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STUDIES ON GROWTH AND WATER RELATIONS OF SORGHUM (*SORGHUM VULGARE*) AS INFLUENCED BY EXTERNAL SALINITY

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A pot experiment was conducted using Hoagland nutrient solution under green house conditions with the objective to explore the water relations of sorghum over a range of external salinities and their impact on growth. Sorghum variety 'Sadabahar' was grown for 15 days in nutrient solution to which NaCl additions were made (0,70 and 140 mol m^{-3}). Measurements were taken at 7 and 15 days of growth after the development of stress. Shoot length, fresh weight, dry weight, leaf area and relative growth rate decreased linearly as the external salinity increased. Leaf water and osmotic potentials were also decreased (became more negative) with the increasing level of salinity and the response was more pronounced at 140 mol m^{-3} salinity. Highly positive correlation was found between water potential and growth characters.

INTRODUCTION

Water potential is considered a fundamental measure of water status of plants and has gained wide acceptance during the last decade (Hsiao, 1973). The water potential of a saline growth medium or soil is lowered (becomes more negative) by the dissolved solutes. To match this decrease and to be able to absorb water from the soil, the plants must lower their water potential than that of soil.

It is likely to be persuasive that when NaCl reduces growth it does so at least partly through its effect on water relations. Therefore, a good understanding of the relationship between growth and water relations of plants under saline conditions could be extremely valuable. However information on this aspect is very limited and only a few species have been explored for these complex relationships (Storey and Wyn Jones, 1979; Yeo and Flowers, 1980). In this paper, we present the data on growth and water relations of sorghum as influenced by salinity.

MATERIALS AND METHODS

Plastic coated iron trays (60 x 45 x 5 cm) containing silica gravel (4 mm dia.) were used for raising the seedlings. The following NaCl concentrations were developed in Hoagland's nutrient solution (Hoagland and Arnon, 1950) using commercial grade NaCl :

1. Control (Hoagland solution half strength)
2. 70 mol m^{-3} NaCl
3. 140 mol m^{-3} NaCl

Four-days old seedlings were transplanted into the plastic tubs (20 litres cap.) having thermopol sheets suspended over 15 litres of Hoagland solution. The salt stress was imposed stepwise (within 4 days @ 1/4 increment day^{-1}) to achieve the desired levels of salinity. Electrical conductivity and pH of the solution were maintained daily and the data regarding shoot length, fresh weight, dry weight, leaf area $plant^{-1}$, relative growth rate and leaf water and osmotic potential were recorded at 7 and 15 days of growth.

The methods of sap extraction and osmotic pressure determination were similar to Gorham *et al.* (1984). All analysis were performed on uppermost, fully expanded leaves of healthy appearance. Leaf water potential was measured with water potential apparatus (Chas W. Cook and Sons, Birmingham B 42 ITT. England) following the method described by Scholander *et al.* (1964). The data collected were subjected to statistical analysis according to Steel and Torrie(1980)

RESULTS AND DISCUSSION

Plant Growth

The effect of salinity on sorghum growth under various salinity regimes is obvious from the data presented in the Table-I. The decrease in shoot length, ifresh weight, dry weight, leaf area and relative growth rate was linear with the ncrease in NaCl concentrations between 0 mol m^{-3} and 140 mol m^{-3} NaCl. The response likely seems to be the indirect effect of salt which induced water deficit and caused a decrease in leaf water potential (Table-3). This is supported by the correlation coefficient analysis (Table-2) which showed a highly positive correlation between leaf water potential and growth characters.

Table 1 : *Effect of external salinity on growth of sorghum (Average of 4 repeats*

Growth characters	salinity NaCl		
	Control	70 mol m^{-3}	140 mol m^{-3}
Shoot length (cm)	64.01a	49.82b	22.16c
Shoot fresh weight (g)	9.94a	5.70b	1.94c
Shoot dry weight (g)	1.0063a	0.8109b	0.3683c
Leaf area (cm^{-2})	113.06a	85.4b	18.9c
Relative growth rate (gg^{-1} dry wt. day^{-1})	0.2092a	0.1970b	0.1432c

Table 2 : *Relationship between leaf water potential and different growth parameters of sorghum grown in saline media*

Variable	Correlation coefficient	
	7 days after stress	14 days after stress
Leaf water potential vs shoot length	0.9475	0.9642
Leaf water potential vs shoot fresh weight	0.9755	0.9741
Leaf water potential vs leaf area	0.8875	0.9561
Leaf water potential vs relative growth rate	0.9759	0.9254

*Any two means not sharing a letter in common differ significantly at 5% probability.

Reduction in plant growth at low leaf water potential can be attributed tos the (i) reduction in cell elongation due to reduced turgor in the growing cell under the influence of the decreased water potential of the root medium (Nieman, 1965), and (ii) damaging of the enzymic proteins exposed to low water potential

(Poljakoff-Mayber, 1982). Other possible reasons for the reduction in growth under saline conditions could be (i) energy derived from respiration was diverted to processes other than growth like synthesis of organic osmotica or the maintenance of ion uptake processes (Poljakoff-Mayber, 1982), (ii) limited supply of metabolites to the young growing tissues (Mass and Nieman, 1978), (iii) interference of NaCl with the production of proteins (Nieman, 1965), and (iv) accumulation of toxic ions like $Na+$ and Cl^- which damaged the growing cells (Bernstein and Hayward, 1958).

Water Relations

Plant yield can be well correlated with leaf water, osmotic and pressure potentials and these measurements may provide a good characterization of salt stress (Cerda *et al*, 1979). A careful examination of the data on water relations of sorghum as affected by salinity (Table-3) revealed that leaf water and osmotic potential decreased as salinity level increased and the responce was more pronounced at 140 mol m^{-3} NaCl salinity. The low leaf water potential at higher salinity may be the requirement of the plant for turgor maintenance. As water potential of saline growth medium or soil is lowered by the osmotic potential of the dissolved solutes, the intracellular water potential must decrease otherwise the plant tissue will lose turgor and dehydrate (Wyn Jones, 1981). The high osmotic pressure (low osmotic potential) may be due to more solute accumulation in response to external salinity. Bernstein (1975) reported that osmotic potential of all the plant parts i.e. roots, stems and leaves decreased to match the decrease in osmotic potential caused by salinization. The results are in good agreement with those of Cerda *et al.* (1979) and Munns and Passioura (1984).

Table 3 : *Effect of External Salinity on Water Relations of Sorghum (Average of 4 repeats)*

Characters	salinity NaCl		
	Control	70 mol m^{-3}	140 mol m^{-3}
Leaf water potential (—bars)	6.08a*	6.46b	9.21c
Osmotic pressure (mOsmol kg^{-1} cell sap)	278.00a	352.00b	580.00c
Tissue water contents (%)	89.00a	85.00b	81.00c

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