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The Number and Enzymic Activity of Microorganisms in the Soil Under Wheat Grown after Sugar Beet

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Abstract: The microbiological activity in compact and loose soil under wheat grown after sugar beet was investigated. The trial was set on a calcareous chernozem soil. The microbiological activity in the soil under wheat depended on the degree of the soil compactness, soil depth, species of microorganisms and time of sampling for the analysis. The number of almost all the investigated groups of microorganisms and the activity of the dehydrogenase, protease and urease enzymes were lower in the compact soil than in the loose soil. The number and enzymic activity of microorganisms decreased with the increase of the profile depth both in the compact and loose soils. The microbiological activity was on average highest in the first, and lowest in the last soil sampling period.

Key words: microorganisms, enzymic activity, wheat, sugar beet

Introduction

Soil is a natural open system of many components formed in the process of functioning of microorganisms and a great number of other factors. Soil is a microbiological reservoir, with a great number of different microorganisms that create humus and all the nutritional matters necessary for a plant. Soil is, therefore, considered to be a natural and geochemical reservoir, in which humus is the most important chemical substance, providing its fertility and stability. By modern technical measures, the speed and economy of the soil cultivation increase as well as the compacting and degradation of soil. Additional cultivation and, thus, greater fuel consumption are necessary for making the compact soil looser, which increases the cost of already expensive agricultural production. Compact soil has a negative effect on seed and seed germination processes as well as on the development of the root system and the whole plant. In the compact soil, the plant root system is placed in the surface layer of 10-15 cm, as a result of which the plant is very sensitive and dies mostly due to the lack of water. The acceptance of mineral fertilizers by plants decreases by 10-20 percent as a result of the soil compacting process. The normal development of the root system is prevented in the compact soil because the root hairs can go through soil pores of less than 0.01 mm in diameter. Microorganisms cannot develop in pores of less than 0.003 mm in diameter. If the pore diameter decreases, the microbiological activity will not occur, soil will become an inert carrier and the yield of cultivated plants will, thus, in any way decrease (Hadzic et al., 1998; Marinkovic et al., 1998; Nikolic et al., 1998; Govedarica et al., 1998 etc.). As a result of the soil compactness, the humification and dehumification processes reduce, the biochemical activity of microorganisms decreases, moisture and aeration, the amount of structural aggregates and the resistance of plants to philopathogenic microorganisms also decrease, whereas their number is often increased. Due to their sensitivity, microorganisms can serve as a clear indicator of the soil fertility (Klevenskaja, 1978; Misustin, 1975; Aleksander, 1977; Kiss et al., 1978; Lynch, 1983; Milosevic, 1990; Sikora, 1990; Govedarica et al., 1998).

Bearing all that in mind, the aim of the investigation was to examine the effect of soil compactness on the microbiological activity in the soil under wheat grown after sugar beet.

Material and Method

For the purpose of the investigation, we have selected the wheat crops grown on the soil having the following properties - the chernozem type, the subtype on loess and loessial sediments, a calcareous variety, medium deep form, in locality near Becej. Sugar beet was a pre-crop. The soil samples for microbiological analyses were collected in a sterile manner from 6 depths (5-10 cm, 15-20 cm, 25-30 cm, 35-40 cm, 45-50 cm, 70-75 cm), twice during the wheat vegetation (at the end of March and at the end of May). The analyses were made in the compact and loose soils. The number of microorganisms was determined by standard microbiological methods (Pochon and Tardieux, 1962; Krasiljnikov, 1965). The dehydrogenase activity was determined by the spectrophotometric method after Lenhard (1956) modified by Thalman (1968). The protease activity was determined by the titration method after Romeik (1969) and the urease activity after Tabatabai and Bremner methods (1972).

Results and Discussion

During the investigation, it was determined that microbiological activity of soil under wheat depended on the soil compactness degree, the soil depth, the species of microorganisms and the time of sampling for the analysis.

Due to the lack of oxygen and moisture, the total number of microorganisms (tab. 1), ammonifiers (tab. 2), oligonitrophilic bacteria (tab. 3), ureolithic microorganisms (tab. 4), fungi (tab. 6), actinomycetes (tab. 7) and azotobacter (tab. 8) decreased in the compact soil, the dehydrogenase (tab. 9), protease (tab. 10) and urease activities (tab. 11) increased, whereas the number of denitrifiers increased (tab. 5). These results were also confirmed by our previous investigations. (Govedarica et al., 1993, 1995 a, b, c, 1996). A number of research workers (Dudcenko et al., 1976; Kalmikova et al., 1974; Petrenko and Bokorov, 1974; Lipovickaja, 1975; Govedarica et al., 1993, 1995, 1996, 1998) detemined that the compacting of soil under sugar beet had a negative effect on the microbiological activity. The compacting of soil, which occurred in soil under sugar beet crops, had a negative effect on the next crop, which reduced the microbiological activity in the soil. The reduction of the microbiological activity, due to the soil cultivation, was determined by Lynch (1993) and Gupta et al. (1998). In order to prevent the compacting of soil, a suitable crop rotation should be applied, monoculture, organic and microbiological fertilizers should be avoided and soil should be cultivated under optimal soil moisture conditions (Banikova, 1996). These as well as all future investigations should draw farmers' attention to the rational use of heavy machinery and specific modern farming methods, in order to prevent the compacting of soil and reduction of the microbiological activity and, thus, the reduction of the soil fertility.

Tab. 1. Total number of microorganisms (10^6/g soil)

Depth (cm)	March		May	
	compact soil	loose soil	compact soil	loose soil
5-10cm	243.38	306.46	136.52	251.15
15-20cm	241.28	266.46	114.72	175.4
25-30cm	196.27	205.41	88.05	125.11
35-40cm	134.35	198.96	86.18	124.46
45-50cm	99.6	165.38	84.49	99.1
70-75cm	69.37	139.73	42.7	53.58

Tab.2. Number of ammonifiers (10^6/g soil)

Depth (cm)	March		May	
	compact soil	loose soil	compact soil	loose soil
5-10cm	210.93	439.38	150.87	365.82
15-20cm	196.51	420.79	95.41	290.43
25-30cm	131.27	151.87	46.28	277.52
35-40cm	49.3	100.69	34.02	130.17
45-50cm	21.16	86.98	19.41	62.23
70-75cm	15.14	81.63	16.16	27.36

Tab.3. Number of oligonitrophilic bacteria (10^5/g soil)

Depth (cm)	March		May	
	compact soil	loose soil	compact soil	loose soil
5-10cm	210.93	259.69	245.04	270.64
15-20cm	173.22	213.41	189.68	194.76
25-30cm	101.26	170.55	105.68	136.49
35-40cm	45.61	117.68	101.02	125.6
45-50cm	31.12	110.25	94.77	102.56
70-75cm	22.7	83.01	77.33	84.36

Tab.4. Number of ureolithic microorganisms (10^3/g soil)

Depth (cm)	March		May	
	compact soil	loose soil	compact soil	loose soil
5-10cm	74.89	75.08	53.325	69.61
15-20cm	51.97	57.87	45.434	51.139
25-30cm	0	0	21.673	22.634
35-40cm	0	0	18.823	19.182
45-50cm	0	0	3.197	5.762
70-75cm	0	0	0	4.56

Tab.5. Number of denitrifiers (10^4/g soil)

Depth (cm)	March		May	
	compact soil	loose soil	compact soil	loose soil
5-10cm	298.3	268.31	35.01	22.94
15-20cm	209.11	186.88	14.77	9.11
25-30cm	181.27	140.67	13.54	9.09
35-40cm	43.14	37.61	9.07	6.85
45-50cm	42.33	13.53	3.42	0
70-75cm	26.49	277	3.42	0

Tab.6. Number of fungi (10^4/g soil)

Depth (cm)	March		May	
	compact soil	loose soil	compact soil	loose soil
5-10cm	11.23	14.77	5.83	8.03
15-20cm	7.42	9.64	8.67	7.97
25-30cm	6.25	8.71	4.51	5.69
35-40cm	2.46	6.06	3.4	3.43
45-50cm	1.24	4.9	2.28	2.31
70-75cm	0	4.15	0	0

Tab.7. Number of actinomycetes (10^4/g soil)

Depth (cm)	March		May	
	compact soil	loose soil	compact soil	loose soil
5-10cm	52.42	60.31	19.84	44.72
15-20cm	44.54	56.67	18.17	34.17
25-30cm	36.25	53.53	15.8	18.2
35-40cm	37.12	27.9	5.67	6.85
45-50cm	3.74	20.82	3.42	5.76
70-75cm	2.52	17.98	2.31	5.69

Tab.8. Number of azotobacter (10^1/g soil)

Depth (cm)	March		May	
	compact soil	loose soil	compact soil	loose soil
5-10cm	53.04	161.54	51.26	114.68
15-20cm	27.84	139.18	28.4	42.71
25-30cm	9.38	37.34	16.93	25.59
35-40cm	0	9.1	0.5	11.42
45-50cm	0	0	0	0
70-75cm	0	0	0	0

Tab.9. Dehidrogenase activity (μg TPF/10g soil)

Depth (cm)	March		May	
	compact soil	loose soil	compact soil	loose soil
5-10cm	317	449	621	433
15-20cm	472	410	485	182
25-30cm	259	301	261	222
35-40cm	145	436	128	187
45-50cm	83	693	0	41
70-75cm	2	8	13	13

Tab.10. Protease activity (gel. unit./g soil)

Depth (cm)	March		May	
	compact soil	loose soil	compact soil	loose soil
5-10cm	11.25	21	25	26.5
15-20cm	10.5	20.75	23.5	28
25-30cm	8	18.5	20.55	22.25
35-40cm	9.5	18.75	18	18
45-50cm	7.05	22.5	11	8
70-75cm	5	8.25	8.8	8.5

Tab.11. Urease activity (µg N-NH4/g soil)

Depth (cm)	March		May	
	compact soil	loose soil	compact soil	loose soil
5-10cm	40	50.1	50.1	80.3
15-20cm	20.2	40.2	40.6	70.1
25-30cm	0	0	20	54.4
35-40cm	0	0	10.8	44.1
45-50cm	0	0	10	30.2
70-75cm	0	0	0	18.1

Conclusion

The microbiological activity in the soil under wheat depended on the degree of the soil compactness, soil depth, species of microorganisms and time of sampling for the analysis.

The number and the activity of almost all the investigated groups of microorganisms were lower in the compact soil than in the loose soil.

The number and the enzymic activity of microorganisms decreased with the increase of the profile depth both in the compact and loose soils.

The microbiological activity was on average highest in the first, and lowest in the last soil sampling period.

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BROJNOST I ENZIMATSKA AKTIVNOST MIKROORGANIZAMA U ZEMLJIŠTU POD USEVOM PŠENICE GAJENE POSLE ŠEĆERNE REPE

-originalni naučni rad-

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Rezime

U ovim istraživanjima ispitivana je mikrobiološka aktivnost u sabijenom i rastresitom zemljištu pod usevom pšenice posle šećerne repe. Ogled je postavljen na zemljištu tipa karbonatni černozem. Mikrobiološka aktivnost u zemljištu pod usevom pšenice zavisila je od stepena sabijenosti zemljišta, dubine zemljišta, vrste mikroorganizama i vremena uzimanja uzoraka za analizu. U sabijenom zemljištu brojnost skoro svih ispitivanih grupa mikroorganizama kao i enzimatska aktivnost enzima dehidrogenaza, proteaze i ureaze manja je nego u rastresitom zemljištu. Brojnost i enzimatska aktivnost mikroorganizama opada sa povećanjem dubine profila kako u sabijenom tako i u rastresitom zemljištu. U proseku, mikrobiološka aktivnost je najveća u prvom, a najmanja u zadnjem roku uzimanja uzoraka zemljišta.