Salinity stress in maize: presence of genetic variability in the mechanism of tissues tolerance.

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Salinity is one of the environmental stresses that adversity affects plant growth and development. NaCl is the predominant salt in the saline soils. The development of salt tolerance crop cultivars is proposes as the most effective strategy to overcome this problem (Epstein & Rains, 1987).

Maize (*Zea mays* L.) is the third most important cereal in the world after wheat and rice, and grows under a wide range of climatic conditions. It is moderately sensitive to salinity and considered as the most salt-sensitive of the cereals (Maas & Hoffman, 1977). Maize is a highly cross-pollinated crop, In consequence, it is highly polymorphic for the natural and domesticated evolution and in which salinity tolerance may exist (Paterniani, 1990).

Munns (1993) has proposed a biphasic model of growth response to salinity. The growth reduction in the first phase is an effect of salt outside rather than inside the plant (osmotic phase). In the second phase, the concentration of toxic ions increases rapidly, especially in old leaves, which die as a result of a fast increase of the salt concentrations in the cell wall or cytoplasm when vacuoles can no longer sequester incoming salts (ionic phase). In this second phase, genotypes that vary in salt tolerance may respond differently because of their different abilities to exclude toxic ions or to sequester them in the vacuoles (Munns 1993).

The tolerance to salinity could be classified in three mechanisms:

1. Tolerance to osmotic stress: the mechanisms controlling this phase are not specific to salinity; they are associated with water stress.
2. Na+ exclusion from leaf blades: the Na+ is accumulating by the root and this protected the leaves to arise the salt to toxic level.
3. Tissue tolerance: the tissue tolerance to accumulated Na+, the ion is compartmentalization at cellular and intracellular level to avoid toxic concentration within the cytoplasm (Munns & Tester, 2008).

Maize is considered as a crop moderately sensitive to salinity (Maas & Hoffman, 1983) and has been characterized as a plant that presents as a method of tolerance the exclusion of Na^+ (Drew & Lauchli, 1985). However, it is believed that the two other mechanisms would also be important in determining the tolerance (Munns & Tester, 2008).

The aim of this study was: explore the presence of genetic variability for mechanism of tissue tolerance; for the purpose of identifying genotype with response tolerant that could be used in a breeding program.

Seeds of 66 different genotypes were tested (Table 1) in a saline treatment (400mM ClNa). The different genotypes were sown at the field. Healthy and fully expanded leaves (of similar age) were briefly washed in deionized water, and leaf discs of 2 cm diameter were punched out and floated in a 6-ml of NaCl solution. They were left under light for 3 days

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Each genotype was assigned a score based on a damage level scale. This scale established 7 degrees of tolerance based on yellowing and / or tissue necrosis (grade 1 without apparent damage to grade 7 with 100% necrosis).

The trait measured is non-parametric, in consequence the Kruskal-Wallis method for a one-way ANOVA was used.

A distribution of frequency can be identified, pointing an appreciable variability of the genotypes for the tolerance of the tissues (Figure 1). Consequently, this test could be a good indicator of tolerance to salinity associated with ionic stress. The identification of materials with good behavior could be used in a saline stress improvement program.

References

Epstein E. & Rains D.W. 1987. Advances in salt tolerance. Plant & Soil 99:17-293 7 Maas, E. V. & Hoffman, G. J. 1977. Crop salt tolerance current assessment. J. Irrig. & Drain Div. ASCE 103:115-134.

Munns R. 1993. Physiological processes limiting plant growth in saline soils: some dogmas and hypotheses. Plant, Cell and Environment 16:15-24.

Munns R., Tester M. 2008. Mechanisms of salinity tolerance. Annu. Rev. Plant Biol. 59:651-681.

Singla-Pareek S., Reddy M., Sopory S. 2003. Genetic engineering of the glyoxalase pathway in tobacco leads to enhanced salinity tolerance. PNAS 100: 14672–14677.

Paterniani E. 1990. Maize breeding in tropic. Cri. Rev. Plant Sci. 9:125-154.

Table 1. Name of accessions, kernel type, genetic structure and place of recollections of genotypes evaluated.
* : these entries corresponds to experimental lines and the remaining genotypes are open pollination populations.
N/D: no data.

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N°	Entry	Kernel Type	Province
1	ARZM01001	Red flint	Buenos Aires
2	ARZM01005	Red flint	Buenos Aires
3	ARZM01006	Red flint	Buenos Aires
4	ARZM01009	Red flint	Buenos Aires
5	ARZM01013	Red flint	Buenos Aires
6	ARZM01015	Red flint	Buenos Aires
7	ARZM01029	Red flint	Buenos Aires
8	ARZM01039	Red flint	Buenos Aires
9	ARZM01043	Red flint	Buenos Aires
10	ARZM01052	Red flint	Buenos Aires
11	ARZM01080	Red flint	Buenos Aires
12	ARZM01102	Red flint	Buenos Aires
13	ARZM02005	Red flint	Santa Fe
14	ARZM02006	Red flint	Santa Fe
15	ARZM02016	Red flint	Santa Fe
16	ARZM03003	Camelia	Entre Ríos
17	ARZM03013	Camelia	Entre Ríos
18	ARZM03020	Camelia	Entre Ríos
19	ARZM03023	Camelia	Entre Ríos
20	ARZM03034	Camelia	Entre Ríos
21	ARZM04012	Red flint	Corrientes
22	ARZM04018	Camelia	Corrientes
23	ARZM06020	Red flint	Chaco
24	ARZM07140	Red flint	Formosa
25	ARZM14004	Red flint	Córdoba
26	ARZM14044	Red flint	Córdoba
27	ARZM14049	Red flint	Córdoba
28	ARZM14056	Red flint	Córdoba
29	ARZM14103	Red flint	Córdoba
30	ARZM14110	Red flint	Córdoba
31	ARZM16021	Red flint	Mendoza
32	ARZM16026	Red flint	Mendoza
33	ARZM16035	Red flint	Mendoza
34	ARZM16050	Red flint	Mendoza

N°	Entry	Kernel Type	Province
35	ARZM17001	Red flint	San Luis
36	ARZM17026	Red flint	San Luis
37	ARZM17035	Red flint	San Luis
38	ARZM17040	Red flint	San Luis
39	ARZM17056	Red flint	San Luis
40	ARZM18001	Red flint	La Pampa
41	ARZM18005	Red flint	La Pampa
42	ARZM18006	Red flint	La Pampa
43	ARZM18010	Red flint	La Pampa
44	ARZM18012	Red flint	La Pampa
45	ARZM18017	Red flint	La Pampa
46	ARZM18037	Red flint	La Pampa
47	ARZM18043	Red flint	La Pampa
48	ARZM19010	Yellow flint	Neuquén
49	ARZM19068	Red flint	Neuquén
50	ARZM20010	White flint	Río Negro
51	ARZM21011	Yellow flint	Chubut
52	B73 *	Yellow dent	N/D
53	AD3 *	Red flint	N/D
54	SC75 *	Yellow flint	N/D
55	F564 *	Yellow flint	N/D
56	LP3	Red flint	N/D
57	P21 *	Red flint	N/D
58	WXEB *	Red flint	N/D
59	26A	Yellow flint	N/D
60	10F	Yellow flint	N/D
61	P1338	Red flint	N/D
62	arzm12209	Red flint	N/D
63	arzm18054	Yellow flint	N/D
64	arzm18029	White flint	N/D
65	arzm01151	Red flint	N/D
66	arzm06070	Red flint	N/D

Table 2: Analysis of variance of Tolerance degree of pieces of leaves in NaCl solution.

Source of variation	df	MS
Genotypes	65	40353.4**
error	330	6767.1
Total	395	

**,*, indicates differences significant at p <0.01; 0.05 respectively, while ns, denotes not significantly differences.

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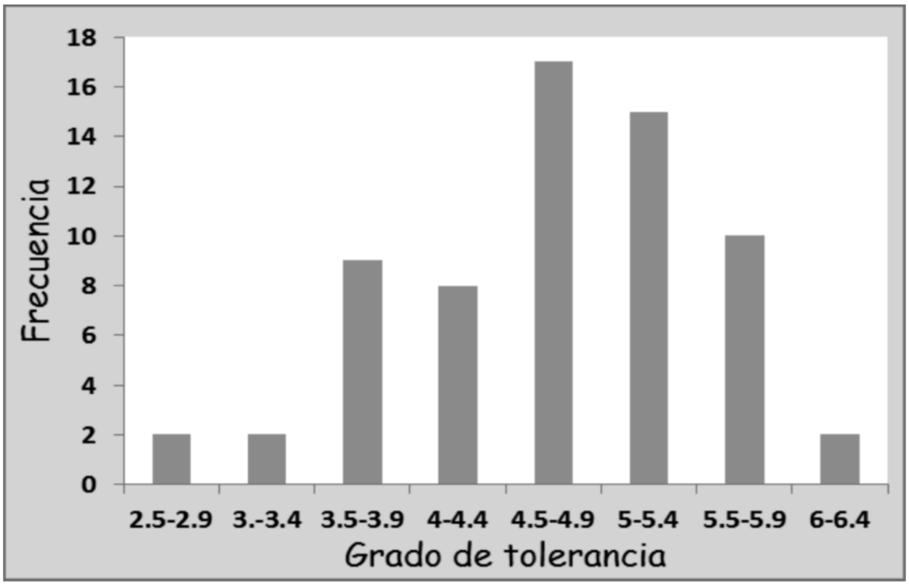
Figure 1: Distribution of frequency of Tolerance degree for 66 genotypes evaluated in NaCl solution.



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