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Katarzyna SOŁEK-PODWIKA[1], Miłosz PODWIKA[2]
and Joanna NIEMYSKA-ŁUKASZUK[1]

TRACE ELEMENT CONCENTRATION IN SOIL OF SELECTED FORESTS OF KRAKOW CITY

ZAWARTOŚĆ PIERWIASTKÓW ŚLADOWYCH W GLEBACH WYBRANYCH LASÓW MIASTA KRAKOWA

Abstract: The aim of the paper was to evaluate the total content of cadmium, lead and chromium in the humus horizons of the forest and turf soils, rendzinas and mucky soils, located in the city of Krakow. In the examined soils; rendzinas and mucky soil, located in the south-western part of Krakow, the accumulation of these elements did not exceed limits considered as harmful. In the humus horizons of the examinated soils the anthropogenic accumulation of Cd and Pb which was estimated and confirmed by the calculated coefficient of accumulation. The accumulation coefficient was highier for mucky soils than for rendzinas.

Keywords: trace elements, turf and forest soils, the city of Krakow.

Introduction

The amount of heavy metals found in soil depends on many factors, both natural and anthropogenic [1]. In the current changes of the natural environment we can often observe the domination of multidirectional economic activity of man over natural causes, creating soil forming processes [2, 3]. Under the influence of gas emissions and the liquids from industrial institutions as well as the different elements of traffic pollution different types of chemical elements get into soil and accumulate there.

The aim of this research was to determine the influence of human activity and pollution on the total content of cadmium, lead and chromium in the humus horizons of soil differently used (forest and turf), representing two types of soil, located in the area of Krakow.

[1] Soil Science and Soil Protection Department, Agricultural University in Krakow, al. A. Mickiewicza 21, 31–120 Kraków, Poland, phone: +48 12 662 43 70; fax: +48 12 633 62 45; email: rrpodwik@cyf-kr.edu.pl

[2] Local Parc and Zoological Garden Foundation in Krakow, ul. Kasy Oszczędności Miasta Krakowa 14, 30–232 Kraków, Poland, phone: +48 12 425 35 51; fax: +48 12 424 27 10; email:miloszp@interia.pl

Materials and the methods of investigation

The area chosen for the research was located in the south-western part of the city of Krakow. The main risks in the area of research which have an anthropogenic character are mainly caused by pollution connected with car transport and communication. The object of research were forest and turf soils which, according to the IV issue of Polish Soil Systematics (1989), belong to the mucky soils and mixed rendzinas, with loamy light and heavy sand texture. The comparison of the content of cadmium, lead and chrome in the humus horizons with a depth of 0–20 cm, became possible thanks to the realization of turf soil profiles neighbouring the profiles of forest soils. At the same time the studied soils were found in the same physiographic conditions (with similar configuration of terrain, climate, similar water relations and the origin of geological parent rocks), these are soils with similar soil texture. This way of selecting the soil made it possible to determine the influence of economic activity of man, because the main factor differentiating the proprieties of the tested soil types was their use.

In the collected soil material the total content of cadmium, lead and chrome was determined in air dried samples using atomic absorption spectrometry (AAS) after soil dissolving in a mixture of concentrated nitric(V) and chloric(VII) acids. For the studied humus horizons *coefficients of accumulation* (AC) were counted for cadmium and lead (in relation to their content in the parent rock). In order to determine the properties of some physicochemical properties of the studied soils the following analyses were performed: soil texture according to the areometric Casagrande method in modification by Proszynski, pH by the potentiometer in 1 mol KCl · dm^{-3}, organic C concentration by oxidation with potassium dichromate(VI) using the modified Tiurin method.

Results and discussion

Table 1 presents the results of the performed analyses of the soil reaction, the content of organic carbon and elements of cadmium, lead, and chromium. Both humus horizons of forest and turf soils of the studied types of soil were characterized by the approximate pH values. Rendzinas were characterized by a neutral reaction through weak acid, acid to strong acid, and mucky soils from acid to strong acid. Forest soils of both types were generally richer in organic carbon than turf soils (Table 1).

According to statistical analyses and the use of the t-Student test it was confirmed, that the content of the chosen elements (Cd, Pb and Cr) was not connected with content of organic carbon, the soil reaction and the granulation of studied soils. The similar lack of dependence between proprieties of soils and the content of Cu, Ni and Zn was also confirmed by Mazurek and others [4] researching the content of these elements in forest soils located in the city of Krakow.

The mineral parent rock materials of the studied soils, ie rendzinas and mucky soils, respectively were characterized by the following content of trace elements: the Jurassic limestone 0.54 mg Cd · kg^{-1} and 54.17 mg Pb · kg^{-1} and fluvioglacial sands 0.1 mg Cd · kg^{-1} and 4.47 mg Pb · kg^{-1}. The content of cadmium and lead in fluvioglacial sand

is smaller than that quoted by Czarnowska [5] for the geochemical background of different origins of sand from northern and central Poland.

Table 1

Total content of cadmium, lead and chrome and selected soil properties of studies soils

No. profile	pH in KCl	C_{org} [g · kg^{-1} soil]	Cd [mg · kg^{-1} soil]	AC	Pb [mg · kg^{-1} soil]	AC	Cr [mg · kg^{-1} soil]
RENDZINAS							
Turf soils							
1	4.1	14.9	1.05	1.9	34.09	0.6	7.08
2	6.9	34.1	0.38	0.7	39.47	0.7	13.75
Forest soils							
3	6.5	11.8	1.97	3.7	76.74	1.4	21.97
4	5.0	54.9	1.98	3.7	89.82	1.7	23.70
5	6.8	59.4	1.02	1.9	32.80	0.6	9.07
6	4.1	52.4	1.19	2.2	59.60	1.1	16.22
7	4.7	62.3	2.03	3.8	82.27	1.5	15.40
MUCKY SOILS							
Turf soils							
8	4.4	31.3	0.91	9.1	20.82	4.7	3.82
9	5.0	19.8	2.08	20.8	78.48	17.6	18.97
Forest soils							
10	3.7	44.2	0.59	5.9	23.47	5.3	10.25
11	4.0	11.5	0.86	8.6	29.18	6.5	11.22
12	5.0	33.4	1.19	11.9	61.19	13.7	6.89
13	4.9	33.2	0.76	7.6	20.19	4.5	11.22

The value of *coefficients of accumulation* (AC) for cadmium and lead calculated for the humus horizons of the studied soils in the majority of cases confirm the anthropogenic origin of the accumulated metals. Higher accumulation coefficients for Cd, which varied in the range from 5.9 to 20.80 and Pb from 4.52 to 17.56, were calculated for mucky soils than rendzinas (Table 1). High values of coefficients of enrichment according to many authors [1, 6], result in small amounts of these metals in parent rocks.

The total content of cadmium in the horizons of rendzins covered with forest varied between 1.02 to 2.03 mg · kg^{-1} the soil and was about twice higher than in analogous horizons of turf soils (0.38–1.05 mg · kg^{-1} soil), in which also generally smaller total content of lead and chromium were found. The opposite dependence for studied heavy metals was estimated in mucky soils, in which the total content of cadmium (0.59–1.19 mg · kg^{-1} soil) in the humus horizons of forest soils was smaller than in analogous horizons of turf soils (0.91–2.08 mg · kg^{-1} soil). The total content of lead and chromium

in mucky soils of different use are shaped similarly, they are generally larger in horizons of turf soils than forest ones. On the basis of the results of the conducted research we cannot unambiguously determine a connection between the studied elements and the different way of use of the studied soils. The similar lack of relation in the total content of different trace elements between forest soils and the cultivated ones were affirmed by Kocowicz [7] as well as Zablocki and others [8].

Anthropogenic intensification can be estimated through the comparison of the amount of the studied metals with their admissible values. At present the estimation of the state of soils is mostly carried out with the support of the Decree of Minister of the Environment on the basis of soil quality standards as well as the standards of quality of the ground dated 9th September 2002 [9], this act is the legal basis for the protection of the environment, this act defines in section IV the principles of soil protection. This Decree establishes the admissible values of contaminants in the soil and ground for different substances, included heavy metals, in three groups of grounds and soils. In the studied soils, which were placed in group B, including among others different agricultural soils, forest soils, waste lands: (depth 0.0–0.3 m under ground level) according to the Decree of the Minister of the Environment [9] the influence of city and industrial agglomeration in Krakow did not confirm exceeding the admissible values of concentrations of selected trace elements.

Conclusion

1. In the humus horizons of the studied soils on the basis of the calculated coefficients of enrichment, the anthropogenic accumulation of cadmium and lead was confirmed, higher for mucky soils than for rendzinas

2. On the basis of the results we cannot unambiguously determine a connection between the total content of the studied elements in the studied soils of different use.

3. The studied soils which were located in the south-western part of the city of Krakow can be ccounted as areas where the concentration of the chosen trace elements does not exceed admissible amounts defined in the Decree of the Minister of the Environment.

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ZAWARTOŚĆ PIERWIASTKÓW ŚLADOWYCH W GLEBACH WYBRANYCH LASÓW MIASTA KRAKOWA

[1] Katedra Gleboznawstwa i Ochrony Gleb
Uniwersytet Rolniczy im. Hugona Kołłątaja w Krakowie
[2] Fundacja Miejski Park i Ogród Zoologiczny w Krakowie

Abstrakt: Celem przedstawionych badań było określenie całkowitej zawartości kadmu, ołowiu i chromu w poziomach próchnicznych gleb leśnych i zadarnionych; rędzin i gleb murszowatych położonych na terenie miasta Krakowa. Badane gleby położone w południowo-zachodniej części miasta Krakowa zaliczono do obszarów, gdzie koncentracja wybranych pierwiastków śladowych nie przekraczała norm uważanych za szkodliwe. W poziomach próchnicznych badanych gleb stwierdzono antropogenne nagromadzenie Cd i Pb co potwierdziły obliczone współczynniki wzbogacenia, które były większe dla gleb murszowatych niż rędzin.

Słowa kluczowe: pierwiastki śladowe, gleby zadarnione i leśne, miasto Kraków