ASSESSEMENT OF SOIL QUALITY THROUGH PHYSICAL AND CHEMICAL ANALYSES

Claudia Ionela TARCEA[1], Daniela Ioana STEFAN[2], Andreea TURCANU[3*], Ecaterina MATEI[4], Andra PREDESCU[5], George COMAN[6], Cristian PREDESCU[7]

This paper presents the results of the soil quality collected in Romania, Dâmbovița district. Soil analyses were performed for 7 soil samples, used for rapeseed and wheat crops, and 2 soil samples from an arid area. Since the physical and chemical properties influence the crop yield, for all soil samples the following analyses were determined: pH, conductivity, and quantity of elements, including nutrients. In this context, the results show an acidic capacity of soil (pH between 4.74–7.03), low values of electrical conductivity (EC) (159–608) as a measure of the salinity of soil and a significant concentration of Fe, Ca, K, Mg, Na and Zn.

Keywords: quality, soil, electroconductivity, XRF analysis

1. Introduction

Soil is one of the three environmental factors, being the link between the biosphere and the lithosphere, having a key role for the environment and for agriculture. Knowing that soil is a major source of nutrients needed for sustainable plant production, it is very important to understand the interactions between nutrients-soil-plants [1, 2]. Thus, an important factor in nutrient management and environmental assessment is soil analysis, which provides essential information about its characterization and fertility [3]. Soil characterization contains information about pH, texture, percentage of organic

[1] Center for Research and Eco-Metallurgical Expertise, University POLITEHNICA of Bucharest, e-mail: tarceaclaudia@yahoo.com
[2] Center for Research and Eco-Metallurgical Expertise, University POLITEHNICA of Bucharest, e-mail: danyvevy20@gmail.com
[3*] Center for Research and Eco-Metallurgical Expertise, University POLITEHNICA of Bucharest, e-mail: andreea.turcanu90@yahoo.com
[4] Faculty of Materials Science and Engineering, University POLITEHNICA of Bucharest, e-mail: ecaterina.matei@ecomet.pub.ro
[5] Faculty of Materials Science and Engineering, University POLITEHNICA of Bucharest, e-mail: andra.predescu@ecomet.pub.ro
[6] Faculty of Materials Science and Engineering, University POLITEHNICA of Bucharest, e-mail: George.coman@ecomet.pub.ro
[7] Faculty of Materials Science and Engineering, University POLITEHNICA of Bucharest, e-mail: predescu@ecomet.pub.ro

matter and salinity as electroconductivity, while fertility includes information about the nutrients available to the plant. Soils are usually analyzed for primary nutrients such as nitrogen (N), phosphorus (P) and potassium (K), primary cations such as magnesium and calcium (Mg and Ca) and micronutrients such as zinc, manganese, chlorine and copper (Zn, Mn, Cl, Cu) [4, 5]. Because soils are defined as nutrient-poor soils or soils that have a sufficient amount of nutrients but can be removed at harvest fertility plays an important role in its nutrient enrichment [6]. According to Marianna Makádi, a new method of enriching the soil with nutrients takes place through the use of digestate [7]. Thus, it is considered to be a new source of nutrients. Digestate is the material left after the anaerobic digestion of a biodegradable raw material and can be used as a fertilizer for plants [8, 9]. Specifically, anaerobic digestion (AD) is a biological process that transforms organic matter into two final products: the desired product (biogas) and a solid-liquid by-product (digested) [10]. According to studies, it has been observed that the use of digestate increases the content of macro and microelements in soil and plants, not having a negative effect on the soil [11].

One factor that can influence the absorption of nutrients in plants is pH. Thus, according to RS Yost [12], when the soil pH is maintained at the appropriate level, the availability of plant nutrients is optimized, the solubility of toxic elements is minimized and the beneficial organisms in the soil are the most active

Therefore, taking into account the fact that the physical and chemical properties influence the crop yield, this paper was designed to evaluate the quality of the soil collected in Romania, Dâmbovița district, by performing a set of analyses.

Study area

The agricultural farm is located central-southern area from Romania, in Dâmbovița district, Racari city, Balteni village. The agricultural lands cover a total area of 717 hectares, being divided into several fields on different areas. The visual analysis of the soil indicates a clay-sandy aspect (sand to loam), specific to the plain area where it was found the presence of a gravel cover of variable thickness over which loessoid or meadow deposits are located.

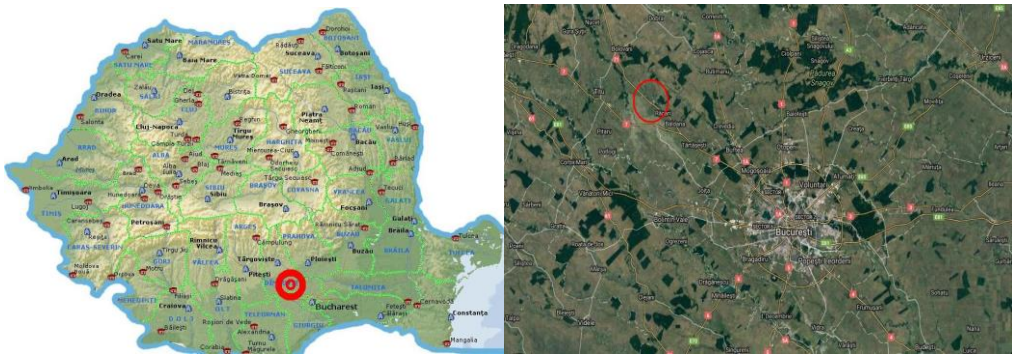

Fig. 1. Farm location. Satellite view

Over time, the most fertile soils in the county were formed on these deposits. The loess consists largely of fine sand and siliceous and clayed dust. The located area is shown in the Fig.1.

2. Experimental section

Soil analyses were performed for a number of 9 soil samples. The following samples were investigated:

-4 soil samples from rapeseed crop, at 0 and 30 cm height, from 2 different areas (see Fig. 2);

-3 soil sample from wheat crop, from 3 different areas (see Fig. 3);

-2 soil samples from an arid area without crops during 2 years period (see Fig. 4).

Fig.2 Green area, soil from rapeseed

Fig.3 Red zone, wheat crop soil

Fig.4 Yellow area, soil on an uncultivated agricultural land for 2 years

The processed soil samples were analyzed for the basic soil parameters: nutrients, pH and electroconductivity in the UPB-ECOMET laboratory, Romania.

In order to establish pH and conductivity values of soil, a Consorte C862 benchtop conductivity/pH/DO meter was used. For pH analysis the procedure was developed according to SR ISO 10390:2015 [13]. Thus, an instrumental method of routine pH measurements was applied, using a glass electrode in a 1: 5 suspension (volume fraction) of soil in water, after weighing of about 10 g of soil. For determination of electric specific conductivity, according to SR ISO

11265+A1:1998 [14], an aqueous soil extract was used, in order to obtain a specific value for electrolytes content as salinity indicator.

To determine the nutrient concentrations, the soil samples were dried, homogenized, weighed and analyzed using the Tiger S8 XRF X-ray fluorescence spectrometer. Each sample was analyzed through a small plastic cup covered with mylar film and the concentration of the elements was expressed as an elementary percentage.

3. Results

The results of all the relevant soil characteristics collected from Balteni village are presented in Table 1. These values show an acidic capacity of soil (pH in the range 4.74–7.03) and low values of electrical conductivity (EC) (159 – 608) as a measure of the amount of salts in soil (salinity of soil). Low EC values indicate a poor salinity of soil, according to Salimi et al., [15]. The XRF results for the collected soil samples highlighted the existence of the following elements Fe, Ca, K, Mg, Na and Zn present in the descending order of concentrations as follows: Fe> K> Ca> Mg> Na> Zn. A critical role in the absorption and use of macro and microelements essential for healthy plant growth depends on soil pH.

Table 1

pH and electroconductivity and nutrients values for soil samples

Sample	pH	EC [µS/cm]	Observations*	Elements (%)					
				Fe	K	Ca	Mg	Na	Zn
P1	5,91	207	Slightly acidic, non-saline soil	4.3	2.2	0.86	0.67	0.57	0.01
P2	5,7	212	Moderate acid soil	4.14	2.11	0.97	0.57	0.56	-
P3	5,61	305	Moderate acid soil	4.37	2.2	0.85	0.67	0.53	0.01
P4	5,64	327	Moderate acid soil	4.34	2.16	0.85	0.66	0.5	-
P5	6,71	658	Slightly acidic soil with salts	5.41	2.18	1.25	0.83	0.32	0.02
P6	7,03	688	Slightly acidic soil with salts	5.69	2.28	1.28	0.86	0.31	0.02
P7	6,85	680	Neutral soil with the presence of salts	5.88	2.29	1.41	0.93	0.41	0.02
P8	4,74	167	Strongly acidic soil	4.4	2.18	0.62	0.63	0.47	0.01
P9	4,82	159	Strongly acidic soil	4.29	2.12	0.6	0.59	0.46	0.01

**The soil samples have sand to loam texture*

According to Whitney, there is a relationship between conductivity and degree of salinity, depending on texture soil [16]. Thus, for a sand to loam texture,

the EC values are situated between 0 and 1.200 µS/cm for non-saline soils, values that are corresponding for all investigated samples. It should be noted that some valuable EC values were obtained for soil samples from the red area (P5, P6, P7) highlighted in Table 1 with values over 600 µS/cm. In these samples the presence of some important salts with nutrient role is higher in comparison with other analyzed samples (P1, P2, P3, P4, P8 and P9).

Also, a critical role in the absorption and use of macro and microelements essential for healthy plant growth depends on soil pH. Thus, the high content of Ca, Mg and Fe are closely correlated with the almost neutral pH value of the samples, indicating a balanced composition of the soil with nutrients (Ca, Mg, Fe) that ensure its fertility and the possibility of plant growth [17]. More, the recorded EC values suggest the formation of salts of these elements contributing to the ion exchange capacity of the soil.

Generally, all soils contain water soluble salts which include essential nutrients for plant growth, but on the other hand an excess of total soluble salts indicates a saline soil that usually affect soil processes and productivity.

From this point of view the analyzed soil samples indicate a poor capacity to store and hold cations and lose nutrients easier than silty and clayey soils. In order to use this soil for agriculture it is compulsory a management strategy development including nutrient use, fertility growing and productivity.

4. Conclusions

Soil quality in Romania was investigated through a set of analyses. The results in the red zone (P5, P6 and P7) indicate neutral pH values, results that are correlated with the values obtained for electroconductivity. Also, in soils where the presence of the elements is high and the values of electroconductivity are high, it suggests that in these areas agricultural crops can be further developed. As for the other areas where the presence of the elements and the conductivity values are low, they can be enriched with digestate and subsequently analyzed.

R E F E R E N C E S

[1] *W. H. Schlesinger and A. M. Pilmanis*, "Plant-soil interactions in deserts", Biogeochemistry, vol. 42, 1998, pp. 169-187.

[2] *C. Popescu (Popiniuc), C. Popescu, S. Manea, V. Vladut, I. Caba, I. C. Covaliu, H. Abbas, A. Dune, D. Lupuleasa*, "Study on Portulaca Oleracea Native Species as Vegetal Source of Omega-3 and Omega-6 Fatty Acids", Revista de Chimie (Rev. Chim.), vol. 69, 2018, pp. 2973-2980.

[3] *D. Geisseler and G. Miyao*, "Soil testing for P and K has value in nutrient management for annual crops," California Agriculture, vol. 70, 2016, pp. 152-159.

[4] *E. Vasile, C. I. Covaliu, O. Stoian, G. Paraschiv, E. Matei, G. A. Catrina (Traistaru), A. Ciric*, "Manganese Ions Removal from Industrial Wastewater", Revista de Chimie (Rev. Chim.), vol. 71, 2020, pp. 391-396.

[5] *S. Hemidouche, L. Favier, A. Amrane, P. Dabert, S Le Roux, Z. Sadaoui*, "Successful Biodegradation of a Refractory Pharmaceutical Compound by an Indigenous Phenol-Tolerant Pseudomonas aeruginosa Strain", Water Air Soil Pollut, Vol. 229, 2018, pp. 229-103.

[6] *A. P. Mallarino, D. J. Wittry, and P. A. Barbagelata*, "Iowa soil-test field calibration research update: Potassium and the Mehlich-3 ICP phosphorus test. p," in In North-Central Extension-Industry Soil Fertility Conf. Proceedings. Vol. 17. Des Moines, IA, 2002.

[7] *M. Makádi, A. Tomócsik, and V. Orosz*, "Digestate: a new nutrient source–review," Biogas, vol. 295, 2012, p. 312.

[8] *M. Koszel and E. Lorencowicz*, "Agricultural use of biogas digestate as a replacement fertilizers," Agriculture and Agricultural Science Procedia, vol. 7, 2015, pp. 119-124.

[9] *T. Eickenscheidt, A. Freibauer, J. Heinichen, J. Augustin, and M. Drösler*, "Short-term effects of biogas digestate and cattle slurry application on greenhouse gas emissions affected by N availability from grasslands on drained fen peatlands and associated organic soils", Biogeosciences, vol. 11, 2014, p. 6187.

[10] *F. Cecchi, P. Traverso, J. Mata-Alvarez, J. Clancy, and C. Zaror*, "State of the art of R&D in the anaerobic digestion process of municipal solid waste in Europe", Biomass, vol. 16, 1988, pp. 257-284.

[11] *M. Odlare, M. Pell, and K. Svensson*, "Changes in soil chemical and microbiological properties during 4 years of application of various organic residues", Waste management, vol. 28, 2008, pp. 1246-1253.

[12] *R. Yost and R. Uchida*, "Interpreting soil nutrient analysis data," Plant Nutrient Management in Hawaii Soils. JA Silva, and RS Uchida (eds.). College of Tropical Agriculture and Human Resources, University of Hawaii, *Honolulu, HI*, 2000, pp. 87-94.

[13] SR ISO 10390:2015, Calitatea solului. Determinarea pH-ului

[14] SR ISO 11265+A1:1998, Calitatea solului. Determinarea conductivităţii electrice specific

[15] *M. Salimi, M. M. Amin, A. Ebrahimi, A. Ghazifard, and P. Najafi*, "Influence of electrical conductivity on the phytoremediation of contaminated soils to Cd^{2+} and Zn^{2+}", International Journal of Environmental Health Engineering, vol. 1, 2012, p. 11.

[16] *J. R. Brown*, Recommended chemical soil test procedures for the North Central Region: Missouri Agricultural Experiment Station, University of Missouri--Columbia, 1998

[17] *Dora Neina*, "The Role of Soil pH in Plant Nutrition and Soil Remediation", Applied and Environmental Soil Science, 2019