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ASSESSMENT OF SOIL NUTRIENTS AVAILABILITY OF AN EXPERIMENTAL FIELD USED IN ORGANIC VEGETABLE CROPS FROM BUZĂU COUNTY, ROMANIA

Aurora DOBRIN[1], Andrei MOȚ[1], Marian MUȘAT[2], Roxana CICEOI[1], Roxana Maria MADJAR[2]

[1]Research Centre for Study of Food and Agricultural Products Quality, University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, 011464, Bucharest, Romania
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, 011464, Bucharest, Romania

Corresponding author email: auroradobrin@yahoo.com

Abstract

Macro and micronutrients status of soil is very important not only for plant grows and development (function of plant enzymes and biochemical processes and integrity of plant cells) but is also an indicator for soil fertility. Deficiency of nutrients in soil can lead to the crop yield reductions, while the excess can affect the plant quality and health. In this context, the aim of the study was to evaluate the macro and microelements (Na, Mg, K, Ca, Fe and Se) content in an organic experimental field from Buzău region, using ICP-MS method. The results reveal positive correlation between nutrients content and soil profile. Soil nutrient availability has a significant impact on organic crop production.

Key words*: ICP-MS, macronutrients, micronutrients, soil availability, soil fertility.*

INTRODUCTION

The chemical composition of plants reflects their requirements for environmental factors.
Carbon, hydrogen and oxygen represent over 90% from plant composition, being taken by plants from the atmosphere and water.
The rest of the elements are taken by the plants from the soil, as follows: 4.4% - the sum - N, P, S and K; 2.7% of the Na, Ca, Mg, Cl and 0.2-0.3% sum of microelements (Fe, Mn, Cu, Zn, B, Mo etc.).
Ca, Mg, K, Na, Cl in plants, participate in specific reactions related to enzyme formation and activation, which regulates the osmotic cell pressure, sweating, carbohydrate circulation and translocation. They participate in the synthesis of organic compounds (chlorophyll, carbohydrates, and proteins).
Fe, Cu, Mn are the important constituents of enzymes, participating in their formation and activation. They play a role in the resistance of plants to unfavourable conditions and in the formation of vitamins, pigments.
Zn and Mo are part of the organic complexes, chelates and regulators of oxidoreduction process in plants.
Plants can be found in the following states with nutrients: poor, normal, abundant, excess, and toxic), depending on the level of soil nutrition, physical and chemical properties, and climatic conditions.
In neutral and alkaline soils the permanent load is compensated by basic cations (Ca^{2+}, Mg^{2+}) (Lacatusu, 2016).
Very important for plants is the amount of essential nutrients in the soil, supply of soil with nutrients. It is a close link between the amounts of nutrients available to the plant (Florea, 2008).
Rich nutrient conditions reveal that vegetation grown in fertile soil can be more efficient in sequestering carbon, thereby combating greenhouse gas effects and global warming (Zhang et al., 2019).
The upward transport of nutrients by plants depends not just on the ratios of uptake to availability for each nutrient, but also on aboveground allocation (the greater the aboveground allocation by plants, the faster the upward transport).
Rooting depth could determine the total pool of nutrients subject to upward transport by plants, with pools below the maximum rooting depth

being relatively undepleted (Jobbagy et al., 2001)

There are strong relationships between soil physical properties and soil chemical properties. The nutrients held by the soil in this manner are called "exchangeable cations" and can be displaced or exchanged only by other cations that take their place. Soils with high cation exchange capacity (CEC) not only hold more nutrients, they are better able to buffer or avoid rapid changes in the soil solution levels of these nutrients.

For plant growth, most soil scientists agree that 50% pore space, 45% mineral matter, and 5% organic matter make up an ideal ratio.

Soils properties vary with the soil depth. Top soil is usually more fertile than the other layers and has the greatest concentration of plant roots. How much and when to apply fertilizers should be based on observing plant performance, a reliable soil test, and an understanding of the factors that affect growth: light, water, temperature, pests, and nutrition

The accumulation of extractable N, P, and exchangeable K, and the depletion of exchangeable Ca^{2+}, Mg^{2+}, and Na^{+} found under shrub canopies in arid ecosystems was determined also shown by Schlesinger et al. (1996) and Jobbagy et al. (2001).

For efficient fertilizer use and the resultant reduction of their loading on the environment, precise evaluation of nutrient availability and a better understanding of the nutrient dynamics in soil, which is primarily mediated by microorganisms, would be indispensable. Microorganisms can be highly responsive to nutrient availability (Fujita et al., 2019).

The soil content in different elements influence also the soil life evolution. Soil potassium content positively influence the abundance of soil fungi, either saprotrophic or ectomycorrhizal, as well as the presence of soil bacteria (Koorem et al., 2014).

The current research paper presents the soil nutrients analysis of the organic research field of the Vegetable Research and Development Station Buzău, offering valuable insights for further research studies on vegetables crop technologies. It also came into the help of farmers located in this famous vegetable basin, offering practical information about the fertilisation plan they should consider.

MATERIALS AND METHODS

The experiment was conducted in the organic research plot from Vegetable Research and Development Station Buzău, România (lat.:45.16108714 N and long: 26.82423914 E, alt: 92 m), in 2018. The soil belongs to the soil class of Calcaric alluvial soils, usually found on fluvial deposits (Muşat et al., 2018). The ground water is lower than 3 m.

Three soil surveys were taken up to a depth of 125 cm, with soil samples collected in plastic bags, than dried in the laboratory and milled.

The nutrients content analysis were made in the Research Centre for Study of Food and Agricultural Products Quality, University of Agronomic Sciences and Veterinary Medicine of Bucharest. For soil samples preparation (mineralization by microwave digestion) and quantification at ICP-MS (with MassHunter Workstation software), was followed the protocols used by Dobrin et al., 2018. The calibration curve was made with ICP-MS multi-element calibration standard that contain the following concentrations of the elements: 1000 µg/ml of Ca, Fe, K, Na and 10 µg/ml of Fe and Se in 5% HNO_3 (Yamanaka K. et al., 2014; Wilbur S. et al., 2015).

RESULTS AND DISCUSSIONS

The highest content of Mg (Figure 1) was found in 40-60 cm soil profile, like Fe and Se content (Figures 4, 5).

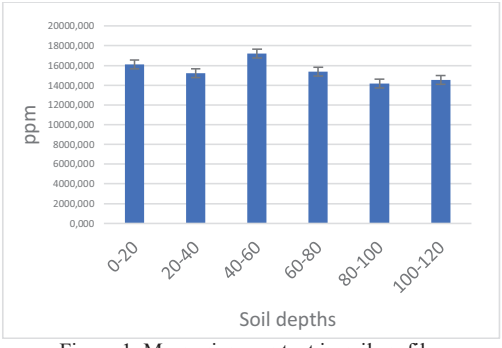

Figure 1. Magnesium content in soil profiles

Potassium it is an important macroelement that helps plants overcome drought stress, improves winter hardiness, increases disease resistance, improves the rigidity of stalks.

It was find the highest content in 0-20 cm soil profile, having decrees to 100-120 cm soil profiles (Figure 2).

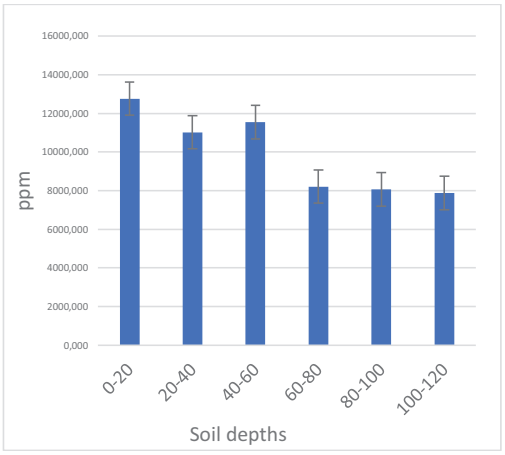

Figure 2. Potassium content in soil profiles

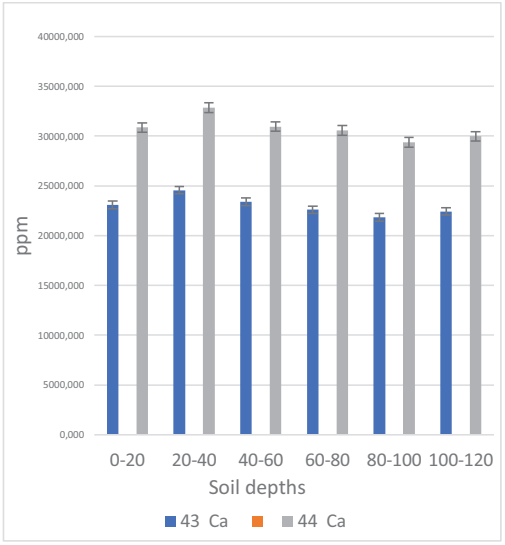

Figure 3. Calcium content in soil profiles (different isotopes)

The highest content of Ca was found in 20-40 cm soil profile (Figure 3).
Calcium it is an important macroelement, helps to bind organic and inorganic substances.
It is important in the development of a good soil structure, and for plants represent an important structural component of cells, present in cell walls, essential for growth of shoot and root tips

Microelements content
Iron it is a relatively immobile microelement being very important for the maintenance of chlorophyll.

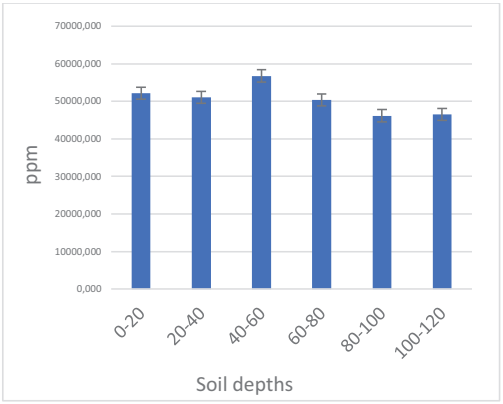

Figure 4. Iron content in soil profiles

As iron, selenium content, for its three isotopes (Figure 5), had the highest content for the 40-60 cm depth.

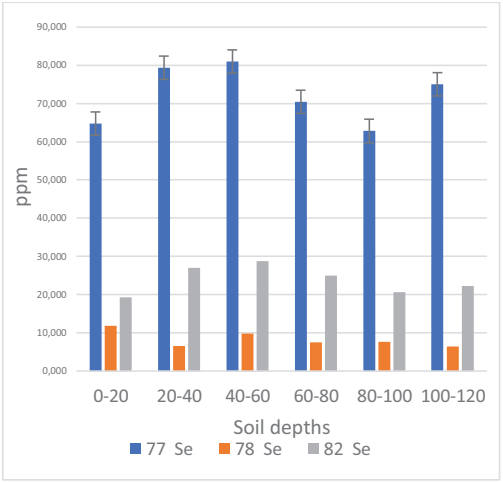

Figure 5. Selenium content in soil profiles (different isotopes)

It was find a very strong positive relationship between Na-K content (r = 0.947), Mg-Fe (r = 0.980). A strong correlation between Mg-K (r = 0.759), Na-Se (r = 0.782), K-Fe(r = 0.766), K-Se (r = 0.749) (Table 1).
It was find also a very strong positive relationship between all the soil profiles regarding nutrients composition (r = 0.998) (Table 2).

Table 1. Correlation between soil profile and nutrients content

Soil profile	*0-20*	*20-40*	*40-60*	*60-80*	*80-100*	*100-120*
0-20	1					
20-40	0.998	1				
40-60	0.998	0.995	1			
60-80	0.996	0.998	0.997	1		
80-100	0.996	0.9992	0.995	0.9995	1	
100-120	0.995	0.998	0.994	0.9993	0.999	1

Table 2. Correlation between macro and microelements content and soil profile

	23 Na	*24 Mg*	*39 K*	*43 Ca*	*44 Ca*	*56 Fe*	*77 Se*	*78 Se*	*82 Se*
23 Na	1								
24 Mg	0.592	1							
39 K	0.947	0.759	1						
43 Ca	0.523	0.455	0.656	1					
44 Ca	0.477	0.365	0.590	0.985	1				
56 Fe	0.561	0.980	0.766	0.577	0.497	1			
77 Se	-0.017	0.436	0.197	0.680	0.608	0.515	1		
78 Se	0.782	0.682	0.749	0.012	-0.049	0.585	-0.310	1	
82 Se	-0.144	0.494	0.146	0.615	0.576	0.614	0.884	-0.276	1

CONCLUSIONS

The results reveal positive correlation between nutrients content and soil profile. Soil nutrient availability has a significant impact on organic crop production. It was found that experimental field from Buzau have a very important content both in macro and microelements.

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