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INFLUENCE OF NICKEL IN SOIL

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ABSTRACT - Influence of nickel in soil
The objective of this investigation has been to study consequences of soil pollution with nickel in five locations in the municipalities of Sremska Kamenica, Ledinci and Beocin. The analysis of soil samples collected in the five locations has shown that the percentage of nickel differed from location to location. Nickel contamination was registered in 60% of the analyzed sites. A possible nickel polluter in this area is the cement factory in Beocin (CFB). The intensity of nickel contamination of soil decreased progressively with the distance of the sampling sites from the cement factory in Beocin.

Key words: Srem, CFB, environmental protection, emission, nickel, soil

INTRODUCTION

Highly industrialized countries are prone to high contamination with heavy metals in some areas or regions. Study of the presence of heavy metals in agroecological systems requires a multidisciplinary approach. Accumulation of heavy metals can significantly impair the ecological balance in nature.

Soil is a vital ecological and agricultural resource and it should be protected from further degradation. The rapid increase in the global population brings a corresponding increase in food demand. On the other hand, the intensified soil contamination with heavy metals caused by anthropogenic factors can reduce crop yields and quality of agricultural produce. Knowledge of factors that affect the behavior and accessibility of heavy metals in soil is of prime importance. A total content of heavy metals in a soil is the sum of metal inputs from several sources: parent material, precipitation, fertilizers, agrochemicals, organic and inorganic pollutants minus the amount of metals removed with crop yields, leaching and volatilization (KASTORI, 1997).

Heavy metals in soil are either formed by geochemical processes or are introduced from numerous external sources of contamination. Anthropogenic sources of heavy metals may be primary, e.g., heavy metals added to soil by fertilization, or secondary, when heavy metals released from nearby industrial facilities are transmitted by air. Ni is in the 24 place regarding its importance. Ni concentration is estimated tovary, depending on rock type, between 2 and 3600 mg/kg. Highest Ni concentrations are found in pyroxenes, acidic volcanic rocks contain less Ni, and particularly low Ni concnetrations are found in alkaline and sedimentary rocks (BOGDANOVIĆ ET AL. 1997). According to BOWEN (1979), Ni persists in the soil for 1000-3000 years. The wide persistence range is due to differences of soil. In general, soil pollution with heavy metals is a long-term problem.

Degree of pollution of soils, especially with heavy metals, and potential risks of this pollution on safe food production have been extensively investigated (DAVIES ET AL., 1979, SEKULIĆ ET AL., 1999, PROTIĆ, 2004, POPOVIĆ ET AL., 2008, 2009.). The results indicated that about 5% of the soils analyzed so far fall in the category of very high risk, with Ni, Cr and Pb being the most common pollutants (PROTIĆ, 2004). Knowledge of soil status is a key factor in the planning and production of safe food (SEKULIĆ ET AL., 1999).
We have investigated the basic soil chemical properties and total Ni content, in order to establish potential risks for agricultural production.

MATERIALS AND METHODS

The subject of this investigation were soils from the municipality of Srem. The paper deals with selected samples of arable land. Soil samples of, typically of the chernozem soil, have been taken for laboratory analyses. Samples were taken from the depth of 0-30 cm and they were analyzed for the following fertility parameters in laboratories of Institute of Field and Vegetable Crops in Novi Sad: pH value of soil suspension in KCl, potentiometric method; free $CaCO_3$ content - calcimeter by Scheibler; humus content - Tjurin's method; available phosphorus (extraction with ammonium lactate - AL method); phosphorus content determined by the; spectrophotometric method; available potassium (extraction with ammonium lactate - AL method); potassium content determined by flame photometry. After drying and grinding, soil samples were analyzed for total Ni content by the AAS method, after digestion with concentrated HNO_3 and H_2O_2.
These data were systematized by the given statistical and mathematical methods. Certain occurrences are presented in the form of tables.

RESULTS AND DISCUSSION

The results of chemical analyses showed that the analyzed soils had retained their original basic chemical properties. The analyzed samples belonged to the class of slightly alkaline to moderately alkaline soils containing free calcium carbonate (*Table 1.*).
Humus content in the soil was low, ranging from 1.45% to 2.83%, while nitrogen content was medium, except at one site (0.098%). Available phosphorus ranged from medium, high to very high. Fertilization without prior soil analysis led to a situation that 60% of the soil samples belonged to the classes of high and very high content of available phosphorus (*Table 1.*). For the soils with extremely high contents of available phosphorus it is recommended to omit fertilization from one to three years while keeping track of the level of microelements.

Table 1. Chemical properties of soil

No.	pH in 1M KCl	pH in H_2O	$CaCO_3$ %	Humus %	N %	P_2O_5 mg/100g	K_2O mg/100g
1	7.37	8.22	5.86	2.83	0.187	36.2	90
2	7.40	8.51	11.34	1.45	0.098	12.3	31
3	7.40	8.46	11.71	2.00	0.132	11.2	45
4	7.35	8.38	10.88	2.15	0.141	48.1	47
5	7.29	8.36	13.39	2.06	0.136	27.5	47

These high variations in phosphorus content across a relatively small research area are an indication of excessive application of phosphorous fertilizers. The anthropogenic impact on soil phosphorus content is therefore evident.
All investigated sites were found to have high to very high levels of available potassium, except in one location where potassium content has reached a toxic level that is not safe for the production of food, amounting to 90 mg/100g soil. Clearly, potassium fertilization can be safely and significantly reduced in the investigated area. A large range between minimum and maximum values of available potassium indicate a high influence of the anthropogenic factor on soil fertility. Results of soil analysis for total Ni content are shown in *Table 2*.

Table 2. Total soil Ni content (mg/kg) in the analyzed locations (digestion with HNO_3 and H_2O_2)

No.	Location	Description of location	Ni (mg/kg)
1	Sremska Kamenica	Mišeluk, 500m from the tunnel, close to the intersection	40.58
2	Sremska Kamenica	On the road to Popovica, in front of Mošina Vila, Fruškogorski Put St. 3	**52.41**
3	Ledinci	On the right hand side of the road towards the Danube, opposite the house no. 60	48.27
4	Rakovac	Salaksija , over housing area	**85.91**
5	Beočin	Exit of the Beocin roundaboutroad, 1.5 km, uphill, a plot to the right of the road	**112.48**
LSD		0.05	**7.21**
		0.01	**9.48**

The analysis of soil samples collected in the five locations has shown that the percentage of nickel differed from location to location. The results presented in *Tables 2.* and *3.* clearly show that 60% of the analyzed sites were contaminated with nickel. The high difference between the minimum and maximum values of soil Ni indicates that its origins are not uniformly distributed across the analyzed area. Ni content statistically significantly decreases with further distancing from cement factory in Beočin (*Table 2.*).

Table 3. Percentage of Ni in relation to MAC

Parameter	**Ni percentage**
Average value	**67.92**
Minimum value	40.58
Maximum value	**112.48**
MAC	**50**
Percentage of measurements exceeding MAC	60

Ni content in soil may have geochemical origin, coming from parent material, or there is another source of Ni emission. In this case we have grounds to believe that the cement factory in Beočin is the source of Ni emission. This hypothesis is supported by the fact that the intensity of nickel contamination of soil decreases progressively with distance of the sampling sites from the factory.

CONCLUSION

For production of quality food it is crucial to have good knowledge of soil properties, to be able to correct them by applying proper cultivation practices in order to ensure satisfactory crop yield and quality. The general situation found in the investigated area demonstrates strong anthropogenic influence on basic soil properties and a necessity to instruct the local farmers about basics of fertilizer application.

The conducted investigation indicated clearly of presence of heavy metals in the analyzed soils. Ni content statistically significantly decreases with further distancing from cement factory in Beočin. Although the soils in this area are only moderately degraded, they deserve due attention. Efficient elimination of industrial emissions and waste is a crucial factor for maintaining a healthy environment.

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