RESEARCHES CONCERNING THE SEASONAL DYNAMICS OF MICROBIAL ACTIVITY IN SALINIZED AND IMPROVED SOILS

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ABSTRACT

This paper presents the latest results concerning the seasonal dynamics of microbial activity in salinized and improved soils sampled from Măxineni – Corbu Nou, Brăila county. With regard to soil microbial population, quantitatively, it varied within a wide range, according to chemical and physical characteristics (salinization degree, pH values). Regarding the taxonomy of bacteria and fungi from these soils, most of the isolates are known for their capability of adaptation to salinity stress. The bacteria species *Pseudomonas lemonnieri* and *Azotobacter chroococcum* may be considered as indicators in the process of soil improvement.

Key words: microbiological activity, salinized and alkalized soils

INTRODUCTION

Researches conducted till now in salinized soil domain, in Romania, have revealed important physical and chemical modifications (Florea, 1958; Măianu, 1964; Sandu, 1984; Nițu et al., 1986; Mihalache et al., 1989). Concerning the microflora of these soils, Papacostea (1976), Mihalache et al. (1989) and Mihalache et al. (1997) reported on some bacterial indicators of their amelioration. However, there are few researchers (Kimura and Murase, 1992; Zviagintseva and Kulichevskaia, 1992) who studied the negative effects of salinized soils on the microorganism activities.

In this paper we present the researches carried out with the aim to characterize the quantitative and qualitative distribution of microflora and its activity in the salinized soils from the zone Măxineni – Corbu Nou, Brăila county, in natural and improved soils.

MATERIALS AND METHODS

Researches were conducted both in mollic, gleyic soloncheak soil and mollic, weak salinized, gleyic alluvial soil formed on different textural deposits. These soils were analysed in two situations: natural conditions (common) and experimental improved conditions. Soil sampling and microbial analyses were effectuated in spring and in summer. Soil samplings were made from the depths: 0 – 10 cm and 10 – 20 cm in spring and in summer from 20 – 40 cm in common soils and from arable soil (0-20 cm) in improved salinized soils. The following microbial determinations were made: quantitative analyses of bacterial and fungal soil microflora, by the met hod of soil decimal dilutions and distribution on the surface of agar-nutritive media (Papacostea, 1976); - taxonomic determination of bacterial and fungal colonies isolated from Petri dishes with different nutritive media, by the usual technics (macro and microscopial aspects of the colony, physiological tests in selective, nutritive media); - dehydrogenase activity such as soil respiration test, by Casida's method (Casida et al., 1964).

RESULTS AND DISCUSSIONS

The physical and chemical features of different analysed soils are presented in table 1. The seasonal variation of the number of bacteria and fungi and dehydrogenase activity are presented in tables 2 and 3. In this way, in the salinized natural soils, the highest number of bacteria was found at the depth 0-10 cm in spring time, in the soil with medium texture (Table 2). In the summer time, under warm and droughty conditions, the highest number of bacteria was found in the soil with fine texture, at the depth of 20-40 cm. These values were concordant with the higher content of humus and the more reduced content of soluble salts at this level. This unusual distribution of heterotrophic bacteria points out a perturbation of ecological conditions in the upper layer of soil (0-20 cm) which determined their migration and multiplication in the deep soil layer.

After the salinized soils were improved, the number of bacteria increased, especially in

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Table 1. Physical and chemical characteristics of salinized soils from Măxineni-Corbu Nou

Soil	Texture	Clay % (<0.002 mm)	pH (H_2O)	Humus Ct %	Total nitrogen %	C/N ratio	$CaCO_3$ %	V_{Na} %	Mineral residues mg/100 g soil
Natural conditions									
Mollic, gleyic solon-chak soil	coarse	15.0	7.55	1.14	0.089	12.81	2.6	18.65	1213
	medium	29.3	7.80	1.47	0.125	11.76	4.9	9.10	1352
	fine	68.6	8.15	1.74	0.147	11.84	6.4	5.75	939
Improved conditions									
Mollic, gleyic alluvial soil	coarse	15.0	8.25	1.18	0.089	13.56	2.6	4.00	148
	medium	29.3	8.30	1.39	0.134	10.37	4.9	2.60	120
	fine	68.6	8.30	2.03	0.195	10.41	6.4	3.90	136

Table 2. Physical and chemical characteristics of salinized soils from Măxineni-Corbu Nou (spring 1994)

Soil	Texture	Depth (cm)	Bacterial number n x10^6/g soil	Bacterial indicators[1] *Azotobacter chroococcum* (n x 10^6/g soil)	Bacterial indicators[1] *Pseudomonas lemonnieri* (n x 10^6/g soil)	Fungi (n x 10^3/ g soil)	Dehydro-genase activ-ity (formazan) mg/100 g soil
Natural conditions							
Mollic, gleyic solonchak soil	coarse	0-10	65.7	+	o	42.2	14.1
		10-20	48.7	+	o	35.6	9.6
	medium	0-10	130.1	+	o	102.0	13.4
		10-20	73.1	+	o	36.2	8.0
	fine	0-10	88.4	o	o	61.0	17.1
		10-20	51.8	o	o	88.4	3.0
Ameliorate conditions							
Mollic, gleyic, alluvial soil	coarse	0-20	136.7	+++	++	72.2	31.8
	medium	0-20	228.2	+++	++	119.2	17.1
	fine	0-20	196.4	+++	++	133.3	10.2

1) + weak growth; ++ moderate growth; +++ abundant growth o absent growth

Table 3. Microbial analyses of salinized and improved soils from Măxineni – Corbu-Nou (summer 1994)

Soil	Texture	Depth (cm)	Bacterial number n x10^6/g soil	Bacterial indicators[1] *Azotobacter chroococcum* (n x 10^6/g soil)	Bacterial indicators[1] *Pseudomonas lemonnieri* (n x 10^6/g soil)	Fungi (n x10^3/ g soil)	Dehydro-genase activity (formazan) mg/100 g soil
Natural conditions							
Mollic, gleyic solonchak soil	coarse	0-10	45.2	o	o	119.0	34.8
		10-20	29.4	o	o	86.3	14.2
		20-40	72.1	o	o	127.7	3.6
	medium	0-10	21.6	+	o	131.9	86.3
		10-20	35.5	o	o	131.4	8.4
		20-40	50.0	o	o	29.2	4.0
	fine	0-10	58.6	o	o	163.9	26.2
		10-20	43.2	o	o	121.1	20.1
		20-40	127.2	o	o	191.6	4.7
Improved conditions							
Mollic, gleyic, alluvial soil	coarse	0-20	213.1	+++	++	100.4	17.2
		20-40	45.5			160.0	15.3
	medium	0-20	92.7	+++	++	194.0	13.6
		20-40	15.1	+++	++	69.2	11.9
	fine	0-20	97.2	+++	++	48.6	12.3
		20-40	249.4			160.3	10.3

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spring time and in the soils with medium and fine texture. Also, in the summer time, the number of bacteria from improved soils with fine texture was higher at the depth of 20-40 cm. At this level, the humus is enriched with calcium and magnesium.

Concerning the taxonomical distribution of bacteria it was remarked that both in spring and in summer time, bacterial genus *Bacillus* represented by the species: *B. megaterium, B. circulans* and *B. cereus* had a high frequency in the improved soils indifferently of their textural quality. These bacterial species are found in all types of soil, but they are capable to multiply in the salinized soils, also. The specialized literature mentions that *B. circulans* has a high capacity of surviving in salinized soils, benefitting by precise mechanisms of ionic regulation (Zarnea, 1994). Also, the species *B. subtilis*, characterized by its resistance to high concentration of salts (Papacostea, 1976) was isolated as dominant species in solonchak soils formed on coarse texture with high contents of soluble salts and exchangeable natrium.

In the case of improved salinized soils, the species of the genus *Bacillus* frequently were associated with the species of *Arthrobacter* and *Pseudomonas* genera. *Azotobacter chroococcum* was identified, with a moderate frequency, only in salinized soils with gleyey and loamy textures at the depth of 0-10 cm and 10-20 cm, in spring time. In summer time, *A. chroococcum* was present in salinized soils with loamy texture only, at the depth of 0-10 cm.

In the improved soils, owing to the diminution of saltness degree and favourable evolution of physical and chemical features, the species *Pseudomonas lemonnieri* associated with *A. chroococcum*, was isolated as indicatory bacteria of superior ecological conditions.

Concerning the microfungi, quantitatively, some differences depending on soil texture and season were observed. So, under natural conditions, in salinized soils with coarse and fine structure, the fungal population was scarce, especially in spring time. However, the growth of the fungal population in the medium texture at 0-20 cm was observed. In the summer time, high values were registered in salinized soils formed on clayey texture deposite, at all the analysed depths. This situation was due to the aboundant multiplication of genera: *Penicillium, Aspergillus* and *Fusarium,* capable to tolerate high quantities of soluble salts (Pushkinskaia, 1966, cited by Szegi, 1988).

Other identified genera of fungi were: *Cladosporium, Absidia, Mortierella* and *Tritirachium* which presented a reduced frequency, what points out that salinized soils, even after amelioration, do not create favourable conditions for microfungi development and proliferation.

The dehydrogenase activity was clearly influenced by season and the depth of the soil layer, by the contents of soluble salts and pH values. So, whether in spring, these values continue at a high relative level at 0-10 cm in soil, like in normal soils, in summer, at 0-20 cm, one observes a significant increase of dehydrogenase activity values, especially in loamy soils. This situation is difficult to explain now. In the case of improved soils, the dehydrogenase activity presented evident seasonal variations, without any differences depending on the depth of soil layer.

CONCLUSIONS

Microbial activity is strong influenced by physical and chemical features of the salinized soils. In these soils some new ecological conditions have been established owing to high concentration of salts which determines the structure of bacterial and fungal communities.

Depending on the isolating frequency of the bacterial genera, the following classification was established: *Bacillus, Arthrobacter* and *Pseudomonas.* The species *Bacillus circulans* and *Bacillus subtilis*, known for their high capacity of adaptation to salinity conditions, were frequently isolated.

Fungal microflora from salinized soils is characterized by a reduced number and taxonomical scarcity due to unfavourable conditions, especially to high salinity and/or alkalinity and pH values. *Penicillium* and *Aspergillus* genera are dominant in fungal community, proving a high degree of tolerance to high contents of soluble salts in soil.

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Table 2

Physical and chemical characteristics of salinized soils from Măxineni-Corbu Nou Spring 1994

Soil	Texture	Depth (cm)	Bacterial number n x 10^6/g soil	Bacterial indicators[1)] (n x 10^6/g soil)		Fungi (n x 10^3/g soil)	Dehydrogenase activity (formazan) mg/100 g soil
				Azotobacter chroococcum	Pseudo-monas lemonnieri		
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Table 3

Microbial analyses of salinized and improved soils from Măxineni – Corbu-Nou Summer 1994

Soil	Texture	Depth (cm)	Bacterial number n x10^6/g soil	Bacterial indicators[1)]		Fungi (n x10^3/g soil)	Dehydrogenase activity (formazan) mg/100 g soil
				Azotobacter chroococcum	Pseudomonas lemonnieri		
				(n x 10^6/g soil)			
Natural conditions							
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