PRELIMINARY SCREENING OF *GOSSYPIUM SPP.* GERMPLASM LINES AGAINST DIFFERENT SALT CONCENTRATIONS

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Abstract

Soil salinity is one of the major abiotic stresses that affect 23% of irrigated land in the southwest and west regions of the United States. Worldwide it affects 20% of the total irrigated land and is projected to affect 30% and 50% of arable land by 2030 and 2050, respectively. Using hydroponic techniques, 150 *Gossypium spp.* from the Mississippi Converted Race Stock were screened against different salt concentrations: control, 125mM and 250mM. Out of 150 genotypes, 66 genotypes survived at 250mM. MT-224 had the highest shoot length followed by MT-634, MT-45, MT-62, MT-43, MT-32 and MT-245. Similarly, the highest fresh shoot weight was observed in MT-634, but it was not significant different with MT-224, MT-45, MT-62, MT-43, MT-32 and MT-245. Although MT-245 has the highest dry shoot weight, it was not significantly different with MT-224 and MT-634. The highest root length, and fresh and dry root weight were observed in MT-720 and MT-117, respectively, but they were not significantly different with MT-224, MT-634, MT-45, MT-62, MT-43, MT-32 and MT-245.These results revealed that the effect of salt on shoot length is more prominent than other response parameters. Overall, MT-224, MT-634, MT-45, MT-62, MT-43, MT-32 and MT-245 performed better at higher salt concentrations.

Introduction

Soil salinity is one the major abiotic stresses that affects 20% of the total irrigated land in the world (Munns and Tester, 2008). Wang et al. (2003) predicted that 30% of arable land will be deteriorated by salinity in the coming 25 years and projected it to affect 50% of total arable land by 2050. At the same periods, food production needs to be increased by 38% by 2025 and by 57% by 2050 to supply the current levels of food for growing world population (Wild, 2003). In the near future, salinity might become the alarming issue that needs to be managed for crop production either through the soil reclamation/management practices or developing the salt tolerant crops by breeding techniques to meet food demands from the growing global populations. In the US, salinity is a real problem in the southwest and west regions affecting 23% of irrigated land (Ghassemi et al., 1995). In Louisiana, soil salinity is a threat to cotton production in Macon Ridge region. It is also reported that irrigation water taken from the Red River contains about 2600 ppm of salt (Delta Farm Press, 2010). As the use of irrigation is increasingly prevalent in cotton production, salinity is expected to become a more serious problem in cotton production and the area affected by salinity will rise. Maas and Hoffman (1977) reported that the stress threshold level for *Gossypium spp.* is 7.7dSM^{-1} suggesting that it is moderately tolerant to salinity. However, even low levels of salt (concentrations less than 1.0 dS/M) can affect cotton growth depending on life stage (Ashraf and Ahmad, 2000). In addition to reductions in shoot and root growth, yield is drastically reduced with increasing salt concentrations due to higher boll shedding and a concomitant decrease in fruit positions. Salinity also reduces the lint percentage as well as the length, strength, and micronaire of fibers and eventually reduces fiber quality (Longenecker, 1974). With respect to the total number of germplasm accessions in US cotton germplasm collection, the number of germplasm lines included in past salinity studies is quite low. This study was conducted to explore the tolerance levels of *Gossypium spp*. in the Mississippi Converted Race Stock collection against different salt concentrations to assess their potential for future breeding.

Materials and Methods

This study using a hydroponic system consisting of 17 gallon (64.4L) flat plastic tubs were fitted with an air pump and two bubble stones (35.4 in). A split plot design with two replications (5 plants/rep) was used. The nutrient solution was prepared using 1 gram of Peters fertilizer (20:20:20), 150 mg of calcium nitrate and 150 mg of magnesium sulfate per liter of water. Seven days old seedlings from germination towel were transferred to a hole punched in a Styrofoam panel glued with nylon mesh floating on the nutrient solution. Four days after transfer to hydroponics, the holes were plugged with small amount of cotton fibers to support upright seedling growth. Seven days after transfer to hydroponics, sodium chloride was added stepwise in increments of 61.25 mM every 24 hour until final concentrations of 125 and 250 mM NaCl were reached. The hydroponics system was monitored daily and pH maintained between 6.5-7.0. The seedlings were harvested 14 days after final salt concentrations were reached. Seedling height, root length, fresh shoot and root weight, dry shoot and root weight, and chlorophyll content were measured.

Results

Out of 150 genotypes, 66 survived at 250mM. The factors of salt concentration, genotypes and their interaction were significant for all response parameters except chlorophyll content where there was no significant difference among genotypes. From these 66 genotypes, only 25 genotypes were selected for mean comparisons based on their performance on individual parameters.

Table 1: ANOVA table for shoot length

Source	DF	Anova SS	Mean Square	F Value	Pr > F
block	1	2.61	2.61	0.38	0.5367
salt	2	18238.12	9119.06	1334.91	<.001
block*salt	2	7.01	3.50	0.51	0.59
genotypes	65	1686.59	25.94	3.80	<.001
salt*genotypes	130	1555.04	11.96	1.75	<.001

Table 2: Mean comparison of selected genotypes at 250mM

Genotypes	Shoot length (cm)	Shoot weight (g)	Dry shoot weight (cm)	Root length (cm)	Root weight (g)	Dry root weight (g)
MT-224	16.83 a	2.66 abc	0.45 ab	9.51 abc	0.49 abcd	0.035 ab
MT-634	16.82 a	3.74 a	0.46 ab	10.57 ab	0.68abcd	0.047 ab
MT-45	16.76 a	2.15 abc	0.29 bcde	6.33 abc	0.73 abcd	0.048 ab
MT-62	16.66 a	2.57 abc	0.24bcde	10.05 ab	0.60 abcd	0.030 ab
MT-43	16.57 a	2.17 abc	0.27 bcde	9.57 abc	0.56 abcd	0.032 ab
MT-32	16.56 a	3.34 abc	0.29 bcde	9.21 abc	0.61 abcd	0.025 ab
MT-245	16.45ab	3.39 ab	0.57 a	7.43 abc	0.59 abcd	0.015 ab
MT-242	15.82 abcd	2.05 abc	0.34 abcd	10.51 ab	0.56 abcd	0.032 ab
MT-1219	15.75 abcd	3.31 abc	0.43 abc	9.06 abc	0.84 abc	0.061 ab
MT-61	15.66 abcde	2.84 abc	0.42 abc	10.24 ab	0.90 ab	0.05 ab
MT-171	15.26 abcde	2.73 abc	0.39 abcd	9.48 abc	0.55 abcd	0.009 b
MT-120	14.97 abcde	3.52 ab	0.39 abcd	9.96 abc	0.74 abcd	0.043 ab
MT-175	14.76 abcde	2.62 abc	0.18 cde	8.50 abc	0.80 abc	0.031 ab
MT-636	14.66 abcde	2.28 abc	0.36 abcd	9.52 abc	0.51 abcd	0.046 ab
MT-212	14.57 abcde	2.98 abc	0.34 abcd	8.99 abc	0.71 abcd	0.043 ab
MT-36	14.41 abcdef	2.60 abc	0.18 cde	9.46 abc	0.67 abcd	0.034 ab
MT-1291	14.41 abcdef	3.12 abc	0.28 bcde	9.47 abc	0.80 abcd	0.048 ab

MT-188	13.99 [abcdef]	2.84 [abc]	0.39 [abcd]	7.98 [abc]	0.69 [abcd]	0.020 [ab]
MT-11	12.78 [abcdef]	1.97 [abc]	0.21 [de]	9.46 [abc]	0.40 [bcd]	0.029 [ab]
MT-117	11.25 [cdefg]	2.87 [abc]	0.32 [abcde]	9.59 [abc]	1.03 [a]	0.065 [a]
MT-106	10.87 [defg]	2.60 [abc]	0.24 [bcde]	8.32 [abc]	0.90 [ab]	0.048 [ab]
MT-720	9.41 [fg]	2.36 [abc]	0.18 [cde]	11.36 [a]	0.89 [ab]	0.051 [ab]
MT-754	9.25 [fg]	2.38 [abc]	0.34 [abcd]	10.64 [ab]	0.80 [abcd]	0.032 [ab]
MT-99	9.00 [fg]	2.58 [abc]	0.16 [de]	9.53 [abc]	0.76 [abcd]	0.048 [ab]
MT-198	6.70 [g]	1.49 [c]	0.08 [e]	5.6 [c]	0.26 [d]	0.009 [b]

MT-224 had the highest shoot length followed by MT-634, MT-45, MT-62, MT-43, MT-32, MT-245 and MT-242. Similarly, the highest fresh shoot weight was observed in MT-634, but it was not significant different from MT-224, MT-45, MT-62, MT-43, MT-32 or MT-245. Based on above ground parameters, MT-224, MT-634, MT-45, MT-62, MT-43, MT-32 and MT-245 performed better at 250mM. Although the highest values for root parameters were observed in other genotypes, rather than genotypes selected based on the shoot parameters, they were not significantly different from MT-224, MT-634, MT-45, MT-62, MT-43, MT-32 or MT-245.

Conclusions

Salt injury in susceptible genotypes was observed within 5-6 days after start of the salt treatments. Shoot length reduction in response to increasing salt concentrations was more prominent than for root length. In some genotypes, both root length and weight increased as salt concentration increased to support the shoot growth. More typically, root length and weight decreased as salt concentration was increased. It is difficult to identify any single best genotype based on all the response parameters. Given the prominent effect of salt on shoot length, MT-224, MT-634, MT-45, MT-62, MT-43, MT-32 and MT-245 were selected as the better performing genotypes at higher salt concentrations.

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