cdot H_2O$ - 0.13. As the temperature rises, the soil uptake increases with polyvalent cations with lower entropy and higher hydration energy. With increasing humidity, it is preferable to absorb cations with lower hydration energy and higher dissolution entropy.

According to our data, with an increase in temperature from 20^0 to 40^0 Ca uptake by soils was 204%, Mg – 55%, Na – 21% [6]. Also, according to our data, the electrical resistance value of sod-podzolic soils was 60-300 Ohm/m; for gley soils – 40-180 Ohm/m; for breed – 60-80 Ohm/m.

As can be seen from the data presented, in the solonetzic soil from the analyzed soils, the solid phase density is higher, the electrical conductivity is higher, the soils electrical resistance is lower, the water-soluble salts content is higher, serozem, in comparison with other compared soils, less loss on ignition, less soil moisture, lower pH(KC1) suspension and pH(H_2O) extract.

The suspension effect magnitude (pH(H_2O) of the extract minus pH(H_2O) of the suspension) is higher in solonetzic saline soil (1.4) and lower in brown saline soils (1.3) and in gray soil (1.2).

Seasonal changes in soil temperature and moisture and their effect on the electrical conductivity of soils. The electrical resistance of soils changes with seasonal dynamics. However, these patterns differ for individual soils groups, horizons, for soils developed on different elements of the meso- and micro-relief.

Gyulalyev Ch.G. [1] established the changes regularities in the electrochemical characteristics of soils from temperature and humidity. The author has shown that an increase in the specific surface area and bulk density of soils causes a linear increase in the electrophysical coefficients. With an increase in temperature from 50 to 400, the electrophysical coefficients increased almost linearly. At first, with increasing humidity, they increased intensively. Then the electrical conductivity continued to grow, but less intensively.

According to our data, the seasonal dynamics of readily soluble salts in the chestnut soils profile in Dagestan also showed a change in the salinity type during the year. The change of sulfate-chloride salinity type to sulfate or chloride-sulfate salinization type was established.

It is shown that the electrical conductivity of soils increases with an increase in soil salinity and ionic strength of the solution. However, the sodium and calcium salts, carbonates and sulfates effect on it is different. The salts solubility depends on pH, pCO_2, temperature, humidity, complexing ability of soil solutions.

According to the data obtained by us for the chestnut saline soils of Dagestan, a large scatter of the specific electrical resistances values along the surface and along the soil profile was established. At the same time, the electrical resistivity at the soil surface was 71-82 Ohm/m, although the soils differed at the typical level and in the salinity and alkaline degree, which is obviously associated with the insignificant moisture content of the upper soil layer. So, in the upper layer of the salt marsh, the moisture content was <5-7%, and already in the 12 cm layer it varied in the 12-18% range. With a water-soluble salt content of 4-30% in the salt marsh, the electrical resistance was close to zero, and in slightly saline soils with a salt content of less than 1%, the electrical resistance varied in 20-160 Ohm/m range.

Influence of the nature and salinity degree on the crops state individual crops.

The salinity effect on individual crops is very different. Так, снижение урожая на 25% наблюдается у сои при 5,7 Ммо/см, а у ячменя – при 13,0; снижение урожая на 10%отмечается у сои при 3,8 Ммо/см, а у ячменя – при 10,0.

For soils of Libya on moderately saline soils with a total salt of 0.2-0.4% in Ap and the amount of toxic salts 0.1-0.35%; with chlorine content - 0,03-0,10% at EC mmol/cm, at 25^0C – 0,75-1,5 the olive and date palm showed good growth, and for potatoes, peas, almonds, there was a decrease in yield by 50-80% [5]. At the same time, the salinity gradations are also different for soils of different granulometric composition, humus content, depends on the mineralogical composition of soils, absorption capacity, etc.

Certain crops and varieties are more resistant to different salinization types: к C1 и SO_4, Na and Ca etc. [5]. The toxic effect of salinity on plants largely depends on the composition and ratio of salts and salt plants tolerance.

With the less harmful salts predominance in the soil solution, plants are mainly subjected to osmotic pressure; with more harmful salts predominance, 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 developing under conditions of chloride salinization have a higher degree of salt tolerance, but at the same time, they are less drought-resistant and cold-resistant, compared with plants developing under conditions of sulfate salinity.

CONCLUSION

The vertical electrical sounding (VES) method used to assess the soil salinity degree, is rapid and convenient for use in the field. However, when interpreting the data, it is necessary to take into account that the results obtained depend not only on the water-soluble salts content in the soil, but also on their composition, soil moisture, density, temperature, humus content, pH and Eh. This determines the change in the soil salinity degree in the seasonal dynamics and in the soil covers structure, and should be taken into account when interpreting the VES data in the agroecological assessment of lands.

REFERENCES

1. Gyulalyev Ch.G. Electro- and thermophysical properties of soils, Abstract of Candidate's Dissertation, IPA, Academy of Sciences of Azerbaijan SSR, Baku, 1989, 18 p.
2. Kopikova L.P. Study of the electrical conductivity of soils and pore solutions in order to diagnose their degree of salinity, Author's abstract of thesis for a thesis, Moscow, Moscow State University, 1984, 23 p.
3. Kotenko M.E., Zubkova T.A., Balamirzoev M.A. The use of electrophysical express methods in the diagnosis of soils of the Prisulakskaya lowland of the Western Caspian region, in collection of articles. "South of Russia, development", 2009, №3, p. 18-23
4. Pozdnyakov A.I., Pozdnyakova L.A., Pozdnyakova A.D. Stationary electric fields in soils, M., KMK, 1996, 388 p.
5. Savich V.I., Shishov L.L., Amerguzhin Kh.A. Agronomic assessment and methods for determining the agrochemical and physicochemical properties of soils in the tropics and subtropics, Astana, 2004, 620 p.
6. Savich V.I. Physicochemical foundations of soil fertility, M., RSAU-Moscow Agricultural Academy, 2013, 431 p.
7. Savich V.I., Mazirov M.A., Sedykh V.A., Gukalov V.V. Agroecological assessment of geophysical fields, M., RGAU-Moscow Agricultural Academy, VNIIA, 2016, 492 p.
8. B.P. Stroganov. The value of the salinity quality in the salt tolerance of plants, Author's abstract of doctoral dissertation, Alma-Ata, 1961, 40 p.
9. Savich V.I., Artikova H.T., Nafetdinov Sh.Sh., Salimova Kh. H. Optimization Of Plant Development In Case Of Soil Salinization. (2021). The American Journal of Agriculture and Biomedical Engineering, 3(02), 24-29.