Žarnovičan, H., 2002: Soils and forest communities of the Lučenecká kotlina basin (in Slovak). Department of Soil Science, Faculty of Natural Science Comenius University Bratislava, msc.

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Žarnovičan H.: **Ekologické parametre dubových a dubovohrabových lesov v Lučeneckej kotline.**

V rokoch 1999-2001 sme na vybratých lokalitách Lučenskej kotliny opísali a fytocenologicky spracovali asociácie *Aceri tatarici-Quercetum* Z ó l y o m i 1957, *Querco petraeae-Carpinetum* S o ó et P ó c s (1931) 1957 so subasociáciami *Querco petraeae-Carpinetum caricetosum pilosae* a *poetusum nemoralis* a asociáciu *Genisto pilosae-Quercetum petraeae* Z ó l y o m i et al. in Z ó l y o m i et J a k u c s 1957. Definované lesné spoločenstvá sme podopreli aj pedologickým výskumom. V príspevku uvádzame výsledky ekologickej analýzy, ktorá podáva presnejšie informácie o nárokoch opísaných spoločenstiev na ekologické faktory prostredia: svetlo, teplotu, kontinentalitu, vlhkosť, pôdnu reakciu a pôdny dusík. Ich konkrétny priebeh vidieť na obr. 1-6.

SOIL AND GENOTYPE INFLUENCES ON HEAVY METALS STATUS IN MAIZE

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Abstract

Kovacevic V., Antunovic M., Bukvic G., Rastija M., Kadar I.: Soil and genotype influences on heavy metals status in maize. Ekológia (Bratislava), Vol. 23, No.1, 65-70, 2004.

Ten maize hybrids were grown under fields conditions on two soils type: Calcaric Fluvisols (caFL) and Stagnic Albe Luvisol (stAB), during two growing seasons in four replicates. Both soils are situated of Drava valley and they are mutually distanced about 2 km. Cd, Pb, Cr and Ni concentrations in ear-leaves (beginning of silking) and soil were measured by ICP-AES technique after their microwave digestion using concentrated $HNO_3+H_2O_2$. Maize yields on stAB were about 25% lower in comparison with caFL. Also, there were found differences among the hybrids. In general, we found low concentrations of heavy metals in maize with significant differences among the hybrids as follows (mg. kg^{-1} in dry matter): from 0.112 to 0.224 (Cd), from 0.73 to 1.04 (Pb) and from 0.303 to 0.391 (Pb), while Ni values were similar (mean 1.58). These values are very low with aspects of harmful influences on environment. For this reason, production of healthy food is possible in Croatia. By growing of genotype characterizing lower uptake of heavy metals, especially under contaminated conditions, is possible to alleviate environmental problem.

Key words: soil type, maize hybrids, cadmium, chrom, lead, nickel

Introduction

Contamination of soil with heavy metals is result human, industrial and agricultural activities. The accumulation, mobility and availability of heavy metals in the soil depend on soil factors such as acidity, humus content, clay mineral content, and their binding capacity (Szabo, 1995). Source of soil contamination is in close connection with metal fractions content in soil: exchangeable or organic (Boruvka et al., 1997). Tillage systems can affect on concentration and distribution heavy metals in plants (Lavado et al., 2001). Uptake heavy metals depend also on pH value, soil moisture and plant species (Bujnovský, 2001). In general, there are inadequate information concerning heavy metals status on fields in Croatia.

Aim of our study is testing levels and differences of yield and heavy metal status among maize hybrids on two soil types.

Material and methods

The field experiments, sampling and analysis

Ten maize hybrids were grown on two soil types (FAO, 1998): Calcaric Fluvisols (caFL) and Stagnic Albe Luvisol (stAB), of Drava Valley in Slatina area during two growing seasons (1998 and 1999). The field trials were sown by pneumatic sowing machine in four replicates (exp. plot 14m^2). Planned plant density (PPD) depends on the hybrids and it was 71428, 63493 or 58310 seed/ha (seed distance in row: 20.0, 22.5, or 24.5 cm: inter-row spacing 70 cm). Maize was harvested manually in the first decade of October. Grain yields were calculated on 14% moisture and 90% realization of PPD basis.

The ear-leaf at beginning of silking stage (the second decade of July) were taken for chemical analysis (about 25 leaves in the mean sample) from each plot (Bergmann, 1992). Mean soil sample was taken by auger to 30 cm of depth from each experimental plots in autumn 1997. Cd, Pb, Cr and Ni in maize leaves and soil samples was measured by ICP-AES technique after their microwave digestion using concentrated HNO_3+H_2O_2. Mobile fraction of these elements in soils extracted by ammonium acetate-EDTA (pH 4.65) solution (Lakanen, Ervio, 1971). Plant and soil analysis were made in the laboratory of Research Institute for Soil Science and Agricultural Chemistry (RISSAC), Budapest.

The results were processed by contemporary statistical methods (ANOVA and multiple correlation) using computer program described by Vukadinovic (1985).

Characteristics of the experimental fields

Choice two typical soils of the Slatina area were made for experimentation. In general, Calcaric Fluvisols is more fertile in comparison with Stagnic Albe Luvisol. Both soils are mutually distanced about 2 km. Calcaric Fluvisols has pH neutral reaction and it contains considerable higher levels of total and mobile fractions of calcium (Ca), magnesium (Mg), cadmium (Cd), lead (Pb) and nickel (Ni) in comparison with Stagnic Albe Luvisol (Table 1).

T a b l e 1. Some properties of the experimental fields (pH, clay and humus percent, concentrations for Ca, Mg, Cd, Pb, Cr and Ni)

pH	[%]		Concentrations in soil [mg.kg^{-1}]						
(KCl)	clay	humus		Ca	Mg	Cd	Pb	Cr	Ni
Calcaric Fluvisols									
6.81	12.72	1.35	Total* mobile	30800 12000	20900 1760	0.43 0.22	41.2 12.9	48.4 0.02	43.8 3.5
Stagnic Albe Luvisol									
3.80	11.92	1.09	Total mobile	2250 730	4320 102	0.15 0.05	14.4 2.6	30.9 0.02	21.7 0.9

* total (HNO_3+H_2O_2 digestion) and mobile fraction (NH_4Acet.+EDTA extraction)

Weather characteristics

The growing seasons 1998 and 1999 were favorable for maize growing, mainly because of satisfied rainfall and their favourable distribution during the growing season. In general, water shortage during July and August are mainly in close connection with low maize yields (Kovacevic, Josipovic, 1998). Rainfall quantities (the data of Slatina Weather Bureau – about ten km from the experimental fields in south direction) in the period May-September (V-IX) as well as July and August (VII+VIII) in both tested growing seasons were higher compared to long-term mean (V-IX: 465, 496 and 377 mm; VII+VIII: 203, 171 and 133 mm, for 1998, 1999, and long-term mean, respectively).

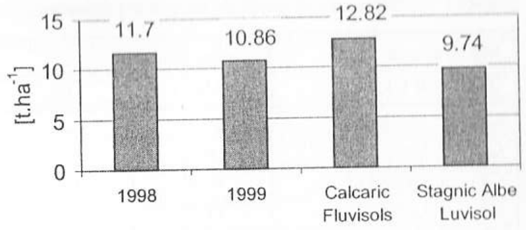

Fig. 1. Influences of the growing season and soil types on grain yield of maize (LSD 1% significance).

Results and discussion

In general, considerable influences of growing season, soil type and genotype on yields and heavy metals status of maize were found (Fig. 1-3, Table 2). Mean grain yields were 11.71 and 10.86 t.ha^{-1}, for the 1998 and 1999 growing season, respectively. In both year of testing, maize yields on Stagnic Albe Luvisol were about 25% lower in comparison with Calcaric Fluvisols (Fig. 1). Heavy metals concentrations in maize leaves were higher in the 1999 compared to 1998 (Fig. 2). Yields of individual hybrids (2-year means) were from 10.40 to 12.35 t.ha^{-1} (Table 2). The higher yields on Calcaric Fluvisols were found by 3 hybrids (OsSK554, OsSK458 and OsSK568exp.: mean 14.01 t.ha^{-1}). Yields above 10 t.ha^{-1} on Stagnic Albe Luvisol were found by OsSK332, OsSK444, OsSK458exp. and OsS490exp. (mean 10.84 t.ha^{-1}).

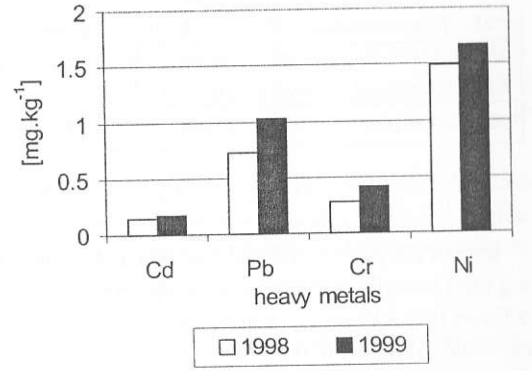

Fig. 2. Influences of the growing seasons on heavy metals status in maize (levels of significance: LSD 5% for Cd and LSD 1% for Pb, Cr and Ni).

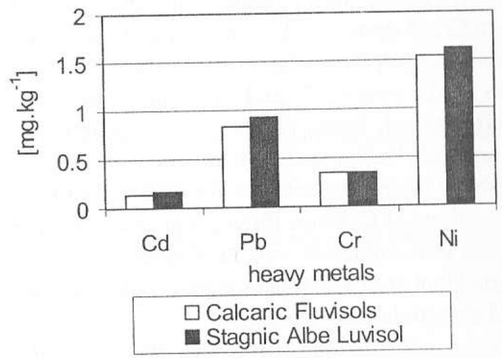

Fig. 3. Influences of soil types on heavy metals status in maize (levels of significance: LSD 1% for Cd, Pb and Ni; non-significant for Cr).

Table 2. Influences of genotype on maize properties

Maize hybrid (the factor C)		Grain yield [t.ha^{-1}]	The ear-leaf at silking [mg.kg^{-1}]			
			Cd	Pb	Cr	Ni
C1	OsSK332	11.28	0.224	1.04	0.391	1.63
C2	OsSK382	10.78	0.186	1.01	0.360	1.60
C3	OsSK413	10.40	0.120	0.93	0.375	1.59
C4	OsSK425exp	11.00	0.127	0.95	0.321	1.54
C5	OsSK444	10.68	0.156	0.90	0.317	1.55
C6	OsSK458exp	12.34	0.118	0.73	0.303	1.62
C7	OsSK490exp	11.71	0.112	0.79	0.322	1.62
C8	OsSK552	10.84	0.124	0.90	0.379	1.59
C9	OsSK554	12.00	0.146	0.78	0.335	1.53
C10	OsSK568exp	11.73	0.222	0.81	0.391	1.54
LSD C 5%		0.54	0.021	0.10	0.035	n.s.
LSD C 1%		0.74	0.030	0.14	0.049	
Mean of the trial		11.28	0.153	0.88	0.350	1.58

By our testing were found low concentrations of heavy metals in maize leaves concerning their harmful influences on environment (Table 2, Fig. 1-3). Their mean values were as follows (mg.kg^{-1} on dry matter basis): 0.153 (Cd), 0.88 (Pb), 0.350 (Cr) and 1.58 (Ni). For example, Mengel, Kirkby (2001) cited the critical concentrations of various heavy metals (higher levels are toxic) in plants (mg.kg^{-1} on dry matter basis): from 5 to 10 (Cd), from 10 to 20 (Pb), from 1 to 2 (Cr) and from 20 to 30 (Ni). Kaferstein (1979) reported acceptable maximum Pb and Cd levels in edible parts or food plants – for cereals these values are less than 0.5 ppm Pb and less than 0.1 ppm Cd. Davis et al. (1978) found heavy metal levels in young summer barley plants at tillering (5-leaf stage) with 10% loss of yield as follows: 10 ppm Cr, 15 ppm Cd, 26 ppm Ni and 26 ppm Pb. Fritz et al. (1977) found mean heavy metal levels in fruit, root, tuber and leaf vegetables from "non-contaminated regions" as follows: less than 1 ppm of Cd and Cr, from 2.0 to 9.0 ppm Ni and from 5.3 to 28.7 ppm Pb.

In general, levels of heavy metals contents in two soil types (Table 1) did not correspondingly influenced on their status in maize because hevay metals plant status in leaves (Table 2) were more similar for different soils (Fig. 3). We presume that under neutral soil conditions of Calcaric Fluvisols is less favourable conditions for heavy metals uptake by plants in comparison with acid reaction of Stagnic Albe Luvisol. Singh et al. (1995) reported that increase of pH values is in connect with decrease of cadmium and zinc mobility and accumulation by plants.

Also, considerable differences of Cd, Pb and Cr status were found among tested hybrids (Table 2) as follows (mg.kg^{-1}): from 0.112 to 0.224 (Cd), from 0.73 to 1.04 (Pb) and from 0.303 to 0.391 (Pb). OsSK458exp had the lowest concentrations (mg.kg^{-1}) of Cd (0.118), Pb (0.73) and Cr (0.303). At the same time, OsSK332 characterized the highest values as follows: 0.224 (Cd), 1.04 (Pb) and 0.391 (Cr). Probably, low concentrations of these metals in OsSK458exp hybrid could be in connection with its the highest yield (Table 2). Testing our data (2-year means), we found significant coefficient of correlation only between yield and Pb (r = -0.755**). Lead is major chemical pollutant of the environment, and is high toxic to man. By many studies was shown that Pb contents very clearly follows the motorway areas. Vegetation of the side of the road may have levels of 50 ppm Pb but distance of only 150 m away from the motorway the level is normal about 2 or 3 ppm (Mengel, Kirkby, 2001). Kadar, Koncz (2000), Kadar et al. (2002) tested influences of soil contamination with 13 pollutants, their mobility and phytotoxicity for maize, carrot and potato in calcareous chernozem. Cd and Pb were very mobile in soil, but they accumulated moderately (Cd) and weakly (Pb) in plant. Carrot root and potato tuber yields significantly decreased in the Cr, Hg, and Se treatments. Other applied elements did not effect the yield substantionally. Kovacevic et al. (2002) tested heavy metal status in two maize hybrids following fertilization by 1500 kg P_2O_5 and K_2O ha^{-1}. Applied fertilization had not effects on Pb and Ni status in maize. However, using of P fertilizer (MAP = monoammonium phosphate: 12% N + 52% P_2O) resulted by increase of Sr and Cr, while Cd concentrations in maize leaves increased as affected by both MAP and KCl. By this study was also found non-toxic levels of tested elements in plants.

By comparison of these data with our results, low quantities of tested pollutants were found in maize leaves and production of healthy food is possible on arable lands in Croatia. Also, by growing of genotype characterizing lower uptake of heavy metals, especially in contaminated environment, is possible to alleviate food contamination.

Translated by the authors

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Kovacevic V., Antunovic M., Bukvic G., Rastija M., Kadar I.: **Vplyvy pôdy a genotypu na stav ťažkých kovov v kukurici.**

Na vápnitej fluvizemi (caFL) a stagnickej bielej luvizemi (stAB) sme počas dvoch vegetačných období v štyroch opakovaniach sledovali desať kukuričných hybridov, ktoré v terénnych podmienkach rástli na dvoch pôdach.

Obe pôdy ležia v údolí Drávy a od seba sú vzdialené asi na 2 km. Koncentrácie kadmia, olova, chrómu a niklu v šúpolí a v pôde sme namerali technikou ICP-AES po mikrovlnovom vylúhovaní pri použití koncentrovaného $HNO_3+H_2O_2$. Výnos kukurice na stAB bol o 25% nižší ako na caFL. Podobné rozdiely sme zistili aj medzi hybridmi. Vo všeobecnosti sme nízke koncentrácie ťažkých kovov našli v kukurici s významnými rozdielmi medzi hybridmi (mg.kg^{-1} v sušine): od 0,112 do 0,224 (Cd), od 0,73 do 1,04 (Pb) a od 0,303 do 0,391 (Pb), kým hodnoty Ni boli podobné (stredná 1,58). Tieto hodnoty z aspektu škodlivých vplyvov na prostredie sú veľmi nízke. Preto produkcia zdravých potravín je v Chorvátsku možná. Vypestovaním genotypu charakterizujúceho nízky príjem ťažkých kovov, hlavne v kontaminovaných podmienkach, možno zmierniť environmentálny problém.

MICROBIOLOGICAL CHARACTERIZATION OF THE SOIL INFLUENCED BY THE NEGATIVE ANTHROPIZATION

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Abstract

Šimonovičová A., Krnáčová Z., Pavličková K., Beňová A.: Microbiological characterization of the soil influenced by the negative anthropization. Ekológia (Bratislava), Vol. 23, No. 1, 71-79, 2004.

In the contribution we have dealt with a long-term negative influence on anthropogenic activities on microbial character of soil in the studied territory – Nováky region. The affected area belongs to region with the most important energetic raw in Slovakia, where one of the biggest fuel – energetic complex is build. The main environmental problems of the region are: the air contamination, the surface water contamination, and also the problematic of arsenic. The source of arsenic is the brown coal from Nováky mine. The samples for microbiological analysis were sampled from the Novaky mine – from the brown coal and mound in the depth 0-5 cm, 20-30 cm. The species from kind *Aspergillus*, *Penicillium* and *Paecilomyces* were dominant. Species *Paecilomyces lilacinum* and *Scopulariopsis brevicaulis* have the ability of methylation As from inorganic into the organic form.

Key words: environment, Nováky region, arsenic, soil microscopic fungi, methylation

Introduction

In accordance to the geomorphologic classification of Slovakia the studied territory belongs to Hornonitrianska basin (Upper Nitra basin), exactly to its partial basin – Prievidza basin. Hornonitrianska basin forms branched ditched founder between the arch of cored mountains (Strážov mountain, Small Fatra, Žiar, Tríbeč) and volcanic mountains of Slovak upland (Kremnica upsides, Vtáčnik). Toward cored mountain it is limited with heavy faults,