STUDY CONCERNING THE EVOLUTION OF MICROBIAL COMMUNITY ON SOYBEAN, SPRING BARLEY AND CORN CROPS IN TRANSYLVANIA PLAIN

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Abstract *One of the major priorities for today's agriculture is the implementation of a sustainable system, context where zeolite could feet very well due to its influence in production increase and soil quality. The results achieved by the research conducted until present days recommend the use of zeolite in agriculture being highlighted the positive role of zeolite in plant nutrition and in the stability of microbial community. In Romania there is a lack of knowledge concerning the effect of zeolite on soil microbial community. Therefore thru this research we followed the effect of zeolite on soil-microorganism on three of the most used cultures from our country. The experiences were installed in Agricultural Research Development Turda, Cluj County on an argillic (clay illuviated) soil. The climate specific for the experimental area is continental, with an annual average temperature of the last 57 years of 8.40C and an annual sum of rainfall of 540 mm. The biological material consists in soybean (Glycine max L. Merril, Felix variety), spring barley (Hordeum vulgare L., Romanița variety) and corn (Zea mays L., Turda Star variety). The experience covers 6 experimental plots, in 2 replicates. Each plant was cultivated in 2 experimental variants (control and a treated variant), as follows: soybean (S1 – control variant, untreated; S2 – treated with 100 kg/ha zeolite), spring barley (O1 – control variant, untreated, O2 - treated with 150 kg/ha zeolite) and corn (P1 – control variant, untreated; P2 - treated with 200 kg/ha zeolite). The evaluation of the decomposition groups was undertaken on 15 different substrates, responsible for the decomposition of amino sugars, amino acids, neutral sugars and carboxylic acid. The profile of microbial community was asses using MicroResp method. Determination were performed on the University for Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, on the Laboratory for Soil microbiology. The experimental data were statistically analyzed using Statistica program, version 10. Our results showed that the input of zeolite has a positive effect on the stability of soil microbial community, the highest value being achieved on the group specia1ized in the decomposition of oxalic acid.*

Key words: *microbial community, soybean, spring barley, corn*

INTRODUCTION

Soil microbial diversity is huge, as it was shown by TORSVIK *ET AL.* (1990), who reported that one single gram of soil contains thousands of bacterial species. Microbial communities have the ability to adapt to changing environmental conditions by different ways such as modification of individual activity, increasing reproduction of species with favorable abilities or by developing new capabilities via horizontal gene transfer (VIDICAN AND STOIAN, 2015).

Despite the importance of the carbon-transformation function, there are, as yet, no robust and validated methodologies for assessing the ability of the soil microbial community to metabolize a wide range of substrates. One potential approach is the so-called community-level physiological profiling (CLPP) profiling technique, pioneered by GARLAND AND MILLS (1994). The basis of this concept is to measure simultaneously the extent to which the soil community can metabolize a range of carbonaceous substrates supplied separately but in tandem. A popular version of the technique utilizes Biolog™ plates, which allow researchers to measure simultaneously the metabolic utilization of a suite of 95 (or more) compounds. Many studies have demonstrated how such Biolog response profiles discriminate between soils, communities and environmental factors (such as, GARLAND 1996, INSAM AND RANGGER 1997, GRAYSTON *ET AL.* 2004).

One of the major priorities for today's agriculture is the implementation of a sustainable system, context where zeolite could feet very well due to its influence in production increasement and soil quality (SFECHIȘ, 2015). The results achieved by the research conducted until present days recommend the use of zeolite in agriculture being highlighted the positive role of zeolite in plant nutrition and in the stability of microbial community (MUMPTON, 1999). In Romania there is a lack of knowledge concerning the effect of zeolite on soil microbial community.

This research aims to follow the effect of zeolite on soil-microorganism on three of the most used cultures in Romania. In order to accomplish our goal we analyzed the response of the physiological profile of the microbial community to the inputs of zeolite.

MATERIAL AND METHODS

The experiences were installed in Agricultural Research Development Turda, Cluj County on an argillic (clay illuviated) soil. The climate specific for the experimental area is continental, with an annual average temperature of the last 57 years of 8.40C and an annual sum of rainfall of 540 mm.

The biological material consists in soybean (*Glycine max* L. Merril, Felix variety), spring barley (*Hordeum vulgare* L., Romanița variety) and corn (*Zea mays* L., Turda Star variety). The experience covers 6 experimental plots, in 2 replicates. Each plant was cultivated in 2 experimental variants (control and a treated variant), as follows: soybean (S1 – control variant, untreated; S2 – treated with 100 kg/ha zeolite), spring barley (O1 – control variant, untreated, O2 - treated with 150 kg/ha zeolite) and corn (P1 – control variant, untreated; P2 - treated with 200 kg/ha zeolite).

The evaluation of the decomposition groups was undertaken on 15 different substrates, responsible for the decomposition of amino sugars, amino acids, neutral sugars and carboxylic acid. The profile of microbial community was asses using MicroResp method. This method determinates the reaction of microbial community to different carbon sources (amino sugars, amino acids, neutral sugars and carboxylic acids (TIILI *ET AL.*, 2011). MicroResp method is characterized by several advantages among which the simplicity in using it is one of the most important. Determination were performed on the University for Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, on the Laboratory for Soil microbiology. The experimental data were statistically analyzed using Statistica program, version 10.

RESULTS AND DISCUSSIONS

Our results highlighted that the highest values are recorded on the group specialized in oxalic acid decomposition, experimental plot where we registered a minimum consume of 1,14 µg CO2-C/g/h and a maximum consume of 6,73 µg CO2-C/g/h (Table 1). In the same time all of the neutral sugars (D-trehalose, D-galactose, D-glucose, L-arabinose, D-fructose) were well metabolized by microorganisms having very significant values from statistical point of view. The lowest values were achieved on L-arginine (0,17 µg CO2-C/g/h and 1,19 µg CO2-C/g/h), values assured from statistical point of view.

Table 1

Profile of the microbial community

Source of carbon	N Valid	Signification	Minimum	Maximum	Std. Dev.
Nacet	18	1.08	0.33	1.54	0.30
Oxalac	18	1.98	1.14	6.73	1.51
Dtreh	18	1.44	0.50	2.14	0.43
Aminob	18	0.86	0.48	1.05	0.15
Ketog	18	3.75	2.64	4.52	0.56
Llys	18	0.85	0.49	1.21	0.17
Lmal	18	2.46	1.45	4.83	1.00
Lcys	18	1.00	0.59	1.70	0.26
Dfruc	18	1.92	1.07	2.47	0.38
Dgalac	18	1.32	0.67	1.69	0.38
Dgluc	18	1.96	1.25	2.53	0.32
Lalan	18	1.09	0.75	1.39	0.18
Larab	18	1.52	0.84	1.98	0.28
Larg	18	0.77	0.17	1.19	0.31
Citrac	18	3.20	1.62	5.27	0.83
Dwat	18	0.74	0.47	0.93	0.13

The input of zeolite produces powerful variations on the group specialized in N-acetyl-glucosamine (Table 2). The differences recorded on soybean are very significant (p<0,05), and the activity of the microbial group on soybean without any input was higher than the activity recorded on both experimental plot with corn (p<0,001).

Table 2

The dynamic of acetyl-glucosamine decomposers

Experimental plot	Average	Experimental plot					
		S1	S2	P1	P2	O1	O2
S1	1.51		0.042	0.000	0.000	0.003	0.016
S2	1.22	0.042		0.022	0.001	0.186	0.608
P1	0.90	0.000	0.022		0.141	0.246	0.058
P2	0.68	0.000	0.001	0.141		0.016	0.003
O1	1.04	0.003	0.186	0.246	0.016		0.398
O2	1.15	0.016	0.608	0.058	0.003	0.398	

S1-soybean-control; S2-soybean-100 kg/zeolite; P1-corn-control; P2-corn-200kg/zeolite; O1-spring barley-control; O2-spring barley 150kg/zeolite.

p<0.05 *; p<0.01**; p<0.001***.

Differences were registered also in the group specialized in the decomposition of γ-aminobutyric acid, between the experimental plot fertilized with zeolite compared to control (Table 3). We observed that the input with zeolite results in a lower intensity of decomposition on all amino acids, except of the experimental plot with spring barley on γ-amino butyric substrate.

Table 3

The dynamic of amino acids decomposers

Source of carbon	Experimental plot	Average	Experimental plot					
			S1	S2	P1	P2	O1	O2
γ-aminobutyric acid	S1	1.02		0.050	0.021	0.001	0.080	0.643
	S2	0.84	0.050		0.645	0.033	0.798	0.115
	P1	0.80	0.021	0.645		0.077	0.477	0.051
	P2	0.64	0.001	0.033	0.077		0.021	0.001
	O1	0.86	0.080	0.798	0.477	0.021		0.176
	O2	0.98	0.643	0.115	0.051	0.001	0.176	
L-arginine acid	S1	0.72		0.446	0.000	0.000	0.000	0.870
	S2	0.78	0.446		0.000	0.000	0.001	0.546
	P1	1.20	0.000	0.000		0.000	0.665	0.000
	P2	0.17	0.000	0.000	0.000		0.000	0.000
	O1	1.07	0.000	0.001	0.665	0.000		0.000
	O2	0.73	0.870	0.546	0.000	0.000	0.000	
L-lysine	S1	0.84		0.948	0.744	0.343	0.005	0.209
	S2	0.83	0.948		0.696	0.376	0.969	0.189
	P1	0.90	0.744	0.696		0.211	0.724	0.340
	P2	0.70	0.343	0.376	0.211		0.356	0.039
	O1	0.83	0.979	0.969	0.724	0.356		0.201
	O2	1.02	0.209	0.189	0.340	0.039	0.201	
L-alanine	S1	1.34		0.147	0.035	0.003	0.003	0.021
	S2	1.17	0.147		0.423	0.051	0.048	0.288
	P1	1.08	0.035	0.423		0.206	0.194	0.783
	P2	0.94	0.003	0.051	0.206		0.968	0.313
	O1	0.93	0.003	0.048	0.194	0.968		0.295
	O2	1.05	0.021	0.288	0.783	0.313	0.295	
L-cystein	S1	1.01		0.973	0.421	0.247	0.495	0.891
	S2	1.02	0.973		0.403	0.259	0.475	0.865
	P1	0.70	0.421	0.403		0.063	0.900	0.501
	P2	0.60	0.247	0.259	0.063		0.079	0.199
	O1	0.86	0.495	0.475	0.900	0.079		0.583
	O2	0.98	0.891	0.865	0.501	0.199	0.583	

S1-soybean-control; S2-soybean-100 kg/zeolite; P1-corn-control; P2-corn-200kg/zeolite; O1-spring barley-control; O2-spring barley 150kg/zeolite.

p<0.05 *; p<0.01**; p<0.001***.

In the same time our results showed that all of the neutral sugars were very well metabolized by microorganism having values very significant from statistical point of view

(Table 4). The microorganism responsible for D-galactose decomposition are obviously encouraged by zeolite input such that between the two experimental plots cultivated with spring barley the differences are distinguished significant.

Table 4

The dynamic of neutral sugars decomposers

Source of carbon	Experimental plot	Average	Experimental plot					
			S1	S2	P1	P2	O1	O2
γ- D-trehalose	S1	2.09		0.045	0.022	0.000	0.021	0.061
	S2	1.48	0.045		0.697	0.014	0.688	0.865
	P1	1.40	0.022	0.697		0.029	0.990	0.578
	P2	0.82	0.000	0.014	0.029		0.030	0.010
	O1	1.39	0.021	0.688	0.990	0.030		0.570
	O2	1.52	0.061	0.865	0.578	0.010	0.570	
D-galactose	S1	1.67		0.961	0.048	0.012	0.000	0.100
	S2	1.67	0.961		0.044	0.011	0.000	0.092
	P1	0.78	0.048	0.044		0.455	0.002	0.685
	P2	1.18	0.012	0.011	0.455		0.006	0.258
	O1	0.68	0.000	0.000	0.002	0.006		0.001
	O2	1.38	0.100	0.092	0.685	0.258	0.001	
L-arabinose	S1	1.83		0.767	0.019	0.007	0.023	0.057
	S2	1.78	0.767		0.034	0.011	0.040	0.097
	P1	1.37	0.019	0.034		0.569	0.926	0.564
	P2	1.27	0.007	0.011	0.569		0.510	0.262
	O1	1.39	0.023	0.040	0.926	0.510		0.627
	O2	1.47	0.057	0.097	0.564	0.262	0.627	
D-fructose	S1	2.45		0.051	0.363	0.851	0.962	0.021
	S2	2.02	0.051		0.245	0.072	0.047	0.288
	P1	1.24	0.363	0.245		0.466	0.340	0.783
	P2	1.07	0.851	0.072	0.466		0.813	0.313
	O1	1.83	0.962	0.047	0.340	0.813		0.295
	O2	1.77	0.684	0.105	0.607	0.826	0.649	

S1-soybean-control; S2-soybean-100 kg/zeolite; P1-corn-control; P2-corn-200kg/zeolite; O1-spring barley-control; O2-spring barley 150kg/zeolite.

$p<0.05$ *; $p<0.01$**; $p<0.001$***.

Analyzing the dynamic of the group specialized in carboxylic acids decomposition our results highlighted that the input of zeolite doesn't influence too much the decomposition, the differences recorded being in general insignificant or with low signification from statistical point of view (Table 5). Exception is the group specialized in L-malic acid where we recorded increases as a result of zeolite input.

Table 5

The dynamic of carboxylic acid decomposers

Source of carbon	Experimental plot	Average	Experimental plot					
			S1	S2	P1	P2	O1	O2
Oxalic acid	S1	1.36		0.852	0.791	0.000	0.774	0.934
	S2	1.45	0.852		0.937	0.000	0.637	0.788
	P1	1.49		0.791		0.000	0.583	0.729
	P2	5.05		0.000	0.000		0.000	0.000
	O1	1.21		0.852	0.791	0.000	0.774	0.934
	O2	1.32	0.852		0.937	0.000	0.637	0.788
α-Ketoglutaric acid	S1	4.15		0.547	0.872	0.017	0.007	0.010
	S2	4.33	0.547		0.448	0.005	0.002	0.003
	P1	4.10	0.872	0.448		0.023	0.010	0.013
	P2	3.36	0.017	0.005	0.023		0.642	0.774
	O1	3.22	0.007	0.002	0.010	0.642		0.858
	O2	3.28	0.010	0.003	0.013	0.774	0.858	
Citric acid	S1	2.71		0.100	0.258	0.054	0.730	0.836
	S2	3.76	0.100		0.564	0.732	0.054	0.142
	P1	3.41	0.258	0.564		0.364	0.149	0.348
	P2	3.97	0.054	0.732	0.364		0.029	0.079
	O1	2.50	0.730	0.054	0.149	0.029		0.583
	O2	2.83	0.836	0.142	0.348	0.079	0.583	
L-malic acid	S1	2.16		0.446	0.796	0.000	0.144	0.480
	S2	2.43	0.446		0.610	0.000	0.037	0.155
	P1	2.11	0.796	0.610		0.000	0.092	0.340
	P2	3.61	0.000	0.000	0.000		0.000	0.000
	O1	1.63	0.144	0.037	0.092	0.000		0.420
	O2	1.91	0.480	0.155	0.340	0.000	0.420	

S1-soybean-control; S2-soybean-100 kg/zeolite; P1-corn-control; P2-corn-200kg/zeolite; O1-spring barley-control; O2-spring barley 150kg/zeolite.

p<0.05 *; p<0.01**; p<0.001***.

CONCLUSIONS

Based on the results achieved we conclude that the input of zeolite can have a favorable effect on the stability of soil microbial community.

Our results pointed out that the highest values are achieved on the group specialized in oxalic acid decomposition.

Positive reaction was observed also on neutral sugars which seemed to be very well metabolized by microorganism with values very significant from statistical point of view.

Variations in the functional compound of microbial community appeared on the variants fertilized with zeolite lead to the appearance of cyanobacteria on all of the 3 cultures studied with the highest values recorded on corn crop (3,97 µg CO2-C/g/h).

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