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The ear-leaf percentage of calcium and magnesium in maize inbred lines and their diallel progeny

V. Kovačević
Agricultural Institute, Osijek, Yugoslavia

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Summary. Eight maize (*Zea mays* L.) inbred lines and their single cross hybrids were grown for one year under field conditions near Osijek. The ear-leaf was taken in the tasseling stage and analysed for Ca and Mg percentage. Parental effects on ear-leaf content of Ca and Mg were very high. The hybrids of line C103 had low mean percentages of ear-leaf Ca and Mg while the hybrids of line Os64 had high mean percentages.

Key words: Maize – Diallel crossing – Ear leaf Ca and Mg

Introduction

Many plants within the same species exhibit genetic differences for mineral uptake and utilization (Myers 1960; Gerloff 1963; Epstein 1972; Arnon 1975; Foy et al. 1978; Kovačević 1980; Sarić 1981). More information on differential responses to various mineral elements would be useful for overcoming particular element problems and for developing plants which would utilize mineral elements more efficiently. These genetic differences can be used to adapt plants to unusual growing conditions and to improve them. The purpose of the study reported here was to determine the genetic differences in Ca and Mg ear-leaf percentages of eight maize inbred lines and their diallel progeny (56 singl cross hybrids). The differences among N, P, and K percentage have been shown in a previous study (Kovačević 1983).

Material and methods

Seven domestic maize inbred lines (Osijek Agricultural Institute; Zemun Polje-Belgrade Corn Research Institute; Novi Sad Institute of Field and Vegetable Crops) and one line from USA (FAO groups 500 and 600) were grown in field trials on Osijek brown soil ($pH_{KCl}=6.0$; available Ca and Mg extracted with 0.05 n HCl and 0.025 n H_2SO_4 = 0.193% and 0.03% Mg; humus = 2.0%).

The inbred lines were diallel-crossed and the seed was sown the following year on the same plot. Prior to sowing, the experimental plot was fertilized with 155 kg N, 130 kg P_2O_5 and 160 kg K_2O/ha. The experiment was a randomized block design with four replications. Each experimental plot of hybrids measured 14 m². Population density was 47,619 plants/ha. The ear-leaf of ten plants was taken from each plot when the plants were in the tasseling stage. Ca and Mg percentage was determined after dry ashing by atomic absorption spectrophotometry (Isaak and Johnson 1975).

Results and discussion

Levels of Ca and Mg in the ear-leaf of inbred lines ranged from 0.29 to 0.51% Ca. Lines ZPL161, ZPR455 and Os56 had lower values while NS358/II and Os2 had higher ones (Table 1). Parental effects on ear-leaf percentages of single crosses were very pronounced. Maternal effects showed differences from 0.33 to 0.49% Ca and paternal effects from 0.36 to 0.41% Ca. The hybrids of lines C103 and ZPL161 had the lowest.

The hybrids and their parents also differed in the ear-leaf Mg percentage (Table 1). Line ZPR455 had the lowest, while line Os64 had the highest, Mg percentage. Differences between the mean Mg percentages of single crosses were from 0.23% to 0.32% Mg (paternal effects) and from 0.19% to 0.49% Mg (maternal effects). The hybrids that included line Os64 as female parent had the highest mean Mg percentage. The hybrids with line C103 as female parent had the lowest percentage Mg.

The maize inbred lines and their hybrids varied considerably in ear-leaf percentages of Ca and Mg. Differences between the lowest and the highest levels

Table 1. Percentage of Ca and Mg (on dry weight basis) in the ear-leaf tissue (tasseling stage) of single cross maize hybrids and their parents

Female parent	Male parent of maize hybrids								Mean	LSD	
	Os 56	Os 64	Os 2	C 103	NS 358/II	NS 796	ZP L161	ZP R455		5%	1%
	Calcium (% Ca)										
Os56	–	0.34	0.38	0.35	0.40	0.36	0.37	0.40	0.37		
Os64	0.51	–	0.54	0.53	0.44	0.50	0.44	0.46	0.49		
Os2	0.36	0.40	–	0.30	0.41	0.36	0.37	0.37	0.37		
Cl03	0.28	0.46	0.29	–	0.29	0.36	0.26	0.36	0.33		
NS358/II	0.46	0.39	0.37	0.35	–	0.42	0.39	0.35	0.39		
NS796	0.40	0.46	0.38	0.31	0.46	–	0.35	0.40	0.39		
ZPL161	0.39	0.34	0.35	0.33	0.33	0.33	–	0.40	0.35		
ZPR455	0.40	0.48	0.46	0.41	0.36	0.43	0.38	–	0.42		
Mean	0.40	0.41	0.40	0.37	0.38	0.39	0.36	0.39		0.01	0.02
Inbred lines	0.35	0.42	0.49	0.42	0.51	0.40	0.29	0.33		0.03	0.05
	LSD	5%	0.03								
		1%	0.05								
	Magnesium (% Mg)										
Os56	–	0.16	0.20	0.22	0.31	0.31	0.36	0.27	0.26		
Os64	0.46	–	0.44	0.46	0.35	0.55	0.44	0.73	0.49		
Os2	0.26	0.24	–	0.17	0.23	0.23	0.27	0.23	0.23		
C103	0.13	0.34	0.18	–	0.14	0.18	0.19	0.18	0.19		
NS358/II	0.45	0.32	0.28	0.20	–	0.27	0.31	0.22	0.29		
NS796	0.27	0.32	0.24	0.16	0.24	–	0.27	0.29	0.26		
ZPL161	0.29	0.26	0.25	0.23	0.20	0.29	–	0.33	0.26		
ZPR455	0.24	0.35	0.24	0.19	0.23	0.29	0.29	–	0.26		
Mean	0.30	0.28	0.26	0.23	0.24	0.30	0.30	0.32		–	0.01
Inbred lines	0.21	0.43	0.19	0.23	0.33	0.32	0.20	0.16		0.02	0.04
	LSD	5%	0.02								
		1%	0.04								

were 43% and 63% (inbred lines), and 82% (hybrids), for Ca and Mg, respectively. The hybrids of lines C103 and ZPL161 had the lowest, and hybrids of line Os64 had the highest, mean Mg percentage, but only when this line was the female parent.

A comparison of all 28 analogous pairs of single crosses (correlation coefficient of reciprocal hybrids) showed very complex effects of the parental genotype on the percentage of the elements investigated ($r=0.48$ and $r=0.38$ for Ca and Mg, respectively).

When the mean values of hybrids which had the same parent (male or female) were compared with the leves of Ca and Mg in the inbred lines, low correlations were usually found (female component: $r=0.30$ and $r=-0.24$; male component: $r=0.09$ and $r=0.79$ for Ca and Mg, respectively). When the same parental lines were compared (reciprocal mean values), then correlation coefficients were as follows: $r=0.69$ and $r=0.15$ for Ca and Mg, respectively.

The same inbred lines, as well as hybrids, were analysed for ear-leaf percentage of N, P, and K. Differences between the lowest and the highest levels were 22%, 24%, 50% (inbred lines) and 28%, 38% and 51% (hybrids) for N, P, and K respectively (Kovačević 1983). In an earlier study with the same inbred lines, we found considerable differences for N, P, K, and Mg concentrations of entire kernel, endosperm and embryo (Sarić and Kovačević 1978).

The genetic differences of ear-leaf percentage of Ca and Mg of maize inbred lines or hybrids has been previously reported by other researchers. Differential responses of maize to Ca and Mg have been reported in a review study by Clark (1976).

When maize genotypes were grown under field conditions, Gorsline et al. (1968) found ranges from 0.84% to 1.14% Ca and 0.11% to 0.21% Mg. Clark and Brown (1974) observed striking differences between maize inbred lines for Mg and Ca utilization when they were grown on soils known to produce Mg and Ca deficiency. Total Mg uptake of B57 and five times that of Ind38–11. Line C103 was in the group with the least

efficiency for Mg utilization. Total Ca uptake by N28 was 60% that of line B37.

Kovačević (1976) found large differences in ear-leaf percentages of Ca (0.62–2.17% Ca) and Mg (0.13–0.44% Mg) among 15 maize inbred lines which were grown under same field condition.

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