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SCREENING OF CORN GENOTYPES FOR SALINITY RESISTANCE

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***Abstract**. The aim of the study was to evaluate salt resistance of corn lines and hybrids at early stages of plant growth and development, as well as at the level of haploid male gametophyte. Under stress conditions of chloride salinity, the variability of such traits as "seed germination", "seedling length", "rootlet length", "number of rootlets" was studied. Correlations and regressions of traits, effects of the factors "genotype", "salinity stress", as well as their interaction were assessed. As a result, reliable positive correlations of the studied traits of early growth and development under salt stress were established, and reliable effects of the "genotype" factor in the variability of traits at the diploid and haploid levels were determined. The hybrid combination with the maternal component L276xP165, as well as the lines P343, L1866, Mo17, Co125 turned out to be genotypes with increased salt resistance.*

Keywords: corn, salinity, resistance, pollen.

INTRODUCTION

At present, it is relevant and important to study the mechanisms of salt tolerance in corn and to develop technologies for growing this crop on saline soils [1]. It should be noted that significant progress has been made in understanding the genetic variability that determines salt tolerance in corn [2]. In further selection for salt tolerance, the study of morphological and physiological indicators of corn seedlings in NaCl solutions is particularly emphasized [3], and it is recommended to use them as selection criteria in corn breeding programs for salt resistance [4]. Researchers have also shown [5] that corn genotypes resistant to salinity are also more resistant to plumbum stress.The aim of our study was to screen corn lines and hybrids under chloride salinity conditions both at the stages of early growth and development of plant and at the stage of mature pollen grains.

MATERIALS AND METHODS

In the experiment 8 inbred lines (P343, A285, XL12, B73, Co125, L1866, Mo17, P346) were used as the initial material, as well as the following hybrid combinations: (459xMK390)xA285 (trilinear hybrid), (L1866x092) x (459xM11) x ((P343xP346)xF2)

(synthetic population), (459xMK390)x(A239xP502) (double hybrid), 5 hybrid combinations in which the paternal genotype was (459xMK390)x(P165xB73) double hybrid and as the maternal genotypes were used simple hybrids (Mo17xW23), (A285xW23), (A285xRf7), (XL12xN6), (L276xP165), and hybrid combination (A285xN6) x ((459 xP502) x P101) - simple hybrid as maternal genotype and trilinear hybrid as paternal genotype. Sodium chloride solutions (in concentrations 1,5-2,0% (seeds) and 10% (pollen)) were used to determine the resistance to salinity. At the initial stages of plant development under NaCl stress were estimated: the frequency of seed germination, the length of seedlings, rootlets and the number of rootlets. At the haploid level the variability of "pollen grain diameter" character was studied. The values of the this trait (in eyepiece micrometer units) were determined using the ocular micrometer MOB-1-15x). The experiments were carried out according to the schemes of the ANOVA, correlation and regression analysis. Statistical processing of data was performed using STATISTICA 7 software.

RESULTS AND DISCUSSION

The values of the trait «seed germination under saline stress» in the genotypes used in the experiment varied significantly. The seed germination in NaCl solutions for the best lines (Co125, L1866, Mo17) by this indicator was 77.3%, 66.7% and 99%, respectively. The seed germination indicators for hybrids varied from 72.7% to 95.8%. The lines P343, A285, XL12, B73, P343 were characterized by seed germination frequency from 13.5% to 57.6%. Correlation analysis of the variability of traits characterizing the early growth and development of plants under salt stress revealed the presence of significant positive correlations (table 1). In hybrids, the highest values of the correlation coefficient were noted for the traits "rootlet length" and "number of rootlets".

Table 1. Correlation and regression coefficients of early growth and development traits under NaCl stress.

Trait	«seedling length»	"rootlet length"	"number of rootlets"
«seedling length»	-	Lines r=0.67*** b_{yx}=0.95*	Lines r=0.74*** b_{yx}=0.58***
"rootlet length"	Hybrids r=0.37* b_{yx}=0.57*	-	Lines r=0.72*** b_{yx}=1.3***
"number of rootlets"	Hybrids r=0.47* b_{yx}=0.4***	Hybrids r=0.6*** b_{yx}=0.53***	-

-$p<0.05$, *-$p<0.001$*

The correlation of the trait "seedling length" with the trait "number of

rootlets" was weaker. The lowest value of the correlation coefficient had the relationship between the traits "rootlet length" and "seedling length". It should be noted that the inbred lines had higher values of the correlation coefficients for these traits. The traits "rootlet length" and "seedling length" showed the highest values of the correlation coefficient with the trait "number of rootlets". The highest difference in the correlation coefficient values for the lines and hybrids was found between the traits "seedling length" and "rootlet length". Regression analysis revealed significant values of the regression coefficients, and their values were higher in inbred. The dispersion analysis of the variability of the traits of the seedlings and rootlets under salt stress conditions showed a significant effect of the "genotype" factor (Table 2). The highest values of the effect of this factor were determined for such traits as "rootlet length" (hybrids) and "number of rootlets" (lines and hybrids).

Table 2. ANOVA results of traits variability under NaCl stress.

Traits variability	MS	F	η_p^2	R^2
Lines «seedling length»	8.1	3.3	0.59*	0.77*
Lines "rootlet length"	36.4	5.8	0.72***	0.85***
Lines "number of rootlets"	3.8	2.8	0.83*	0.74*
Hybrids «seedling length»	0.27	6.17	0.73***	0.82***
Hybrids "rootlet length"	0.83	10.4	0.82***	0.91***
Hybrids "number of rootlets"	5.5	15	0.87***	0.93***

-$p<0.05$, *-$p<0.001$*

Almost equal values of the effect size of the "genotype" factor were found out for the traits "rootlet length" (lines) and "seedling length" (hybrids). The effect size of the "genotype" factor was the smallest for the trait "seedling length" (lines). The coefficients of determination of the experimental model for each trait in hybrids had very high values, and in inbred lines similar indicators for the rootlet traits were significantly lower. The hybrids also had a higher determination coefficient for the trait "seedling length". The lines had the highest determination coefficient for the trait "rootlet length", and the values of the determination coefficients for the other two traits were approximately at the same level.

High average values of the trait "rootlet length" under salinity stress were noted in the lines P343, L1866, Mo17, while the other lines were characterized by very low average values of this trait (Table 3). For hybrid combinations, the average values of the "rootlet length" trait under salt stress conditions did not exceed 1.6 cm and were significantly inferior to similar values for the lines P343, L1866 and Mo17. It should be noted that only three lines used in this study were characterized by the lowest values of the "number of rootlets" trait (A285, XL12, P346).

Table 3. Average values of early growth and development traits under salinity stress.

Geno Type	Lines			Geno type	Hybrids		
	seedling length,cm	rootlet length,cm	number of rootlets		seedling length, cm	rootlet length, cm	number of rootlets
P343	4.65	9.45	4.0	1	0.83	0.73	1.0
A285	0.27	0.43	1.0	2	0.17	0.97	1.0
XL12	0.2	0.5	1.0	3	0.6	0.34	0.83
B73	0.85	0.9	2.0	4	0.3	0.4	1.0
P346	1.0	0.95	1.0	5	0.95	1.15	2.0
Co125	3.83	0.53	3.0	6	0.3	0.3	1.0
L1866	2.75	6.0	3.0	7	0.47	1.43	1.0
Mo17	2.77	5.61	2.0	8	0.7	1.57	2.5
$LSD_{0.05}$	2.79	4.35	2.03	9	0.93	1.6	5.0
Mean	2.04	3.05	2.12	$LSD_{0.05}$	0.36	0.54	1.04

1-(459xMK390)xA285, 2-(L1866x092)x(459xM11)x((P343xP346)xF2), 3-(459xMK390)x(A239xP502), 4-(Mo17xW23)x((459xMK390)x(P165xB73)), 5(A285xW23)x((459xMK390)x(P165xB73)), 6(A285xRf7)x((459xMK390)x(P165xB73)), 7-(XL12xN6)x((459xMK390)x(P165xB73)), 8-(A285xN6)x((459 xP502) x P101), 9-(L276xP165)x((459xMK390)x(P165xB73))

The best values of this trait were in the lines P343, Co125, L1866, while these indicators exceeded the average values of the "number of rootlets" trait in all hybrids, except for the combination in which the maternal genotype was L276 x P165 simple hybrid, which was characterized by the best indicator of this trait in the experiment. Under salt stress conditions, the average values of the "seedling length" trait did not exceed 1.0 cm in hybrids and in the A285, XL12, B73 lines. The highest values of this trait were found in the P343 line, as well as in the Co125, L1866, Mo17 lines.

The assessment of genotype resistance to chloride salinity at the haploid level of the male gametophyte showed that the "salt stress" factor and its interaction with the "genotype" factor had the greatest values of effect size (η_p^2=0. 34*** and η_p^2=0.3***, respectively) on the variability of the "pollen grain diameter" trait. The effect size of the "genotype" factor was lower (η_p^2=0.26***). The determination coefficient in this experimental model was high and significant (R^2=0.75***). The average values of the "pollen grain diameter" trait were significantly higher in

hybrid combinations where simple hybrids A285xN6 and L276xP165 were used as maternal genotypes (Table 4). The remaining hybrids differed from each other with an insignificant difference.

Table 4. Mean values of the pollen grain diameter (PGD) under chloride salinity.

genotype	PGD mic.units	genotype	variant	PGD mic.units
1	147.4	1-(Mo17xW23)x ((459xMK390)x(P165xB73))	control	157.6
2	156.4		NaCl	137.2
3	142.7	2-(L276xP165) x ((459xMK390)x(P165xB73))	control	168.1
4	154.2		NaCl	144.7
5	144.4	3-(A285xW23) x ((459xMK390)x(P165xB73))	control	137.6
6	142.2		NaCl	147.8
$LSD_{0.05}$	7.63	4-(A285xN6) x ((459 xP502) x P101)	control	167.5
Mean value (control)	154.7		NaCl	141.0
Mean value (NaCl)	141.07	5-(XL12xN6) x ((459xMK390)x(P165xB73))	control	151.7
$LSD_{0.05}$	4.4		NaCl	137.0
Mean value of the experiment	147.9	6-(A285xRf7) x ((459xMK390)x(P165xB73))	control	145.7
$LSD_{0.05}$	4.41		NaCl	138.7

The average values of the control and stress variants were significantly different, and the effect of salinity significantly reduced the value of the studied trait. The smallest values of the pollen grain diameter under chloride salinity were demonstrated by hybrids with the maternal genotypes Mo17xW23, XL12xN6, A285xRf7. The hybrid combination with the maternal genotype A285xW23 turned out to be significantly better in terms of the male gametophyte trait value under stress conditions. The smallest difference between the control and stress variants was noted in the hybrid with the maternal genotype A285xRf7.

CONCLUSIONS

At the early stages of growth and development of corn plants, the traits "seedling length", "rootlet length", "number of rootlets" under chloride salinity conditions realized significant positive correlations, and inbred lines had higher values of correlation and regression coefficients than hybrid combinations.

A significant effect size of the "genotype" factor on the variability of early growth and development traits under salt stress was revealed.

The best lines by average values of the studied traits at the early stages of growth and development under stress conditions were P343, L1866, Mo17, Co125. Among the hybrid combinations, the genotype with the maternal component L275xP165 proved to be more salt-resistant.

At the haploid level of the male gametophyte, the effect size of the “stress” factor was the greatest; hybrid combinations with maternal genotypes A285xN6 and L276xP165 stood out for the highest average value of the “pollen grain diameter” trait.

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