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MOBILE NICKEL CONTENT IN CALCAREOUS BLACK SOILS OF RAJAC

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Abstract: A description of mobile Ni contents in various subtypes of calcareous black soils from the area of the mountain massif of Rajac, is given in the present paper.

A hundred soil samples were analysed in all, originating from four subtypes of calcareous black soil (organogenic, organo-mineral, brownized and loessivized black soils).

The extraction of mobile Ni was carried out with 1.0 N HCl and its content was determined by atomic absorption spectrophotometry.

The obtained results indicate that mobile Ni content in the investigated soils varies within a wide range, from 5.0 to 251.3 mg/kg, that it is very seldom (only in 3% of the investigated samples) within the range from 5 to 7 mg/kg, that in over 90% of the 100 investigated samples it is higher than 10 mg/kg, and in almost 3/5 of the samples it is higher than 20 mg/kg.

Calcareous black soils of Rajac massif have much higher mobile Ni content than previously investigated black soils from calcareous massif of Rtanj, which is, by all means, only partly due to their more severe dealkalization and acidification. In addition, here is undoubtedly apparent the influence of the geological substrate, i.e. of serpentine rocks that border the calcareous massif of Rajac.

Key words: calcareous black soils, mobile Ni, Rajac.

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Introduction

Average Ni content within the pedosphere amounts to 40 mg/kg (Vinogradov, 1962), i.e. it most often varies between 10 and 40 mg/kg. It is most abundant in the substrates (or soils) over ultrabasic rocks, and is sometimes higher than 0.55%. According to Scheffer et al. (1966), soils over peridotites and serpentinites may exceptionally contain up to 100 mg/kg of readily mobilized nickel, in which case, the toxic effect of this element on plants may become apparent.

By comparative investigation of the methods for the estimation of solubility of heavy metals in some soil types (brown forest soils, fluvisols) Jakovljević, M. et al. (1997) came to the conclusion that in the mentioned soil types approximately the same quantities of mobile (extraction with 1 M HCl) and readily available nickel (extraction with 0.1 M HCl) are extracted. These amount to approximately 9% for brown forest soils and approximately 14% for fluvisols from the total nickel contents in these soils. All plants take up a certain amount of Ni ions from the soil, although it has not yet been proved that this microelement is essential. Nevertheless, Saprikin (1984) finds that Ni exerts a noticable influence on the yields of agricultural crops (it is not clear if the influence is positive or negative), especially potatoes.

Nickel available to the plants includes Ni ions extracted from the soil by diluted acetic acid (at pH 2.5), which, according to Vinogradov (1957), amount to approximately 3-5% of the total Ni content in the soil.

A. Kabata-Pendias et al. (1989) state that total Ni content in the world soils varies between 1 and 100 mg/kg, and in USA soils between 5 and 200 mg/kg, average values for various soils being between 12 and 30 mg/kg in the surface layer.

Average Ni content for the world soils is estimated to be 20 mg/kg. There is no evidence of the essential role of Ni in plant metabolism. However, its favourable effect on plant growth has been discovered, which allows for an assumption that Ni may have certain functions in plants (Živković, M., 1987).

There are indications that Ni is an essential component of urease, and consequently, that it may be utilized by nodules of leguminous plant roots, where this element is transported in the form of ureides from root to shoot. It has been noticed that Ni exerts especially strong stimulatory effect on nitrification and mineralization of N-compounds.

Total Ni content in limestones amounts to 7-10 kg/mg, which are not small quantities, considering that the insoluble residue in limestones seldom exceeds 5-10% of their mass (Živković, 1987).

Our investigations were carried out in the north-east part of Suvobor mountain, or more precisely, mobile Ni content in black soils of calcareous massif

Rajac was investigated. Calcareous massif of Rajac borders an area of serpentinite massif of Suvobor mountain and is a part of this mountain. Considering that the investigated soil borders the serpentinite soils of Suvobor, our aim was to establish mobile Ni content in various developmental stages of calcareous black soil in that border area.

Material and Methods

Mobile nickel content was determined in four subtypes of calcareous black soil from Rajac area - north-east part of Suvobor mountain. Forty six profiles were opened and 100 soil samples were taken for the analyses. Seven profiles of organogenic black soil, 13 profiles of organo-mineral black soil, 12 profiles of poorly brownized black soil, 10 profiles of more strongly brownized black soil and 4 profiles of loessivized black soil were analyzed.

Extraction was carried out with 1 N HCl and mobile Ni content determination by atomic absorption spectrophotometry.

Results and Duscussion

From the results of the analyses presented in Table 1, it is obvious that all the investigated subtypes of calcareous black soil of Rajac are fairly rich in readily mobilized Ni and in a number of profiles (14 in all) very rich in this microelement in mobile form, the content of which amounts to 30-40 and even to 80 mg/kg. Actually, the results of the analyses show that mobile Ni content in the analysed soil samples from Rajac varies within a very wide range, from 5.0 to 251.3 mg/kg, i.e. it very seldom (only in 3% of the investigated samples) varies within the interval from 5 to 7 mg/kg and that in over 90% of the investigated 100 samples it is higher than 10 mg/kg, and in almost 3/5 of the samples it is higher than 20 mg/kg.

Considering the investigations of Jakovljević et al. (1997), if the content of easily mobilized Ni of 5 mg/kg is taken to be the limit for moderate (normal) levels for most soils (which has been done in this paper, because in the literature any data are unavailable on interpretative classification of the degree of soil supply with easily mobilized Ni), then all the investigated soil samples from Rajac could be classified as soils with average or high mobile nickel (Ni) content.

Even average mobile Ni content in the investigated soil samples from Rajac is fairly high and amounts to 25 mg/kg. As for the distribution of mobile Ni content in various subtypes of calcareous black soil from Rajac, in Table 1 it may

Tab.1.- Content of mobile Ni in calcareous black soils from Rajac

No. prof.	Depth cm	Ni mg/kg Eks.1.0nHCl	Subtypes	No. prof.	Depth cm	Ni mg/kg Eks.1.0nHCl	Subtypes
1	0 - 5	26.3	Organoge-		60 - 75	18.1	Poorly

2	0 - 3 - 5	27.4	nic black	32	75 - 90	8.5	brownized
3	0 - 5	24.1	soil		0 - 20	12.6	calcareous
4	0 - 5	27.7	(shallower		20 - 40	15.0	black
5	0 - 20	50.1	Organoge-		40 - 70	12.6	soil
6	0 - 15	46.4	nic black		70-100	10.3	(very deep)
7	0 - 15	46.6	soil		100-120	6.4	
	15 - 30	45.3	(deeper)		0 - 15	35.2	
8	0 - 20	21.4	Organo-	33	15 - 30	27.5	Muvh
9	0 - 10	32.8	mineral		30 - 40	15.7	brownized
10	0 - 20	25.9	black		0 - 15	88.7	calcareous
11	0 - 20	19.8	soil	34	15 - 30	66.8	black
12	0 - 12	26.8	(shallo-		30 - 45	52.0	soil
13	0 - 20	19.8	wer)	35	0 - 15	201.2	
14	0 - 20	31.2			15 - 30	251.4	
15	0 - 20	31.8			0 - 20	25.1	
16	0 - 20	20.9		36	20 - 30	14.2	
17	0 - 20	40.7			30 - 50	7.9	
18	0 - 20	28.6	Organo-		0 - 20	21.3	
	20 - 40	20.7	mineral	37	20 - 30	15.6	
19	0 - 20	22.8	black		30 - 45	7.8	
	20 - 40	24.7	soil		0 - 15	26.0	
20	0 - 20	19.9	(deeper)	38	15 - 30	23.5	
	20 - 45	20.5			30 - 40	19.2	
	0 - 15	21.8			0 - 25	32.4	
21	15 - 30	20.0		39	25 - 50	27.3	
	30 - 45	12.0			50 - 65	13.3	
	0 - 15	25.2		40	0 - 20	32.3	
22	15 - 30	19.1	Poorly		25 - 40	10.7	
	30 - 40	10.4	brownized	41	0 - 30	16.2	
	0 - 15	26.6	calcareous		30 - 40	8.2	
23	15 - 30	22.6	black		0 - 20	24.3	
	30 - 40	25.8	soil	42	20 - 40	26.5	
	0 - 15	14.6			40 - 60	16.8	
24	15 - 30	13.6			0 - 20	22.8	
	30 - 45	14.6		43	20 - 40	21.6	Loessivi-
	0 - 15	63.0			40 - 60	5.0	zed black
25	15 - 30	59.1			60 - 80	5.2	soil
	30 - 45	48.3			0 - 20	19.3	
26	0 - 25	79.3		44	20 - 40	17.3	
	25 - 40	47.4			40 - 45	13.0	
27	0 - 20	35.8			45 - 60	18.9	
	20 - 40	25.2			0 - 20	15.9	
28	0 - 25	32.6		45	20 - 32	13.2	
	30 - 40	19.0			32 - 47	8.2	
29	0 - 25	26.8			47 - 60	14.5	
	25 - 40	18.2		46	0 - 30	15.4	
30	0 - 25	26.0			30 – 50	7.6	
	25 - 40	14.2			50 - 70	10.7	
31	0 - 30	20.6					
	30 - 60	18.1					

be seen that, on average, this element is most abundant in its mobile form in organogenic black soil (mean value 36.7 mg/kg), followed by organomineral and brownized black soils which show similar mean values (24-26 mg/kg) however,

the loessivized black soils are with much lower content than afore mentioned subtypes, both in humus horizon (mean value 18.3 mg/kg) and in subhumus horizons (mean values 9-15 mg/kg). If calculated for all these soils, the average value amounts to 13.9 mg/kg.

By comparing mobile Ni contents in soils of Rajac with previously (Djordjević et al., 1992) investigated calcareous soils of Rtanj, we found that Rajac soils have much higher (most frequently 3-4 times) content of this microelement in mobile form than Rtanj soils. This is most markedly illustrated by the values of average mobile Ni contents in the surface part of Ah horizons in the analysed soil profiles from these two areas, i.e. these two mountains.

Thus, while the average mobile Ni content in the surface part of Ah horizon of Rajac soil amounts to 27.83 mg/kg, in the surface part of Ah horizon of Rtanj soil, these values are about 5 times lower and amount only to 5.3 mg/kg. Furthermore, while the surface parts of Ah horizon of organogenic and organomineral calcareous black soils of Rajac contain, on average, 35 and 26 mg/kg and of brownized black soils 31 mg/kg, the surface part of Ah horizons of organogenic and organomineral calcareous black soils of Rtanj contain, on average, about 8 mg/kg, and of brownized black soils, on average, only 5.3 mg/kg, which is about 6 times lower value than in the surface part of Ah horizon of brownized black soils of Rajac.

In general, the soils of the calcareous massif of Rajac have much higher content of mobile Ni than the soils of Rtanj, which is, by all means, only partly due to their stronger dealkalization and acidification, but is, besides, due to the influence of the geological substrate, i.e. serpentinite rocks bordering the calcareous massif of Rajac. The conclusion on the influence of serpentinite rocks on an increased mobile Ni content in calcareous black soils of Rajac is confirmed by the results of Djordjević (1997), concerning the content of mobile Ni in rankers situated just in the border area with the investigated calcareous massif of Rajac. According to the same author, the content of mobile Ni in serpentinite rankers from the area of Suvobor amounts, on average, to 337 mg/kg, which absolutely indicates the influence of the vicinity of serpentinite soils on an increased content of mobile Ni in calcareous black soils of Rajac (north-east part of Suvobor).

Conclusion

On the basis of the obtained results of the investigations of Ni mobile forms in the analysed subtypes of calcareous black soils from Rajac, we may conclude the following:

- Mobile Ni content is highest in organogenic black soil (mean value 36.7 mg/kg) followed by organomineral and brownized black soils showing close average values (24-26 mg/kg), while the loessivized black soils are with

significantly lower content than the previous subtypes and their mean value amounts to 13.9 mg/kg.

- Mobile Ni content in the investigated soil is higher compared to the content of mobile Ni in previously investigated our calcareous soils.

- We may safely state that the increased contents of mobile Ni in various subtypes of calcareous black soils of Rajac (north-east part of Suvobor) are mostly due to the vicinity of serpentinite rocks of the Suvobor mountain.

REFERENCES

1. Djordjević, A., Blagojević, S., Živković, M. (1992): Sadržaj lako mobilnih formi mikroelemenata Cu, Zn, Co, Ni, Cr, Pb i Mn u zemljištima krečnjačkog masiva Rtnja. Savetovanje mladih istraživača Srbije, Poljoprivredni fakultet,Beograd.
2. Djordjević, A. (1997): Osobine ranker zemljišta serpentinitskih masiva Srbije s posebnim obzirom na uzroke njihove niske produktivne sposobnosti. Doktorska disertacija, Poljoprivredni fakultet, Beograd.
3. Jakovljević, M., Antić-Mladenović, Svetlana (1997): Uporedno proučavanje metoda za ocenu rastvorljivosti teških metala u zemljištu. Uredjenje, korišćenje i očuvanje zemljišta, Deveti kongres JDPZ, Novi Sad.
4. Kabata-Pendias, K. i Pendias,H. (1989): Mikroelementi v počvah i rastenijah.Moskva.
5. Scheffer, F., Schachtschabel, P. (1966): Bodenkunde. Stuttgart.
6. Saprikin, F. (1984): Geohimija počv i ohrana prirodi. Leningrad.
7. Vinogradov, A. (1957): Geohimija redkih i rassejanih himičeskih elementov v počvah. 2 – e izdanie, Moskva.
8. Živković, M. (1987): Hemija zemljišta. Knjiga 1, Pedohemija elemenata tvrde faze zemljišta, (Rukopis). Beograd.

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SADRŽAJ MOBILNOG NIKLA U KREČNJAČKIM CRNICAMA RAJCA

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R e z i m e

U radu je prikazan sadržaj mobilnog Ni u različitim podtipovima krečnjačke crnice iz područja planinskog masiva Rajac. Analizirano je ukupno 100 uzoraka zemljišta iz četiri podtipa krečnjačke crnice (organogena, organo – mineralna, braunizirana i lesivirana crnica). Ekstrakcija mobilnog Ni je vršena sa 1.0 n HCl, a njegov sadržaj je odredjen atomskom apsorpcionom spektrofotometrijom.

Rezultati analiza pokazali su da sadržaj mobilnog Ni u ispitanim zemljištima varira u širokom intervalu, od 5.0 – 251.3 mg/kg, veoma retko (samo u 3% ispitanih uzoraka) u intervalu od 5 – 7 mg/kg, zatim da je u preko 90% od 100 izučenih uzoraka viši od 10 mg/kg, a skoro u 3/5 uzoraka viši od 20 mg/kg.

U pogledu rasporeda sadržaja mobilnog Ni u raznim podtipovima krečnjačke crnice Rajca, najbogatija je organogena crnica (prosek 36.7 mg/kg), organo – mineralne i braunizirane crnice pokazuju znatno niže i to bliske prosečne vrednosti (24 – 26 mg/kg), dok su lesivirane crnice znatno siromašnije nego prethodni podtipovi (prosek 13.9 mg/kg) tog zemljišta.

Krečnjačke crnice masiva Rajca su mnogo bogatije mobilnim Ni nego ranije ispitivane crnice krečnjačkog masiva Rtanj, što je, svakako, samo delom posledica njihove jače dealkalizacije i acidifikacije, ali je pored toga, nesumnjivo, došao do izražaja i uticaj geološkog supstrata, odnosno serpentinitskih stena s kojima se graniči krečnjački masiv Rajca.

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