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RESEARCH ARTICLE :

Screening of cotton genotypes against salinity stress based on its physiological and biochemical responses

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SUMMARY : The experiment was carried to screened cotton genotypes for salinity tolerance in the kharif season of 2016-17. Eleven cotton genotypes were selected and grown upto squaring stage in different soil ratio of normal soil and saline soil after that leaf samples were collected and all the biochemical parameters were recorded for screening of cotton genotypes for salinity tolerance. Genotypes GISV-218 and G. Cot-16 showed highest relative water content in all the treatment. Genotypes G.Cot-16, GISV-218 and BC-68-2 showed highest membrane stability in normal soil condition where genotypes G. Cot -16, GISV-218 and 76-1H-20 were showed highest membrane stability (78.79%, 78.29% and 74.70%, respectively) in saline soil. Range of proline content was (0.23 to 0.56 mg/g of tissue) in normal soil condition and it was (0.75 to 1.35 mg/g of tissue) in saline soil condition. Highest glycine betaine content was found in G. Cot-16, GISV-218 and BC-68-2 in saline soil while lowest glycine betaine was found in GSHV-01/1338 and G.COT-10 in saline soil. Highest lipid peroxidation were showed by cotton genotypes Surat Dwarf and G. Cot-100 followed by G. Cot-10 and 76-1H-20. Highest surface wax was found in genotypes GISV-218, G.Cot-16 and BC-68-2. Highest total phenol content was found in GISV-218, G. Cot-16 and BC-68-2. Lowest total phenol content was found in G.Cot-10 and G.Cot-100. In all genotypes, total phenol content was increased as salinity increased. Highest peroxidise activity was found in GISV-218, G.Cot-16 and American nectriless while highest catalase activity was found in GISV-218 and Surat Dwarf in ratio of 1:2 (Normal soil: Saline soil). Lowest activity was found in LRA-5166 and BC-68-2. Highest Superoxide dismutase activity was found in GISV-218 and Surat Dwarf in ratio of 1:2 (Normal soil: Saline soil). Lowest Na/K ratio was found in GISV-218 and G. Cot-16 in root while lowest Na/K ratio was found in GISV-218, G. Cot-16 and American nectriless in shoot. Cotton genotypes GISV-218 and G.Cot-16 showed better performance in all the treatments so it might be salinity tolerance while G. Cot-100 and G. Cot-10 might be susceptible to salinity and rest of the genotypes might be moderately tolerant to salinity.

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BACKGROUND AND OBJECTIVES

Cotton (*Gossypium hirsutum* L.) is the leading natural fibre crop. In the present scenario, cotton production fluctuates substantially because of abiotic and biotic stresses. Soil salinity has been a major concern to global agriculture throughout human history (Lobell *et al.*, 2007). In recent times, it has become even more prevalent as the intensity

of land use increases globally (Egamberdieva *et al.*, 2010). Cotton is an important cash crop worldwide. Although it is classified as one of the most salt-tolerant major crops and considered a pioneer crop in reclamation of saline soils (Maas, 1990), its growth and development as well as yield and fiber quality are negatively affected by excessive salts in the soil (Maas and Hoffman, 1977; Qadir and Shams, 1997 and Higbie *et al*., 2010). In general, soil salinity delays and reduces germination and emergence, decreases cotton shoot growth, and finally leads to reduced seed cotton yield and fiber quality characteristics at moderate to high salinity levels (Khorsandi and Anagholi, 2009). However, the cotton plant has a complete self-protection system from salinity (Ashraf, 2002). Under salt stress, the protection system within a cotton plant can be activated to enhance salt tolerance. Salt tolerance can be improved through chemical priming or genetic breeding. Over the last thirty years, studies have been conducted on the response of cotton yields on saline soils and/or irrigated with saline water. Progress has been made in all aspects of soil salinity-cotton plant. Understanding how plants respond to salinity can play a major role in stabilizing crop performance under saline conditions and in the protection of natural vegetation. To understand the tolerance mechanism and nature in different plants, multiple investigations have led to develop understanding of different physiological, Biochemical and morphological features conferring salinity tolerance for getting insight into the molecular basis of tolerance. The understand role of osmoregulators, antioxidate enzymes and different protein conferring salinity tolerance is required.

RESOURCES AND METHODS

The experiment was carried to screened cotton genotypes for salinity tolerance in the *Kharif* season of 2016-17 at Main Cotton Research Station, Navsari Agriculture University, Surat. Eleven cotton genotypes *viz.*, G-67, American nectariless,G.Cot-10, G.Cot-100, Surat Dwarf, BC-68-2, G.Cot.-16,76-IH-20, GSHV-01/ 1338, GISV-218, LRA-5166 were selected and grown upto squaring stage in different soil ratio of normal soil and saline soil (T_1- 1:0 (Control)(Normal soil), T_2- 1:1 (Normal and Saline soil), T_3-1:2 (Normal and Saline soil), T_4 - 0:1(Saline soil) in small plot (Pot experiments: Pot dimension-6.8 foot x 5.5 foot). Leaf samples were collected at squaring stage and all the biochemical parameters were recorded for screening of cotton genotypes for salinity tolerance. Relative water content was estimated as per formula and expressed as RWC = [FW-DW] X 100/ [TW–DW] (Turner, 1986). Membrane stability was estimated from leaf as per method described by Martineau *et al*. (1979). Proline was estimated by using acid ninhydrin method (Bates *et al.*, 1973). Glycine betaine was estimated by standard method (Grieve and Gratian, 1983). Lipid peroxidation in the form of MDA (Malonadialdehyde) was estimated by modified method of Draper and Hardley (1990). Surface wax content was estimated by standard method of Ebercon *et al*. (1977). Phenol extraction and estimation elucidated by the method of Malick and Singh (1980). Protein extraction and estimation elucidated by the method of Lowry *et al*. (1951). Peroxidase activity was estimated as described by Reddy and Gasber (1971). Superoxide dismutase activity was measured by the method as described by Beyer and Fridovich (1987). Catalase activity was measured by method described by Thimmaiah (1999). Na and K ratio from root and shoot was estimated by flame photometer (AOAC, 1990).

OBSERVATIONS AND ANALYSIS

The data presented in the tables were collected in the *Kharif* season of 2016-17 for screening of cotton genotypes for salinity tolerance. Eleven cotton genotypes were selected and grown upto squaring stage in different soil ratio of normal soil and saline soil after that leaf samples were collected and all the biochemical parameters were recorded for screening of cotton genotypes for salinity tolerance.

Relative water content was significantly different for genotypes among all the treatments. Among all genotypes GISV-218 and G. Cot-16 showed highest relative water content in all the treatment and lowest relative water content was found in G. Cot-100, G. Cot-10 and GSHV-01/1338 in saline soil (Table 1). Membrane stability (%) was found significant for all genotypes in all the treatments. Genotypes G. Cot-16, GISV-218 and BC-68-2 showed highest membrane stability in normal soil condition where genotypes G. Cot -16, GISV-218 and 76-1H-20 were showed highest membrane stability (78.79%, 78.29% and 74.70%, respectively) in saline soil. Lowest membrane stability was found in G.Cot-10 and G. Cot-100 in saline soil (Table 2). Proline content was significantly different for all genotypes. Range of proline

content was (0.23 to 0.56 mg/g of tissue) in normal soil condition and it was (0.75 to 1.35 mg/g of tissue) in saline soil condition. Highest proline content was found GISV-218, G. Cot-16 followed by G-67 and American nectariless in saline condition while lowest proline content was found in G. Cot-100 and GSHV-01/1338 followed by 76-1H-20 and G. Cot-10 (Table 3).

Highest glycine betaine content was found in G.Cot-16, GISV-218 and BC-68-2 in saline soil while lowest glycine betaine was found in GSHV-01/1338 and G. COT-10 in saline soil (Table 4). Highest lipid peroxidation were showed by cotton genotypes Surat Dwarf and G.Cot-100 followed by G. Cot-10 and 76-1H-20. Lowest lipid peroxidation was found in GISV-218 and G.Cot-16 followed by American nectariless and LRA-5166 (Table 5).

Highest surface wax was found in genotypes GISV-218, G.Cot-16 and BC-68-2 while lowest surface wax content was found in genotypes G.Cot-100, G. Cot-10 and GSHV-01/1338 (Table 6). Total phenol content was

Table 1 : Relative water content (%) of different genotypes under salinity

Genotypes/Treatments	Normal soil	1:1	1:2	Saline soil	Mean
G-67	88.01	83.30	77.36	73.73	80.60
American nectariless	86.79	79.02	73.14	71.24	77.54
G.COT-10	83.74	77.70	72.95	69.38	75.94
G.COT-100	82.43	78.32	70.30	68.04	74.77
Dwarf Surat	89.22	85.31	76.27	73.03	80.96
BC-68-2	87.99	83.67	74.95	70.90	79.38
G.COT-16	91.66	88.66	79.92	77.74	84.50
76-1H-20	84.63	78.60	73.41	73.52	77.54
GSHV-01/1338	86.28	72.03	70.74	73.48	75.63
GISV-218	92.19	88.62	82.10	79.38	85.57
LRA-5166	87.82	76.55	74.84	76.69	78.98
Mean	87.34	81.07	75.09	73.38	
	Treatments (T)	Genotypes (G)	T x G		
S.E±	0.14	0.24	0.48		
C.D. (P=0.05)	0.41	0.68	1.37		
CV%			1.07		

Table 2 : Membrane stability (%) of different genotypes under salinity

Genotypes/Treatments	Normal soil	1:1	1:2	Saline soil	Mean
G-67	88.14	85.55	80.61	71.50	81.45
American nectariless	86.00	85.64	79.18	73.32	81.04
G.COT-10	81.74	80.38	70.56	62.57	73.81
G.COT-100	78.79	76.61	71.24	68.45	73.77
Dwarf Surat	79.84	78.46	73.86	70.14	75.57
BC-68-2	90.73	86.61	80.21	72.06	82.40
G.COT-16	94.05	88.24	85.75	78.79	86.71
76-1H-20	88.24	86.25	83.68	74.70	83.22
GSHV-01/1338	82.35	80.46	78.23	72.31	78.34
GISV-218	90.99	88.25	86.47	78.29	86.00
LRA-5166	80.88	80.67	77.84	73.91	78.32
Mean	85.61	83.38	78.88	72.37	
	Treatments (T)	Genotypes (G)	T x G		
S.E.±	0.12	0.20	0.40		
C.D. (P=0.05)	0.34	0.56	1.13		
CV%			0.83		

significantly differed for genotypes under saline soil. Highest total phenol content was found in GISV-218, G.Cot-16 and BC-68-2. Lowest total phenol content was found in G.Cot-10 and G.Cot-100. In all genotypes, total phenol content was increased as salinity increased (Table 7).

Highest protein content was found in G. Cot-16, GISV-218 followed by G-67 and American nectariless. Lowest protein content was found in G. Cot-10, GSHV-01/1338 and G.Cot-100 (Table 8). Peroxidase activity was significantly differed for genotypes in all the treatments. Highest peroxidise activity was found in GISV-218, G.Cot-16 and American nectriless while lowest peroxidase activity was found in Surat Dwarf, G.Cot-100 and G.Cot-10 (Table 9). Specific activity of SOD was significantly differed under salinity condition. Highest activity was found in GISV-218 and Surat Dwarf in ratio of 1:2 (Normal soil: Saline soil). Lowest activity was found in LRA-5166 and BC-68-2 (Table 10). Specific activity of catalase enzyme was significant among

Table 3 : Proline content (mg/g of tissue) of different genotypes under salinity

Genotypes/Treatments	Normal soil	1:1	1:2	Saline soil	Mean
G-67	0.35	0.64	0.84	1.25	0.77
American nectariless	0.23	0.56	0.91	1.07	0.69
G.COT-10	0.35	0.54	0.62	0.97	0.62
G.COT-100	0.34	0.54	0.63	0.74	0.56
Dwarf Surat	0.32	0.44	0.72	0.86	0.59
BC-68-2	0.36	0.54	0.67	0.73	0.58
G.COT-16	0.33	0.68	0.96	1.30	0.82
76-1H-20	0.45	0.42	0.64	0.76	0.57
GSHV-01/1338	0.35	0.58	0.67	0.75	0.59
GISV-218	0.33	0.65	0.95	1.35	0.82
LRA-5166	0.56	0.62	0.75	0.93	0.72
Mean	0.36	0.57	0.76	0.97	
	Treatments (T)	Genotypes (G)	T x G		
S.E±	0.0036	0.0060	0.012		
C.D. (P=0.05)	0.01	0.016	0.034		
CV%			1.49		

Table 4 : Glycine betaine (mg/g of tissue) of different genotypes under salinity

Genotypes/Treatments	Normal soil	1:1	1:2	Saline soil	Mean
G-67	25.06	41.03	64.16	68.48	49.68
American nectariless	25.19	44.03	58.54	65.53	48.32
G.COT-10	21.53	37.58	54.46	55.11	42.17
G.COT-100	20.11	41.61	57.46	57.71	44.22
Dwarf Surat	29.40	42.10	68.37	74.19	53.52
BC-68-2	24.05	58.08	72.07	74.52	57.18
G.COT-16	25.84	58.97	86.09	89.04	64.98
76-1H-20	20.08	55.12	58.30	69.41	50.73
GSHV-01/1338	26.08	35.25	39.01	48.74	37.27
GISV-218	26.52	58.49	80.53	86.05	62.90
LRA-5166	24.77	49.22	56.18	65.35	48.88
Mean	24.42	47.41	63.20	68.56	
	Treatments (T)	Genotypes (G)	T x G		
S.E.±	0.18	0.30	0.60		
C.D. (P=0.05)	0.51	0.85	1.7		
CV%			2.06		

genotypes in all treatments. Highest activity was found G. Cot-16, GISV-218 and BC-68-2. Lowest specific activity was found in G.Cot-100, LRA-5166 and G.Cot-10 (Table 11). Na/K ratio in root was found highest in BC-68-2, G.Cot-100 and 76-1H-20. Lowest Na/K ratio was found in GISV-218 and G. Cot-16 (Table 12). Na/K ratio in shoot was found highest in G.Cot-100, G. Cot-10 and GSHV-01/1338. Lowest Na/K ratio was found in GISV-218, G. Cot-16 and American nectriless (Table 13). The soil status of experimental plots before sowing and after analysis of samples (Table 14).

Cotton has been categorized as moderately salt-tolerant with a salinity threshold level 7.7 dS m^{-1}, its growth and seed yield is severely inhibited at high salinity levels. Although from some studies it appears that crop response to salinity at different growth stages varies with change in developmental phase, in others it has been found that the crop maintains its degree of salt tolerance uniformly throughout its all developmental stages.

Relative water content and Membrane stability were

Table 5 : MDA (Lipid peroxidation) (mg/g of tissue) of different genotypes under salinity

Genotypes/Treatments	Normal soil	1:1	1:2	Saline soil	Mean
G-67	10.24	13.70	14.51	17.43	13.97
American nectariless	11.59	12.28	13.68	16.62	13.54
G.COT-10	15.25	17.46	18.32	19.10	17.53
G.COT-100	16.02	19.61	20.52	20.49	19.16
Surat Dwarf	14.33	14.80	15.35	19.90	16.10
BC-68-2	13.36	15.09	17.44	19.30	16.30
G.COT-16	10.05	11.68	12.83	15.67	12.56
76-1H-20	14.60	16.52	18.52	19.53	17.29
GSHV-01/1338	14.53	14.77	15.36	17.91	15.64
GISV-218	10.44	12.21	12.42	13.57	12.16
LRA-5166	12.36	13.38	15.42	16.71	14.47
Mean	12.98	14.68	15.85	17.84	15.34
	Treatments (T)	Genotypes (G)	TXG		
S.E.±	0.047	0.055	0.110		
C.D. (P=0.05)	0.090	0.15	0.31		
CV%			1.30		

Table 6 : Surface wax content (µg/g of tissue) of different genotypes under salinity

Genotypes/Treatments	Normal soil	1:1	1:2	Saline Soil	Mean
G-67	22.37	23.78	37.50	38.78	30.61
American nectariless	23.50	28.34	36.18	37.50	31.38
G.COT-10	21.26	22.63	32.26	35.47	27.91
G.COT-100	22.34	24.98	32.85	34.63	28.70
Dwarf Surat	24.43	25.65	34.15	36.83	30.26
BC-68-2	27.48	27.86	32.90	38.34	31.64
G.COT-16	27.64	28.41	37.92	38.63	33.15
76-1H-20	25.60	25.63	35.34	36.71	30.82
GSHV-01/1338	24.53	26.43	35.29	36.51	30.69
GISV-218	27.83	29.27	38.62	38.89	33.66
LRA-5166	26.93	27.84	35.91	37.96	32.16
Mean	24.90	26.44	35.36	37.29	
	Treatments (T)	Genotypes (G)	T x G		
S.E.±	0.08	0.14	0.28		
C.D. (P=0.05)	0.24	0.39	0.8		
CV%			1.58		

found higher in salt tolerant genotypes and it decrease as the salinity increased. Researchers showed that osmotic potential and water potential became more negative by increasing salt, whereas turgor pressure increased (Ghoulam *et al.,* 2002; Gulzar *et al.,* 2003 and Romero-Aranda *et al.,* 2001). Study on Suaeda salsa known as a halophyte plant indicated that leaf water potential and evaporation rates declined by increasing salt concentration (Lu *et al.,* 2002). Proline is a major amino acid that accumulates in plant at a higher rate than other amino acids (Torabi *et al*., 2011; Abraham *et al.,* 2003). Accumulation of proline occurred in the cytosol and accomplished osmotic adjustment (Ketchum *et al.*, 1991). Proline accumulation affects membrane maintenance and also alleviated the effects of NaCl on cell membrane interruption (Mansour, 1998). Maggio and his coworker noted proline and glycine betaine as a signaling/regulatory molecule able to activate multiple responses that are components of the adaptation process (Maggio *et al.*, 2002). As the soil salinity was increased,

Table 7 : Total Phenol content (mg/g of tissue) of different genotypes under salinity

Genotypes/Treatments	Normal soil	1:1	1:2	Saline soil	Mean
G-67	10.83	13.31	14.87	16.37	13.84
American nectariless	12.82	13.46	14.71	16.77	14.44
G.COT-10	11.74	12.46	13.61	14.12	12.98
G.COT-100	11.21	12.23	13.41	14.55	12.85
Dwarf Surat	13.55	14.29	15.62	18.36	15.45
BC-68-2	12.42	13.61	14.35	19.88	15.06
G.COT-16	14.05	15.37	16.71	20.49	16.65
76-1H-20	13.64	15.26	16.35	19.43	16.17
GSHV-01/1338	13.27	14.42	15.21	17.28	15.05
GISV-218	14.78	15.25	17.46	21.26	17.19
LRA-5166	13.64	14.45	15.70	19.81	15.90
Mean	12.90	14.01	15.27	18.03	
	Treatments (T)	Genotypes (G)	TXG		
S.E.±	0.052	0.087	0.174		
C.D. (P=0.05)	0.147	0.244	0.489		
CV%			0.93		

Table 8 : Protein content (mg/g of tissue) of different genotypes under salinity

Genotypes/Treatments	Normal soil	1:1	1:2	Saline soil	Mean
G-67	6.24	6.69	7.40	8.56	7.22
American nectariless	6.91	6.42	7.72	8.43	7.37
G.COT-10	5.45	6.36	7.05	7.21	6.52
G.COT-100	5.31	5.47	6.78	7.43	6.24
Dwarf Surat	4.61	6.49	6.73	7.53	6.34
BC-68-2	4.68	5.15	6.73	7.63	6.05
G.COT-16	5.44	6.81	7.45	9.07	7.19
76-1H-20	5.55	6.50	7.21	7.59	6.71
GSHV-01/1338	5.36	6.33	7.51	7.24	6.61
GISV-218	5.30	6.83	8.16	8.60	7.22
LRA-5166	5.27	6.83	7.35	7.61	6.77
GMean	5.46	6.35	7.28	7.90	
	Treatments (T)	Genotypes (G)	TXG		
S.E.±	0.023	0.039	0.078		
C.D. (P=0.05)	0.060	0.11	0.22		
CV%			2.09		

glycine betaine content increased in all genotypes. Salt stress is known to result in extensive lipid peroxidation, which has often been used as an indicator of salt-induced oxidative damage in membranes (Hernandez *et al*., 2002). The MDA content increased with increasing salinity in the leaves and roots of both cotton cultivars indicating cell membrane damage in both cotton cultivars. However, as the salinity increased, the accumulation of MDA was higher in Simian 3 as compared to CCRI-79, indicating a higher degree of lipid peroxidation in Simian 3 due to salt stress. Shivasankar and his co-workers reported that the level of ECW was higher in stress condition. Your results also show same trends of surface wax under salinity stress (Shivasankar *et al*., 1993). Phenol content is play important role in defense system of plants. Accumulation of protein under salt condition may play a major role in terms of plants salt tolerance, where the proteins may serve as a reservoir of energy or may be adjuster of osmotic potential in plants subjected to salinity (Ingram and Bartels, 1996; Mansour, 2000;

Table 9 : Peroxidase specific activity (Unit/mg of protein) of different genotypes under salinity

Genotypes/Treatments	Normal soil	1:1	1:2	Saline soil	Mean
G-67	1.28	3.65	4.97	6.44	4.09
American nectariless	1.25	3.55	4.74	7.07	4.15
G.COT-10	1.07	3.62	4.23	5.49	3.60
G.COT-100	1.25	3.19	4.64	5.36	3.61
Dwarf Surat	1.76	3.75	4.41	5.11	3.76
BC-68-2	2.35	4.69	5.68	5.80	4.63
G.COT-16	2.57	5.25	6.33	7.48	5.41
76-1H-20	1.47	4.04	5.76	6.09	4.34
GSHV-01/1338	2.57	3.71	5.21	6.32	4.45
GISV-218	2.21	4.85	6.31	7.90	5.32
LRA-5166	1.72	3.28	5.52	6.78	4.32
Mean	1.77	3.96	5.25	6.35	
	Treatments (T)	Genotypes (G)	T x G		
S.E.±	0.0330	0.054	0.100		
C.D. (P=0.05)	0.092	0.15	0.30		
CV%			4.66		

Table 10 : Superoxide dismutase specific activity (mg/g of tissue) of different genotypes under salinity

Genotypes/Treatments	Normal soil	1:1	1:2	Saline soil	Mean
G-67	0.16	0.11	0.17	0.46	0.23
American nectariless	0.18	0.24	0.14	0.26	0.21
G.COT-10	0.35	0.14	0.25	0.19	0.23
G.COT-100	0.34	0.18	0.52	0.12	0.29
Dwarf Surat	0.29	0.46	0.55	0.14	0.36
BC-68-2	0.08	0.35	0.70	0.44	0.39
G.COT-16	0.19	0.49	0.45	0.24	0.34
76-1H-20	0.14	0.36	0.25	0.26	0.25
GSHV-01/1338	0.16	0.33	0.27	0.28	0.26
GISV-218	0.14	0.36	0.58	0.27	0.34
LRA-5166	0.03	0.04	0.26	0.15	0.12
Mean	0.19	0.28	0.38	0.26	
	Treatments (T)	Genotypes (G)	TXG		
S.E.±	0.0024	0.0039	0.0078		
C.D. (P=0.05)	0.007	0.011	0.022		
CV%			4.54		

Pessarakli and Tucker, 1985 and Pessarakli and Huber, 1991). Protein accumulation also found in salinity tolerant cotton genotypes in your experiment. They may be synthesized de novo in response to salt stress or may be present constitutively at low concentration (Parvaiz and Satyawati, 2008). It has been concluded that a number of proteins induced by salinity are cytoplasmic which can cause alterations in cytoplasmic viscosity of the cells (Pessarakli and Tucker, 1985 and Hasegawa *et al.*, 2000). Environmental stresses that limit photosynthesis can increase oxygen-induced cellular damage due to increased ROS generation (Mittler, 2002). Therefore, salt stress resistance may depend, at least in part, on the enhancement of the antioxidative defense system, which involves antioxidant compounds and several antioxidant enzymes. In present study POD, SOD and Catalase activities suggested that oxidative stress is an important component of salt stress in cotton plants.

Trends of peroxidase activity revealed that soil salinity increased, the activity also increased. POD is

Table 11 : Catalase specific activity (mg/g of tissue) of different genotypes under salinity

Genotypes/Treatments	Normal soil	1:1	1:2	Saline soil	Mean
G-67	0.027	0.058	0.084	0.117	0.072
American nectariless	0.012	0.081	0.077	0.119	0.088
G.COT-10	0.027	0.057	0.065	0.116	0.066
G.COT-100	0.025	0.052	0.063	0.105	0.061
Dwarf Surat	0.036	0.058	0.071	0.118	0.071
BC-68-2	0.022	0.061	0.072	0.128	0.071
G.COT-16	0.037	0.085	0.093	0.135	0.087
76-1H-20	0.016	0.065	0.073	0.116	0.067
GSHV-01/1338	0.025	0.055	0.064	0.126	0.068
GISV-218	0.044	0.074	0.080	0.138	0.084
LRA-5166	0.036	0.053	0.071	0.114	0.069
Mean	0.028	0.064	0.080	0.121	
	Treatments (T)	Genotypes (G)	T x G		
S.E±	0.0015	0.0025	0.0051		
C.D. (P=0.05)	0.004	0.0071	0.014		
CV%			4.33		

Table 12 : Na/K ratio of different genotypes under salinity in root

Genotypes/Treatments	Normal soil	1:1	1:2	Saline soil	Mean
G-67	0.67	0.69	0.53	0.70	0.65
American nectariless	0.84	0.82	0.49	0.80	0.74
G.COT-10	0.53	0.99	0.60	0.68	0.70
G.COT-100	0.93	1.13	0.64	0.92	0.91
Dwarf Surat	0.54	0.57	0.72	0.86	0.67
BC-68-2	0.56	0.69	0.66	1.06	0.74
G.COT-16	0.73	0.85	0.66	0.63	0.72
76-1H-20	0.85	0.93	0.93	0.90	0.90
GSHV-01/1338	0.82	0.75	0.55	0.68	0.70
GISV-218	0.52	0.60	0.82	0.54	0.62
LRA-5166	0.87	0.88	0.76	0.74	0.81
Mean	0.71	0.81	0.67	0.78	
	Treatments (T)	Genotypes (G)	TXG		
S.E.±	0.0046	0.0077	0.0158		
C.D. (P=0.05)	0.013	0.021	0.043		
CV%			5.64		

the primary enzyme that detoxifies H_2O_2 in the chloroplasts and cytosol of plant cells (Zhang *et al.*, 2011). CAT plays an important role in the antioxidant system because it converts H_2O_2 into oxygen and water (Asada, 2006). These two enzymes constitute the main H_2O_2-scavenging systems in cells. The present data showed that the roots had higher POD activity compared to the leaves in both cultivars; however, the enzyme activity in the roots and leaves responded differently to incremental levels of salinity. SOD can catalyze the dismutation of superoxide to molecular oxygen and H_2O_2, this enzyme is considered the most effective intracellular enzymatic antioxidant. Indeed, it has been suggested that SOD plays an important role in plant stress tolerance and provides the first line of defense against the toxic effects of elevated levels of ROS (Gill and Tuteja, 2010).

High external salt concentration causes an ion imbalance or disturbance in ion homeostasis (Parida and Das, 2005). In our experiments, the leaves and roots of both cultivars had higher levels of Na^+ ions under salt stress due to non-specific ion uptake and/or membrane leakage. However, as the NaCl concentration increased. The high levels of Na^+ or Na^+: K^+ ratio can disrupt various enzymatic processes in the cytoplasm. K^+ activates more than 50 enzymes and is an essential element in protein synthesis as it binds tRNA to the ribosomes (Blaha *et al.*, 2000).

Conclusion :

It was concluded that cotton genotypes GISV-218 and G.Cot-16 showed better performance in all the treatments so it might be salinity tolerance genotypes

Table 13 : Na/K ratio of different genotypes under salinity in shoot

Genotypes/Treatments	Normal soil	1:1	1:2	Saline soil	Mean
G-67	0.57	0.73	0.87	0.94	0.78
American nectariless	0.66	0.65	0.64	0.73	0.67
G.COT-10	0.74	0.84	0.95	1.07	0.90
G.COT-100	0.92	0.94	1.06	1.26	1.05
Dwarf Surat	0.64	0.74	0.85	0.95	0.79
BC-68-2	0.75	0.85	0.89	0.96	0.87
G.COT-16	0.55	0.63	0.77	0.78	0.68
76-1H-20	0.63	0.93	0.63	0.73	0.73
GSHV-01/1338	0.73	0.86	1.05	1.05	0.92
GISV-218	0.53	0.54	0.69	0.70	0.62
LRA-5166	0.65	0.69	0.84	0.94	0.78
Mean	0.67	0.76	0.84	0.92	
	Treatments (T)	Genotypes (G)	T x G		
S.E.±	0.0045	0.0074	0.0140		
C.D. (P=0.05)	0.012	0.02	0.042		
CV%			3.96		

Table 14 : Soil status of experimental plots

Soil	EC(ds)	pH	N (kg/ha)	P (kg/ha)	K (kg/ha)
Before sowing					
Normal	0.45	7.58	313.61	49.17	288.89
1:1	6.8	7.59	283.91	37.15	224.54
1:2	7.62	7.58	249.96	32.78	172.21
Salinity	13.14	7.45	292.40	15.30	60.86
After analysis					
Normal	0.39	8.00	195.32	26.22	224.90
1:1	4.7	7.80	176.95	17.48	161.91
1:2	5.47	7.83	163.17	12.02	142.22
Salinity	10.5	8.07	158.58	10.93	48.83

while G. Cot-100 and G.Cot-10 might be susceptible to salinity and rest of the genotypes might be moderately tolerant to salinity.

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