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DYNAMICS OF ALGAE NUMBER IN HUMOGLEY IN VARIOUS ECOSISTEMS

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The aim of this research was to examine the dynamics of algae number in humogley in three different ecosystems (wood, meadows and arable land). The soil was sampled during four weather seasons throughout the year 2000 and samples were taken from three different depths: 0-1, 1-20 and 20-40cm. Number of algae depend on ecosystem type, soil depth and wheather season. Among all the examined sites the highest number of algae was found in wood locality, afterwards in meadow site and arable land has shown to have the lowest number of algae. All the examined ecosystems have highest number of algae is in

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surface layers (0-1cm) which decreases with depth, and is less present in arable soils comparing to non-arable soils.

Key words: Soil-algae, humogley, meadow, forest, arable land

INTRODUCTION

The soil represents a favorable habitat for microorganisms and is inhabited by a wide range of microorganisms, including bacteria, fungi, algae, viruses and protozoa. Their activity in the soil affects water and nutrient availability, decreases erosion, and consequently this has direct and indirect influence on plants (HAWKES and FLECHTNER, 2002). Besides having a role in degrading organic matter, microorganisms also participate in its synthesis in the soil. Being autotrophs algae have great importance in soil formation, contributing to organic matter production, and also soil aggregates stabilization by producing mucilago. Also, many studies have revealed that algae have effects on improving soil structure, contributing to soil fertility, excreting extracellular substances, retaining soil moisture and resisting salt stress (BROTHERSON and RUSHFORTH, 1983; MAZOR et al., 1996; DANIN et al., 1998; BOWKER et al., 2004).

The presence of various populations of bacteria and algae in the soil results in soil fertility increase and improvement of plant growth. These influences are the result of nitrogen-fixation, photosynthesis, as well as organic acid synthesis beneficial for transforming the insoluble phosphates into soluble ones, but also of growth promoting substances synthesis.

In agricultural soils algae represent indicators of soil quality, since their biomass depends on soil treatment (conventional, organic) and also on the applied agricultural and reclamation techniques. The presence of xenobiotic compounds in soil influences algae biomass as well as their photosynthetic activity and therefore represents relevant bioindicators of soil contamination (BERARD et al., 2004).

The aim of this research was to examine the dynamics of algae number in humogley in three different ecosystems.

MATERIALS AND METHODS

The examined humogley was taken from one of Belgrade plains which is spreading from Čukarica to Ostružnica, and is a part of alluvium formed by river Sava (MARKOVIĆ, 1996). This field has a diversity of wood, meadows and arable land.

The examined soil samples were tested for chemical characteristics (pH, N, P, K content, humus and carbonate content) using standard chemical methods.

The soil was sampled during four weather seasons throughout the year 2000 and samples were taken from three different depths: 0-1, 1-20 and 20-40cm. The number of algae was analysed using nutrient solution BG-11 (RIPPKA et al., 1979.) with nitrogen, after 21 day of incubation period and using constant fluorescent light and room temperature.

The experimental results have been processed by statistical procedure (MALETIĆ, 2005). In order to test the importance of differencies in the calculated middle values of the examined factors (location, soil depth and weather seasons) there has been used analitical model, having following mathematical form:

$$y_{ijk} = \mu + \alpha_i + \beta_j + \gamma_m + (\alpha\beta)_{ij} + (\alpha\gamma)_{ij} + (\beta\gamma)_{ij} + (\alpha\beta\gamma)_{ij} + \varepsilon_{ijmk}$$

i=1,2,3; j=1,2,3; m=1,2,3,4,5 k=1,2,3

All importance evaluation were performed by the F-test and LSD-test for determining the treshold of 5% and 10%.

RESULTS AND DISCUSSION

Soil algae are cosmopolitan and have been isolated from soils in a variety of habitats (METTING, 1981). They are photosynthetically active microorganisms showing changeable community structure, depending of the soil type, the agricultural practices and the application of pesticides (BÉRARD, 2005). Generally on agricultural land, algae are a major component of soil microflora, accounting for up to about 30% of total microbiological dry weight biomass.

The humogley on Makiš site has a shifting of different ecosystems. There is a domination of maple, ash, bitter oak and oak in the forest ecosystem and the medow is dominated by a typical low meadow vegetation.The agricultural land is being kept in monoculture i.e. corn, by applying standard agricultural practices and using mineral fertilizers as well as chemical compounds for plant protection.

All the examined sites have shown to have neutral reaction, good content of nitrogen and medium to good content of phosphorus. Apart from having superficial layers (0-1cm) that have characteristics of wood and meadow soil, the humogley is a muck soil, with very high content of humus. The carbonate content in the samples is very low (Tab. 1).

The researches conducted so far (ZANCAN *et al.*, 2006) show that number and structure of soil algae depends on physical and chemical characteristics of soil. Our research revealed that there is a high correlation coefficient between number of algae and humus (r= 0.95**) and nitrogen content (r = 0.92**), as well as low correlation degree between phosphorus content (r = 0.21 ^{NS}) and potassium (r = 0.95 ^{NS}). However, the highest number of algae was found in wood and meadow ecosystems with soils rich in humus and phosphorus, where no agricultural practice was applied.

Table 1. – Chemical characteristics of humogley

ecosystem	Depth (cm)	pH H_2O	pH Cl	$CaCO_3$ (%)	Humus (%)	Total N (%)	P_2O_5 mg/100g	K_2O mg/100g
Meadow	0-1	7,55	6,60	0,4	12,06	0,518	9,2	49,0
	1-20	7,90	6,40	0,04	4,35	0,284	3,0	16,4
	20-40	8,30	6,60	0,2	2,13	0,152	2,5	13,4
Forest	0-1	7,75	6,80	0,3	12,93	0,642	17,9	4,5
	1-20	8,15	7,00	1,2	5,30	0,380	9,2	29,1
	20-40	8,25	7,02	0,8	4,19	0,304	4,8	19,9
Arable land	0-1	8,20	7,00	1,7	5,19	0,304	23,0	27,0
	1-20	8,15	7,05	2,2	4,81	0,318	18,1	21,0
	20-40	8,20	7,10	3,0	3,56	0,243	10,6	15,7

There are significant statistical differences between the examined sites (P<0, 01). Among all the examined sites the highest number of algae was found in wood locality, afterwards in meadow site and arable land has shown to have the lowest number of algae (Tab.2). The examinations conducted on wood soils emphasize that number of algae depend on pH values, time, and also Mg content (HUNT *et al*., 1987).

Table 2. – Algae content on different sites and soil depths in different weather seasons

location	Depth (cm)	Weather season Spring	Summer	Autmn	Winter	$\overline{X}$	Sd	Cv (%)
Meadow	0-1	935,67	222,22	303,03	191,57	413,12	335,94	81,32
	1-20	350,88	196,08	218,58	149,81	228,84	124,046	54,07
	20-40	84,39	49,75	156,25	92,59	95,74	71,438	74,62
Forest	0-1	980,39	682,73	1509,44	483,09	913,91	493,695	54,02
	1-20	512,82	228,31	248,75	311,11	325,25	166,805	51,28
	20-40	48,31	90,09	144,93	112,36	98,92	61,043	61,71
Arable land	0-1	213,68	78,43	156,25	83,33	132,92	78,671	59,19
	1-20	181,16	46,95	106,38	70,17	101,16	73,525	72,68
	20-40	88,89	46,95	103,09	37,04	68,99	62,160	90,10
$\overline{X}$		377,35	182,39	327,41	170,12			
Sd		360,677	247,813	447,200	158,82			
Cv (%)		95,58	135,87	136,59	93,36			

While comparing wood ecosystem and meadow as non-arable soils, and plough land as an arable soil, it is noticeable to have higher number of algae in non-arable ecosystems. This observation was also determined by FOJKAR *et al.* (1997).

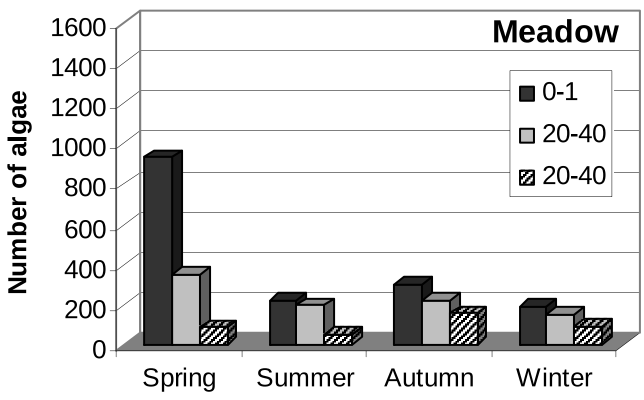

Fig. 1. Number of algae in meadow

This relatively small locality shows the shifting of phytocenosies, wood, meadow, monoculture of corn, on the same type of soil, which influenced the number of algae. Biomass and production of algae depends on type of soil and frame of phytocenosies (KUZYAKHMETOV).

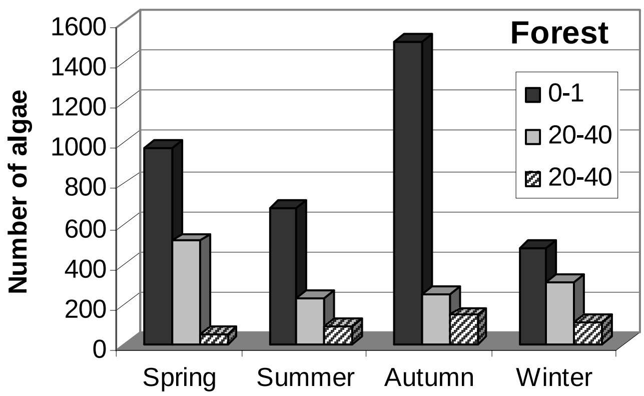

Fig. 2. Number of algae in forest

The weather season has also shown to have influence on number of algae. Statistical significance (P<0, 01) is present in the defined differences regarding algae content in different weather seasons. In spring (graph. 1, 2, 3), all the examined sites and soil depths have revealed the highest number of algae, a bit lower number was present in autumn, and lowest number was during summer and winter. Therefore, the algae content in spring and autumn is not statistically different, as well as in summer and winter (P>0, 05), but all the other differences are statisticaly significant.

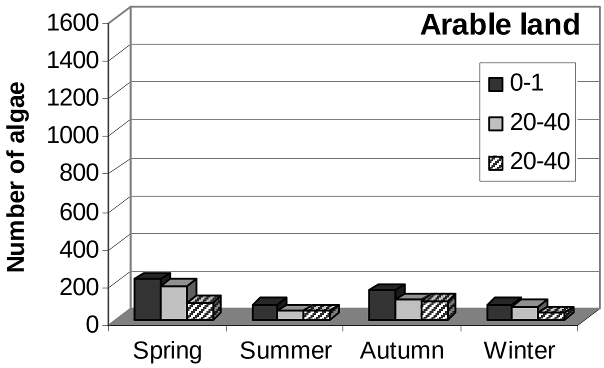

Fig. 3. Number of algae in arable land

The precipitation during spring and autumn was higher comparing to winter and summer season, which is a good factor that initiates the growth of algae in the examined soil. In agricultural soils the number of algae also depends on light intensity, temperature and humidity (SHIMMEL *et al*., 1985). Statistical influence on algae number is also apparent with soil depth (P<0, 01). All the sites show highest number of algae in surface layer of 0-1cm. This is because humogley has high content of montmorionit clay in its surface layers, which results in humidity retention giving ideal conditions for soil algae growth. All the examined ecosystems have highest number of algae is in surface layers (0-1cm), which is not unusual since this phototrophs require light for their growth. Abundance of soil algae and genera were greatest in the uppermost 10 mm of the soil profile, but large numbers and most genera of the uppermost half of the cores remained at 20 mm depths (MYERS *et al.,* 2003) which is also in correlation with the results of this research. However, the wood soil has shown to have highest number of soil algae in surface layer (0-1cm). This sample has the highest content of humus and total nitrogen, as well as very high content of phosphorus comparing to other samples. The lowest presence of algae was noticed in surface layer of plough land. The presence of algae lowers with depth, which is also concluded by other authors, but this is more distinct in non-arable soils.

The interactions of examined factors have statistical significance (P<0,01) on both levels (Tab. 3).

Table 3. – The values of examined features using F-test

Variation source	Freedom degree	F-value	p-level
Site	2	54,416	0,000000
Depth	2	74,947	0,000000
Weather season	3	14,661	0,000000
Site x depth	4	23,999	0,000000
Site x weather season	6	3,551	0,003894
Depth x weather season	6	6,629	0,000013
Site x depth x weather season	12	4,825	0,000009

CONCLUSION

There are significant statistical differences among the examined ecosystems regarding number of algae ($P<0,01$). The highest content of total algae is concluded to be in wood variety of humogley, afterwards in meadow soils (non-arable ones), and the lowest content in field soils (arable one).

Soil depth also had an important statistical influence on number of algae ($P<0,01$). All sites have highest number of algae in surface layer (0-1cm), which decreases with depth, and is less present in arable soils comparing to non-arable soils.

The defined differences regarding number of algae among weather seasons are statistically significant ($P<0,01$). It is concluded for all sites and all soil depths to have highest number of algae during spring, a bit lower content of algae in autumn, and lowest number in summer and winter period.

The interactions of examined factors have statistical significance ($P<0,01$) on both levels.

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DINAMIKA BROJNOSTI ALGI U RITSKOJ CRNICI U RAZLIČITIM EKOSISTEMIMA

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I z v o d

U radu je određena brojnost algi u tri različita ekosistema na ritskoj crnici (livada, šuma i njiva) u području makiškog rita, u toku 2000. godine. Uzorci su uzimani iz tri dubine zemljišnog profila: 0-1, 1-20 i 20-40 cm. Brojnost algi zavisi od tipa ekosistema, dubine zemljišnog profila i godišnjeg doba, kao i interakcije ovih faktora. U ekosistemima u kojima zemljište nije obrađivano konstatovana je statistički značajna razlika u odnosu na obrađeno zemljište. Najveća brojnost algi konstatovana je u šumskom ekosistemu a najmanja u oranici. Ukupan broj algi je najveći u površinskom sloju i sa dubinom zemljišnog profila opada. Opadanje brojnosti po dubini je veće u neobrađenim u odnosu na obrađeni ekosistem.

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