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DECREASING OF POTENTIALLY Mn PHYTOTOXICITY IN MAIZE BY CHANGE OF SOIL REACTION

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Summary

In biological test at defined temperature and moisture conditions the potentially Mn phytotoxicity in maize in relationship to changed soil reaction was tested. The extremly acid soil was used and its reaction was in one of variants changed by using of $CaCO_3$. The added $CaCO_3$ has significantly positive influence on yield of overground biomass and also on yield of roots of maize. Results of biological test show enhanced Mn contents in roots and biomass of maize in unlimed variant in comparison with limed variant. Biological test confirmed the positive influence of added $CaCO_3$ on Mn contents in roots (more than 72% lower Mn content) and overground biomass of maize (more than 77% lower Mn content in comparison with unlimed variant).
Key words: Mn phytotoxicity, maize, roots, overground biomass, soil reaction

Introduction

The soil contamination is one of the biggest environmental problems of this time. The soil is the start point of risk elements input to the food chain of the man. Heavy metals occur in soil in unavailable forms, but at changed soil conditions they can be transformed to bioavailable forms. The origin and sources of heavy metals in Slovakia soils are various. In uplands regions there are many localities with natural geochemical anomalies. But contaminated localities are often caused by various anthropic activities e.g. industry, agriculture, traffic, energetics etc. (BIELEK et al., 1998).
In Slovakia there are nine endangred regions with damaged environment. One of the nine „hot spots“ of Slovakia is Stredný Gemer. ŽELBA Nižná Slaná was one of the most important contaminators of the environment in this region. Despite of strangled industry production of iron-mines Nižná Slaná, the consequence of its activity still exists. The emissions of this plant are characterised as a mixture of polymetalic dust and gass emissions.
Manganese as a component of these exhalats is one of risk elements because of its known toxic influence on animals and risk of its enhanced content in water, soil and plants (VOLLMANNOVÁ, 1998). In Slovakia Mn still isn´t cosidered for soil contaminating element. But many authors propose the maximal allowed Mn concetration in soil because of its potential risk for food chain (PODLEŠÁKOVÁ, NĚMĚČEK, 1995). The important fact of the proposals is the determination of portion of mobile and mobilisationable Mn forms by using extraction methods (GANGWAR, VINAY-SINGH, 1992; AHANGAR et al., 1995; AL-MUSTAFA, 1992; XIAOFU, SELMER-OLSEN, 1992 a o.). In most of soils Mn is prevailingly present as oxidized for plants unavailable Mn^{4+} form. Mn must be probably reduced on root surface for Mn^{2+} and in this form exhausted from soil. Mn^{2+} toxicity is often evident in extremly acid or moist soils, where Mn^{4+} is reduced for Mn^{2+} . In this form Mn is available for plants /LANGE et al., 1983/. Through increase soil pH for ca 6,5 Mn^{2+} is oxidized for Mn^{4+}, owing to Mn solubility and also bioavailability are decreased /ADRIANO, 1986/. According to prevalent knowledges /IVANIČ et al., 1984; LANGE et al., 1981; FOX et al., 1978; ADRIANO, 1986 etc./ Mn toxicity is evident at plants receipt over1000 mg $Mn.kg^{-1}$ d.w..

Material and methods

In biological test at defined temperature and moisture conditions the potentially Mn phytotoxicity in maize was tested. The extremly acid soil with pH/KCl = 4,07; H = 43,31 $mmol.kg^{-1}$; S = 94,1 $mmol.kg^{-1}$; T = 137,41 $mmol.kg^{-1}$ was used. The weight of soil on one pot was 700 g. In 1. variant only NPK fertlilizers (0,66 g of ammonium sulphate; 0,66 g of superphosphate; 0,26 g of potassium chloride) and in 2. variant also 3 g of $CaCO_3$ to one pot was added. The maize harvest was after 36 days from trial founding.
In used soil the available nutrient contents and Mn contents (total Mn content and Mn content in extract of 2 M HNO_3) by AAS method was determined (table 1). In both of variants the weight of root ans biomass yield was ascertained. After adjustment of plant samples Mn content in roots and in overground biomass by AAS method was determined (table 2).

Results and discussion

The added $CaCO_3$ has significantly positive influence on yield of overground biomass and also on yield of roots of maize. The yield of biomass in limed variant was more than 27% higher and the yield of roots more than 72% higher than those in unlimed variant.
Despite of determined Mn soil contents, which aren´t too high (the values are below by PODLEŠÁKOVÁ and NĚMEČEK proposed hygienic limits in Bohemia), determined Mn contents in roots and biomass of maize are higher than legislative obligatory hygienic limits in Slovakia valid for forages and fodders. The legislative hygienic limits for Mn content in forages

and fodders in Slovakia area followed: total feed dose: 100 $mg.kg^{-1}$; forage Mn content: 100 $mg.kg^{-1}$; fodder Mn content: 300 $mg.kg^{-1}$.

[mg.kg^{-1}] ***Table 1***

N-NH$_4^+$	N-NO$_3^-$	K	Mg	P	Mn (2M HNO$_3$)	Mn (Total)
19,66	44,38	64,5	90,4	24,75	574,9	1042,1

Table 2

Determined	NPK	%	NPK + CaCO$_3$	% to control
Yield of biomass d.w. [g]	5,74	100	7,30	127,18
Yield of roots d.w. [g]	0,72	100	1,24	172,22
Mn in roots [$mg.kg^{-1}$]	414,02	100	113,64	27,18
Mn in biomass [$mg.kg^{-1}$]	401,48	100	89,04	22,18

Results presented in table 2 show enhanced Mn contents in roots and biomass of maize in unlimed variant (33,72% higher than allowed legislative norm). The positive influence of added $CaCO_3$ is evident in 2. variant, where Mn content is 70% lower than allowed legislative norm.
These results confirm the possibility to elimine Mn phytotoxical influence on maize plants by application of $CaCO_3$ i.e. by adjustment of soil reaction.
It is evident that monitoring of heavy metal soil contents is one of the most important claims of this time. It is also necessary to ascertain maximal allowed hygienic soil limits for the other metals e.g. Fe, Mn a.o. because of their in high concentrations negative influence on living organisms and risk their input into the food chain of the man.

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