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Paweł ZADROŻNY[1] and Paweł NICIA[1]

HEAVY METALS IN THE PEAT SOILS OF THE KONECKI COUNTY

METALE CIĘŻKIE W GLEBACH TORFOWYCH POWIATU KONECKIEGO

Abstract: The peat soils, like other hydrogenic soils, accumulate heavy metals in a much higher amount than mineral soils. Hight organic matter content in peat soils favours accumulation of heavy metals. The research aimed at determining the degree of accumulation of selected heavy metals (Cd, Pb and Zn) in peat soils located in the area of the Konecki county (Staropolski Industrial Region). The research results demonstrated that location of the analyzed peat bogs influenced heavy metal concentrations. The lowest contents of the analyzed heavy metals were characteristic of the soils of the peat bog situated at the longest distance from potential sources of pollution.

Keywords: heavy metals, peat bog soils

Natural environmental conditionings of the present Konecki county area – extensive forests and shallow lying iron ores caused that from the 2nd century BC this area constituted an important part of a huge iron metallurgy basin [1]. Technological progress, particularly the use of the water wheel dated back to the 12th century AD, caused rapid development of metallurgy and iron manufacturing. The manufactures, ironworks established at that time in this area led to a considerable development of the Staropolski Industrial Region, so that in the second half of the 16th century this region became the greatest metallurgical center on the Polish territories. Out of 320 ironworks operating at that time on the territory of Poland, as many as 142 operated in the sandomierskie province, to which the areas of the present Konecki county belonged. Moreover, a large center of glass manufacturing existed at the turn of the 16th and 17th century in the region of the Koneckie Hills [2].

Accumulation of heavy metals in soils is determined to a great extent by organic matter presence in them [3]. In hydrogenic soils, among which peat soils are counted, accumulation of these components is much higher than in mineral soils [4–7].

[1] Department of Grassland Management, Agricultural University in Krakow, al. A. Mickiewicza 21, 31–120 Kraków, Poland, phone 12 662 43 70, email: rrzadroz@cyf-kr.edu.pl

Rapid development of ironworks and metallurgy in the 19th and the 20th century contributed to a considerable increase in the emission of pollutants supplying to the environment substantial quantities of heavy metals, of which a major part is deposited in soils [8, 9].

The research aimed at determining the degree of accumulation of selected heavy metals (Cd, Pb and Zn) in peat soils located in the area of the Staropolski Industrial Region.

Material and methods

The analyses comprised five peat bogs situated in the area of the Konecki county. The following peat bogs were considered: Pod Stawami Rybnymi, Las Zbojno, Obok Lasu Zbojno, Kolonia Deba i Lesnictwo Zalesie. Soil material representing all determined genetic horizons of individual soils was collected from one soil pit on each peat bog.

The following assessments were made in the soil material: the total content of carbon (C_{tot}) and nitrogen (with the calcination method at 550 ^{o}C, in the TOC 1200C/N apparatus), reaction (pH) determined in H_2O and KCl (using an electrometric method by the CP-135 pH-meter), the contents of cadmium, lead and zinc after former soil mineralization in a mixture of concentrated nitric(V) and chloric(VII) acids (2:1), using the AAS method (PU910 atomic absorption spectrophotometer).

Results and discussion

The analyzed soils were classified as transitory peat soils (Las Zbojno, Kolonia Dęba), low peat soils (Obok Lasu Zbojno) and peat-muck soils (Pod Stawami Rybnymi and Leśnictwo Zalesie) [10].

The researched soils revealed a very acid and acid reaction. The pH values assessed in H_2O fluctuated from 3.3 to 5.8 and in KCl from 2.4 to 5.6. In most of the analyzed soils the highest pH values were determined in the horizons situated within the reach of groundwater, which may be the result of mineral components (Ca^{2+} and Mg^{2+}) presence, which neutralize acid products of organic matter decomposition.

Total contents of carbon and nitrogen in the organic horizons of the investigated soils ranged from 101.3 to 511.5 g · kg^{-1} (C_{tot}) and 2.2–9.2 (N_{tot}). In the underlying mineral levels the amounts of these elements were very high (C_{tot} – 21.9–31.2 g · kg^{-1}, N_{tot} – 0.6–0.7 g · kg^{-1}. The computed C_{tot}/N_{tot} ratio reached high values from 33 to 97.

Concentrations of individual heavy metals in the analyzed soils ranged as follows: Cd – from trace quantities to 2.00 mg · kg^{-1}, Pb – 1.86–49.85 mg · kg^{-1}, Zn – 4.50–205.35 mg · kg^{-1}. The amounts of these elements revealed considerable diversification within the analyzed soil profile. In a majority of the researched soils the highest content of the analyzed elements was assessed in the surface horizons (Table 1). These values are only in some cases slightly higher than those stated by Gorlach and Gambus [9] as the "natural" content in soil.

Table 1

Changes of heavy metal concentrations in the surface and underlying horizons of the analyzed soils and accumulation coefficients

Horizons	Cd	Pb	Zn
	mg · kg^{-1}		
Surface organic	0.45–1.25	17.51–46.20	29.01–99.65
Organic lying on mineral substratum	0.11–0.31	2.30–20.65	13.55–205.35
Underlying mineral	tr.–0.15	2.30–4.91	4.50–14.60
WA	1.45–11.36	(0.85) 3.66–6.76	(0.22) 2.24–5.46

The assessment of the amount of pollution with the analyzed heavy metals conducted on the basis of their allowable values in soil surface horizons [11] revealed that the analyzed soils meet the requirements for the soils in protected areas, classified in group A.

The contents of the analyzed elements in the surface horizons of the studied soils were definitely lower than the contents assessed in the analogous horizons of organic eutrophic [4, 6, 7] and oligotrophic [5] mountain fen soils.

Accumulation coefficients (WA) computed on the basis of individual heavy metal quantities in the surface horizons and the lowest organic horizons revealed that surface enrichment in these elements occurred in a vast majority of the studied profiles (Table 1). This enrichment, doubtlessly of anthropogenic character, most likely results from deposition of the analyzed elements from the polluted atmosphere. Only the Pb content in the soil surface horizons of Kolonia Deba peat bog (WA = 0.85) and Pb concentration in the soils of Lesnictwo Zalesie peat bog (WA = 0.22) were lower than the quantities of these elements in organic horizons lying immediately on the underlying mineral substratum.

The lowest contents of all analyzed heavy metals in the whole profiles were assessed in the peat bog Pod Stawami Rybnymi, which may result from the longest (of all analyzed objects) distance from potential pollutant emission sources.

Conclusions

1. The contents of the analyzed heavy metals in the studied peat soils of the Konecki county varies from the amount of these elements considered as natural contents only to a slight degree.

2. Soils of the majority of the investigated peat bogs are subjected to anthropogenic enrichment in Cd, Pb and Zn originating from pollutant deposition from the atmosphere, as it has been demonstrated by computed accumulation coefficients.

3. Location of the analyzed peat bogs influenced heavy metal concentrations. The lowest contents of the analyzed heavy metals were characteristic of the soils of the peat bog situated at the longest distance from potential sources of pollution.

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METALE CIĘŻKIE W GLEBACH TORFOWYCH POWIATU KONECKIEGO

Katedra Gleboznawstwa i Ochrony Gleb
Uniwersytet Rolniczy w Krakowie

Abstrakt: Gleby torfowisk, podobnie jak inne gleby organiczne, są w większym stopniu narażone na zanieczyszczenie metalami ciężkimi niż gleby mineralne. Akumulacji metali ciężkich w glebach torfowych sprzyja duża zawartość materii organicznej. Celem przeprowadzonych badań była ocena zanieczyszczenia metalami ciężkimi (Cd, Pb, Zn) gleb torfowisk powiatu koneckiego. Przeprowadzone badania wykazały, że wpływ na zawartość metali ciężkich miała lokalizacja badanych torfowisk. Najmniejszymi zawartościami badanych metali ciężkich charakteryzowały się gleby torfowiska położonego w największej odległości od potencjalnych źródeł zanieczyszczeń.

Słowa kluczowe: metale ciężkie, gleby torfowe