Revista Română de Materiale / Romanian Journal of Materials 2014, ***44*** *(4), 375 – 381*

STUDIU PRIVIND VARIABILITATEA PROPRIETĂŢILOR CHIMICE ALE SOLULUI ÎN ROMÂNIA

STUDY ON VARIABILITY OF SOIL CHEMICAL PROPERTIES IN ROMANIA

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The paper presents studies regarding variability of soil chemical properties in Romania. Determination of soil physical and chemical properties is performed using laboratory instrumentation. The soil samples are taken directly from the field using specific instruments. The samples are generally stored in airtight plastic bags and vacuumed eventually. They are transported to the laboratory in order to be analysed or the analysis is immediately made with the aid of some portable analysers It is possible to increase the number of the soil samples and accuracy using VIS–NIR (Visible - Near Infrared Spectrophotometry) and scanning of agricultural surfaces with the aid of specialized equipment that simultaneously can scan the optical properties of the soil, temperature and soil moisture, all being stored in data files. Information obtained from a GPS device is added to files. In this way, the information is geospatial located in order to be also processed in terms of their position. On the other hand, this information can be used after their processing together with other factors to improve the soil quality from agronomic point of view and reducing its pollution. The experimental results on acquiring the soil spectra on a given surface, as well as, the achievement of maps afferent to them are also presented.

Lucrarea prezintă cercetări privind variabilitatea proprietăţilor chimice ale solului din România. Determinarea proprietăţilor fizice şi chimice ale solului se realizează cu ajutorul instrumentelor de laborator. Probe de sol sunt luate direct din teren, folosind instrumente specifice. Probele sunt în general depozitate în pungi de plastic închise ermetic şi eventual vacuumate. Acestea sunt transportate la laborator pentru a fi analizate sau analiza este imediat realizată cu ajutorul unor analizoare portabile. Este posibil să se mărească numărul de probe de sol şi precizia folosind spectroscopia VIS - NIR (Vizibil-infraroşu apropiat) şi scanarea suprafeţelor agricole cu ajutorul echipamentelor specializate, care în acelaşi timp poate scana proprietăţile optice ale solului, temperatura şi umiditatea acestuia, datele fiind stocate în fişiere. Informaţiile obţinute de la un dispozitiv GPS sunt adăugate la aceste fişiere. În acest fel, informaţiile sunt geospaţiale pentru a fi prelucrate în ceea ce priveşte poziţia lor. Pe de altă parte, aceste informaţii pot fi utilizate după prelucrare, împreună cu alţi factori pentru a îmbunătăţi calitatea solului din punct de vedere agronomic şi a reduce poluarea. Rezultatele experimentale privind achiziţionarea spectrelor solului pe o suprafaţă dată, precum şi, realizarea hărţilor aferente acestora sunt, de asemenea, prezentate.

Keywords: *soil, soil variability,maps,VIS- NIR, GPS, pollution*

1. Introduction

In precision agriculture, soil sampling is used within the monitoring activities and determination of its properties. Soil sampling is the process of taking soil samples from an agriculture field. In order to determinatethe soil characteristics, soil sampling is done in compliance with agro technical specifications.

These enable to establish a uniform sampling into an agricultural field. It will be assimilated as 2D surface used in exact sciences (mathematics).

Soil sampling in an uniform way assumes that the samples must be taken at the same distance on *x* and *y* (*x*, *y* coordinates of the 2D surface). The location of sampling points represents the set of points that have the following property:

$$L = \left\{ \begin{matrix} (x_n, y_m) / \; x_n = n \cdot distx, y_m = m \cdot disty, \\ n, m \in \{1, 2, \dots N\}, distx, disty \in R \end{matrix} \right\} \quad (1)$$

The set of locations is finite and its size depends on the sampling rate on x and y.

As the sampling rates are lower, the size of this set increases.

In general, farms use very high rates for the sampling locations that may be at a location on a hectare to a location of several hectares.

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We have sampling rates at distx≥100 m and disty≥100 m. Mainly, rates are settled based on the price / performance ratio. Especially, the usual mechanization technologies do not allow a variability of the nutrients distribution in the soil and then rules are established per hectare.Also, the distribution is achieved per hectare based on some mechanical adjustments of the equipment used for nutrients administration.

In the classic way, the samples density is about 1-4 samples / ha. Variations of soil properties occur at a much higher density of 1-4 samples / ha. Sampling can be done with much higher sampling rates, which can be almost continuous approximately 1 sample / (2-5m^2).

The experiments to be presented in this paper will demonstrate this aspect.

Soil sampling in the areas less than one hectare, i.e. a few square meters is possible by means of equipment designed to precision farming, that automatically sampling at varying distances, so that, it can realize scans of agricultural areas from the point of view of soil properties. This is possible by using GPS technology and spectrophotometry, information technology, performance temperature sensors, humidity, pH, as well as, other sensors (electroconductivity for example) that can highlight the link between the amount of nutrients in the soil and yield obtained. In this way, it can be managed the necessary of nutrients in the soil in the right location[1,2]. This is done in order to reduce the amount of nutrients (low costs) administrated and also reducing the soil pollution when administering chemical nutrients instead of organic nutrients.

In this way new technologies have been developed, some of which are widely applied and other are still in the research phase.

One of the technologies is based on electroconductivtivity determination and soil pH by scanning the soil using specialized machinery. Veris Technologies U.S. Company has developed a range of equipment for this purpose.

Another technology is based on the determination of soil properties using near infrared spectrophotometry [3].

Both technologies can be combined into single complex equipment that provides complex information about soil properties (pH, electrocoductivity, temperature and soil moisture, spectrophotometric information about soil, geospatial coordinates of the samples and sampling moments (time)). One of the problems to be solved in this case is the synchronization of the two technologies. This can be achieved by means of a GPS device with multiple serial outputs (for example Garmin 17 from Garmin Company USA). An image of such equipment is shown in Figure 1.

Likewise, the mapping of agricultural yields constitutes another technology that can be correlated with those two or used independently.

Fig. 1 - Complex combined equipment for scanning of the soil properties / *Echipament combinat complex pentru scanarea proprietăților solului.*

Based on the numerically processed digital maps, according to agro-technical requirements will be accurately distributed in sufficient amounts the necessary of nutrients for each crop and each "position" by means of precision distribution technologies [4].

2. Matherial and methods

There are many methods to soil sampling like soil sampling at equal distance [5]. From a surface of quadratic form about 0.8 ha has been sampled soil at equal distances in about 25 sampling points which represents the nodes of a grid as is shown in Figure 2:

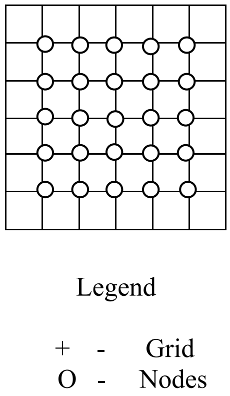


Fig. 2 - The grid and sampling nodes/*Rețeaua şi nodurile de eşantionare.*

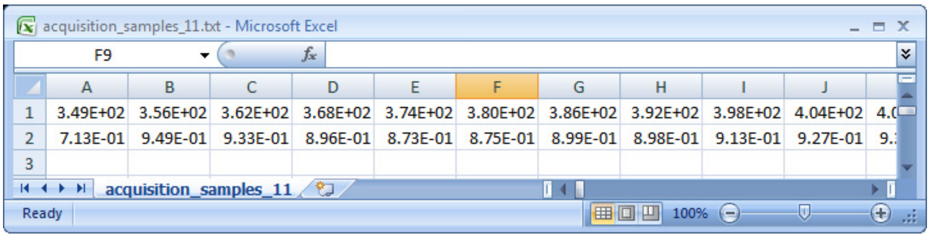
Sampling depth was of 10 cm. For soilssamplings were used specific tools [6]. After sampling, each soil sample was inserted in two closed plastic boxes constituting two sets of samples. One set was sent to the laboratory for chemical analysis (the value of main constituting components). The other set has been analysed using a spectrophotometer on a VIS-NIR equipment (Veris Technology company USA) for spectral determination of absorbance (Figures 3 and 4)

Fig. 3 - Preparing sample for analysis/*Pregatirea eşantioanelor pentru analiză.*

Fig. 4 - Analysis and data processing of a soil sample/*Analiza şi prelucrarea datelor unui eşantion de sol.*

For a sample, the data obtained using VIS-NIR spectrophotometer has the following structure:

- the first row represents the wavelength of VIS-NIR radiation;
- the second row represents the absorbance of the soil.



	A	B	C	D	E	F	G	H	I	J	
1	3.49E+02	3.56E+02	3.62E+02	3.68E+02	3.74E+02	3.80E+02	3.86E+02	3.92E+02	3.98E+02	4.04E+02	4.0
2	7.13E-01	9.49E-01	9.33E-01	8.96E-01	8.73E-01	8.75E-01	8.99E-01	8.98E-01	9.13E-01	9.27E-01	9.
3											

Fig. 5 - Example of file containing the spectroscopic analysis of a soil sample/*Exemplu de fişier care conține analiza spectroscopică a unui eşantion de sol.*

The experimental data obtained have been processed and represented in the form of spatial distribution maps of spectral amplitudes of absorbance at different wavelengths.

On the other hand, for each soil sample, the laboratory determined the components shown in Table 1. Also, the table 1 presents the results of statistical analysis of the components.

The statistical analyses of the experimental data from laboratory are based on the relations below [7]:

Mean:

$$\mu = \frac{1}{N}\sum_{i=1}^{N} x_i \qquad (2);$$

Standard deviation:

$$\sigma = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i-\mu)^2} \qquad (3);$$

Coefficient of variation:

$$C_v = \frac{\sigma}{\mu} \qquad (4);$$

Ratio between maximum value and minimum value:

$$r = \frac{Vmax}{Vmin} \qquad (5);$$

Distance between maximum value and minimum value:

$$d = \sqrt{(x_{max}-x_{min})^2 - (y_{max}-y)^2} \qquad (6)$$

3. Results and discussions

The Figures 6, 7 and 8 show the spectral distribution (absorbance)ofwavelengths for 600 nm,1200 nm and 1800nm.

The spatial maps presented in Figures 6 to 8 demonstrate the high degree of the spectra soil variability (the maps show a lot of "heals" and “valleys”). The soil spectra depend on its chemical properties [8].

Therefore variability of soil spectra implies the variability of soil properties.

The following components presented in the Table 1 have been analysed for each sample within the laboratory. The statistical analysis for every component is given bellow.

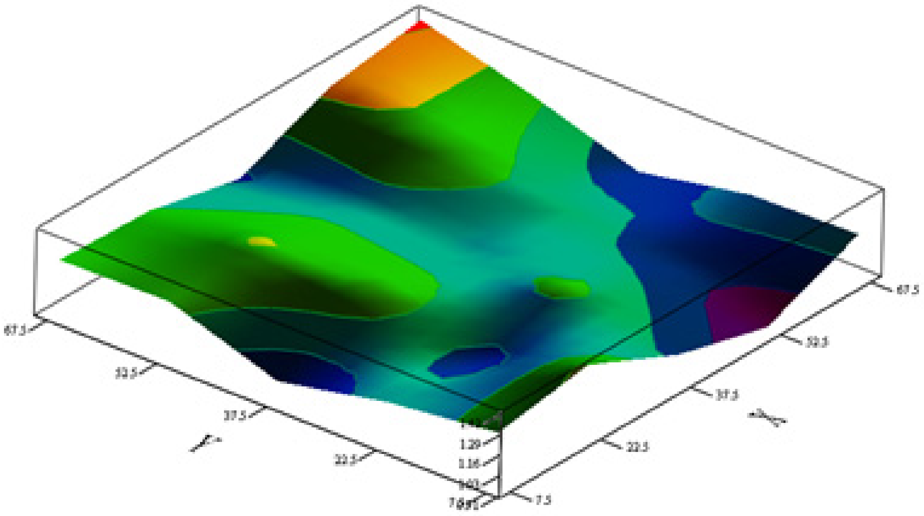


Fig. 6 - Spatial distribution of the soil spectral component of 600 nm (X[m], Y[m])/Distribuția spațială a componentei spectrale de 600 nm a solului (X[m], Y[m]).

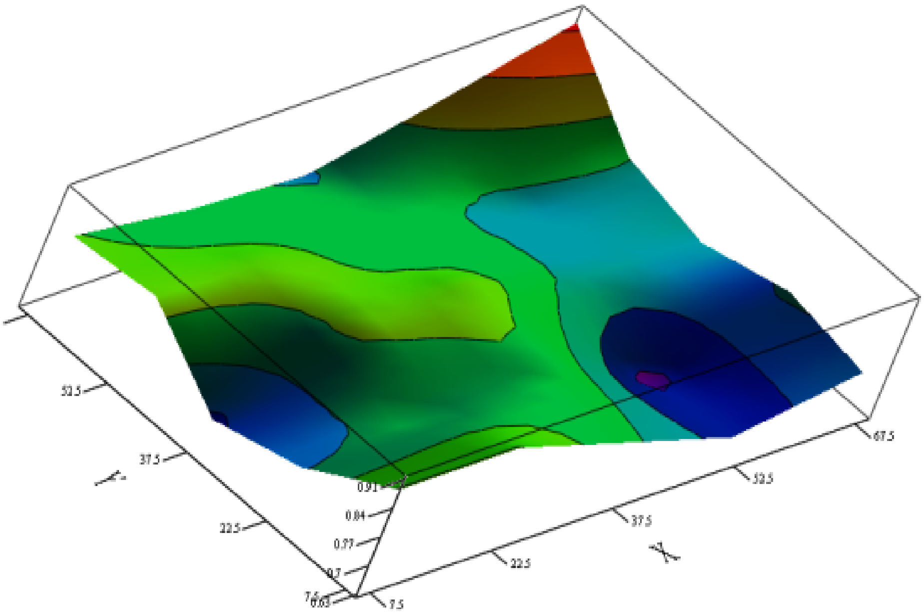


Fig. 7 - Spatial distribution of the soil spectral component of 1200 nm (X[m], Y[m]) /Distribuția spațială a componentei spectrale de 1200 nm a solului (X[m], Y[m]).

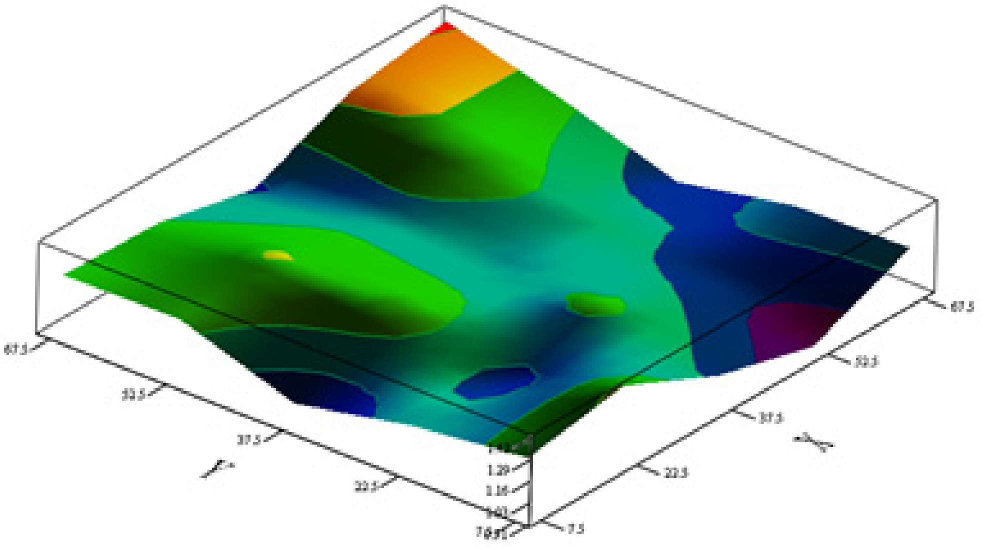


Fig. 8 - Spatial distribution of the soil spectral component for 1800 nm (X[m], Y[m])/Distribuția spațială a componentei spectrale de 1800 nm a solului (X[m], Y[m]).

Table 1

Statistical analysis/*Analiza statistică*

No./ *Nr.*	Component/*Componenta*	Ratio between maximum and minimum value/*Raportul dintre valoarea maximă şi minimă*	Distance between maximum and minimum value [m]/*Distanța dintre valoarea maximă şi minimă [m]*	Coefficient of variation/*Coeficientul de variație*
1	Total nitrogen [mg/kg DM]	2.6	30.92	0.28
2	Total phosphorus [mg/kg DM]	2.7	33.54	0.26
3	Total Organic Carbon(TOC) [%]	9.44	21.21	0.64
4	Magnezium [mg/kg DM]	1.86	15	0.13
5	Potassium [mg /kg DM]	1.96	61.85	0.15
6	Sodium [mg/kg DM]	2.35	42.43	0.2
7	Iron [mg/kg DM]	1.72	15	0.13
8	Aluminium [mg/kg DM]	2.16	30	0.17
9	Manganese [mg/kg DM]	1.48	61.85	0.09
10	Total chromium [mg/kg DM]	2.08	61.85	0.14

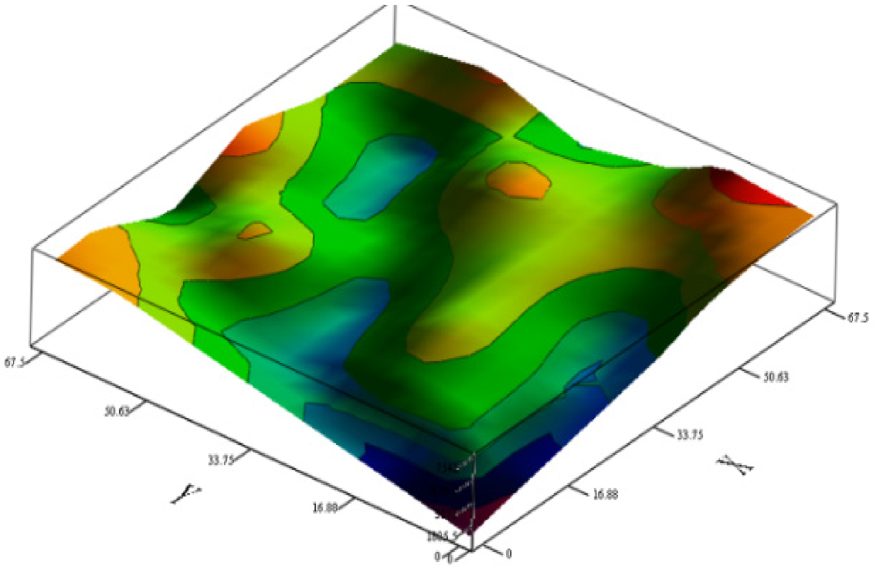


Fig. 9 - Spatial distribution map of total nitrogen/*Harta distribuției spațiale a azotului total.*

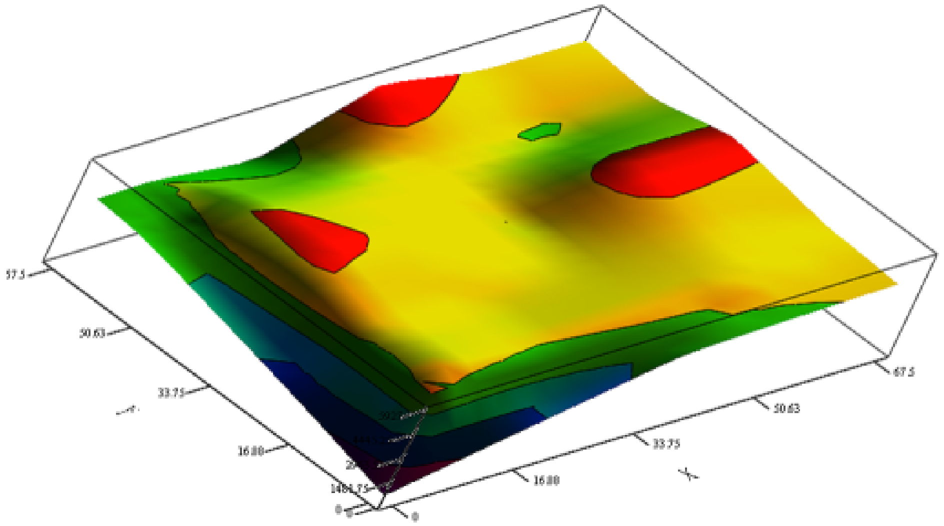


Fig. 10 - Spatial distribution map of magnezium])/ *Harta distribuției spațiale a magneziului.*

The maximum distance between maximum and minimum value of the components = 61.85 m. Minimum distance between maximum and minimum value of the components= 15.00 m (the sample rate was 15 m for x and 15 m for y).

The ratio between maximum and minimum value is minimal for manganese and has the value 1.48.

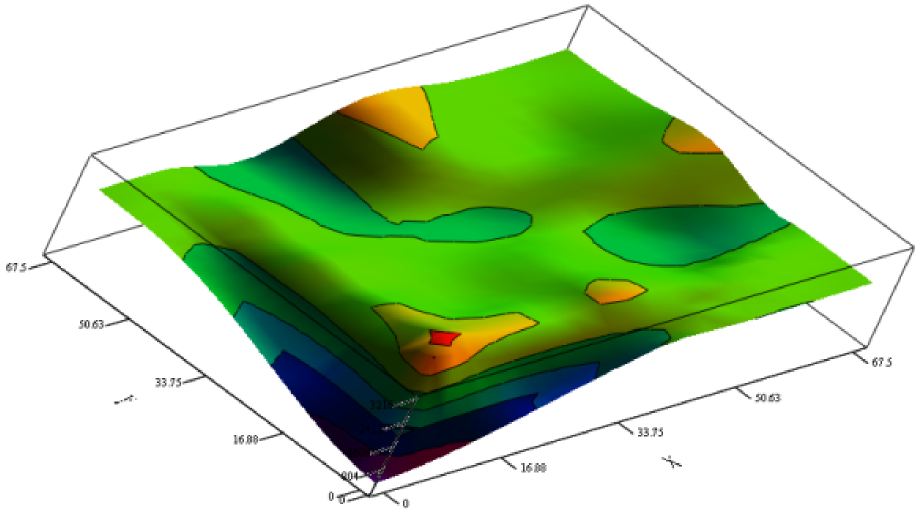


Fig. 11 - Spatial distribution map of potassium
Harta distribuției spațiale a potasiului.

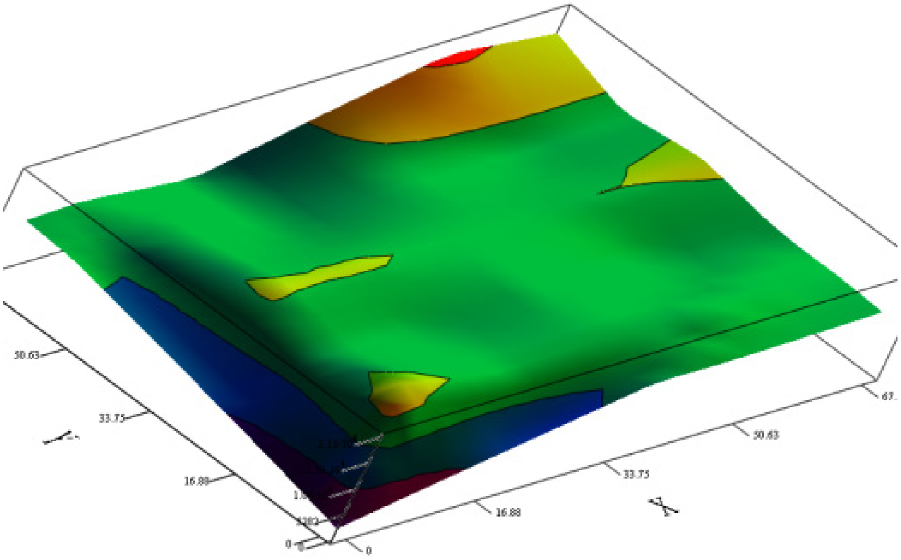


Fig. 12 - Spatial distribution map of aluminium)
Harta distribuției spațiale a aluminului.

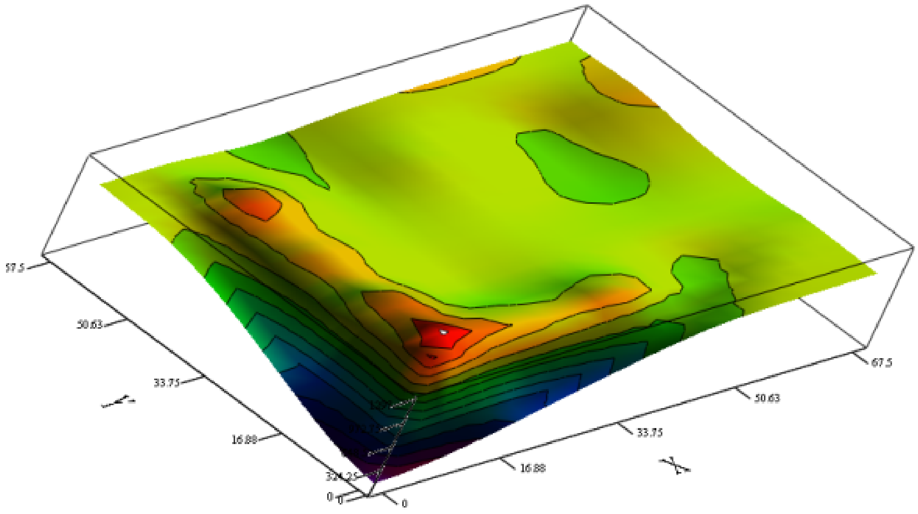


Fig. 13 - Spatial distribution map of manganese])
Harta distribuției spațiale a manganului.

This ratio shows that, the maximum value is bigger than the minimum value of about 50 %. The ratio between maximum and minimum value is maximum for TOC and has the value 9.44. This ratio shows that, the maximum value is bigger than the minimum value of about nine times.

All remarks regarding to distance and ratio show the variability of the soil.

The values of the variation coefficient show the soil properties variability on a smallsurface even less 15 sqm.

The maps with spatial distribution for few analysed components are shown in the figure 9 to 14 to see the variability of the spoil properties.

The spatial maps presented in Figures 9 to 14 also demonstrate the high degree of the soil variability within the conducted experiment (the maps show a lot of “heals” and “valleys”)

4. Concluzii

The soil variability at lower resolutions than consideredin conventional agricultureconstitutes the base of precision technologies implementation in the crops of various plants. The nutrients variation in the soil on smaller areas determining taking in consideration of geospatial positions of the soil samples.This establishes that, one of the precision farming base to be information systems based on GPS (Global Positional System), so-called Geographic Information Systems (GIS).

The analysis of correlations between the soil spectra determined by spectrophotometry and soil components analysed in the laboratory may lead to new direct methods for estimating their, based on calibrations with standard components.

Development of research in this direction is opportune. Modern agricultural technologies and precision farming in particular, through a multidisciplinary approach and high-tech elements involvement will contribute to the current major challenges: sustainable development and limitation of climate change.

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MANIFESTĂRI ŞTIINȚIFICE / SCIENTIFIC EVENTS

HPFRCC-7: 7th RILEM Conference on High Performance Fiber Reinforced Cement Composites
From 01 June 2015 to 03 June 2015, Stuttgart, Germany

OBJECTIVES AND SCOPE:

High Performance Fiber Reinforced Cement Composites (HPFRCC) represent a class of cement composites whose stress-strain response in tension undergoes strain hardening behaviour accompanied by multiple cracking, and leading to a high strain capacity at peak stress. Other indicators may be strength, toughness, ductility, elastic modulus, crack width, fatigue, durability and others. Their scope includes ultra-high performance fiber reinforced cement composites. The primary objectives of this workshop are to provide a compendium of up-to-date information on the most recent developments and research advances in the field of HPFRCC and UHP-FRC Composites; to allow a forum of world specialists to share their knowledge of and experience in such composites; to foster cooperation and technical exchanges between researchers and practitioners in the field; to identify current technical gaps as well as future research needs; and to suggest directions to follow.

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