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MICROELEMENT CONTENTS IN ARABLE SOILS OF THE UPPER SILESIA

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A b s t r a c t. In the present paper arable soils of the Upper Silesia were evaluated as to copper, zinc, manganese and iron contents, determined in the same extract, i.e. 1 M dm^{-3} HCl. The studies comprised 20 points in the vicinity of Sosnowiec and 20 points from near Zawiercie. Soil abundance in the available forms of microelements was assessed on the basis of the limiting numbers suggested by the Institute of Soil Science and Plant Cultivation. Soils of Zawiercie and Sosnowiec belonged to those with high contents of zinc in all the cases; in the majority of objects these were the soils with medium contents of copper and manganese. In half of the cases, the soils were classified as possessing low iron content, and in the remaining half as having medium iron content.

K e y w o r d s: extraction, soil, microelements, contents.

INTRODUCTION

Microelements are indispensable for proper growth and development of all organisms. Both their excess and deficiency may cause disturbances in the proper ecosystem functioning. In the natural ecosystems soil and precipitation are the main and only sources of bio-elements for living organisms. Then the cycle of elements is almost balanced. However, agro-ecosystems and systems affected by industrial pollution are often without such a balance [3]. In this latter case, an inflow of microelements is often higher then their losses by plant absorption and leaching [8,9]. In turn, intensification of plant production causes an increased microelement absorption [7].

According to agricultural criteria, the forms of elements that are available for plants are more important than their total content. For that reason the methods of chemical extraction are applied to determine the level of available forms [1-3].

The aim of the studies was to evaluate the content of available microelement forms (Cu, Zn, Mn and Fe) in the studied soil samples.

MATERIAL AND METHODS

The study materials were collected from production fields in the Sosnowiec and Zawiercie regions. Soil samples from the surface layer of 0-20 cm was analysed. The studies comprised 20 points in the vicinity of Sosnowiec and 20 points from near Zawiercie.

The collected soil samples were air dried, ground in a porcelain mortar and screened with a 1-mm mesh sieve. Granulometric composition was determined by the areometric method after Bouyoucos-Cassagrande in Prószyński's modification, pH by the potentiometric method in the soil suspension with 1 M dm^{-3} KCl, hydrolytic acidity according to the Kappen's method, organic matter contents according to the Tiurin's method and microelement contents after extraction of 1 M dm^{-3} HCl.

In the obtained solutions copper, zinc, manganese and iron contents were determined with a Philips PU 9100X atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

According to the relevant agronomic categories, the studied soils were highly differentiated (Tables 1 and 2). In the Sosnowiec region, 7 of the investigated soils were classified as very light, 8 as light, 3 as medium and 2 as heavy soils. Five soils from the Zawiercie vicinity were classified as very light, 5 as light, 8 as medium and 2 as heavy. As to their acidity level, the studied soils revealed mainly neutral or slightly acid reaction. Acid and very acid soils represented 30% of all the results. Soil reaction was proved as the least diversified property of the studied soils. Coefficient of variation for the soils from the Zawiercie region was not much higher than 18% and almost 15% for the soils from the vicinity of Sosnowiec. Hydrolytic acidity ranged from 0.45 cmol H^+ kg^{-1} to 3.00 cmol H^+ kg^{-1} in the vicinity of Sosnowiec and from 0.38 cmol H^+ kg^{-1} to 5.20 cmol H^+ kg^{-1} in the Zawiercie region. Organic substance contents ranged from 0.61 to 2.51% C in the Sosnowiec region and 0.38-2.64% C near Zawiercie.

In the analysed samples of soils, microelement contents, both in the vicinity of Zawiercie and Sosnowiec, constituted a following series: Cu<Zn<Mn<Fe. Content of the analysed element was characterised by a wide range of variation which was manifested in the calculated coefficient of variation. The range of variation was

Table 1. Some properties of soils from Sosnowiec

Object	Fraction ϕ<0.02 (%)	pH KCl	Hydrolytic acidity cmol(+) kg^{-1}	Org. C (%)	Cu	Zn	Mn	Fe
					mg kg^{-1} d.m.			
Błędów	48	6.02	1.65	2.06	6.49	99.1	463.3	1445.9
Błędów	7	2.98	2.96	1.01	1.83	47.6	201.4	547.3
Błędów	46	6.75	0.68	2.51	8.22	138.9	502	898.7
Błędów	4	4.34	3.00	1.34	1.66	38.7	27.9	724.2
Łęka	12	5.97	1.28	1.10	3.96	169.9	383.8	646.7
Łęka	9	4.88	1.95	0.88	2.98	99.5	268.4	571.0
Porąbka	12	6.31	1.35	1.08	3.65	155.1	351.7	600.9
Okradzionów	11	6.02	1.05	1.18	3.51	106.7	300.8	570.6
Okradzionów	9	5.81	1.65	1.14	3.67	112.4	262.9	631.8
Okradzionów	11	5.93	1.28	1.22	3.63	177.0	352.4	612.2
Ujejsce	14	6.56	0.83	1.77	3.65	291.4	439.8	819.9
Ujejsce	10	5.58	1.50	1.18	3.07	335.2	463.0	641.9
Twardowice	26	6.22	1.13	1.38	5.49	197.9	400.9	1019.3
Twardowice	7	6.49	0.68	0.97	2.80	111.0	324.0	621.1
Ostrowy Górnicze	12	6.37	0.83	0.94	4.13	159.2	265.9	710.6
Ostrowy Górnicze	34	6.90	0.68	1.80	5.95	980.8	821.9	963.2
Klimontów	32	7.14	0.45	1.80	6.25	190.1	415.4	728.5
Dąbie Dolne	18	4.66	2.63	1.45	3.05	96.8	195.5	1210.8
Dąbie Dolne	12	5.19	2.03	1.31	3.17	107.1	178.2	1120.2
Twardowice	8	6.67	0.68	0.61	2.61	140.8	190.6	535.6
Mean	17.1	5.89	1.41	1.34	3.99	187.8	340.5	781.0
Coefficient of variation (%)	76.0	14.8	54.3	33.9	41.8	106.4	48.3	34.2

varied for each metal. Zinc contents showed the widest differentiation. In the case of objects situated in the Zawiercie region, zinc variation was 88% and in the Sosnowiec region, it was higher than 106%.

The average copper content in the analysed soil samples from the vicinity of Zawiercie (3.61 mg Cu kg^{-1}) did not differ much from the values found out in the Sosnowiec region (3.99 mg Cu kg^{-1}). For zinc and manganese, a higher average content was observed in Sosnowiec (187.8 mg Zn kg^{-1} and 340.5 mg Mn kg^{-1}) than in Zawiercie. Whereas in the case of iron, a higher contents was found in Zawiercie (969.9 mg Fe kg^{-1}) than in Sosnowiec (781.0 mg Fe kg^{-1}).

The present results were further evaluated by comparing with the results obtained in the Institute of Soil Science and Plant Cultivation and numerous other chemical and agricultural stations in Poland from 1986 [5]. While determining soil

Table 2. Some properties of soils from Zawiercie

Object	Fraction ϕ<0.02 (%)	pH KCl	Hydrolytic acidity cmol(+) kg^{-1}	Org. C (%)	Cu	Zn	Mn	Fe
					mg kg^{-1} d.m.			
Błędów	7	6.83	0.64	1.03	3.47	81.6	310.4	640.5
Błędów	24	7.01	9.45	1.14	4.11	110.1	377.4	624.2
Błędów	34	7.19	9.53	1.59	4.34	167.4	438.2	594.1
Błędów	31	5.89	1.58	1.39	3.69	38.1	147.6	1406.2
Łęka	10	5.25	1.95	1.21	2.23	59.5	88.6	708.1
Łęka	33	6.95	0.53	1.96	5.69	71.8	234.0	1479.5
Porąbka	6	4.19	3.00	1.08	1.66	23.9	152.6	562.3
Okradzionów	18	5.33	1.95	1.18	1.99	34.3	90.7	1731.5
Okradzionów	14	4.44	3.64	1.56	2.38	50.4	160.9	1065.5
Okradzionów	23	3.89	5.20	1.32	2.61	30.9	201.8	1335.2
Ujejsce	15	4.25	3.79	1.17	1.62	25.4	139.5	1873.2
Ujejsce	11	7.07	0.38	0.85	2.93	68.0	346.4	487.1
Twardowice	54	6.21	1.28	2.47	8.96	57.1	291.4	1853.3
Twardowice	23	5.47	2.03	1.32	3.44	34.9	184.4	1463.9
Ostrowy Górnicze	48	6.98	0.53	2.64	5.99	192.5	389.7	699.1
Ostrowy Górnicze	29	6.37	1.58	1.61	4.61	245.9	538.1	703.1
Klimontów	33	7.12	0.90	1.74	5.17	268.0	282.1	567.5
Dąbie Dolne	9	6.32	1.13	0.96	3.28	261.5	541.5	642.7
Dąbie Dolne	7	5.91	0.83	0.38	1.49	32.9	97.4	430.0
Twardowice	12	6.74	0.53	0.55	2.49	46.8	201.3	530.7
Mean	22.1	5.97	1.62	1.36	3.61	95.1	260.8	969.9
Coefficient of variation (%)	62.3	18.3	82.5	41.0	50.9	87.8	54.0	51.5

levels of available forms of microelements, the same exctractant, i.e. 1 M dm^3 was used. The soils of Zawiercie and Sosnowiec were classified as the soils with high zinc content. Taking into account the level of manganese in the soils of Zawiercie, medium levels were observed in 14 cases, medium to high in 6 cases. However, the soils of Sosnowiec had medium content in 13 cases, and high in 7. In half of the investigated objects, the manganese levels were low and in the other half medium. In half of the cases, the soils were classified as possessing low, and in the other half, medium contents of iron. In the case of copper, a majority of soils had medium levels (15 objects in Sosnowiec and 17 in Zawiercie). The soils with high levels were not numerous (5 objects in vicinity of Sosnowiec and 3 near Zawiercie).

Some authors pointed out a difference between microelement contents determined according to the same extractant method as 1 M dm^3 HCl as adjusted for

each of the microelements [4]. The extractant method used is cheap, easy, quick and useful, which was also confirmed by others [6].

CONCLUSIONS

1. The analysed soils revealed high difference in the determined properties. Reaction was the least differentiated and zinc contents the most.

2. It was found out that the investigated soils of the Upper Silesia did not show any deficiencies in copper, zinc and manganese contents.

3. In half of the analysed objects, a low contents of iron was observed.

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