Analele Universităţii din Craiova, seria Agricultură – Montanologie – Cadastru (Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series) Vol. L/2020

STUDY REGARDING SOIL QUALITY INFLUENCE ON SEVERAL MEDICINAL CROPS

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Keywords: soil quality, water quality, indicators, medicinal plants.

ABSTRACT

Soils are living and dynamic systems that serve as interface between agriculture and the environment. Soil and water quality influence medicinal plant harvest yield, while the cultivation technologies and processes that take place during the growing season may influence soil quality. The significant decrease in soil quality is evidenced by the negative changes in its physical, chemical, biological properties and when soil is contaminated with organic and inorganic substances. The assessment of soil conservation status is performed by determining key indicators and threshold values, which must be maintained for its normal functioning, this analysis being important to determine trends of deterioration or improvement of soil quality, for various agricultural ecosystems.

The main objective of this paper was to determine a series of indicators such as: physical indicators (particle size, humidity, density), chemical indicators (pH, conductivity, N:P:K content), and organic content from soil, in order to evaluate soil and water quality, on a field cultivated with several annual and perennial medicinal plants (basil, marigold, hyssop, lemon balm, lophantus, etc.).

INTRODUCTION

Plant production depends on environmental factors, having potential for negative impact on soil, water, air and biodiversity (MADR, 2018). One of the fundamental objectives of environmental policies is to protect soil, air and water quality (National Research Council, 1993).

There are studies in which organic farming performs better than conventional farming systems in terms of species richness and abundance, soil fertility, nitrogen uptake, water infiltration rate and storage capacity, energy use and efficiency (Ponisio et al., 2015). On the other hand, similar to conventional agricultural practices, the negative impact on the environment of organic farming can occur through the irrational use of manure, natural fertilizers and pesticides, post-harvest residue management, irrigation and works carried out on agricultural land (Udeigweetal et al., 2015). Agricultural production generates a certain amount of residual products (nutrients, sediments, pesticides, salts, etc.) that can become pollutants. Decreasing the quality of agricultural soil is a negative change in its physicochemical, biological properties and the contamination with organic and inorganic substances. Consequently, a number of indicators need to be measured and determined in order to assess changes in soil quality as a result of applying different management systems. The soil organic matter (SOM) indicator provides valuable information on soil fertility, structure, stability, nutrient and water retention, soil erosion. Physical indicators such as: granulometry shows the percentage content of different fine mineral fractions (sand, dust, clay); humidity - the decrease of soil moisture below the value of the minimum limit leads to the appearance of water deficit, which can be avoided and removed using irrigation. Among the chemical indicators, the pH in relation to the soil provides information on biological activity and nutrient availability; conductivity being related to plant growth, microbial activity and salt tolerance; N, P, K extracts - available nutrients and potential for losses of N and P. Changes in soil quality can be assessed by measuring specific indicators and comparing them with critical or threshold limit values, at different time intervals, for a rational, specific use in a desired agro-horticultural ecosystem (Seybold et al., 1998; Arshad and Martin, 2002). At present, models of eco-sustainable technologies for preventing and reducing the aggressiveness of diseases and pests on all types of agro-horticultural crops, which aim at soil and water conservation, are being sought and analysed.

MATERIAL AND METHOD

The material was represented by the existing soil within INMA Bucharest (reddish brown forest soil), in the climatic conditions of 2019, where annual medicinal plant (2 varieties of Basil, Tulsi, Tagetes) and perennial crops (Hyssop, Lemon Balm, Lophantus) were in the vegetation period. Soil samples were analysed in terms of texture and chemical composition. They were taken in a single stage, from a depth of 0-30 cm, analysing the granulometry, by the sieving method, using a number of sieves with a small mesh size, from a 2 mm sieve to a sieve of 0.09 mm, for soil samples of known mass.

Also, the chemical composition of the water used in crop irrigation was analysed, the sample being taken from a deep well.

A series of indicators were determined to monitor the soil texture; its chemical analysis (pH, Humus%, N%, P%, Cu (mg/kg), Pb (mg/kg), Ni (mg/kg), Zn (mg/kg), Cr (mg/kg) , Sulphates (mg/l). To determine the quality of water used to irrigate the crops, were determined: pH, conductivity, ammonium content, nitrates, nitrites, phosphates, CCO-Mn, Ca, Mg, chlorides, sulphates, bicarbonates, carbonates, total hardness.

RESULTS AND DISCUSSIONS

In order to evaluate the quality of the soil (reddish brown forest soil, Băneasa area) on which the medicinal plants were grown, a series of indicators were used.

Soil texture analysis - the data obtained for the granulometric curve are presented in Table 1, for a clearer highlighting of the values resulting from the laboratory analysis of the samples taken from the experimental field. These values were obtained taking into account the soil residues remaining on the sieves, based on which the gravimetric percentage was obtained, and by summing these results the values used to represent the granulometric curves were obtained (Rotaru et al., 2020). The granulometric curves for the analysed soil samples show a texture of the soil with dust (0.02-0.002 mm) and sand (2-0.02 mm). The average texture identified for this type of soil, has favourable properties in terms of: water and air content, nutrient content (especially humus), permeability.

Figure 1 shows that there are no differences in texture between these crops.

Table 1

Graphic points of the values obtained from soil analysis for medicinal plant crops

Sieves (hole diameter) [mm]	Basil		Tulsi	Hyssop	Red basil		Loph	Tagetes	
	P1	P2 + cylinder	P8	P7	P3 + cylinder	P5	P9	P6	P4 + cylinder
2	87.75	88.69	94.89	90.65	93.21	90.66	92.36	93.92	90.73
1	63.02	64.23	73.17	70.35	66.62	66.77	67.75	70.30	65.33
0.5	46.42	47.39	50.34	50.20	47.68	48.96	46.85	49.15	47.66
0.25	35.24	37.12	36.32	36.70	36.45	37.98	33.02	36.13	37.06
0.09	23.50	22.35	23.05	17.14	18.79	21.57	20.55	20.89	20.88

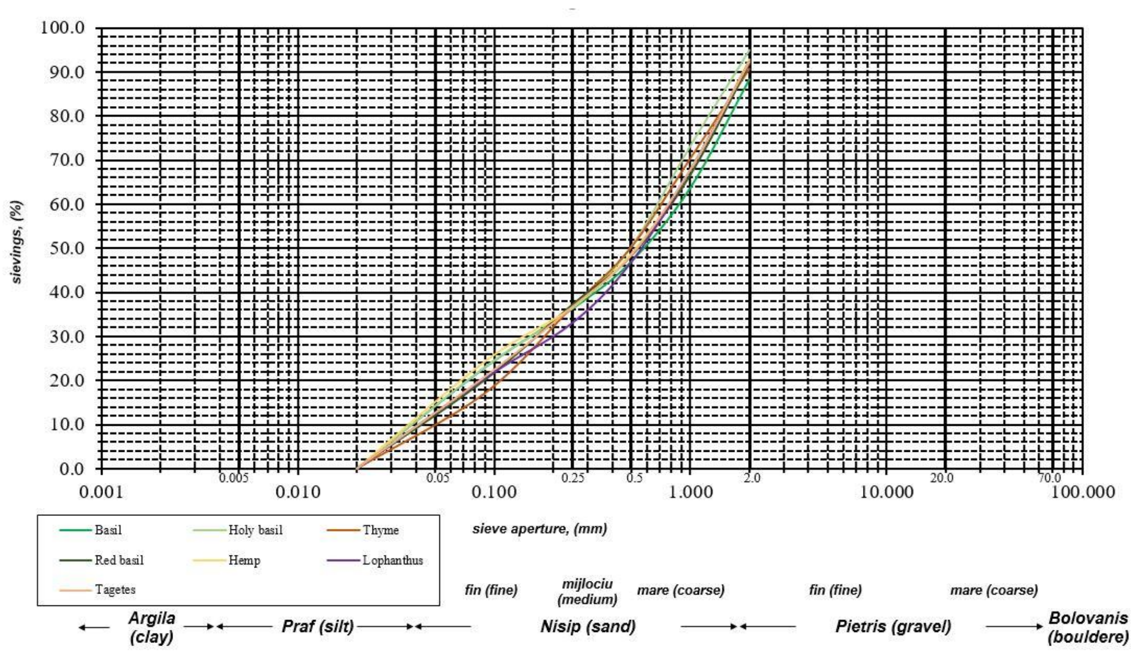

Figure 1: Particle size distribution for soil samples

The chemical analysis of the soil samples was performed to determine if the soil quality and pollution standards for agriculture are met, according to Order no. 756/03.11.1997. Table 2 shows the average values of the soil samples, the following parameters being determined: pH, humus content (%), N (%), P (%), Cu (mg/kg), Pb (mg/kg) , Ni (mg/kg), Zn (mg/kg), Cr (mg/kg), Sulphates (mg/l). According to the results obtained, the maximum amount of nitrogen was found in the Red Basil crop and the minimum amount in the Hyssop crop. Regarding the phosphorus content, the highest amount was found in the field cultivated with Tulsi, and the minimum in the Red Basil crop. With respect to the humus content, the lowest amount was found especially in the field cultivated with Hyssop. To restore the humus content, soil tillage techniques must be rethought, as conservative works applied to the soil are important for humus conservation. The incorporation of plant residues after cultivation is a very important thing for restoring the humus content. The heavy metal content does not exceed the alert threshold.

Table 2

Results of chemical analyses for soil samples

Parameters	Soil samples (average values)	Normal values	Alert threshold (intervention)
pH	7.31	7.3-8.4	-
Humus %	2.5	>2	-
N - Nitrogen %	0.14	0.141-0.270	50.000
P Phosphorus%	0.065	-	5.000
Cu (mg/kg)	32.9	20	100
Pb (mg/kg)	22.47	20	50
Ni (mg/kg)	41.29	20	75
Zn (mg/kg)	80.2	100	300
Cr (mg/kg)	46.98	30	100
Sulphates (mg/l)	43.7	-	2000

Table 3

Results of chemical analyses for water samples

Indicators	UM/Sample code	Water sample (A0151) Average values
pH	unit. pH	7.55 (23.8)
Conductivity	µS/cm	314
Ammonium	mg/l	0.001
Nitrites	mg/l	0.014
Nitrates	mg/l	4.47
Phosphates	mg/l	0.052
CCO-Mn	mgO_2/l	0.96
Ca	mg/l	48.1
Mg	mg/l	6.8
Chloride	mg/l	15.9
Sulphates	mg/l	28.3
Bicarbonates	mg/l	143.4
Carbonates	mg/l	0
Total hardness	German degrees	8.29

Chemical analysis of water samples

The quality of soil and water used in irrigation are inherently linked, so that the prevention of water pollution with nutrients, pesticides, salts, sediments and other pollutants will be very difficult if soil degradation is not controlled (Deák et al., 2018).

Table 3 presents the results of chemical analyses of water samples used in the irrigation of medicinal plant crops. The obtained results show that the water used for irrigation of crops meets the requirements of drinking water, being recorded normal values without exceeding the exceptional values allowed for pH, conductivity, phosphates, nitrites and nitrates, CCO-Mn, calcium, magnesium and hardness, according to STAS 1342-91- Drinking water.

CONCLUSIONS

Soil quality assessment is necessary for improving soils in organic farming, because all the components and interactions of a soil system are viewed together, in a unitary way, in terms of its physical, chemical and biological properties. Changes in soil quality were assessed by measuring the appropriate indicators and comparing them with the desired values (critical or threshold limits), for a specific, rigorous use in a selected agro-ecosystem.

The characterization of the soil cultivated with medicinal plants (annual and perennial), in terms of chemical properties, showed a pH 7.5 (neutral-slightly alkaline reaction), a good supply of nitrogen, potassium and less good supply of phosphorus especially in the field cultivated with Red basil). Regarding the humus content, the low amount was recorded especially in the field cultivated with Hyssop. In terms of texture, the analysed soil has a sandy texture. The heavy metal content does not exceed the alert threshold.

With respect to the water used in crop irrigation, normal values were recorded, without exceeding the exceptional allowed values.

Further research is needed to verify and demonstrate the effects of agricultural practices in relation to environmental conditions and the state of ecosystems.

ACKNOWLEDGEMENT:

- This work was supported by one founding source the **NUCLEU Programme**, carried out with the support of ANCSI, **Project PN 5N/07.02.2019** "***Research on the superior valorisation of some new plants species cultivated in Romania".***
- The work was supported by a grant of the Romanian Ministry of Agriculture and Rural Development, **ADER Contract 25.1.2/27.09.2019, ADER project 25.1.2: *"Research on the development and testing of technical equipment for harvesting medicinal and aromatic plants, used in small farms”.***
- This work was supported by a grant of the Ministry of Education and Research on ***the Programme 1 – Development of the national research-development system, subprogramme 1.2 – Institutional performance – Projects for financing excellence in RDI, contract no. 16 PFE***

BIBLIOGRAPHY

1. Arshad, M. A., Martin, S., 2002 - *Identifying critical limits for soil quality indicators in agro-ecosystems*, Agriculture, Ecosystems & Environment vol. 88 (2), p.153-160.

2. Deák, Gy., Coman, V., Matei, M., Rotaru, A., Voicu, M., Laslo, L., Lupei, T., Vladuţ, V., Tudora C., 2018 – *Innovative technologies to reduce the negative impact of climate changes in vegetable crop,* INMATEH 2018 – Agricultural Engineering, p.807-810

3. MADR, 2018 - *The national framework of environmental protection measures, selected within the operational programmes of producer organizations in the fruit and vegetable sector for the period 2018-2020.*
4. National Research Council, 1993 - *Soil and Water Quality: An Agenda for Agriculture,* National Academy Press, USA
5. Ponisio, L.C., M'Gonigle, L.K., Mace, K.C., Palomino, J., de Valpine, P., Kremen, C., 2015 – *Diversification practices reduce organic to conventional yield gap,* Proceedings of the Royal Society B: Biological Sciences, DOI: 10.1098/rspb.2014.1396
6. Rotaru, M., Coman, V., Laslo, L., Voicu, M., Lupei, T., Bara, N., Boboc, M., Deák, G., 2020 – *Food crop responses to various factors in Romania,* The 7th International Conference on advanced materials engineering and technology (ICAMET-2019), South Korea-Seoul, AIP Conference Proceedings 2291, 020031
7. Seybold, C.A., Mausbach, M.J., Karlen, D.L., Rogers, H.H., 1998 – *Quantification of soil quality,* In R. Lal et al. (ed.) Soil processes and the carbon cycle (Chapter 27), p. 387-404, CRC Press LLC, Boca Raton, FL, ISBN 0-8493-7441-3
8. Udeigweetal, T.K., Teboh, J.M., Eze, P.N., Stietiya, M.H., Kumar, V., Hendrix, J., Mascagni Jr., H.J., Ying, T., Kandakji, T., 2015 - *Implications of leading crop production practices on environmental quality and human health,* Journal of Environmental Management, vol. 151, p. 267-279.