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Testing of available heavy metal content of soils in Long-Term Fertilization Trials with ryegrass (*Lolium perenne* L.)

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ABSTRACT A greenhouse pot experiment was set up to study the Cd and Cr uptake of ryegrass (*Lolium perenne* L.) from the National Long-Term Fertilization Trials (NLFT) in Keszthely. The soil used was Eutric cambisol. Soils samples were taken in October 2000 in the 34th years of the experiment. Ryegrass was grown for four weeks and the plants were cut above the soil. Fresh and dry biomass weight and Cd and Cr concentrations were measured. The "total" (cc. HNO_3 + cc. H_2O_2 soluble) Cd and Cr contents of the NLFT soils were determined. The "total" Cd content of the experimental soils ranged between 0.18-0.21 mg·kg^{-1} soil. The Cd concentration in the aboveground ryegrass parts was 0.14-0.27 mg·kg^{-1} dry matter. The Cd content of plants was 76-141 % of the soils' Cd content. It was found that the "total" Cr content of soils was 37.9-40.3 mg·kg^{-1} soil. The Cr content of ryegrass was 2.68-6.09 % of the soils' Cr content. The concentration of the examined toxic heavy metal in soils was only a fraction of the valid Hungarian maximum permissible quantity. No connection was found between fertilization and the amounts of elements. **Acta Biol Szeged 46(3-4):107-108 (2002)**

KEY WORDS

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plant
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As with other trace elements, Cd and Cr are also toxic to plants and animals under conditions of above average exposure (McGrath 1987).

The total Cd and Cr content of an agricultural soils is the results of inputs of metals from several sources-parent material, atmospheric deposition, fertilizers, agrochemicals, organic wastes and other inorganic pollutants, minus losses in metals removed in crop material, leaching and volatilization (Alloway 1995). The concentrations of Cr and Cd in very few phosphates are greater than the concentrations already in soils. Chromium is the 7th most abundant element on Earth, with an average concentration of 100 mg·kg^{-1}rock (McGrath 1987). The Cd is a relatively rare metal, being 67th in order of elemental abundance (Alloway 1995). In general the total Cd content of soils is 0.01-1 mg·kg^{-1} and in case of contamination it can exceed 200 mg·kg^{-1} (Lisk 1972). Fertilizers contain more Cr than Cd, with phosphates being the richest in both elements. Chromium content of phosphate fertilizers was 66-243 mg·kg^{-1}; Cd content of phosphate fertilizers was 7-170 mg·kg^{-1} (Shroeder et al. 19639).

Concentrations of Cr in plant-available from are extremely in the majority of soils, and this lack of solubility is reflected in the low concentrations of the element in plants. Concentrations of Cr in plants growing on mine spoil and various types of Cr waste are commonly in the range 10-190 mg·kg^{-1} (McGrath 1987). Scientists have concluded that the main risk of Cd on agricultural areas is not phytotoxicity or yield reduction but in more cases without visible symptoms it can reach the food chain (Lehoczky et al. 1996, 1998).

Table 1. Properties of experimental soils (Debreczeni, Debreczeniné 1994).

H %	1.9-2.16
pH_{CaCl2}	4.84–7.59
Al-K_2O mg·kg^{-1}	139
Al-P_2O_5 mg·kg^{-1}	45
Clay % (< 0,002 mm)	24

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Materials and Methods

The pot experiment was carried out under green house conditions using soils of National Long-Term Fertilization Trials in Keszthely in 2001. The experiment was carried out in four replicates. We filled the pots with 1 kg of air-dry soil (Chaminade 1960). The test plant was ryegrass (*Lolium perenne* L. cv. Gulács). One thousand ryegrass seeds were sown in the pots. Ryegrass was grown for four weeks and the

Table 2. The experiments include 18 fertilizer treatments (kg·ha^{-1}·év^{-1}) (Debreczeni, Debreczeniné 1994).

Treatment	Treatment code	N (autumn)	N (spring)	P_2O_5	K_2O
000	1	0	0	0	0
101	2	25	25	0	100
111	3	25	25	50	100
121	4	25	25	100	100
201	5	50	50	0	100
211	6	50	50	50	100
221	7	50	50	100	100
301	8	75	75	0	100
311	9	75	75	50	100
321	10	75	75	100	100
331	11	75	75	150	100
411	12	100	100	50	100
421	13	100	100	100	100
431	14	100	100	150	100
441	15	100	100	200	100
521	16	125	125	100	100
531	17	125	125	150	100
541	18	125	125	200	100

Table 3. Hungarian maximum permissible quantities of the Cd and Cr content in soils (KÖM-EÜM-FVM-KHVM Order, 2000).

Heavy metal	Cd	Cr
mg·kg^{-1} soil	1	75

plants were cut above the soil. The cutting was repeated in four-week periods to investigate uptake dynamics as well. The present paper discusses the results of the first cut in details. Fresh and dry biomass weight and Cd and Cr concentrations were measured. The Cd and Cr contents of plant samples were measured after microwave digestion with cc. HNO_3+ cc. H_2O_2 by using ICP-AES.

The National Long-Term Fertilization Trials were set up in 1967 but winter wheat-maize-maize-winter wheat rotation has been growing since 1989. The experiment soil samples have been given different amounts of NPK fertilizer (Table 2). The soil used was Eutric cambisol. Soils samples were taken in October 2000 in the 34th years of the experiment. For experiment we collected soil samples from the 0-20 cm deep surface layer by mechanic soil drill. The "total" (cc. HNO_3 + cc. H_2O_2 soluble) Cd and Cr contents of the NLFT soils were determined.

The most important physical and chemical properties of the soil used are included in Table 1. Mathematical and statistical analysis of the experimental data was done by ANOVA using of SPSS for Windows statistical program.

Results and Discussion

The concentration of the examined toxic heavy metals (Cd and Cr) in soils were only a fraction of the valid Hungarian maximum permissible quantity (Table 3).

The "total" (cc.HNO_3+cc.H_2O_2 soluble) Cd content of experiment soils varied between 0.18-0.21 mg·kg^{-1} soil.

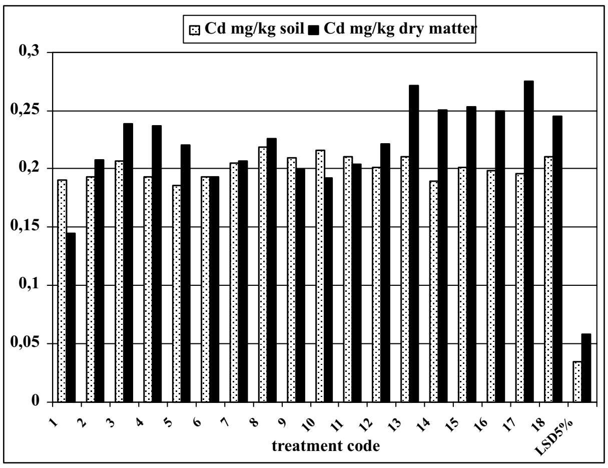

Figure 1. Cd content of the experimental soils and ryegrass.

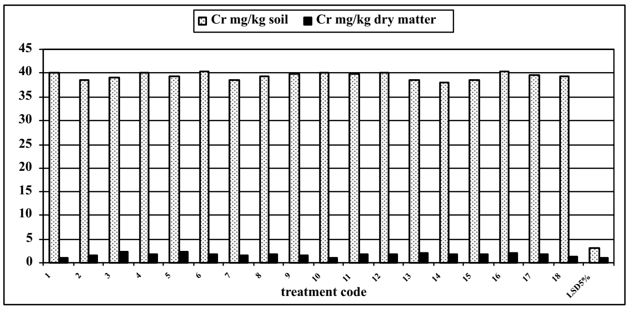

Figure 2. Cr content of experimental soils and ryegrass.

Cadmium concentration of ryegrass was 0.14-0.27 mg·kg^{-1}dry matter. The Cd content of plants was 76-141 % of the soils' Cd content (Fig. 1).

The "total Cr content of soils varied between 37.9-40.2 mg·kg^{-1}soil. The chromium concentration of ryegrass was 1.07-2.38 mg·kg^{-1}dry matter. The Cr content of ryegrass was 2.68-6.09 % of the soils' Cr content (Fig. 2).

The concentration of the examined toxic Cd and Cr in soils was only a fraction of the valid Hungarian maximum permissible quantity. No connection was found between fertilization and the amounts of elements. The cadmium and chromium uptake by ryegrass was different. The cadmium more mobile than chromium in the soil-plant system. The Cd concentration in ryegrass was higher in most case than the soil's. Comparing soil heavy metal contents with plant uptake, it was found that uptake of Cr occurred in the smallest proportion. This element was the least mobile.

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