

PEDO-BIOLOGICAL STUDIES ON SOIL QUALITY

STUDII PEDO-BIOLOGICE ASUPRA CALITĂȚII RESURSELOR DE SOL

**BIREESCU Gianina¹, DRAGHIA Lucia², BIREESCU L¹,
CHELARIU Elena Liliana², ANTON P³, SELLITTO M.V.⁴**

¹Biological Research Institute Iași, Romania

²University of Agriculture and Veterinary Medicine Iași, Romania

³National Institute of Research-Development for Pedology, Agrochemistry and Environmental Protection Bucharest, Romania

⁴Universita degli Studi del Molise, Italia

Abstract. *The researches were conducted on three subtypes of preluvosols (Luvisols Class), under four flower associations from Dobrovăț forestry ecosystem. We analyzed the biotic physiological (soil respiration and cellulololysae), enzymatic potentials (catalase, invertase, urease and total phosphatase) and, also, the biological and synthetically indicators of soil fertility and quality (Indicator of Vital Activity Potential-IVAP%, Indicator of Enzymatic Activity Potential-IEAP% and Biological Synthetic Indicator-BSI %). The soil samples were collected on 0-40 cm and 20-40 cm depth. The analyze of the pedo-biological indicators pointed out low values on 0-40 cm, because the biological activity is stressed and restricted by the ecological factors and determinants of the zonal and regional specific, like the fine texture, hard soil consistency in the summer season, the low level of the aerohidric regime, especially in the summer season excessively droughty. The level of the biological potential, biotic and enzymatic is until 50% lower on the 20-40 cm depth.*

Key words: ecological specific, forestry ecosystem, pedo-biological indicators, soil fertility, soil quality

Rezumat. *Cercetările s-au desfășurat în ecosistemul forestier Dobrovăț în 4 asociații floristice dezvoltate pe 3 subtipuri de preluvosol (clasa Luvisoluri). S-au analizat potențialele fiziologice vitale (respirația și celulozoliza) și enzimatic (catalazic, zaharazic, ureazic și fosfatazic total) precum și indicatorii biologici sintetici de fertilitate și calitate a solului (Indicatorul Potențialului Vital, Indicatorul Potențialului Enzimatic și Indicatorul Sintetic Biologic). Analiza indicatorilor pedobiologici pe adâncimea 0-40 cm evidențiază valori scăzute întrucât activitatea biologică este stresată și limitată, mai ales în sezonul estival excesiv de secetos, de factorii și determinanții ecologici de specific zonal și local, cum ar fi textura fină, consistența estivală dură, porozitatea de aerție scăzută. Pe adâncimea 20-40 cm, nivelul potențialului biologic vital și enzimatic înregistrează valori cu până la 50% mai scăzute.*

Cuvinte cheie: specific ecologic, ecosistem forestier, fertilitate, indicatori pedobiologici, calitatea solului

In the existing conditions, the soil represents an important and strategic resource for the survival of humanity. After Cârstea (2003), Mausbach and Seybold (1998), Montanarella (2006), Marmo (2006), the attention referring to protection, improvement of soil quality and the rehabilitation of degraded lands must be an essential importance in the environmental politics, at regional, national and global scale. The soil, the crucial element in the functioning of the biosphere (Rubio, 2008) is an essential constituent of terrestrial

ecosystems, but not only this one, as is any vegetation, climate, or other environmental factor considered separately, represents the factor which may be assigned ecosystem capacity to produce biomass, only the whole complex of factors and environmental conditions, in the reciprocal interaction of whole components of the environment (Moise *et al.*, 2006; Bireescu *et al.*, 2008). Biological potential of soil resources characterizes the fertility condition of them and reflects the ecological vocation of soil microflora, highlighting the impact of local environmental factors, and various pollutants and stressed anthropogenic factors or others (Ştefanic *et al.*, 2006; Bireescu *et al.*, 2007, 2008; Januszek, 1999). The ecological interpretation of the soil defines, from the quantitative and qualitative point of view, two important and realistic characteristics of its: trofic potential and ecological specific where the soil can completely or restricting, seasonal and local manifest (Chiriță, 1974; Bireescu *et al.*, 2009).

MATERIAL AND METHOD

Ecopedological researches were conducted during vegetative growth phase in the summer season of 2009 year, on soil resources, both, field stationary method and laboratory, on soil samples collected from representative profiles belonging to the forestry ecosystem Dobrovăț, Iași. The four studied floristic stationary are: floristic association *Polygonatum multiflorum*; floristic association *Polygonatum latifolia*; floristic association *Polygonatum officinale* and floristic association *Allium ursium*. Genetic soil types corresponding the four studied floristic stationary, belong to Luvisols class (SRTS, 2003; WRB 2006) and they are: Stagnic Luvisol in the floristic association *Polygonatum multiflorum*; Haplic Luvisol in the floristic associations *Polygonatum latifolia* and *Allium ursium* and Vertic Luvisol in the floristic association *Polygonatum officinale*.

They were analyzed the main characteristics of biotope, in the ecological specific, regional and local, by the study of soil profiles, of genetic horizons, both, field and laboratory, and the ecological specificity file of the forestry ecosystem Dobrovăț, Iași. Referring to the characterization of the effective trophicity of soil resources from studied research stationaries of forestry ecosystem Dobrovăț Iași, we analyzed the main 10 pedo-bio-ecological factors and determinants and we we appreciated their value depending on absolute values determined by the field and laboratory analyses. In this way we gave the Synthetic Indicator of the Eco-Pedological Diagnosis of Effective Trophicity of Soil Resources (EPDETSR).

The main 10 studied pedo-bio-ecological factors and determinants are: 3 physico-mechanical determinants (soil texture-Tx, air porosity-AP and hard soil consistency in the summer season-Con); 1 pedo-biological determinant (Biological Synthetic Indicator-BSI); 3 ecological growth factors (total nitrogen content-Nt; available phosphorus content-P_{AL} and exchangeable potassium content-K_{AL}); 3 eco-pedo-chemical determinants (soil reaction-pH_{H2O}; soil organic matter content-SOM and base saturation-BS). These were assigned in 6 ecological size classes marked with grades from 0 ... 10 points.

The Eco-Pedological Diagnosis of Effective Trophicity of Soil Resources (EPDETSR-points), like general ecologic and synthetic indicator of the background of soil quality, is obtained by sum of the score of each of 10 quality analyzed indicators:

$$EPDT = \sum_1^{10} (Tx + AP + Con + BSI + pH + SOM + BS + Nt + P_{AL} + K_{AL})$$

the 10 main pedo-ecological factors and determinants that compose this formula being above-mentioned.

With a view to comparing of the resulted values we gave an assessment scale, with 5 levels: less than 20 points – low effective trophicity, oligo-trophic soil; 21-40 points – than medium effective trophicity, oligo-mezotrophic soil; 41-60 points – medium effective trophicity, mezotrophic soil; 61-80 points – good effective trophicity, eutrophic soil; 81-100 points – very good effective trophicity, mega-trophic soil.

RESULTS AND DISCUSSIONS

Many scientists (Larson *et al.*, 1994; Karlen *et al.* 1996, 1997) considers the soil quality just soil capacity to function. Cârstea (2001) formulates a more comprehensive definition for soil quality. According to this definition, the soil quality represents the combination of the soil properties which enabling it to preserve, long-term, whole its natural functions, considering this property the result of soil structural multifunctionality. Also, the author consider that, the definition of soil quality should be linked to the use of current, effective and any potential future use. Although the term of soil quality is relatively new, for the assessment of soil quality, from the quantitative point of view, required the characterization of physical, chemical and biological soil properties, corroborated to the regional and local elements of ecological specific (Carter, 2002; Grand, 2002; Barrios *et al.*, 2006). Thus, in the synthesis of the eco-pedological and pedo-biological researches, we pointed out the matrix of eco-pedological diagnose of the effective trophicity for the soil resources from the forestry ecosystem Dobrovăț, Iași, within four floristic stationary studied during the summer season 2009 (table 1 and figure 1).

The analysis of the quantitative values of the 10 main ecological factors and determinants (soil texture, hard soil consistency in the summer season, soil reaction, base saturation, soil organic matter content, nutrient content, air porosity and Biological Synthetic Indicator) highlights the qualities, lacks and excesses of soil resources, which can be used of biocoenosis installed within the forestry ecosystem Dobrovăț Iași, according to the ecological specific. Thus, the value of eco-pedological diagnosis of effective trophicity for the soil resources (EPDETSR) resulted by the sum of the scores of quantitative levels of the 10 analyzed ecological factors and determinants (table 1). The values of this synthetic and integrator indicator of the trophicity and fertility of the biotope have light variations depending on the floristic analyzed stationary, during the summer season 2009. In the case of stagnic luvisol within floristic association *Polygonatum multiflorum*, the value of score for eco-pedological diagnose of the effective trophicity for the soil resources is 58 points, characterizing a mezotrophic background with a medium value of assessment for herbaceous vegetation (figure 1). In the case of haplic luvisol within floristic association *Polygonatum latifolia*, the value of score for eco-pedological diagnose of the effective trophicity for the soil resources is 64 points, characterizing an eutrophic background with a good value of assessment for herbaceous vegetation.

This value represents the best score in case of the forestry ecosystem Dobrovăț, during summer season 2009. In the case of vertic luvisol within floristic association *Polygonatum officinale*, the value of score for eco-pedological diagnose of the effective trophicity for the soil resources is 62 points, characterizing an eutrophic background with a good value of assessment for herbaceous vegetation. In the case of haplic luvisol within floristic association *Allium ursium*, the value of score for eco-pedological diagnose of the effective trophicity for the soil resources is 56 points, characterizing a mezotrophic background with a medium value of assessment for herbaceous vegetation.

Table 1

The matrix of the eco-pedological diagnosis of effective trophicity of the soil, Dobrovăț, Iași, 2009

Indicators	Grades	Dobrovăț forestry ecosystem			
		<i>Polygonatum multiflorum</i>	<i>Polygonatum latifolia</i>	<i>Polygonatum officinale</i>	<i>Allium ursium</i>
Soil texture	value	32,8	33,3	34,5	33,7
	class	V	V	IV	IV
	score	8	8	6	6
Hard soil consistency	value	moderately cohesive	moderately cohesive	moderately cohesive	moderately cohesive
	class	V	V	V	V
	score	8	8	8	8
Soil reaction (pH _{H2O})	value	5,58	6,23	6,51	5,38
	class	IV	V	V	IV
	score	6	8	8	6
Base saturation (%)	value	85	81	80	88
	class	V	V	V	V
	score	8	8	8	8
Soil organic matter (%)	value	3,041	3,342	3,164	2,943
	class	III	IV	IV	III
	score	4	6	6	4
Total nitrogen content (%)	value	0,148	0,162	0,155	0,141
	class	III	IV	IV	III
	score	4	6	6	4
Available phosphorus (ppm)	value	20	28	24	25
	class	IV	IV	IV	IV
	score	6	6	6	6
Exchangeable potassium (ppm)	value	142	158	170	161
	class	IV	IV	IV	IV
	score	6	6	6	6
Air porosity (%)	value	13	14	11	10
	class	III	III	III	III
	score	4	4	4	4
Biological Synthetic Indicator(BSI%)	value	16,73	15,10	14,89	12,28
	class	III	III	III	III
	score	4	4	4	4
Genetic type of soil		stagnic luvisol	haplic luvisol	vertic luvisol	haplic luvisol
EcoPedological Diagnosis of Effective Trophicity of Soil Resources (EPDETSR points)	score	58	64	62	56
	estimate	mezotrophic medium	eutrophic good	eutrophic good	mezotrophic medium

Knowing the pedo-ecological background of the area can help us to understand local ecosystem functioning and enable to consider the best possible way to implement sustainable land use and soil resource conservation (Reintam *et al.* 2001; Kölli *et al.* 2008; Birescu *et al.* 2009). Thus, both in case of haplic luvisol within floristic association *Allium ursium* and for stagnic luvisol within floristic association *Polygonatum multiflorum* we can conclude that, although the natural soil resources have some favorable chemical properties (weak acid to moderate acid soil reaction, middle content of soil organic matter, nutrients and base), however the

main physico-mechanical properties of the soil are restrictive and limitative for effective trophicity, having direct negative effects on the structure and functionality of these biocenosis.

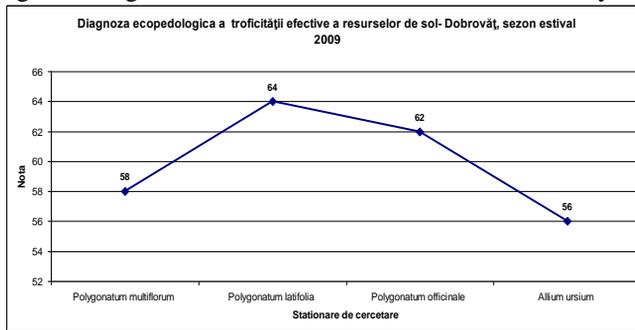


Fig. 1. Eco-pedological diagnosis of soil resources, Dobrovăț, Iași, summer season, 2009

Also, the restrictive and limitative conditions, caused mainly by the local and regional ecological context (summer season excessive droughty during a long time, fine texture, low level of air porosity) cannot allow the development of normal activities of the edaphic microflora. This characteristic is point out by the low values of the synthetic pedo-biological indicators of soil resources, the biological activity being correlated with the physical and chemical properties of the soil, soil organic matter content and the mechanism of action of enzymes (Winding *et al.*, 2005). In this way, the analysis of these pedo-biological indicators of soil quality and fertility (Indicator of Vital Activity Potential-IVAP%, Indicator of Enzimatic Activity Potential-IEAP% and Biological Synthetic Indicator-BSI%) highlights the medium quality of the trophic background of soil resources just in the first 20 cm in case of forestry ecosystem Dobrovăț Iași, during the summer season 2009.

CONCLUSIONS

1 The most pedo-ecological factors and determinants are included into the middle ecological size classes and ecological favorability, from the quantitative and qualitative point of view, according to ecological specificity file. We pointed out some ecological climatic, edaphic and physico-mechanical factors and determinants, like stressed and limitative, by lack or excess: excessive and prolonged summer drought, fine soil texture, hard soil consistency in the summer season excessive droughty and the low level of air porosity.

2. Although the natural soil resources have some chemical favourable properties (weak acid to moderate acid soil reaction, middle content of soil organic matter, nutrients and base) however the main physico-mechanical properties of the soil are restrictive and limitative for effective trophicity, having direct negative effects on the structure and functionality of these biocenosis.

3. The analysis of some pedo-biological indicators of soil quality and fertility (IVAP%, IEAP% and BSI%) highlights the medium quality of the trophic background of soil resources just in the first 20 cm. The analysis of Biological Synthetic Indicator (BSI%) by the sum of the scores for quantitative values from 10 eco-pedological factors and determinants pointed out a medium to good effective trophicity, depending on the floristic analyzed stationary, during the summer season 2009.

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