Genotype and Soil Influences on Zinc Status in Maize

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INTRODUCTION

Some soils in Croatia have nutritional imbalances. Growing more tolerant genotypes could be a solution for an alleviation of this problem. The aim of this study was to test ten maize hybrids on two soils of moderate fertility (calcaric fluvisol and pseudogley) with emphasis on the Zn status of plants. A previous study showed data concerning the K and Mg status, and Sr and Cd concentrations (Kovacevic et al. 2002). High levels of mobile Mg and Ca, and low levels of mobile Zn are main characteristics of calcaric fluvisols, while pseudogleys are moderately supplied with P and well supplied with Zn.

METHODS

Ten maize hybrids were grown on two soils of moderate fertility in the Eastern part of Sava valley, Croatia (Zupanja calcaric fluvisol and Luzani pseudogley). The experiments were conducted with four replicates, and an experimental plot was 14 m^2. Maize was sown at the end of April and harvested in the first decade of October in 1998. Common soil and crop management practices for maize were applied in both experiments including fertilization (in kg ha^{-1}: 160 / 150 N + 100 / 130 P_2O_5 + 150 / 130 K_2O for fluvisol / pseudogley, respectively). Ear-leaves were sampled at silking stage for chemical analysis. Elemental sample composition, including Zn, was determined after microwave digestion using concentrated HNO_3+H_2O_2 by Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) in the laboratory of RISSAC Budapest. Grain yields were calculated on a 14% grain moisture basis and 90% planned plant density. Statistical calculations were made in two-factorial trials (soil = factor A; maize hybrids = factor B).

An oversupply of Mg and Ca and a low content of available Zn are the main characteristics of the Zupanja calcaric fluvisol, while the Luzani pseudogley has adequate Zn concentrations and is moderately supplied with P (Table 1).

Table 1. Properties of the surface soil layer (0-30 cm) of calcaric fluvisol and pseudogley.

Soil	pH	Humus	NH_4-Acetate+EDTA extracted (pH 4.65) in mg kg^{-1}				
	1 N KCl	(%)	P_2O_5	K_2O	Ca	Mg	Zn
Calcaric fluvisol	7.12	3.14	77.3	98.4	11300	1010	0.93
Pseudogley	5.17	1.26	23.7	115.0	3750	205	30.0

RESULTS AND DISCUSSION

Similar low maize grain yields were found in both trials (means 6.31 and 6.07 t ha^{-1}, for fluvisol and pseudogley, respectively. Yield variations among maize hybrids ranged from 4.09 to 9.15 t ha^{-1}. Five hybrids (group B1: OsS552, OsSK558, OsSK554, OsSK497exp. and OsSK382) yielded under 6.0 t ha^{-1} (mean 4.97 t ha^{-1}), while the remaining five hybrids (group B2: OsSK458exp., OsSK444, OsSK617exp., OsSK602 and OsSK568exp.) had considerably higher yields (mean 7.41 t ha^{-1}) (Kovacevic et al. 2001).

Differences in the Zn status of maize grown under two soils conditions were considerably lower than differences of the mobile Zn status in these soils. Considerable influences of the genotype on Zn concentrations of maize leaves were found, because the variation of Zn contents among the hybrids ranged from 25. 6 to 41.7 mg Zn kg^{-1}.

Table 2. Influence of soil and genotype on maize properties.

Maize hybrid	Influence of soil (fluvisol=A1 and stagnosol=A2) and genotype on P, Zn status and P:Zn ratios of ear-leaves (on dry matter basis)								
	Phosphorus (%P)			Zinc (mg Zn kg^{-1})			P:Zn ratio		
	A1	A2	Mean B	A1	A2	Mean B	A1	A2	Mean B
OsSK382	0.493	0.236	0.364	22.5	28.7	25.6	220	83	152
OsSK444	0.516	0.262	0.389	33.2	45.4	39.3	156	58	108
OsSK458exp.	0.582	0.266	0.424	30.7	35.2	32.9	191	76	134
OsSK497exp.	0.477	0.246	0.361	31.7	40.0	35.9	151	62	107
OsSK552	0.482	0.238	0.360	34.6	43.3	39.0	139	56	98
OsSK554	0.602	0.265	0.433	33.6	33.3	33.5	180	80	130
OsSK558	0.586	0.252	0.419	24.3	35.2	29.7	245	72	158
OsSK568exp.	0.515	0.232	0.373	36.9	46.5	41.7	139	50	95
OsSK602	0.597	0.285	0.441	24.7	43.5	34.1	243	66	155
OsSK617exp.	0.547	0.227	0.342	28.4	52.1	40.3	164	44	104
Mean A	0.531	0.251	0.391	30.1	40.3	35.2	183	65	124
LSD	5%	1%		5%	1%		5%	1%	
AB	0.025	0.045		2.7	4.9		5	8	
AB	0.037	0.048		3.7	4.9		19	25	
	0.061	0.093		6.3	9.8		26	35	

In general, a less favourable nutritional status was found in the B1 group than in the B2 group (0.90% and 0.97% K, 0.98% and 0.85% Mg, for B1 and B2, respectively). Acute K deficiency (mean 0.64 % K) and an oversupply of Mg (mean 1.23% Mg) were found in maize on the calcaric fluvisol. Analogical comparison for pseudogley resulted in a considerably better nutritional status (1.27% K and 0.55 % Mg, respectively) of maize (Kovacevic et al. 2001). Analogical comparison of P and Zn status in maize resulted mainly in low differences between the two groups of hybrids.

Blasl and Mayr (1978) reported an optimal P:Zn ratio of 65 and an acceptable range from 15 to 180. A normal Zn status was found in our study based on these criteria. Growing maize on a pseudogley resulted mainly in optimal P:Zn ratios, while there can be problems with the Zn nutrition of some hybrids on a fluvisol (Table 1).

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