MICROBIOLOGICAL ACTIVITY OF BARLEY RHIZOSPHERE GROWN ON DEPOSOL

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ABSTRACT: The aim of this paper was to investigate microbiological activity in barley rhizosphere, after the experiment with 17 recultivation treatments of deposols with different organo-mineral materials. The most important agrochemical properties of deposols have been examinated. The presence of the microorganisms was determined by the usual microbiological mediums. Dehydrogenase activity was determined by the Cassida et al. method. The deposols were poor in organic matter, nitrogen, phosphorus and potassium. The number of bacteria ranged from 9.3 to 413.3 × $10^6 g^{-1}$. The addition of organo-mineral materials into deposols has caused an increase of microbial biomass and dehydrogenase activity, comparing with control.

Key words: microbiological activity, barley, rhizosphere, deposol, dehydrogenase activity

INTRODUCTION

Electrical industry Inc. of Serbia possesses over 10,000 ha of mostly arable soil, characterized with high productivity, which is located near the coal mines. The coal exploatation induces changes of chemical and physical soil properties (Đorđević i sar., 1997), as well as disturbance of geological layers and mixing of different sediments. That leads to the formation of new, anthropogenic soil, known in practice as deposol. A degradation processes dominate in deposols, which, as a results, decreases their fertility. The earlier investigation of such processes reveled that microorganisms might be an indicators of "state of illnes" of particulate ecological system. The microorganisms have an important role in soil formation and fertility. Their abundance in different substrates and their metabolitic activity provide an information about soil biological activity (Tabatabai, 1982).

The aim of this paper was to investigate microbiological activity in barley rhizosphere, grown in greenhouse conditions, with the additions of different organo-mineral recultivation materials. The rhizosphere was separated mechanically.

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MATERIAL I METHODS

The different organo-mineral materials: coal dust, celuloflora (organo-mineral substrat originate from wood industry), organic fertilizer with the commercial name "Ofert" (originate from chicken manure) and zeoplant (the zeolit in the form of natural mineral fertilizer) have been used for the recultivation of investigated deposols. Slow-release and liquid fertilizers have also been included in the experiment.

The experiment has been conducted with 17 different treatments, as follows: 1. deposol (control); 2. deposol + NPK; 3. deposol + slow-release fertilizers; 4. deposol + celuloflora; 5. deposol + celuloflora + NPK; 6. deposol + celuloflora + liquid fertilizers; 7. deposol + celuloflora + slow-release fertilizers; 8. deposol + coal dust; 9. deposol + coal dust + NPK; 10. deposol + coal dust + liquid fertilizers; 11. deposol + coal dust + slow-release fertilizers; 12. deposol + zeoplant; 13. deposol + zeoplant + liquid fertilizers; 14. deposol + ofert; 15. deposol + ofert + NPK; 16. deposol + ofert + liquid fertilizers; 17. deposol + ofert + slow-release fertilizers.

The following agrochemical properties have been determined: active and substitutional acidity (in H_2O and KCl), carbonate, humus and total nitrogen content, as well as available phosphorus and potassium.

The presence of the microorganisms was determined by the usual microbiological nutrition solution, after the samples preparation by dilution method, in three replicates. The total number of microorganisms was determinated on 10 × attenuated tripton soya agar (TSA), ammonifiers (total and sporogeneous) on MPA medium, aminoautotrophs on starch-ammonia agar, fungi on Czapek agar, actinomycetes on synthetic agar with sucrose, oligonitrophils on Fjodorov's medium, *Azotobacter* by fertule drops method on the Fyodorov's medium, while dehydrogenase activity was determinated by the Casida et al. method (1964), expressed in μmol TPG $g^{-1}min^{-1}$.

RESULTS AND DISCUSSION

The obtained agrochemical properties indicate that the investigated deposols represent very heterogenous substrates. Their mechanical composition classified them as clay loam and loam. Almost all of the investigated deposols were poor in organic matter. They have neutral to low alcali reaction, with a low content of total nitrogen. This substrates are absolutely poor in phosphorus, while the potassium content might not be sufficient for agricultural crops production (tab.1).

Table 1. Results of agrochemical analyses of several deposol types from coal mine Kolubara

No.	pH	pH	$CaCO_3$	Humus	N	P_2O_5	K_2O
	H_2O	KCl	%	%	%	mg/100g	mg/100g
1.	7.65	5.65	0.2	0.11	0.010	0.5	5.8
2.	7.50	6.05	0.2	0.12	0.010	0.5	3.8
3.	7.20	5.35	-	0.11	0.010	0.2	4.2
4.	7.05	5.50	0.2	0.48	0.050	1.5	15.4
5.	6.90	5.90	0.2	0.19	0.013	0.7	4.2
6.	7.75	6.65	0.1	0.29	0.022	0.9	9.6
x	7.32	6.02	0.15	0.19	0.019	0.7	7.2

Microorganisms are important component of each biocenose. Their number, as well as soil enzymatic activity are important parameters of biogenicity. According to earlier investigation enzymatic activity may be consider as "index" of soil fertility.

The presents of microorganisms in the investigated samples varried, depending on recultivating material (tab. 2.).

Table 2. Total number of bacteria, fungi, actinomycetes and oligonitrophils in barley rhizosphere

T r e a t m e n t s	Total number of bacteria ($\times 10^6 g^{-1}$)	Fungi ($\times 10^4 g^{-1}$)	Actino-mycetes ($\times 10^4 g^{-1}$)	Oligo-nitro-phils ($\times 10^6 g^{-1}$)
Control	9.3	10.2	0.68	3.39
NPK	21.4	16.8	1.4	7.78
Liquid fertilizers	70.2	17.18	10.3	10.5
Celuloflora	13.6	16.3	6.12	4.71
Celuloflora + NPK	22.9	19.1	26.2	7.72
Celuloflora + liquid fertil.	413.3	11.4	0.71	22.5
Celuloflora+slow-rel.fertil.	85.9	9.02	20.83	15.25
Coal dust	16	4	100	32.2
Coal dust+ NPK	55.1	4.8	2.74	6.81
Coal dust + liquid fertil.	113.7	10.9	0.68	20.0
Coal dust + slow-rel.fertil.	99.0	6.94	12.5	10.79
Zeoplant	15.3	6.87	9.62	6.54
Zeoplant + liquid fertile.	22	5.69	2.72	1.17
Ofert	31.9	10.8	17.6	8.85
Ofert +NPK	65.7	7.48	18.36	11.89
Ofert + liquid fertil.	91.7	17.1	6.87	13.11
Ofert + slow-rel.fertil.	47.6	6.8	16.3	10.04
Average (without control)	74.0	10.65	15.81	11.8

The bacteria are dominant group of microorganisms in this soils and their number ranged from 9.3 to 413.3 $\times 10^6 g^{-1}$. The total number of microorganisms increased in all examinated variants, comparing wih control. The biggest amount of total microflora was recorded in the treatment with celuloflora and liquid fertilizers, which migth be relating to the amount of organic matter added with celuloflora. The different mechanical measures, as well as the addition of organic matter, lead to an increase of microbiological biomass and soil biological activity (Garcia et al., 1998).

Fungi are important group of microorganisms, involved in mineralization processes. They are dominant in the soils characterized with acid reaction. The biggest number of fungi was recorded at the treatment deposol + celuloflora + NPK fertilizers. This treatment, besides the addition of organic matter, affects the soil pH.

Actinomycetes also have the role in important soil procesees, like transformation of less soluble compounds. Their biggest number was recorded after the addition of coal dust. Agrochemical analyses indicate that coal dust contain significant percent of total nitrogen, that after the transformations, might become available for both plants and microorganisms.

The number of oligonitrophils have also increased after the addition of coal dust. Comparing with the control, their number was up to ten times higher.

The number of aminoautotrophs increased after the addition of different reculti-vation materials and fertilizers. It is higher in all treatments, compared with control (tab. 3).

Azotobacter is relativelly low present in the examinated samples, which might be the result of samples moisture, but also caused by insufficiant amount of phosphorus and organic matters (Alexander, 1971). Nevertheless, in some extend, the higher number of *Azotobacter,* was recorded at treatments with celuloflora and slow-release fertilizers.

Table 3. Total number of Azotobacter, aminoautotrophs, amonificators (total and sporogeneous) and dehydrogenase activity in barley rhizosphere

T r e a t m e n t s	Azoto-bacter ($\times10^3 g^{-1}$)	Amino-autotrophs ($\times10^5 g^{-1}$)	Total amoni-ficators ($\times10^5 g^{-1}$)	Sporo-geneous ($\times10^4 g^{-1}$)	dehydrogenase activity (µmol TPG $g^{-1}min^{-1}$)
Control	154	5,98	15.78	6,8	8.41-5
NPK	14	13,4	33.8	9,12	6.08-5
Liquid fertilizers	32	78,6	41.8	13,05	5.85-5
Celuloflora	85	20,06	25.9	37,4	5.99-5
Celuloflora + NPK	5,3	49,07	46.1	31,58	0.00018
Celuloflora + liquid fertil.	304,6	208,8	489.3	184,2	0.000221
Celuloflora+slow-rel.fertil.	116	141,8	94.3	26,3	0.000173
Coal dust	210,6	322	205.3	2	0.000167
Coal dust+ NPK	51	32,9	38.2	7,56	0.000262
Coal dust + liquid fertil.	92	175,2	363.9	6,87	0.000118
Coal dust + slow-rel.fertil.	434	125,1	65	39,6	0.000126
Zeoplant	194	43,4	22.5	6,18	0.000104
Zeoplant + liquid fertile.	1,7	10,8	12.9	2,72	9.01-5
Ofert	42,5	71,1	36.8	63,2	0.000124
Ofert +NPK	52,7	93,8	35.17	343	0.000135
Ofert + liquid fertil.	34,3	98,4	70.5	210,3	6.91-5
Ofert + slow-rel.fertil.	112	113	42.3	199,3	8.31-5
Average (without control)	111,36	99.84	101.4	73,89	

The addition of different organo-mineral recultivation materials increased the number of ammonifiers (both total and sporogeneous forms). The biggest increase was recorded in the treatment with ofert and celuloflora, plus the addition of slow-release and liquid fertilizers. This might be explained by the high content of organic matter, which has stimulating effects on the growth of ammonifiers.

Dehydrogenase is enzyme who carries the hydrogen from donor to acceptor during the assimilation. This enzyme in soil mostly originate from microbiological activity. The higher dehydrogenase activity indicates higher assimilation intensity, as well as mineralization of humus. The addition of different organo-mineral recultivation materials increased, in average, the dehydrogenase activity in all examinated variants, compared with the control.

CONCLUSION

The examinated deposols are being classified as loam clay and clay, mostly poor in organic matter, with low content of total nitrogen, while phosphorus and potassium contents are not sufficient for agricultural crops production.

Neutral to low alcali reaction caused bacteria to be the most present group of microorganisms in those substrates and their number ranged from 9.3 to 413,3 $\times 10^6$ g^{-1}. Comparing with the control, their total number was higher in all examinated treatments.

The highest number of fungi was recorded after the addition of celuloflora + NPK fertilizers, while the highest number of actinomycetes was recorded after the addition of coal dust.

Becouse of the lower organic matter content, oligonitrofils and aminoautotrophs was the dominating population of microorganizms that utilize mineral nitrogen and have low demands for nutrients.

The biggest increase of dehydrogenase activity was recorded after the addition of celuloflora and liquid fertilizers.

REFERENCES CITED

Alexander M. (1977): Introduction to Soil Microbiology. John Wiley and Sons. New York. London.

Casida, L.E., Jr.Klein, D.A., Santoro, T. (1964): Soil dehydrogenase activity. Soil Science 98: 319-328.

Đorđević i sar. (1997): Rekultivacija i rekolonizacija prirodne vegetacije jalovišta i pepelišta u Kostolcu. IX Kongres Jugoslovenskog društva za proučavanje zemljišta, 22-27 juni: 575-587.

Garcia C., Hernandez, T., Albaladejo, J., Castillo, V., Roldan, A. (1998) Revegetation in semiarid zones: influence of terracing and organic refuse on microbial activity, Soil Science Society of America Journal, Vol 62, Issue 3: 670-676.

Raičević, V., Vasić, G., Ličina, V., Lalević, B. (2003): Microbial activity of external depots of the coal mine in Kostolac. Simpozijum "Ekologija i proizvodnja zdravstveno bezbedne hrane u Braničevskom okrugu". Požarevac.

Tabatabai, (1982): Soil enzymes. In Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties. American Society of Agronomy. Medison: 903-935.