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TOXICITY LEVELS OF Na^+ AND Cl^- IN WHEAT LEAVES CELL SAP

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Seven-day old seedlings were exposed to incremental NaCl stress in order to determine the toxicity levels of Na^+ and Cl^- in leaf cell sap of two wheat varieties, viz. Pb-85 (sensitive) and LU-26S (tolerant). Concentration of Na^+/Cl^- in leaf cell sap giving 50% reduction in fresh weight of shoot/root was tentatively taken as toxic level of the respective ion. Accordingly, the toxic levels of Na^+ in both the varieties were around 250 m mol kg^{-1}, whereas the corresponding value for Cl^- was about 300 m mol kg^{-1} indicating that Na^+ was probably more toxic than Cl^- in wheat. Toxicity level when based on fresh weight gave comparatively more realistic values than expressing it on dry weight basis.

INTRODUCTION

Salinity is a major problem in arid and semi-arid regions like Pakistan and the problem gets accentuated with the introduction of artificial irrigation. According to El-Ashry *et al.* (1985) salinity is seriously limiting crop production on 20 million hectares in the world. In Pakistan, of the total cultivated area of 20.18 million hectares, 5.7 million hectares are salt-affected and 56% of that is saline-sodic in nature (Muhammed, 1983).

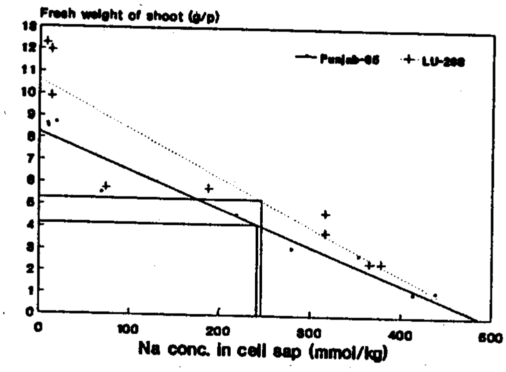
Salinity is inimical to plant growth through numerous complex interactions including specific toxic effects, osmotic effects and/or induced nutrient deficiency (Wyn Jones, 1981). Plants exposed to saline environments may overcome these problems through physiological tolerance involving compartmentation and active exclusion of Na^+ and Cl^- ions (Greenway and Munns, 1980; Wyn Jones and Storey, 1981).

The previous data based on analysis of number of wheat varieties have shown a strong negative correlation between the Na^+ and Cl^- concentration in third leaf sap and fresh weight of wheat (Qureshi and Aslam, 1989). The present study was conducted to determine the toxicity levels of Na^+ and Cl^- in the leaf sap of two wheat varieties differing in salt tolerance.

MATERIALS AND METHODS

Seven-day old seedlings were transplanted in plastic tubs containing Hoagland nutrient solution (Hoagland and Arnon, 1950). 'Tubs' were covered with thermopol sheets having eight holes. Seedlings were supported by foam wraps and nutrient solution was gently aerated with an air compressor.

After six days of seedling establishment, plants were subjected to incremental NaCl stress developed by adding four equal increments of NaCl, adjusting final electrical conductivity to 1.3, 4.6, 6.0, 8.6, 11.0, 13.0, 16.0, 18.0 and 20.0 dS m^{-1}. The pH (6.0-6.5) was adjusted daily and solution was changed weekly during the entire experimental period. Plants were harvested after forty days of transplanting but prior to harvesting fully expanded third leaf samples were collected for chemical analysis.



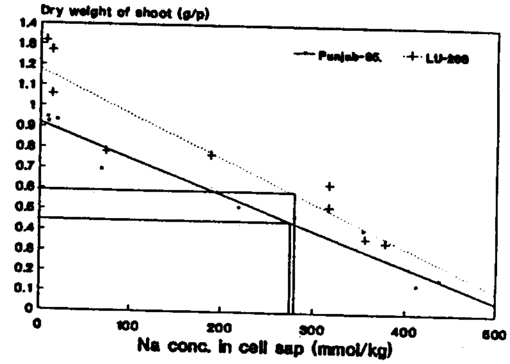
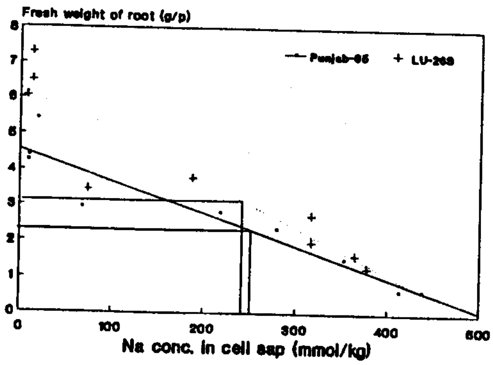


Fig 1 a. Regression between fresh weight of shoot and Na concentration in leaf cell sap.

Fig. 1 b. Regression between shoot dry weight and Na concentration in leaf cell sap.



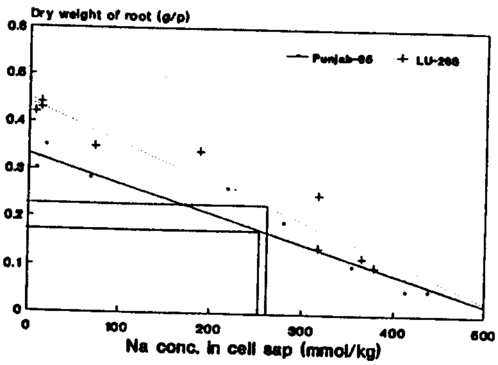
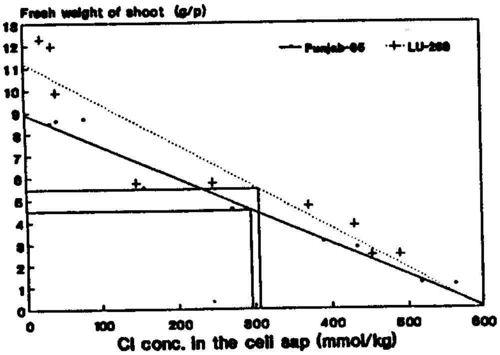


Fig. 1 c. Regression between fresh weight of root and Na concentration in leaf cell sap.

Fig. 1 d. Regression between dry weight of root and Na concentration in leaf cell sap.



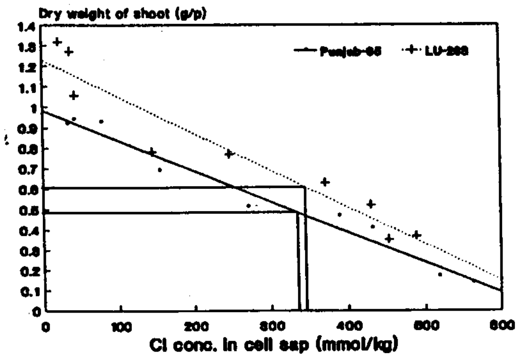
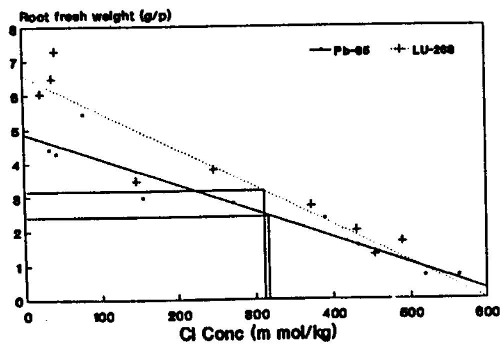


Fig. 2 a. Regression between fresh weight of shoot and Cl concentration in leaf cell sap.

Fig 2 b. Regression between dry weight of shoot and Cl concentration in leaf cell sap.



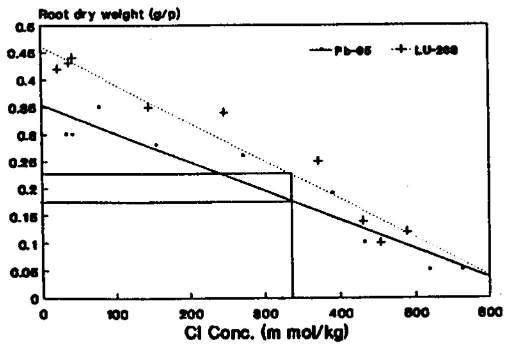


Fig. 2 c. Regression between fresh weight of root and Cl concentration in leaf cell sap.

Fig. 2 d. Regression between dry weight of root and Cl concentration in leaf cell sap.

Frozen leaf samples were thawed and crushed using a glass rod with tapered end and centrifuged for 15 minutes. The supernatant cell sap was removed by micropipette and stored in Eppendoff tubes. An aliquot of the extract was used for the determination of Na^+ by flame-photometer. Chloride from cell sap was determined by using Corning Chloride Analyser 925 directly calibrated in m mol kg^{-1}.

RESULTS AND DISCUSSION

In order to determine the Na^+ and Cl^- toxicity levels in leaves of two wheat varieties LU -26S (salt tolerant) and Pb-85 (salt sensitive), the relationships between shoot/root growth and Na^+/Cl^- concentration in leaf cell sap were computed. Toxicity levels of Na^+ and Cl^- in leaf was arbitrarily defined as "the concentration of Na^+/Cl^- in leaf cell sap at which 50% reduction in growth took place."

Sodium toxicity: Regression analysis between leaf Na^+ and shoot weights are presented in Fig. 1 a and 1 b. As expected, the shoot fresh weight and dry weights decreased as the Na^+ concentration in the leaf increased. It is remarkable to note that both the varieties, although differing in salt tolerance, had nearly the same Na^+ toxicity level in their leaves. This is in line with the data from *in vitro* studies on sensitivity of enzymes extracted from salt tolerant and salt sensitive plants (Flower *et al.*, 1977).

The relations between leaf Na^+ concentration and root fresh weight and dry weight are shown in Fig. 1 c and 1 d. Again the varieties did not differ much in toxicity level of Na^+ in the leaves. Based on 50% reduction in fresh weight, Na^+ toxicity level was about 250 m mol kg^{-1} for root as well as shoot growth of both the varieties. This may be tentatively considered as toxic level of Na^+ in the leaf sap of wheat. There was some discrepancy in the Na^+ toxicity level when expressed in terms of dry weight of these tissues. However, basing toxicity levels on fresh weight and expressing the value in m mol kg^{-1}, it is easier to recognise physiological relationships.

Chloride toxicity: Fig. 2 a and 2 b illustrate the relationship between Cl^- concentration in the cell sap of leaf and shoot growth. An examination of regression revealed that 50% reduction in shoot fresh weight of both the varieties occurred at 300 m mol kg^{-1} Cl^{-1} in the leaf cell sap. The corresponding value for the dry weight was somewhat higher for the obvious reasons. The Cl^- concentrations in the leaf cell sap associated with 50% reduction in fresh and dry weights of root were exactly the same in both the varieties (Fig. 2 c and d). The Cl^- toxicity level based on fresh weight of root (310 m mol kg^{-1}) compared well with the toxicity level of Cl^- in the shoot (300 m mol kg^{-1}).

A comparison between toxicity levels of Na^+ and Cl^- in shoot and root tissues of wheat revealed that Na^+ was more toxic (250 m mol kg^{-1}) compared to Cl^- (300 m mol kg^{-1}) on the basis of 50% reduction in fresh weight of these tissues.

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