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THE CONTENT AND RATIO OF ADSORBED Ca AND Mg IN THE SERPENTINITE SOILS OF SERBIA

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The contents of adsorbed Ca and Mg and their ratio (Ca/Mg) were researched in the serpentinite rankers of Serbia. The samples were taken from seven wider locations (Zlatibor, Kopaonik, Miroč, Maljen, Bukovi, Suvobor and Bubanj Potok) in the altitudinal belt between 100 and 1700 m. Altogether 32 soil profiles were opened and 47 soil samples were analysed. The percentages of adsorbed Ca and Mg were determined by the method of the Atomic Absorption Spectrophotometry, after extraction with NH_4–acetate. The study results show that the content of adsorbed Mg-ions in almost all analysed samples was higher than the percentage of adsorbed Ca–ions, so their ratio (Ca/Mg) is less than 1. This

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Ca/Mg ratio has an unfavourable impact on the plant development and it was concluded that this is one of the basic reasons of the low productive capacity of the serpentinite rankers in Serbia.

Key words: Ranker, Serbia, Ca, Mg, lithogenic soils

INTRODUCTION

Serpentinites or more precisely, to various degrees serpentinised peridotite rocks, constitute one of the most widely distributed groups of siliceous rocks in the hilly and mountainous areas of Serbia. They occupy the area of not less than 280,000 ha (ĐORĐEVIĆ, 1997).

Serpentinite rankers are distributed in various parts of Serbia, starting from the river Drina, i.e. the border with Bosnia and Herzegovina on the west, to the slopes of Stara Planina (vicinity of Zaječar) and Miroč, almost on the borders with Bulgaria and Rumania in the east. However, the predominant part of the area under serpentinite rankers is located in the following three extensive hilly and mountainous areas of the west and central Serbia: the first massif consists of the mountainous massifs Bukovi-Maljen-Suvobor, which extends southwards to the slopes of the mountain Vujan, between Gornji Milanovac and Čačak; the second massif extends over the spacious area of Zlatibor, and includes a series of mountain massifs (Tara, Čigota, Tornik) and spreads from the Drina in the west, to the do west slopes of the mountain Golija in the east; the third of the most widely distributed serpentinite massifs in Serbia includes a group of the mountains of the river Ibar region – Kopaonik, Radočelo, Rogozna, Stolovi and Goč.

Humus-siliceous soils or ranker soils formed on serpentinite bedrock, represent mainly the soils of very low productive capacity, i.e., the unfavourable environment for plant development. The specific vegetation on the soils formed over serpentinites distinguishes clearly these areas from the neighbouring non-serpentinite terrains in many parts of the world. In Europe, the weathering of serpentinite formations results in the soils of poor fertility which support the characteristic endemic plant species.

The well-known Czechoslovakian pedologists NOVAK and PELIŠEK (1938) described the soils in Moravska as a special type of rendzina named «magnesian rendzinas», which by modern classifications belong to the group of humus – siliceous soils (rankers).

The soils on serpentinites were identified in Serbia as far as a hundred years ago, when GAVRILOVIĆ (1893) proposed that it would be good to divide Serbia into four zones, depending on the distribution of the particular geological formations in Serbia. The fourth zone, after this author, is the zone of Palaeozoic schists and serpentinites as the bedrocks of the most infertile soils in Serbia.

Taking into account that these are the soils which are formed on magnesian rocks, the objective of our study was to determine the percentage of adsorbed Ca-ions and Mg-ions, in order to determine their ratio in the study soil.

MATERIALS AND METHODS

In the aim of the maximally real survey of the state of adsorbed Ca- and Mg-ions in serpentinite soils of Serbia, altogether 32 soil profiles were opened on seven wider locations (Zlatibor, Kopaonik, Miroč, Maljen, Bukovi, Suvobor and Bubanj Potok) and 47 soil samples were taken for the laboratory research.

The percentage of adsorbed Ca- and Mg–ions was determined by the Atomic Absorption Spectrophotometry method, after the extraction with neutral solution of 1N NH_4–acetate. The extraction was performed till the cessation of the reaction on Mg, which had a positive effect on the preciseness of the results of the analyses.

RESULTS AND DISCUSSION

The adsorbed cations affect many processes and characteristics (physical, chemical and biological) of the soil. Table 1 presents the contents of Ca– and Mg–ions in the serpentinite soils in Serbia.

The study results show that in almost all the tested soil samples the percentage of adsorbed Mg–ions is higher than the percentage of Ca–ions, so the ratio Ca/Mg in the majority of the study samples is less than one.

The content of Mg–ions varies 11.45–54.47% of T (total adsorption capacity), on average 36.47% of T (Table 1), while the content of adsorbed Ca–ions varies 11.75–49.52% of T, on average 27.42% of T, for all the tested samples from all locations.

According to the results by NOVAK and PELIŠEK (1938), serpentinite soils from the region of Moheln, Moravska, contain 71-86% of adsorbed Mg–ions in their adsorption complex, while the saturation of Ca–ions is 12–26%. ŽIVKOVIĆ (1966) reports that in our serpentinite rankers the content of Mg–ions regularly exceeds 60%, and the content of Ca–ions accounts for about 30% of the sum of adsorbed base cations.

In the majority of the soils in the world, the ratios of these two important cations are opposite. Thus, according to SCHEFFER and SCHACHTSCHABEL (1960), the optimal percentage of Ca–ions expressed as % of the cation exchange capacity, varies from 60-85%, and Mg–ions from 10 to15%.

In the study samples, the ratio Ca/Mg is mainly less than one, except in some samples from the area of Maljen, in which the ratio Ca/Mg is somewhat greater than 1. Consequently, the results of our research show that the study soils have an unfavourable percentage of adsorbed Ca– and Mg–ions for the normal plant growth and development, which is irreversibly reflected on their productive capacity. This is especially shown by the values of the Ca/Mg ratio, in which almost all values are less than 1.

Table1. – Exchangeable adsorbed cations of serpentinite rankers from different parts of Serbia

Profile	Depth	Adsorbed cations					Ca/Mg
		T	Ca^{2+}	Mg^{2+}	Ca^{2+}	Mg^{2+}	
	cm	meq/100g			% od T		
				Zlatibor			
4	0-20	46.51	9.4	16.4	20.21	35.26	0.57
5	0-15	59.75	14.0	12.0	23.43	20.08	1.20
9	0-15	38.63	9.8	13.0	25.37	33.65	0.75
	15-30	37.45	11.9	16.1	31.77	42.99	0.74
10	0-15	50.76	12.5	18.9	24.62	37.23	0.66
	15-30	46.52	16.3	21.4	35.04	46.00	0.76
17	0-15	47.87	13.4	18.1	27.99	37.81	0.74
	15-30	35.57	5.5	15.6	15.46	43.86	0.35
				Kopaonik			
1	0-10	66.35	16.0	16.4	24.11	24.72	0.97
2	0-5	70.95	17.0	15.6	23.96	21.99	1.09
3	0-15	59.28	16.0	23.0	26.99	38.80	0.69
4	0-15	59.49	19.0	18.1	31.94	30.42	1.05
	15-30	57.71	15.5	19.7	26.86	34.14	0.79
5	0-15	44.19	16.1	20.5	36.43	46.39	0.78
				Miroč			
1	0-15	73.78	16.0	33.7	21.69	45.68	0.47
2	0-15	65.02	11.0	26.1	16.91	40.14	0.42
	15-30	56.24	10.2	27.6	18.14	49.07	0.37
3	0-12	45.41	10.2	17.3	22.46	38.10	0.59
4	0-15	57.64	17.4	26.3	30.19	45.63	0.66
	15-30	ND	5.2	31.3	ND	ND	0.17
				Maljen			
1	0-8	42.78	14.2	4.9	33.19	11.45	2.90
	10-25	20.80	7.8	4.9	37.50	23.56	1.59
2	0-15	45.38	15.7	9.9	34.60	21.81	1.58
3	0-15	54.93	15.0	23.7	27.31	43.14	0.63
4	0-15	54.62	17.4	14.0	31.86	25.63	1.24
5	0-17	39.22	10.5	13.2	26.77	33.66	0.79
6	0-10	59.21	11.6	28.8	19.59	48.64	0.40
7	0-10	55.44	11.1	18.9	20.02	34.09	0.59
	10-20	49.83	18.7	17.2	37.53	34.52	1.09
				Bukovi			
1	0-15	62.00	20.2	24.7	32.58	39.84	0.82
2	0-15	53.26	18.1	18.1	33.98	33.98	1.00
	15-25	49.58	10.5	18.9	21.17	38.12	0.55
3	0-15	45.85	13.9	14.8	30.32	32.28	0.94
	15-30	49.64	11.0	21.4	22.16	43.11	0.51
5	0-17	50.28	24.9	14.0	49.52	27.84	1.78
	17-30	41.73	15.0	22.2	35.94	53.20	0.67
	30-45	39.98	11.3	19.7	28.26	49.27	0.57
				Bubanj Potok			
1	0-15	50.46	16.6	25.5	32.90	50.53	0.65
3	0-20	46.38	13.6	15.6	29.32	33.63	0.87
7	0-20	43.90	21.0	13.2	47.83	30.07	1.59
	20-40	37.82	11.9	20.6	31.46	54.47	0.58
	40-60	37.60	8.6	16.4	22.87	43.62	0.52

Suvobor							
1	0-10	57.49	13.6	14.0	23.66	24.35	0.97
	10-25	47.71	10.0	14.8	20.96	31.02	0.67
2	0-20	45.03	8.9	14.0	19.76	31.09	0.63
3	0-10	51.91	6.1	25.5	11.75	49.12	0.24
4	0-20	48.61	7.2	11.5	14.81	23.66	0.63

ND-not detected

Similar results of Ca/Mg ratio are reported by JAKOVLJEVIĆ and STEVANOVIĆ (2004) for the serpentinite soils under natural grasslands in the area of Zlatibor, and they conclude that this is one of the significant factors of the poor productive capacity.

After SCHACHTSCHABEL's (1954) citation, the detailed researches by CHI and TURK (9,19) show Ca/Mg (meq)= 7 (for oat and rice), while the studies by SANIKI *et al.* (44,19) show that the highest plant yield was under the ratio Ca/Mg=4 (wheat and common millet). The Ca/Mg ratio in the soil reported by the above authors justifies the optimal yield, because plants absorb Ca and Mg by the ratio (4-6):1.

CONCLUSION

Based on the study results of the ratio of adsorbed Ca/Mg in serpentinite rankers in Serbia, we can conclude the following:

- Regardless of the location of the formation of serpentinite rankers in Serbia, the ratios of adsorbed Ca/Mg are unfavourable, which causes the unfavourable uptake ratio by plants and reduces the productive capacity of these soils;
- Serpentinite rankers of Serbia are true lithogenic soils in which the parent rock has an absolute effect on the chemical composition of the soil, and in this way also on the ratio of adsorbed Ca/Mg.

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SADRŽAJ I ODNOS ADSORBOVANOG Ca I Mg U SERPENTINITSKIM ZEMLJIŠTIMA SRBIJE

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U radu su prikazani rezultati istraživanja sadržaja adsorbovanog Ca i Mg kao i njihovog odnosa (Ca/Mg) u serpentinitskim rankerima Srbije. Uzorci su uzeti iz sedam širih lokacija (Zlatibor, Kopaonik, Miroč, Maljen, Bukovi, Suvobor i Bubanj Potok) u visinskom pojasu između 100 i 1700 m nad.visine. Ukupno su otvorena 32 pedološka profila i analizirano je 47 uzoraka zemljišta. Sadržaj adsorbovanog Ca i Mg određen je metodom atomske aprsorpcione spektrofotometrije, posle ekstrakcije sa NH_4–acetatom. Rezultati istraživanja su pokazali da je skoro u svim ispitanim uzorcima sadržaj adsorbovanog Mg-jona veći od sadržaja adsorbovanog Ca–jona, te je i njihov odnos (Ca/Mg) manji od jedinice. Ovakav odnos Ca/Mg se nepovoljno odražava na uspevanje biljaka i smatramo da je jedan od osnovnih uzroka niske produktivne sposobnosti serpentinitskih rankera Srbije.

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