EVALUATION OF COTTON GERMPLASM AND BREEDING POPULATIONS FOR SALT TOLERANCE

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Abstract

Three experiments were conducted in 2005 and 2007 to evaluate a total of 211 cotton germplasm and breeding lines for salt tolerance in the greenhouses. The randomized complete block designs with two or three replications were employed for those experiments. 200 mM salt solutions or tap water were applied on alternate days for 21 to 30 days after planting or emergence. Data for the seedling and plant characteristics such as germination percentage, cotyledon length, first true leaf length, plant height, plant fresh weight, and plant dry weight were collected to compare control and treated plants. Genotypes and breeding lines that showed the lowest reduction in parameters of overall seedling and plant characteristics were considered salt tolerant. They were JAJO 1145, STV 4892 BR, STV 5599 BR, STV 4575 BR, DPL 555 BR, NM 03K1001, SG 747, 1517-88, 1517-SR2, and DPL 444 BR from experiment I, and PHY 72, AR 9314-24-16, FM 960 BR, FM 958 LL, STV 4575 BR, STV 6636 BR, TAM 98D-102, NM 03K1001, HA 195, and DP 444 BR from Experiment II. Thirty back-crossed inbred lines (BIL) out of 146 entries that showed more salt tolerance than parents (checks) from Experiment III were also selected for further genetic studies.

Materials and Methods

The experiments were conducted in the greenhouses, including Experiment I (2005) with 31 Pima (*Gossypium barbadense* L.) and Acala (*G. hirsutum* L.) cotton genotypes, Experiment II (2005) with 32 cotton genotypes, and Experiment III (2007) with a backcross inbred line (BIL) population of 146 lines derived from Upland x Pima and two parents.

A randomized complete block (RCB) design with two or three replications was arranged for each test. Treatments included tap water as a control and 200 mM salt (NaCl) solution used as a treatment. The control and salt treatment were applied on alternate days from planting to 21st day for Experiment I and II in 2005, and from emergence to 30th day for Experiment III in 2007.

Germination and plant characteristics were collected for Experiment I and II in 2005, and plant characteristics were collected for Experiment III in 2007. Statistical Analysis System (SAS) software was used to analyze data, using ANOVA, GLM, and VARCOMP procedures.

Results and Analysis

Variance component analyses showed that variations in seedling and plant characteristics among genotypes were mainly due to salt treatment. The contribution of salt treatment to the total variance ranged from 94.7% to 99.5% for Experiment I (Table 1) and from 83.6% to 99% for Experiment II (Table 2). Although

the effect of genotypes on seedling and plant characteristics was highly significant, most of their contributions to the total variance were less than 5%, except for germination percentage and 21 DAE fresh weight in Experiment II (Table 2).

The effect of Genotype (G) x Treatment (T) interactions on all characteristics were significant in Experiment I (Table 1). But in Experiment II, G x T was significant for only two traits (Table 2).

Genotypes and breeding lines that showed the lowest reduction in parameters of overall seedling and plant characteristics were considered salt tolerant. They were JAJO 1145, STV 4892 BR, STV 5599 BR, STV 4575 BR, DPL 555 BR, NM 03K1001, SG 747, 1517-88, 1517-SR2, and DPL 444 BR from Experiment I, and PHY 72, AR 9314-24-16, FM 960 BR, FM 958 LL, STV 4575 BR, STV 6636 BR, TAM 98D-102, NM 03K1001, HA 195, and DP 444 BR from Experiment II (data not shown).

30 BIL lines out of 146 entries that showed more salt tolerance than parents (checks) were selected for further genetic studies (Table 3).

Salt treatment significantly decreased seed germination, seedling emergence and growth including cotyledon and true leaf size, seedling fresh weight and plant height (Figure 1, Table 1, Table 2, and Table 3).

Conclusions

1. Salt treatment significantly reduced seed germination, emergence and seedling growth and had the highest contribution to the variations in parameters of germination and seedling characteristics studied.
2. Some genotypes from private companies showed more salt tolerance than the local check (Acala 1517-99).
3. 30 BIL lines from the population exhibited higher salt tolerance than their two parents (checks).

Figure 1. Comparisons between control and salt treated pots.

Table 1. ANOVA for the effects of 31 cotton genotypes, salt treatments, and their interactions on seedling and plant characteristics (Experiment 1, 2005).

Source of Variation	Characteristics						
	Germination (%)	Cotyledon Length (cm)	Cotyledon Width (cm)	1st True Leaf Length (cm)	7 DAE Fresh Weight (g)	21 DAE Fresh Weight (g)	21 DAE Plant Height (cm)
Genotype (G)	**	**	**	**	**	**	**
Treatment (T)	** (94.7%)[1]	** (97.9%)	** (98.6%)	** (99.1%)	** (97.9%)	** (99.3%)	** (99.5%)
G x T	**	*	*	**	**	**	**
C.V.	16.6	6.4	6.6	11.1	11.8	10.3	6.7
R2	0.96	0.97	0.96	0.98	0.97	0.98	0.99
Grand Mean	56.2	4.8	2.5	5.4	0.9	2.7	13.9

Probability of significance – NS-not significant; *, ** - significant @ 0.05 and 0.01 levels, respectively; [1] - variance components (%); Genotype – 32 genotypes; Treatment – tap water (control) and 200 mM salt solution; DAE – days after emergence. Note: Variance Components with less than 5 % contributions from G and G x T are not shown.

Table 2. ANOVA for the effects of 32 cotton genotypes, salt treatments, and their interactions on seedling and plant characteristics (Experiment 2, 2005).

Source of Variation	Characteristics						
	Germination (%)	Cotyledon Length (cm)	Cotyledon Width (cm)	1st True Leaf Length (cm)	7 DAE Fresh Weight (g)	21 DAE Fresh Weight (g)	21 DAE Plant Height (cm)
Genotype (G)	** (13.9%)[1]	**	**	**	**	** (6. %)	**
Treatment (T)	** (83.6%)	** (97.8%)	** (98.0%)	** (95.2%)	** (95.8%)	** (88.1%)	** (99.0%)
G x T	NS	NS	NS	NS	NS	**	*
C.V.	12.3	9.4	10.7	11.8	17.3	12.5	8.2
R2	0.93	0.91	0.89	0.95	0.88	0.93	0.97
Grand Mean	77.9	4.5	2.3	5.3	0.8	2.5	20.6

Probability of significance – NS-not significant; *, ** - significant @ 0.05 and 0.01 levels, respectively; [1] - variance components (%); Genotype – 32 genotypes; Treatment – tap water (control) and 200 mM salt solution; DAE – days after emergence. Note: Variance Components with less than 5 % contributions from G and G x T are not shown.

Table 3. Selected lines from a BIL population for salt tolerance (Experiment III, 2007)

Genotype	% Difference in Fresh Weight	% Difference in Dry Weight	% Difference in Plant Height
NMHT -03	3.9	22.5	36.5
NMHT -08	9.3	26.2	32.2
NMHT -10	19.7	31.8	44.1
NMHT -15	-1.0	18.6	41.6
NMHT -24	-5.6	30.2	35.0
NMHT -26	19.8	32.5	42.7
NMHT -29	10.6	20.4	37.5
NMHT -31	19.9	30.8	41.5
NMHT -33	-6.8	13.2	37.6
NMHT -34	-8.2	21.6	24.4
NMHT -38	18.3	29.6	37.7
NMHT -42	-5.7	15.2	38.8
NMHT -43	17.2	29.9	29.5
NMHT -59	18.5	30.3	39.4
NMHT -72	16.7	21.5	36.2
NMHT -74	11.9	33.5	39.3
NMHT -77	0.9	22.5	34.0
NMHT -79	17.4	27.4	37.5
NMHT -82	14.6	24.1	40.3
NMHT -85	17.8	28.1	39.8
NMHT -86	6.2	23.6	39.5
NMHT -94	1.5	19.7	35.6
NMHT -97	1.4	27.4	38.5
NMHT -99	2.7	34.0	36.6
NMHT -104	6.0	20.6	36.0
NMHT -117	-6.2	4.1	30.2
NMHT -127	5.0	20.4	35.7
NMHT -130	-4.7	12.0	32.8
NMHT -135	9.0	31.4	43.6
NMHT -146	-3.9	-2.6	34.9
SG 747 (CK1)	23.0	39.7	42.0
Pima S-7 (CK2)	27.9	39.9	45.9