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CHOSEN CHEMICAL PROPERTIES OF SOILS FROM BASIN AND AN INNER-FIELD PEAT ALBERTÓW

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Summary. The research was conducted at Łęczyńsko-Włodawskie Lake District, in locality Albertów. Soil samples were collected from peat bog (transitional bog and low bog) from an area of 3.5 ha (10 pits) and from a basin (soils generated from loose sandy soil and coarse sandy soil) (6 profiles). In the upper layers of examined peats, the content of cooper was located in the range of 14–24 mg·kg^{-1}, and zinc 66–198 mg·kg^{-1}. Soils of low bog were characterised by higher zinc content than the transitional bog. Directed changes were not found in this metal content in deeper layers (to 30 cm). In basin soils the content of cooper in the humus horizons was from 2.4 to 9.3 mg·kg^{-1}, and zinc content from 12.3 to 46.3 mg·kg^{-1}. The content of both analysed elements in basin soils systematically decreased in the profiles.

Key words: peat bog, basin, soils, content Cu, Zn, Albertów

INTRODUCTION

In their natural habitat, peat-bogs accumulate large amounts of water, hence mid-field peat-bogs, besides they are valuable natural objects and also play an important role in water balance on agricultural areas. Tillage of soils within peat-bog catchments may contribute to their degradation [Wójcikowska-Kapusta and Urban 1999, Urban and Wójcikowska-Kapusta 2003,]. Soils with water management of the retention type and high content of organic matter are used to monitor the environmental pollution with heavy metals [Miechówka *et al*. 2002].

The present study aimed at analysing selected chemical properties of soils, namely copper and zinc, in the catchment and mid-field peat-bog Bagno Wytrzeszczone.

STUDY OBJECTS AND METHODS

Studies were carried out upon a small peat-bog (3.5 ha) and its catchment in Albertów I in Pojezierze Łęczyńsko-Włodawskie district. Within the catchment, soil samples were collected from 6 profiles (from every horizon including mother rock). Among the six profiles selected for determination, three were located on cultivated fields, one in the forest, one on the pasture, and one on the wasteland. Typologically, they were podzolic, chernozem, and ground-gley soils. The transitional peat was formed in the middle of the peat-bog area with fragments of tall peat. Short peat can be found at the edge of the peat-bog. The whole peat-bog is strongly hydrated [Urban and Wójcikowska-Kapusta 2003]. Samples from 10 soil pits were collected from the peat-bog, 3 at each of the depths: 0–10, 10–20, and 20–30 cm. Thickness and description of the horizons as well as peat layers are presented in Tables 1 and 2.

The following items were determined in soil samples collected from the catchment: grain size composition by means of Casagrande method with Prószyński modifications; pH_{H2O} and pH_{KCl}, organic carbon content by means of Tiurin method with Simakov modifications; and total copper and zinc contents. In order to determine the total contents of these elements, samples were digested in concentrated $HClO_4$ and HNO_3 mixture, and then analysed applying AAS technique. Soil samples collected from the peat-bog were subjected to determinations of reaction (pH_{H2O} and pH_{KCl}), organic matter content by means of combusting at 560°C, as well as total copper and zinc concentrations after wet digestion [Sapek and Sapek 1997]. The heavy metals were determined the same way as in soil samples from the catchment.

RESULTS AND DISCUSSION

Soils in the catchment were developed from loose and weak loamy sands (content of <0.02 mm fraction in the mother rock made up 1–10 %).

The pH of humus horizons of studied mineral soils was strongly acidic: pH in 1 mol KCl ranged from 3.63 to 4.08 (Tab. 1). Only in humus horizon of cultivated podzolic soil pH in 1 mol KCl was 5.86. Decrease of pH value along with the depth was observed in that soil, and weakly acidic reaction proved the field was limed.

The organic carbon content in humus horizons of cultivated soils within the catchment amounted to from 0.87 to 4.26%. The specific fallow chernozem was characterised by the largest organic carbon amounts.

Studied mineral soils from the catchment were characterised by natural copper concentration [Kabata *et al*. 1993]. The metal content ranged from 0.4 to 9.3 $mg \cdot kg^{-1}$ DM. The highest copper content (9.3 $mg \cdot kg^{-1}$) was determined in the organic horizon of the forest soil, which may result from considerable affinity to

Table 1. Chemical characteristics of the basin mineral soils tested

Study objects	Depth cm	Horizons	pH		Org. C (%)	Cu	Zn
			H_2O	1mol KCl · dm^{-3}		mg·kg^{-1}s.m.	
1) gley soil, field (W)	0–30	Ap	3.89	3.63	1.29	2.4	13.3
	30–50	AG	3.99	3.76		2.1	8.5
	>50	C	5.04	4.51		1.6	12.2
2) podzolic, forest (N)	0–5	O	4.31	3.85	7.02	9.3	46.3
	5–30	A	4.27	3.62		1.0	11.8
	30–45	Ees	4.11	3.64		0.4	4.2
	45–60	Bhfe	4.32	3.91		0.6	7.6
	>60	C	4.48	4.18		0.6	4.0
3) podzolic, field (S)	0–20	Ap/Ees	6.18	5.86	0.93	2.5	14.7
	20–50	Bfe	4.90	3.98		2.4	6.8
	>50	C	5.31	4.40		1.6	3.5
4) podzolic, field (S)	0–25	Ap/Ees	4.75	3.96	0.87	2.7	12.3
	25–45	Bh	5.36	4.70		2.1	8.9
	>45	R	5.27	4.59		3.6	9.2
5) typical meadow black earth, Pasturek (E)	0–5	A	4.47	3.72	2.19	3.0	17.4
	5–30	Aa	5.12	4.21		3.6	13.0
	>30	C	5.71	4.90		1.2	4.5
6) typical meadow black earth, uncultivated soil (S)	0–5	Ap	4.64	4.08	4.26	3.7	22.1
	5–25	Aa	4.28	3.86		2.7	15.9
	25–35	C	5.59	4.73		0.6	2.6
	>35	Cg	5.52	4.89		1.5	5.1

humus rather than due to contamination [Kabała *et al*. 2003, Kalembasa *et al*. 2006a]. Decrease of copper concentration along with the depth was observed in all studied soil profiles, which may confirm its anthropogenic origin.

Zinc content in mineral soils oscillated from 3.5 to 46.3 mg·kg^{-1} DM (Tab. 1). As in the case of copper, the highest amounts of zinc were found in organic horizon of the forest soil. Humus horizons of studied soils were more abundant in zinc as compared to deeper horizons.

Acidity of the transitional peat determined at 5 points in bog horizons at the level of 0–10 cm ranged from 4.20 to 4.28. No apparent changes in pH value in these soil profiles were recorded. Short peat was characterised with varied pH from 4.50 to 6.45, with the lowest value for mucking horizon (Tab. 2).

Within the peat-bog object, the organic matter content in transitional peat exceeded 90%, while in short peat its amount was from 49 to 96%. The mucking horizon at the 0–10 cm depth was characterised by the lowest organic matter percentage.

Copper concentration in peat-bog soils was about ten times higher than in the mineral soils from the catchment. Only in two soil pits – from transitional peat (point III) and short peat (with 20 cm muck layer) – copper content was similar: from 14 to 15 mg·kg^{-1} DM. The metal contents in other measurement points oscillated from 21 to 27 mg·kg^{-1} DM. Nevertheless, they were characteristic

Table 2. Chemical characteristics of the peat bog soils tested

Study objects	Depth cm	Peat profiles	pH		Organic mater %	Cu	Zn
			H_2O	1mol KCl dm^{-3}		mg·kg^{-1}s.m.	
I. transitional peat bog	0–10	POtpr	3.21	4.20	94	21	110
	10–20	POtpr	3.31	4.37	92	21	95
	20–30	Otprms	3.65	4.70	93	15	139
II. transitional peat bog	0–10	POtpr	3.13	4.20	98	21	66
	10–20	POtpr	3.11	4.28	90	24	80
	20–30	Otprms	3.33	4.23	91	25	110
III. transitional peat bog	0–10	POtpr	3.24	4.28	98	14	84
	10–20	POtpr	3.02	3.77	95	15	68
	20–30	Otprms	3.18	4.02	95	14	88
IV. transitional peat bog	0–10	POtpr	3.24	4.20	97	25	110
	10–20	POtpr	3.21	4.13	92	25	86
	20–30	Otprms	3.38	4.36	88	21	80
V. low-bog peat	0–10	POtni	5.05	6.45	72	27	198
	10–20	POtni	4.22	5.00	74	21	116
	20–30	Otnitu	4.10	4.92	83	15	102
VI. low-bog peat	0–10	POtni	4.27	5.08	86	21	116
	10–20	POtni	4.32	5.16	87	25	95
	20–30	Otnitsz	4.30	5.10	96	14	58
VII. low-bog peat	0–10	POtni	4.45	5.52	88	25	134
	10–20	POtni	4.38	5.03	83	21	145
	20–30	Otnitu	4.32	5.14	68	21	134
VIII. low-bog peat	0–10	POtni	4.63	5.37	86	25	172
	10–20	POtni	4.40	5.23	87	15	134
	20–30	Otnitu	4.57	5.27	90	14	102
IX. low-bog peat	0–10	M_1	3.74	4.50	49	14	80
	10–20	M_2	3.92	4.69	64	14	88
	20–30	Otnisz	4.13	4.80	83	21	66
X. low-bog peat	0–10	POtni	4.29	5.06	56	21	140
	10–20	POtni	4.28	5.06	72	27	139
	20–30	Otnitu	4.25	5.16	73	21	102

values for natural organic soils [Kabata-Pendias *et al*. 1993, Kalembasa *et al*. 2006b, c]. No tendencies in copper content changes within studied peat-bog profiles were found.

As compared to the mineral soils from the catchment, the peat-bog soils were also characterised by about ten times higher zinc concentrations. In the transitional peat soil, it ranged from 66 to 110 mg·kg^{-1} DM, while in short peat from 66 to 198 mg·kg^{-1} DM. Referring to literature data [Christianis and Kreshtapova 2004, Urban 2004, 2006, Czarnecka and Sugier 2006, Kalembasa *et al*. 2006b, c,], in majority of studied points in short peat, as well as two points in transitional peat, zinc content indicated its elevated levels. No apparent tendencies in zinc content changes within studied peat-bog profiles were recorded.

Higher copper and zinc concentrations in organic soils mostly result from the natural biological accumulation process, but it also may prove anthropogenic contamination, e.g. due to runoff from cultivated fields within the catchment. Such thesis can be confirmed by studies of Kabała *et al*. [2003]. Kabała *et al*. [2003] found copper and zinc concentrations in peat-bog soils of Sudeten Mountains similar to the results achieved here. In their studies, such a high content remained down to the 50 cm depth; in deeper layers concentrations of these elements decreased. Research of Miechówka *et al.* [2002] indicated that most of heavy metals, including zinc, were accumulated in sub-surface layers of peat-bogs, which the authors attributed to their elution inside the soil profiles along with the organic matter. Czarnecka and Sugier [2006] determined much lower copper and zinc contents in peat soils from peat-bogs in Poleski National Park and Szumy Valley in Roztocze region as compared to the values achieved in this study.

CONCLUSIONS

1. Studied soils from the catchment and short peat were characterised by strongly acidic to weakly acidic reaction. Soils of transitional peat were strongly acidic.
2. Copper concentration in the soils from catchment and peat-bog, as well as that of zinc from the catchment can be considered as natural.
3. Soils of short peat contained more zinc than transitional peat.
4. In mineral soils of the catchment, copper and zinc contents decreased along with depth, while in peat profiles no such tendencies were observed.

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WYBRANE WŁAŚCIWOŚCI CHEMICZNE GLEB ZLEWNI I ŚRÓDPOLNEGO TORFOWISKA ALBERTÓW

Streszczenie: Badania prowadzono na Pojezierzu Łęczyńsko-Włodawskim w miejscowości Albertów. Próbki glebowe pobrano z torfowiska (przejściowego i niskiego) o powierzchni 3,5 ha (10 odkrywek) oraz ze zlewni (gleby wytworzone z piasków luźnych i słabo gliniastych) (6 profili). W wierzchnich warstwach badanych torfów zawartość miedzi mieściła się w przedziale od 14 do 27 $mg \cdot kg^{-1}$s.m, a cynku od 66 do 198 $mg \cdot kg^{-1}$s.m. Gleby torfowisk niskich charakteryzowały się wyższą zawartością cynku niż torfowisk przejściowych. Nie stwierdzono ukierunkowanych zmian w zawartości tych metali w warstwach do 30 cm. W glebach zlewni zawartość miedzi w poziomach próchnicznych wahała się od 2,4 do 9,3 $mg \cdot kg^{-1}$s.m, natomiast cynku od 12,3 do 46,3 $mg \cdot kg^{-1}$s.m. Zawartość obu analizowanych pierwiastków w glebach zlewni systematycznie malała w głąb profili.

Słowa kluczowe: torfowisko, gleby mineralne, zawartość Cu, Zn, Albertów