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RESEARCH FOR PHYSICAL CHARACTERIZATION OF SALINATED SOIL

BY

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Abstract. This paper had been aiming to analyze salinated soils, of the area Osoi-Moreni from the village Prisacani, Iasi city from physical properties point of view of this salinated soils. For this research we had took soils from two places: the first place are currently cultivated with corn (Zea mays), and the second soil place came from an area of uncultivated, which has not suffered work agricultural about seven years.

The methods for analysis of physical characteristics of saline soils are important research for the diagnosis, monitoring and quality control saline soils which are used in agricultural.

Key words: saline soil; physical characteristics.

1. Introduction

Salinity is a process where we have accumulation in soil with excessive quantities of sodium salts, calcium, magnesium, potassium; particularly accumulations of chlorides, sulphates, carbonates and bicarbonates, which give us a negative fertility soil (Eckelmann *et al.*, 2006). This accumulation of salts, especially sodium salts, it is the first physiological threat when we speak about ecosystem.

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Saline and alkaline soils are found on almost all continents, having a higher spread in arid areas and the semi-arid as well as the relatively wetlands or where we found favorable terms of the manifestation to factors which determine their formation and evolution.

Salsodisoils (Florea, 2003) are represented by Aquisalids and the Solonetzs. These soils are characterized through an increased content of slowly soluble salts in the saline soils (Aquisalids), or by the high content of exchangeable sodium in alkali soils (Solonetzs), or both processes may be found in aquisalids -alcalinizate.

For physical characterization of the saline soils it is necessary to know physical properties: grain size distribution and texture of the soil, bulk density, porosity, moisture content, the degree of compaction, as well other features such as the depth of the accumulation of salts, the content of salts present, the quality and the quantity of water available for the leaching, the quality and depth of groundwater, the topographic characteristics of the land, the nature of vegetation cover and the climate conditions (Stătescu & Paul, 2011). All these characteristics are important both for the agriculture but also for land that needs to construct, imposing these special features into consideration the use protection systems for civil construction especially (Pastia *et al*., 2005).

Saline soils generally have a fine texture and are characterized by the presence of large quantities of water, but which is unreachable for the plants. From the mechanical point of view, these soils are working hard, because the presents high capacity for shrinkage and the swelling and the optimal period to carry out of agricultural works is very low.

Knowledge of soil bulk density provides data that can not be deduced from other properties. In other words, a soil which belong to a genetic type with a certain texture, and specific chemical properties may have very differing bulk density values (Canarache, 1990). Knowledge of this indicator has a special importance in the calculation of water, nutrient elements, salts, of the necessary fertilizers and amendments.

It is estimated that the permeability and porosity differentiated analysis are indispensable in soil studies, to characterize pedogenetic conditions and to explain the processes of soil pedogenetical formation under specific conditions (Dumitru *et al*., 1999).

When we speak about salinized soils, the highest values of bulk density can be found in the horizons heavily compacted, as Btna horizons of the Luvisols or Solonetzs.

The saline soils have in generally a lower porosity less than 50% in the Ao horizons, and this value decreases with the soil depth profile, the horizons of Btna take values from 30 to 40%.

Salinated soils are soils with very low fertility because of physical and chemical negative attributes. Are used as meadows, but these have a poor nutritional value and give reduced productions. These soils can be improved by amendments and irrigation wash application.

2. Material and Methods

2.1. Description of the Research Perimeter (Site)

The area in which the research took place and the soil samples were taken, (Figs. 1,…,3) is part of Iaşi County, Prisăcani village, common meadow Prut and Jijia. The village is located in the eastern part of the county.

Common meadow and Prut rivers Jijia consists of alluvial deposits with sandy-clayey facies or sandy loam, tens of meters thick argillized surface, instead of the old river bed or lake bottoms, these layers are deposited on a bed of marl.

Plain climate Moldova is continental with cold winters and mild summers moderately warm, with maximum rainfall in late spring and minimum in autumn and winter. Annual rainfall varies between 500,…,600 mm.

The most important affluent of the Prut River on the right part is Jijia (Fig. 1), in this area has a deep riverbed, with single meandering, Jijia waters are discharged into the Prut, in Oprişeni village area upstream of the experimental field.

Fig. 1 – Jijia confluence with the Prut River.

Fig. 2 – Clogged soil profile, with the presence of groundwater to surface.

According to the literature (Nițu *et al.*, 1986) the soils from the common meadow Jijia and Prut rivers, occur as alluvial, calcareous and saline marshy grounds. Alluvial soils are clayey, fallow, or becoming fallow, some evolved, other less developed, with morphological differentiation and clear texture. In the formation of these soils an important role has been the influence of groundwater, located at depths of 1,…,2 m and its mineralization till 5 g/l (Fig. 2).

2.2 Methods and Techniques of Analysis

2.2.1. *Soil Sampling*

Soil sampling was carried out from 25 to 25 cm to a depth of 100 cm, in disturbed sample and undisturbed sample from two areas: a control region, uncultivated, (denoted in the paper by M) and an area that was converted from grassland to arable land, currently being planted with corn (noted in the paper by Sa).

Soil sampling in the undisturbed sample (Figs. 3 and 4) was performed with the metal cylinder, defined volume (100 cm^3), made of stainless steel, having the walls with a thickness of about 1 mm. The rings are pointed at one end, thus facilitating the penetration into the soil and to avoid disturb of soil during sampling. On the soil surface have been removed residual traces of plant, roots of the plants and the rocks.

After cleaning the soil surface, the metal cylinders have been introduced in the soil with a hard plastic hammer, their position is kept vertically. The excess of soil from the metal cylinders has been removed carefully with a pedological knife. To be able to carry and preserve the soil samples in optimal conditions, the cylinders were covered on both ends with plastic covers. Soil sampling has been carried from 25 to 25 cm to a 100 cm depth, in disturbed sample and undisturbed sample from two areas: a control region, uncultivated, (denoted in the paper by M) and an area that was converted from grassland to arable land, currently being planted with corn (noted in the paper by Sa).

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a

b

Fig. 3 – The soil sampling in the the natural state: *a*- scraping the soil, *b*- introducing in the soil of rings.

a

b

Fig. 4 – Materials necessary sampling: *a* – hammer, cylinders with caps and spade to extract the cylinders, *b* – soil with cylinders.

The samples were taken from the ground with the spade of 25 to 25 cm down to a 100 cm and were placed into plastic bags. Preparation of soil samples, taken in a modified settlement, for laboratory analysis, consisted in organic debris removed and skeleton, followed by grinding and the sifting through a sieve of 2 mm Ø (except soil samples collected in natural settlement).

The physical properties of the soil were determined by the following tests in the laboratory.

2.2.2. *Laboratory Tests*
Particle size analysis

In the general texture of the soil analysis we take in consideration organic matter (humus) and the mineral constituents (carbonates, sulfates, soluble salts) and in the case of determining the texture of fine mineral material (< 2 mm) these components must be totally eliminated by different methods (using a furnace).

After the opening of the bags and the soil drying to the air and the remove of organic debris and the soil skeleton, then we grinding and sifting the soil through 2 mm meshes.

The method is based on the principle of total dispersion of the soil structural formations.

Pretreatment was done in relation to the composition of the sample, thereby that, carbonate samples with >2%, with organic matter <5%, was treated with 1N hydrochloric acid solution and dispersion solution of tetrasodium pyrophosphate concentration 4%.

Determination of particle size fractions was carried out through:

• sedimentation method in version with hydrometer for fractions <0.02 mm;

• wet and dry sieving method for fractions and sub-fractions included between from 2 to 0.02 mm.

The results had expressed in percentage to material remaining after the pretreatment, being 100% the sum of the fractions.

For the classification into classes and subclasses of texture use the methodology presented in Soil Assessment Study (ICEPA,1987).

Soil density (D) had determined by the method pycnometric, and the results had expressed in g/cm^3.

Bulk density (DA) had determined by the metal cylinder of known volume (100 cm^3) momentary soil moisture, expressed in g/cm^3.

$$\mathrm{DA} = \frac{m_2 - m_1}{V_t}. \qquad (1)$$

Total porosity (PT) had determined by mathematical calculation according to formula:

$$\mathrm{PT} = \left(1 - \frac{\mathrm{DA}}{D}\right), \qquad (2)$$

and the results had expressed in% by volume (% v/v).

Aeration porosity (PA) had determined by mathematical calculation according to

$$\mathrm{PA} = \mathrm{PT} - \mathrm{CC} \times \mathrm{DA}, \qquad (3)$$

and the results had expressed in% by volume (% v/v).

Compressibility of soil: had determined in laboratory by the method of test in the endometrium (Stanciu & Lungu, 2013). The main feature of the compressibility test is the fact that deformation lateral of soil sample is completely prevented. On the basis of test results, compressibility in the endometrium can be drawn as compressive-compaction curve. With the curve help we shall determined: specific compaction:

$$\varepsilon_i = \frac{\Delta h_i}{h_0} \times 100, \qquad (4)$$

where: ε_i is the compaction for each level of loading stage, is expressed in%; Δh_i – compaction sample recorded on microcomparator, under the load stage; h_0 – initial height of the sample.

The initial moisture content of the soil (W) or the water content in the soil, it is amount of water which is physical linked with the soil matrix and which was evaporated to 105ºC. The soil was dried at 105ºC till constant weight and then it had weighed. The weight difference obtained before and after drying, is the humidity expressed as a percentage.

The degree of humidity (Sr)**:** the initial degree of moisture is defined as the ratio between the volume of water contained in the soil pores and the total volume of the pores in that soil,had determined during the test endometrium:

$$\mathrm{Sr} = \frac{\rho_s}{e_0 \rho_w} \cdot \frac{w}{100}, \qquad (5)$$

where: ρ_s is the skelett density; e_0 – the index of the initial pore; ρ_w – the density of water; w – humidity of the soil sample in their natural state.

Pore index (e0) had determined by mathematical calculation according to formula:

$$e_0 = \frac{\mathrm{PT}}{100 - \mathrm{PT}}, \qquad (6)$$

where: PT is the total porosity of the soil.

3. Results and discussion

The results obtained by the laboratory analyzes and mathematical calculations, give us the possibility to define the both soils studied in terms of: texture, total porosity, degree of compaction, moisture and pore index. These results are showed in Table 1.

In Table 1, the notations Sa1, Sa2, Sa3, Sa4 represents soil samples from cultivated area, on the depths of 0,…,25 cm, 25,…,50 cm, 50,…,75 cm, 75,…,100 cm. Samples of the soil control, had taken from the perimeter which was not cultivated, had denoted with M1, M2, M3 and M4, for the depths of 0,…,25 cm, 25,…,50 cm, 50,…,75 cm, 75,…,100 cm.

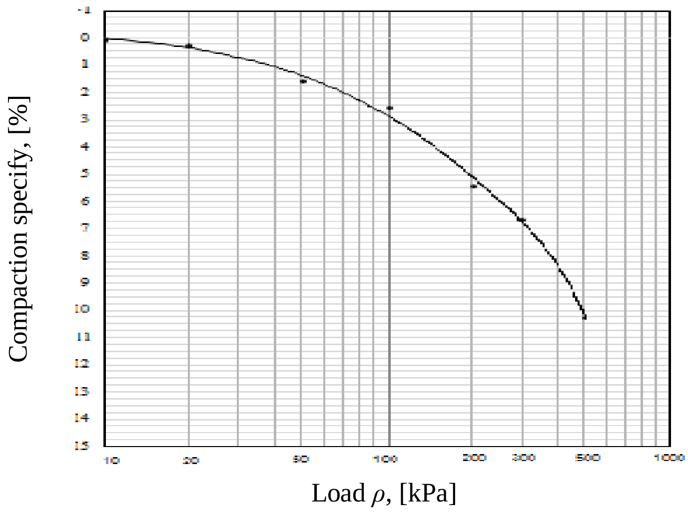
Table 1

Analytical Data on the Physical Properties of Soils in the Studied Area

	UM	Sa1 (0-25 cm)	Sa2 (25-50 cm)	Sa3 (50-75 cm)	Sa4 (75-100 cm)	M1 (0-25 cm)	M2 (25-50 cm)	M3 (50-75 cm)	M4 (75-100 cm)
Gravel (>2mm)	%g/g	-	-	-	-	-	-	-	-
Coarse sand (0,5mm<d<2mm)	%g/g	-	-	-	-	-	-	-	-
Medium sand (0,25mm<d<0,5mm)	%g/g	-	-	-	-	-	-	-	-
Fine sand (0,05mm<d<0,25mm)	%g/g	8,17	8,17	6,14	4,85	4,25	2,60	4,25	4,25
Silt (0,005mm<d<0,05mm)		43,21	43,35	29,93	35,99	39,20	63,34	26,23	30,04
Clay (0,002mm<d<0,005mm)	%g/g	23,58	20,37	18,92	16,31	41,19	26,81	23,11	25,48
Fine clay(<0,002mm)	%g/g	25,04	28,12	45,01	42,84	15,36	7,25	46,41	40,23
Textural class	-	Clay	Clay	Loamy clay	Loamy clay	Clay	Silty-clay	Loamy clay	Loamy clay
Bulk density	g/cm^3	1,69	1,81	1,66	1,70	1,79	1,81	1,89	1,84
Total porosity	%v/v	49,86	42,27	47,31	48,24	49,79	44,88	42,06	42,89
Degree of compaction	%v/v	10,4	6,85	5,3	6,3	10,3	4,85	2,7	5,85
Content of moisture	%	25,19	16,10	16,59	21,84	32,12	21,79	20,73	19,02
The degree of humidity	%	0,68	0,59	0,50	0,63	0,87	0,72	0,77	0,68
Pore index	%	0,99	0,73	0,90	0,93	0,99	0,81	0,73	0,75

After analysis of particle size, the both soils had denoted Sa and M, had classified as belonging to the textural clay and clay-loam classes (Nițu *et al.*,1986). The soil is characterized by a content of clay between 48.60 to 65%, of cultivated soil. For the control soil the clay content values falls between 56 and 69.2%. The resulting data are in agreement with the specialty literature, which describes broadly, the soils of common meadow the Prut- Jijia river as fine textured soils.

Bulk density values range between 1.66 to 1.81% for the cultivated soil and 1.79 to 1.89 for the control soil. It was observing that the density values increase with the depth, and the fact that the cultivated soil density has values lower compared to control soil, confirm the fact that tillage have a role in improving the physical properties of the soils.



NATURAL

Load, [kPa]	10	20	50	100	200	300	500
Readings, [10^{-2}mm]	2	6	31	51	108	133	205
Compaction specify, [%]	0,1	0,3	1,55	2,55	5,4	6,65	10,3

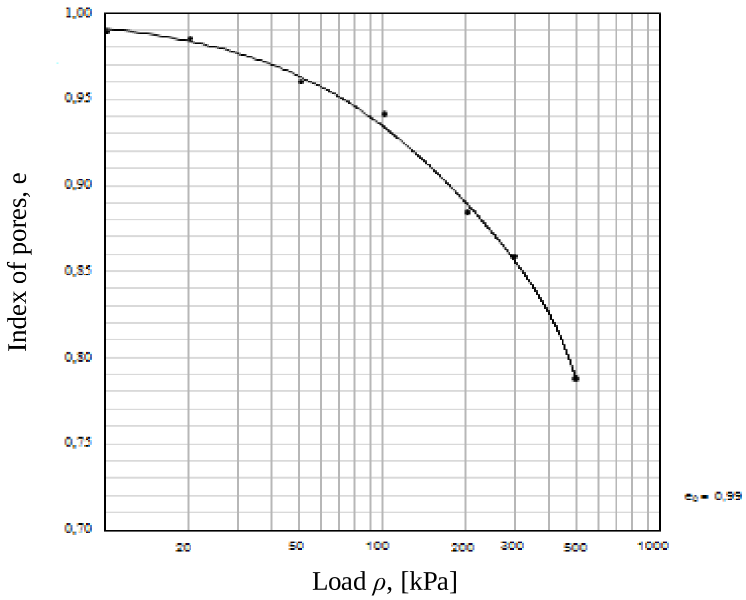
UNLOADING

Load, [kPa]	500	200	100	50	20	10
Readings, [10^{-2}mm]						
Compaction specify, [%]						

Fig. 5 – Compressive-compaction curve for sample M1.

The soil with porosity values of less than 50%, large values of density and a fine texture, will negatively affect the retention capacity of the water, the permeability, aeration and the ratio drainage/water infiltration (Thomsen *et al.*, 1999). Total porosity values for the cultivated soil falls between 42.27 to 49.86, the highest value being recorded in the 0,…,25 cm layer.

The porosity values of the control soil are smaller than cultivated soil and decrease with the depth. This fact happens because the cultivated soil becomes loose and also increase the organic matter content.



NATURAL

Load, [kPa]	10	20	50	100	200	300	500
Readings, [10^{-2}mm]	2	6	31	51	108	133	205
Compaction specify, [%]	0.1	0.3	1.55	2.55	5.4	6.65	10.3
Index of pores, e	0.99	0.99	0.96	0.94	0.88	0.86	0.79

UNLOADING

Load, [kPa]	500	200	100	50	20	10	
Readings, [10^{-2}mm]							
Compaction specify, [%]							
Index of pores, e							

Fig. 6 – Compressive-porosity curve for sample M1.

The soils with a high clay swells strongly in the presence of water, which reduces the water permeability. The low permeability leads to stagnation of water in the soil and at the soil surface. This is accompanied by a number of processes and transformations under anaerobic conditions (Gardner, 1986). The results obtained regarding the soil moisture and soil the degree of humidity, confirms this assertion.

Results obtained after the determination of compressibility, allowed drawing compressive-compaction curve (Fig. 5), respectively compressive-porosity (Fig. 6). Based on the results for all eight soil samples analyzed the soils was classified as soft plastic clays with high compressibility, this characteristic making him hard to cultivate and for civil construction requires a special approach to of the calculation methods (Pastia, 2004).

4. Conclusions

The analysis of the results obtained from conducted research, allow us issuance the following conclusions:

1. According to the analysis of particle size, the soil present fine texture.
2. The soils present high values of bulk density, lower value of porosity, with high degree of compaction, these qualities printing a low water a permeability of soils
3. Soils are characterized by a high degree of humidity, water stagnation at the surface and inside the soil horizons.
4. Corroborating these dates allow us the characterization of these soils from the point of view of physical features. Same dates are used in the calculation of the water stocks, chose agrotechnical applications and in the calculation of the amendments.

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CERCETĂRI PENTRU CARACTERIZAREA FIZICĂ A UNUI SOL SALINIZAT

(Rezumat)

Această lucrare are ca scop analiza solului salinizat din zona Osoi-Moreni, comuna Prisăcani, judeţul Iaşi, din punct de vedere al proprietăţilor fizice ale acestor soluri. S-au luat în cercetare două perimetre: unul cultivat în prezent cu culturi de porumb (*Zea mays*), iar cel de al doilea sol provine dintr-un perimetru necultivat, ce nu a suferit lucrări agricole de aproximativ şapte ani.

Metodele de analiză a însuşirilor fizice ale solurilor salinizate sunt instrumente utile în diagnosticarea, monitorizarea şi controlul calităţii solurilor salinizate care sunt date în folosinţă agricolă.