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The content of copper in soils of allotment gardens in Zielona Góra, Poland

Zawartość miedzi w glebie ogródków działkowych w Zielonej Górze, Polska

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Abstract

In this paper, the total and phytoavailable form of copper in allotment garden in Zielona Góra are presented. Soil samples were collected from eight places in the allotments gardens and two samples from outside in the neighbourhood. The total content of copper varied from 2.58 to 16.23 mg•kg^{-1}. The form of copper potentially available for plants varied from 0.2 to 3.85 mg•kg^{-1}. The total content of copper meets the requirements of Directive by the Minister of Agriculture and Rural Development of the 21st March 2002 on the acceptable content of heavy metals in soils and Directive by the Minister of the Environment of the 9th September 2002 on the standards of soil quality and the standards of land quality.

Streszczenie

W artykule przedstawiono zawartość miedzi całkowitej oraz potencjalnie dostępnej dla roślin w glebach ogródków działkowych w Zielonej Górze. Próbki glebowe były pobrane z ośmiu miejsc na terenie ogródków działkowych i z dwóch miejsc poza ogródkami działkowymi. Zawartość miedzi całkowitej wynosiła od 2,58 do 16,23 mg•kg^{-1}. Zawartość miedzi potencjalnie dostępnej dla roślin wynosiła od 0,2 do 3,85 mg•kg^{-1}. Zawartość miedzi spełnia wymogi Rozporządzenia Ministra Rolnictwa i Rozwoju Wsi z dnia 21 marca 2002 r. w sprawie dopuszczalnych stężeń metali ciężkich zawartych w glebie oraz Rozporządzenia Ministra Środowiska z dnia 9 września 2002 r. w sprawie standardów jakości gleby oraz standardów jakości ziemi.

1. INTRODUCTION

In addition to decorative plants, fruit and vegetables are also grown for consumption. People need to eat and grow ecological products. According to GUS [Central Statistical Office], in 2012, there were 4,929 gardens (43,350 ha) divided into 965,328 allotments (33,972 ha). Is what we grow in our allotments really so healthy? The atmospheric dust, traffic, the fact that allotments are often located in post-industrial areas, the use of artificial fertilizers and pesticides and contaminated compost may all lead to a high quantity of pollution in the soil, including heavy metals. The heavy metals in urban soil were first investigated in the late 1960s [Purves, 1967, Szolnoki et al., 2013]. Gardens soils have a specific function: cultivating vegetables and fruits. Taken up by plants, heavy metals may enter the food chain in significant amounts. Therefore, people could be at risk of adverse health effects by consuming vegetables and fruits grown in soil containing elevated metal concentrations [Aleksander et al., 2006].

2. MATERIALS AND METHODS

The research site is located in the western part of Zielona Góra. The town is located in the middle west of Poland. Zielona Góra is situated on a number of hills and belongs to the Silesia-Wielkopolska climatic region, which is an area with prevailing oceanic influences, characterized by small amplitudes of air temperature fluctuations (GUS 2011).

The examined soil samples were collected in the western part of Zielona Góra, in allotment gardens located in Łużycka street (Figs 1–3). Ten samples of soil were collected in total. Eight soil samples were collected in the allotment gardens and two in the neighbourhood of the gardens, as a reference. Between these allotments runs a busy road.

Soil samples were taken in September 2011, from 0 up to 30 cm of the soil profiles. Soil material was air-dried and filtered through a sieve with a mesh diameter of 2.0 mm. Particle size distribution was determined by the Casagrande-Proszynski areometer method. Textural classes were established according to the FAO procedure. Electrical conductivity was determined conductometrically. Sorption properties (hydrolytic acidity – HA and total exchangeable bases – TEB) were determined by the Kappen method, pH in H_2O and 1 M $CaCl_2$ by the potentiometric method, TOC content using Tiurin method and the Cu content in aqua regia and 0.1 M hydrochloric acid using atomic absorption FAAS. Extracts in aqua regia (HCl + HNO_3 in a 3:1 ratio) were prepared according to PN-ISO 11466:2002.

All analyses were performed in triplicate.

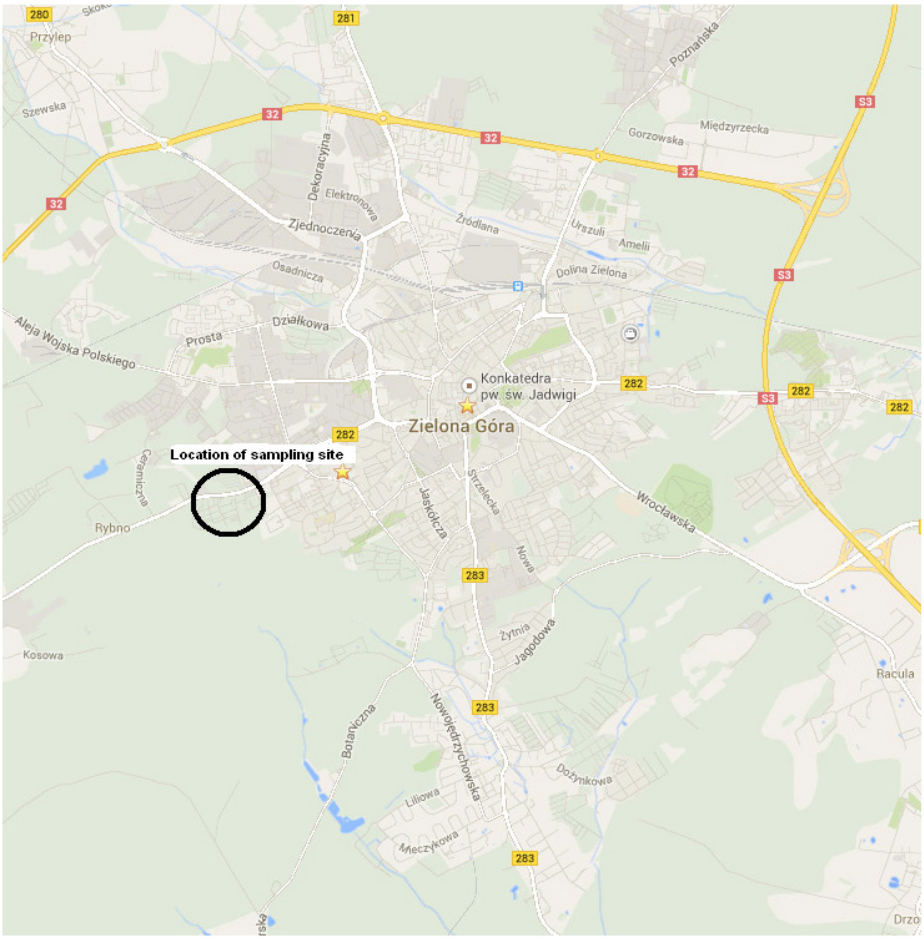

Fig. 1. Soil sampling site, allotment gardens in Zielona Góra, Poland

Fig. 2. Soil sampling site, allotments gardens in Zielona Góra, Poland

3. RESULTS AND DISCUSSION

Results of contents are shown in Table 1.The soil was sand and loamy sand. The soil from gardens have pH level from 6.6 to 7.5 in the water, and from 6.3 to 7.0 in $CaCl_2$. Five control samples have pH level from 7.1 to 7.4 in the water and from 6.8 to 6.9 in $CaCl_2$. In five cases, soil samples taken from allotment gardens have a lower pH value than control samples.

Electric conductivity shows the results ranging from 0.05 to 0.3 mS•cm^{-1} (for soil and control), which illustrates a state of soil typical for non-saline ones. TOC content ranges from 1.14% to 2.49%. It is four times less than control samples, where TOC was from 8.31% to 8.74%. Soils on the plots are poor.

Phytoavailable copper constituted less than 36% of its total form.

In comparison to other allotment garden in the world, the content of Cu was from 18.51 to 579.84 mg•kg^{-1} in Szeged in Hungary [Szolnoki et al., 2013].

The average content of total copper in the allotment gardens in Zielona Góra was lower than in the control samples. The maximum content of total copper in the examined soil samples from the allotments is 14.8 mg•kg^{-1} and does not exceed the acceptable lead content as specified in the Directive by the Minister of Agriculture and Rural Development of the 21[st] March 2002 on the acceptable content of heavy metals in soils [10]. In addition, it does not exceed the standards specified in the Directive by the Minister of the Environment of the 9th September 2002 on the standards of soil quality and the standards of land quality.

Table 1. Physical and chemical properties of tested soil

Sample	Soil type	pH		EC	HA	TEB	CEC	BS	TOC	Cutotal	Cuv.
		H_2O	$CaCl_2$	mS•cm^{-1}	cmol•kg^{-1}			%		mg•kg^{-1} d.m.	
1	Sand	6.9	6.4	0.25	0.8	35.6	36.4	97.8	2.49	7.20	0.84
2	Loamy sand	6.6	6.3	0.23	0.9	37.5	38.4	97.6	1.84	6.83	0.71
3	Loamy sand	6.9	6.5	0.13	0.6	34.2	34.8	98.2	1.85	6.11	1.21
4	Sand	7.2	6.7	0.05	0.4	29.9	30.3	98.6	1.80	3.95	0.20
5	Sand	6.9	6.4	0.07	0.5	23. .0	23,5	97.8	1.14	2.80	0.41
6	Sand	6.7	6.3	0.09	0.6	21.2	21.8	97.2	1.26	10.41	0.82
7	Sand	7.2	6.8	0.14	0.3	34.0	34.3	99.1	2.04	2.58	0.95
8	Sand	7.5	7.0	0.10	0.3	41.5	41.8	99.2	2.04	14.80	1.78
Mean	-	-		0.13	0.55	32.1	32.8	98.1	1.81	6.83	0.86
9	Sand	7.1	6.8	0.18	0.8	15.0	15.8	94.9	8.31	10.82	1.33
10	Sand	7.4	6.9	0.30	0.5	30.0	30.5	98.3	8.74	16.23	3.85
Mean	-	-	-	0.24	0.65	22.5	46.3	96.6	5.52	13.53	2.59

HA – hydrolytic acidity, TEB – total exchangeable bases, CEC – cation exchange capacity, BS – base saturation, TOC – total organic carbon

Fig. 3. Soil sampling site number 3

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