Pak. J. Agri. Sa, Vol. 31, No. 3, 1994

EFFECT OF SALINITY STRESS ON THE RATE OF CHLORIDE TRANSPORT (JCI-) OF FOUR COTTON CULTIVARS

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Four cotton cultivars i.c. NIAB 7H and MNH I)~ *(GoS.\)'pillIII hirsutuni)* and Ravi and D 9 *(Gos.I:VpilI11I arborcl/III)* were compared at 4 salinity levels (0, 75, 150, 250 mol III-:I NaCl) to study their effect on Cl- concentration in plant parts (leaves and stem) and rate of chloride transport eCl-) from root to shoot at seedling stage in nutrient culture. The tolerant cultivar maintained lower concentrations of CI- in leaves and stem than the sensitive ones although the rate of chloride transport eCI-) was higher in the tolerant cultivar as compared to the sensitive ones. It is noted that probably effec1ive ion regulation contributed to sail tolerance of the coli on cultivars studied.

INTRODUCTION

Among. other factors, specific ion toxicity can seriously inhibit growth of plants in a saline environment (Flowers *et al., 1977;* Greenway and Munns, 1980). Rate of ion uptake and the rate of toxic ion transport from root to shoot arc among the factors related to salt tolerance of plants. For example, good correlations were observed between relative growth rate at different developmental stages and rate of transport of potassium and chloride in barley (Greenway, 1965; Greenway *et al., 1965).* The processes involved in the differential distribution of ions in various plant organs. include active transport into and across the root, movement in the transpiration stream, reabsorption in xylem parenchyma, retranslocation through phloem and possibly upon the overall control based on photosynthesis in t~e leaves (Pit man, 1972; Greenway and Munns, 1980). This paper presents data regarding the rate of transport of CI- from root to shoot and CI- concentration in plant tissue of four cotton cultivars belonging to two different species and known to have varying degrees of salt tolerance.

MATERIALS AND METHODS

Cotton seedlings of NIAB 7H (G. *hir-.1'11/1111I),* MNH 93 (G. *hirsuiuni,* Ravi (G. *arboreum'}* and D 9 *(G. arboreum)* were raised in silica sand in plastic coated iron trays (60 x 30 x 5 cm). Two leaves seedlings were transferred to aerated half strength Hoagland's solution (Hoagland and Arnon, 1(50) in galvanized painted plastic lined iron growth tanks (120 x 90 x 30 cm) covered with foam sheet having holes for holding plants. Growth tanks were supported on iron stands 90 cm above ground. The solution was aerated day and night using an air compressor. The medium was changed to full strength Hoagland's solution after two days of seedling establishment. . Nutrient solutions were salinized in increments of 25 mol m^{-3} NaCI daft up to the desired salinity levels (75, 150, 250 mol m^{-3} NaCl) which were maintained for the rest of the growth period.

Nutrient solution alone served as control. Two harvests were done (the first on day 3 and the second on day 17 after salinization). Chloride concentration in HNO_3 extracts from shoot, leaves, stem and root were determined with chloride analyzer (Pitman, 1965).

The rate of Cl- transport (J_{Cl^-}) was calculated as under (Salim and Pitman, 1983):

$$J_{Cl^-}\ (\mu mol\ (g\ dw)^{-1}\ h^{-1}) = \frac{M_2-M_1}{W_2-W_1} \times \frac{\log_e W_2 - \log_e W_1}{T}$$

where M1, M2 are the amounts of ion at harvest 1 and harvest 2; W1, W2 are the root fresh weights (g) at harvest 1 and harvest 2, respectively and T is the difference in time (days).

Table I. Chloride concentration in leaves (mmol g-1 DW*) of cotton cultivars at different harvests under saline conditions

Variety	mol m-3 NaCl								Mean
	0 (Control)		75		150		250		
	H_1	H_2	H_1	H_2	H_1	H_2	H_1	H_2	
Chloride concentration (mmol g-1 DW)									
NIAB78	0.247 km	0.153 m	0.775 hi	0.582 ij	1,383 g	1,900 e	1,533 g	2.233 cd	IJOb
MNH 93	0.307 km	0.1601m	0.833 hi	0.667 hj	U50g	1,975 de	1,833 ef	2,475 be	1,23 a
D9	0.437 jl	0.223 km	0.875 h	0.738 hi	1,430 g	1,483 g	1,925 e	2.750 a	1,23 a
Ravi	0.450jk	0.223 km	0.908 h	0.763 hi	1,500 g	1,617 fg	2.000 de	2.695 ab	1.27 a
Mean	0.360 f	0.190 g	0.848 b	0.688 e	1,466 c	1,744 b	1,823 b	2.538 a	

*DW = Dry weight, harvesting time = H_1 (3 days), H_2 (17 days) after salt stress.
Means with different letters differ significantly according to Duncan's Multiple Range test ($P \leq 0.05$). Extra letters have been omitted except the first and the last ones to simplify the Table.

RESULTS AND DISCUSSION

Chloride concentration in cotton leaves and stem increased significantly with increase in NaCl levels in the external solution (Tables 1 & 2). The average concentrations of chloride in leaves and stem were significantly higher at H_2 than H_1 at higher salinity levels (150 and 250 mol m^{-3} NaCl in external solution). However, at control and 75 mol m^{-3} external salt concentration, the chloride concentration of plant tissue was significantly lower at the second harvest (17 days) compared with the first harvest (3 days). In general, NIAB 78 had lower Cl- concentration in leaves and stem than other cultivars at various salinities. Data clearly indicate that the tolerant cultivar NIAB 78 was able to maintain significantly the lowest mean Cl- concentration (dry weight basis) in leaves and stem than all other cultivars, although, the rate of Cl- transport from root to shoot (lel-) was much greater in the tolerant cultivar than the sensitive ones (Table 3). rate of CI- transport also" increased markedly when the external salinity was increased from control to 150 mol m;3 NaCl.

plants. Data clearly showed that the tolerant cultivar (NIAB 78) maintained significantly lower concentration of Cl- in leaves and stem compared with the sensitive cultivars D 9 and Ravi (Tables 1 & 2). These data are in

Table 2. Chloride concentration in stem (mmol g.1 DW) 01' cotton cultivars at different harvests under saline conditions

Variety	mol m^{-3} NaCI								
	0 (Control)		75		150		250		Mean
	Hi	11₂	11,	11₂	11,	11₂	II}	11₂	
Chloride concentration (mmol g-I DW)									
NIAB78	0.273 j	0.197 j	0.675 h	0,(,')2 h	I.OM, de	1,383 h	1,336 be	1,500 ab	0,89 h
MNII'.I3	0.297 j	0.173 j	0.'.108 fg	0.751J gh	1,204 cd	1,467 ab	1,390 b	1,571 a	0.'.17a
09	0,477i	0.183 j	1,000 er	0.810 gh	1,075 de	1,156 de	1,334h	1,563 a	0.95 a
Ravi	0,493i	0.207 j	0.908 fg	0.743 h	UtI de	1,088 de	1,467 ab	1,594 a	0.95 a
Mean	0.38 g	0.19 h	0.87 e	0.75 f	1,11 d	1,27 c	1,38 b	1,56 a	

OW = Dry welght, harvesting time = HI (3 days), H_2 (17 days) after salt stress.
Means with different leLLers differ significantly according to Duncan's Multiple Range test (P = 0.05). Extra letters have been omitted except the lirst and the last .ones to simplify the Table.

Table 3. Rate of chloride transport (·ICI·) from root to shoot of cotton cultivars under saline conditions

Variety	mmol m^{-3} NaCI			
	0 (Control)	75	150	250
	H₂ - HI	H₂ - H}	H₂ - HI	H₂ - HI
JCl- from root to shoot J.Lmol(g DW)-I h-I				
NIAB 78	1.08	2.600	4.164	4,315
MNH 93	1,169	2,349	3,506	3.804
D 9	0,585	1,904	2.794	2,422
Ravi	0.749	1,460	2.861	1,515
Mean	0.896	2.078	3,331	3.014

Harvesting time = HI (3 days), H_2 (17 days) after salt stress.

There is enough evidence available in the literature regarding toxic effect of CI- on

line with the lindings of Abel and Mackenzie (1964) and Abcl (1969) who suggested that higher concentration of toxic ion (CI-) to the plant tissues are amongst the important causes of greater yield depression of the sensitive eultivars.

It is important to note that JCI- value of the tolerant cultivar (NIAB 78) was higher than the sensitive cultivars (0 9 and Ravi) at salt concentrations of 75, 150 and 250 mol m^{-3} NaCI salinity which showed a relatively poor control of the tolerant cultivar over Cl- uptake at the root plasmalemma level. Alternatively, higher transpiration rates and "demand" for solutes for osmoregulation in the case of the tolerant cultivar could enhance the transport rates. According to Pitman (19H4), such a trend was related to "demand" for solutes set up by the growing plants for osmoregulation. However, it was very c1car that the tolerant cultivar maintained a relatively lower concentrations of the toxic ion CI- in sap leaves and stems in spite of the high :lC1- which indicated some dilution mechanism through rapid growth etc. operative in the tolerant cultivar (NIAB 78).

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