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Effect of External Sodium Chloride Salinity on Ionic Composition of Leaves of Cotton Cultivars II. Cell Sap, Chloride and Osmotic Pressure

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ABSTRACT

This study was conducted to observe the effect of external sodium chloride salinity on cell sap, chloride and osmotic pressure of leaves of cotton cultivars. Leaf to leaf variations of four cotton cultivars were compared in hydroponic system. Chloride and osmotic pressure of the older leaves were greater than the younger ones. The sensitive cultivars (D 9 and Ravi) accumulated significantly greater concentration of chloride as well as osmotic pressure values in young and old leaves than salt tolerant one (NIAB 78) in different salt stress conditions.

Key Words: Salinity; Ionic Composition; Cotton

INTRODUCTION

Plants growing in stress environments have evolved or developed a number of adaptive mechanisms, which enable plants to survive and grow in saline environments. Greenway and Munns (1980) considered mechanisms in nonhalophytes viz-a-viz halophytes. There is, however, no doubt to the conclusion that plants much achieve and maintain a favorable water balance as well as a favourable ionic balance at the cellular and whole plant levels for a successful growth in saline environments. Some plants overcome the effects of salt recess by dilution in the cell sap through rapid growth or greater succulence while other have differential distribution of salts with greater accumulation in the older than the younger leaves (Yeo & Flowers, 1982). The leaf death of a plant in saline conditions is primarily due to differential ion accumulation in various leaves. The older leaves die while younger ones remain green and growing. Shedding of leaves is a common character in monocot halophytes. (Albert, 1975) and gradients in salt concentration from leaf to leaf are often reported for nonhalophytes exposed to salinity (Flower *et al*., 1977).

This study was conducted to observe the effect of external sodium chloride salinity on cell sap, chloride and osmotic pressure of leaves of cotton cultivars.

MATERIALS AND METHODS

Seedlings were raised in silica sand in iron trays (60 x 30 x 5 cm). Seedlings 2 leaf stage of four cultivars were grown in hydroponic system in growth tanks (120 x 90 x 30 cm) in ½ Hoaglands nutrient solution. After 2 days seedlings establishment, the nutrient medium was changed to full strength Hoaglands solution salinized with 0, 75, 150, 250 mol m^{-3} NaCI in increments of 25 mol m^{-3} per day. Two weeks after imposing salt stress, plants were harvested and separated into root and leaves. Fresh leaves were washed with distilled water and blotted with tissue paper. The leaves were grouped into expanding (young; leaf 1 + leaf 2) and expanded (old; leaf 3 + leaf 4) groups for comparisons and that the cell sap was used for the determination of chloride and osmotic pressure by chloride analyzer and osmometer, respectively. The experiment was laid out in Completely Randomized Design.

RESULTS AND DISCUSSION

Chloride concentration in various leaves (Table I) progressively increased with increase of salt concentration. The younger leaves had significantly lower chloride concentration than the fully expanded older leaves in various salinity treatments. Similarly, the tolerant cultivars exhibited significantly lower CI^- accumulation in leaves compared with the sensitive ones. The statistical differences between the young and old leaves at the varietal level were more striking at the highest external salinity.

Osmotic pressure of the sap of young leaves was significantly lower than the older leaves at various salinity levels and also in the control treatment (Table II). Moreover, osmotic pressure levels in leaves increased with increase in external salinity although the ratio O.P. young: O.P old did not alter at various salinities. Similarly, the tolerant cultivars showed lower osmotic pressure than the sensitive ones; the difference being significant between NIAB 78 and D 9 and Ravi as well as between MNH 93 and Ravi. All the cultivars exhibited significantly higher osmotic pressure in older than in the younger leaves at 250 mol m^{-3} NaCI external salinity

Table I. CI^- Contents (m mol Kg^{-1}) of Leaf Cell Sap of Various Cotton Cultivars Grown at Different Salinity Levels

	mol m^{-3} NaCI								
Variety	**O (Control)**		**75**		**150**		**250**		**Mean**
	Leaves								
	Young	**Old**	**Young**	**Old**	**Young**	**Old**	**Young**	**Old**	
NAIB 78	28 n	32 mn	76 lm	124 jk	190 fh	233 df	419c	543 b	206c
MNH 93	37 mn	42 mn	75 Im	153 hj	172 hi	274 d	349c	505 b	201c
D 9	35 mn	44 mn	100 kl	157 hj	216 eg	259de	521b	625a	245b
Ravi	34 mn	42 mn	145 ij	186 gi	217 eg	372 c	520 b	633 a	269 a
Mean	34 g	40 g	99 f	155 e	199 d	285 c	452 b	577 a	

Young (Expanding) and Old (Expanded) leaves
Means with different letters differ significantly according to Duncan's Multiple Range Test (P= 0.05)
Extra letters have been omitted except the first and the last ones to simplify the Table.

Table II. Osmotic Pressure (m osmol Kg^{-1}) of Leaf Cell Sap of Various Cotton Cultivars Grown at Different Salinity Levels

	mol m^{-3} NaCI								
Variety	**O (Control)**		**75**		**150**		**250**		**Mean**
	Leaves								
	Young	**Old**	**Young**	**Old**	**Young**	**Old**	**Young**	**Old**	
NAIB 78	535 mn	687 ik	660 jl	796 fi	781 gi	888 eg	953 ce	1174 b	809 c
MNH 93	509 n	646 km	672hj	801 hj	877 eh	952 ce	1049 c	1177 b	847 bc
D 9	513 n	618 kn	732 ik	865 eh	890 eg	922 de	1167 b	1439a	893a b
Ravi	560 In	622 kn	799 fi	907 df	941 ce	1018 cd	1165 b	1408 a	928 a
Mean	529 g	643 f	738 e	842 d	872 d	945 c	1084 b	1300 a	

Young (Expanding) and Old (Expanded) leaves
Means with different letters differ significantly according to Duncan's Multiple Range Test (P= 0.05)
Extra letters have been omitted except the first and the last ones to simplify the Table.

while, at the lower salinities, various cultivars behaved differently.

The accumulation of chloride and in sap osmotic pressure of leaves different with ages. CI^- accumulated to a much greater extent in the older than in the younger leaves and, according, osmotic pressure of leaves had a similar trend. Differential accumulation of CI^- in leaves of different ages has also been reported earlier in beans (Salim & Pitman, 1983) and wheat (Rashid, 1986).

The differences in chloride concentration and osmotic pressure levels between cultivars clearly showed that the tolerant cultivar NIAB 78 had significantly the minimum CI^- and osmotic pressure in the young and old leaves than salt sensitive (D 9 & Ravi). These results are in agreement with the general mechanism of salt tolerance i.e. to maintain a lower concentration of Na^+ and / or CI^- in plant tissues in most of the nonhalophytes (Greenway & Munns, 1980).

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