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Effect of Salinity on Seed Germination and Growth of Squash (*Cucurbita pepo* L.) Seedlings

M.O. Basalah

Botany and Microbiology Department,
College of Science, King Saud University,
P.O. Box 2455, Riyadh 11451, Saudi Arabia

ABSTRACT. Effects of six salinity levels on seed germination, length, fresh and dry weights, carbohydrate contents and α-amylase activity of squash seedlings were studied. Salinity progressively decreased the percentage of germination. The length, and the fresh and dry weights of root and shoot increased as the salinity level increased up to 8 m mhos/cm EC, indicating that squash can tolerate quite a high level of salinity at seedling stage. The soluble and insoluble carbohydrate contents and α-amylase activity were also affected by salinity.

High levels of salinity aggravate the delay in emergence and also retard the final percentage of plant seed germination (Ayears and Hayward 1948, Paliwal and Maliwal 1972, Varshney and Baijal 1977). Salinity decreased the percentage of emergence (germination) in soybeans (Abel and MacKenzie 1964), barley (Kummar *et al.* 1981) and wheat (Khetawat *et al.* 1967, Kumar 1978). Moderate salinity did not affect the germination much (Verma 1981) and only caused retardation in emergence of wheat and barley (Ayears *et al.* 1952).

In addition to inhibition of germination, early seedling growth stages also may be sensitive to salinity. Bernstein and Hayward (1958) and Nieman (1962) have reported that soluble salts at high salinity levels significantly supress growth in different crop plants. Fresh and dry weights of root and shoot decreased with the increasing salinity levels (Verma 1981, Kumar *et al.* 1981). The saline aerosol has affected much the sugar contents in beans (Sacher and Staples 1985).

As the information available on crop performance under saline conditions is very limited (Paliwal 1972), it may be of much importance to know the effect of different salinity levels on different growth parameters, especially the germination and early seedling growth. With the above consideration in mind, the present studies were undertaken to study the effect of different salinity levels on germination, seedling growth, carbohydrate contents and α-amylase activity in squash (*Cucurbita pepo* L.), an important crop of Saudi Arabia.

Materials and Methods

Squash (*Cucurbita pepo* L.) var. squash Marrow. Seeds were secured from market sources, and the experiments were performed under saline conditions at controlled temperature (25 ± 1°C) in 9 cm petri dishes. Initially seeds were surface sterilized with 1% sodium hypochlorite, and ten seeds were germinated in petri dishes, each containing 2, Whatman No. 1 filter papers.

Saline solutions of specific m mho/cm EC was prepared by dissolving NaCl, $NaHCO_3$, Na_2SO_4 and $Cacl_2$ in distilled water, following the method of United States Salinity Laboratory Staff Hand Book No. 60 (1968). Treatments consisted of five ml saline solution at 0,4,8,12,16 and 20 m mhos/cm EC were added to the petri dishes. Each treatment was replicated 3 times following the soaking, numbers of germinated seeds were taken every 24 hours up to 5 days, when germination was almost complete. Measurements of root and shoot (hypocotyls) lengths (for all the seeds) and samples for weights (fresh and dry) and sugar contents were taken from 5-day-old seedlings.

Two g samples of plant material (root and shoot) were taken in triplicate for the extraction of α-amylase and carbohydrates. Enzyme assay and analysis of carbohydrates were carried out as previously done by Basalah *et al.* (1986). Standard deviation from the mean values was calculated for all the results.

Results

The final percentage germination progressively decreased as the level of salinity increased (Fig. 1). However, the rate of germination during the first few days of incubation was high at moderate salinity levels. An increase in root and shoot length was observed with the increase in salinity level of 4-8 m mhos/cm EC, but above those levels there was a gradual decrease (Fig. 2). Similarly, the fresh and dry weights of root and shoot increased at salinity levels of 4-8 m mhos/cm EC. However, shoots showed maximum weight (fresh and dry) at 4, and roots at 8 m mhos/cm EC salinity levels. Above those levels of salinity, the fresh and dry weight in both root and shoot decreased gradually (Fig. 3 & 4).

Soluble reducing sugars content of seedlings exposed to salinity are shown in Fig. 5. The sugar content were high at control level, and low at 4-8 m mhos/cm EC, increasing gradually up to 20 m mhos/cm EC. The sugar content in roots was higher than that of shoots.

Figure 6 reveals that at low salinity levels the α-amylase activity increased as compared with the control, in both root and shoot, but the activity decreased with an increase in salinity level. Conversely, (Fig. 6), hydrolyzed polysaccharides decreased at low salinity in roots and shoots but increased sharply in shoots with the increase in salinity levels. However, in roots the hydrolyzed polysaccharides did not show much increase with the increase in salinity levels.

Discussion

The percentage germination decreased with increasing salinity levels in this study. These results agree those of Kumar *et al.* (1981), Abel and MacKanzie (1964), Paliwal and Maliwal (1972) and Varshney and Baijal (1977), who have reported that salinity decreased both the rate and percentage of germination, and emergence, in different crops. The decrease in the ultimate germination, in my study, may be due to the combined effect of osmotic pressure and toxicity of salts (Bernstein and Hayward 1958, Uhvit 1946) or due to the effect of added Cl^- ions (Abel and MacKanzie 1964).

In my study it is observed that there was more growth at low salinity (4 and 8 m mho/cm) levels than in the controls and more than at higher levels of salinity. This supressed growth at higher levels of salinity has been reported by many workers (Gauch and Eaton 1942, Hayward and Wadleigh 1949, Nieman 1962, Sacher and Staples 1985). However, more growth at lower levels of salinity may be explained by the findings of Kumar *et al.* (1981) who found that the effect of salinity on plant growth may depend on its state of development. Moreover, responses may be quite different at the germination stage than at later stages of development.

During growth, it is observed that root and shoot fresh and dry weights increased at low salinity levels and decreased at high levels of salinity. Varma (1981) has reported the decrease in fresh and dry weights due to salt stress. A similar effect was also observed in barley seedlings (Abel and MacKanzie 1964), Kumar *et al.* 1981). However, the increase in fresh and dry weights at low salinity levels may be due to more growth at those levels or uptake of more salts at that stage of growth.

Elevated sugar content in salt-stressed tissue is widespread phenomenon (Greenway and Munns 1980). In my study (Fig. 2), it was shown that there is maximum growth at 4 to 8 m mho/cm salinity levels as well as less sugars (Fig. 5), though there is more α-amylase activity at those levels of salinity (Fig. 6). Conversely, there are more sugars recorded at higher salinity levels with less enzyme activity. These results may be explained on the assumption that accumulation of sugars, which occured in the controls and at higher salinity levels, may be the result of reduced utilization due to reduced growth; and reduction in sugar content at lower salinity levels may be the result of higher growth and, hence, more utilization of sugars (Sacher and Staples 1985). The hydrolyzed polysaccharides, in the present study, are generally correlated with the enzyme activity, but roots showed a higher level than shoots.

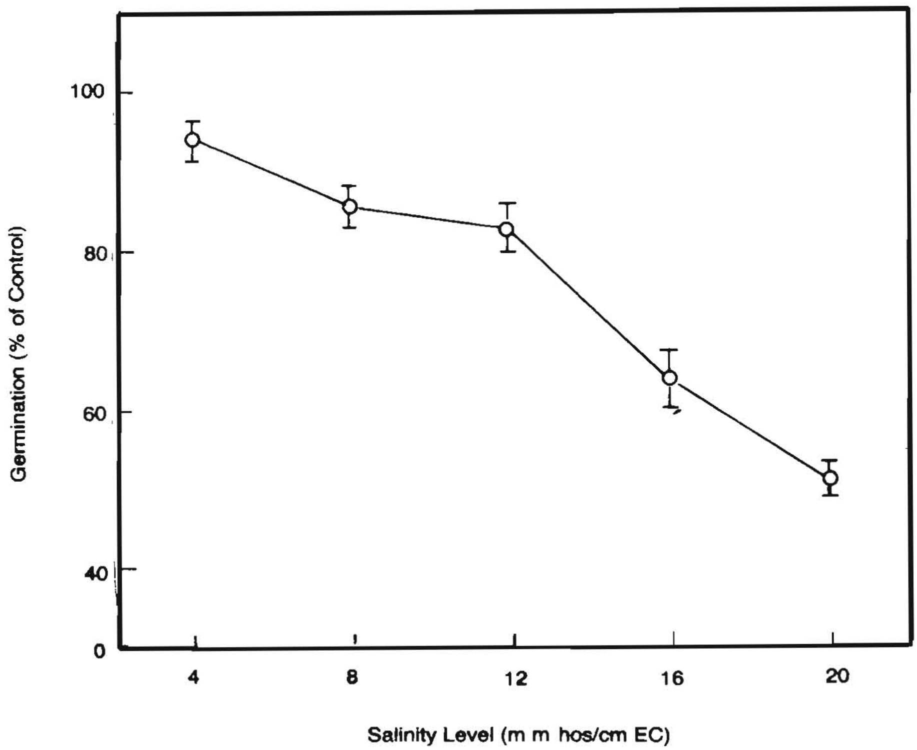

Fig. 1. Germination (as of control) of squash seeds germinated at different levels of salinity. Vertical **lines** show the S.D. from the mean values.

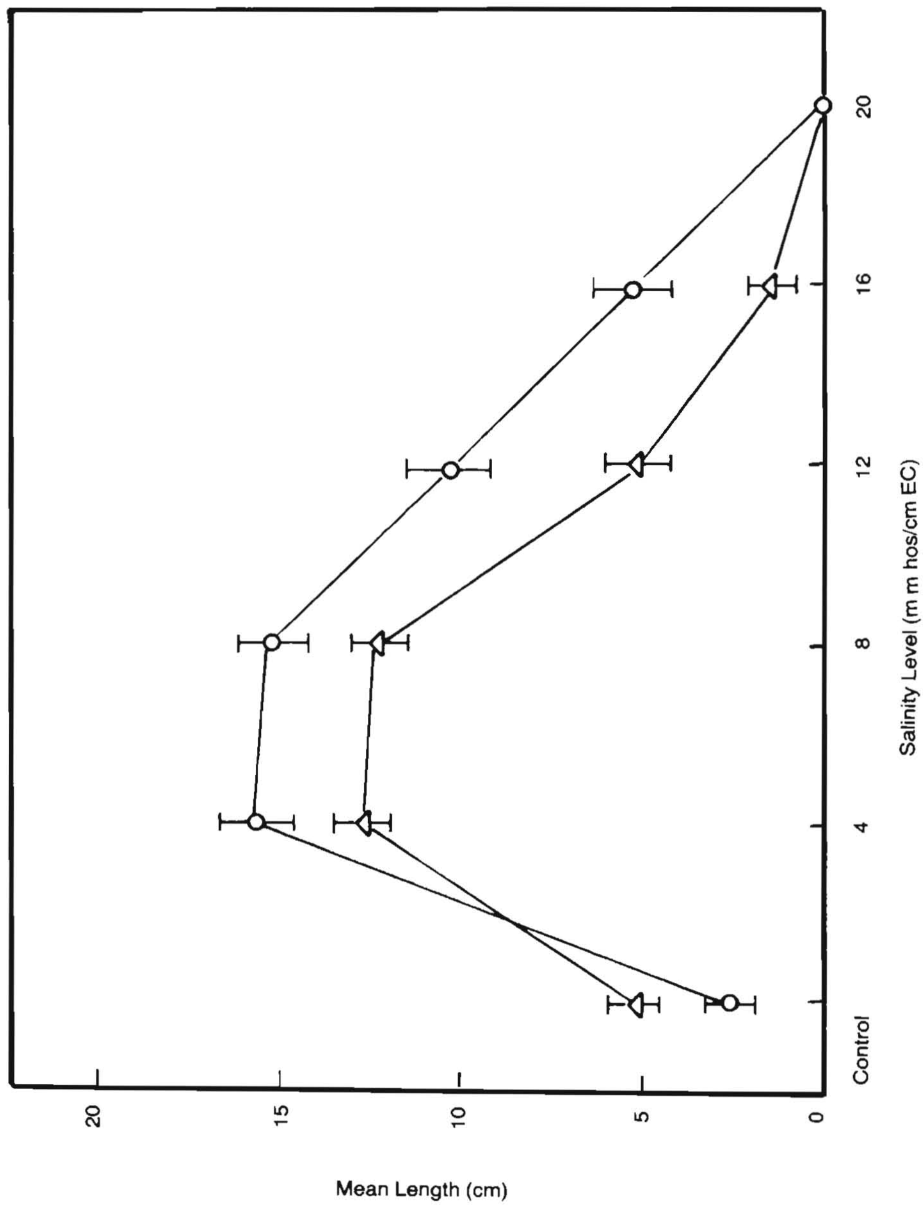

Fig. 2. Lengths (cm/seedling) of root o——o and shoot △——△ of squash seedlings grown at different levels of salinity. Vertical lines show the S.D. from the mean values.

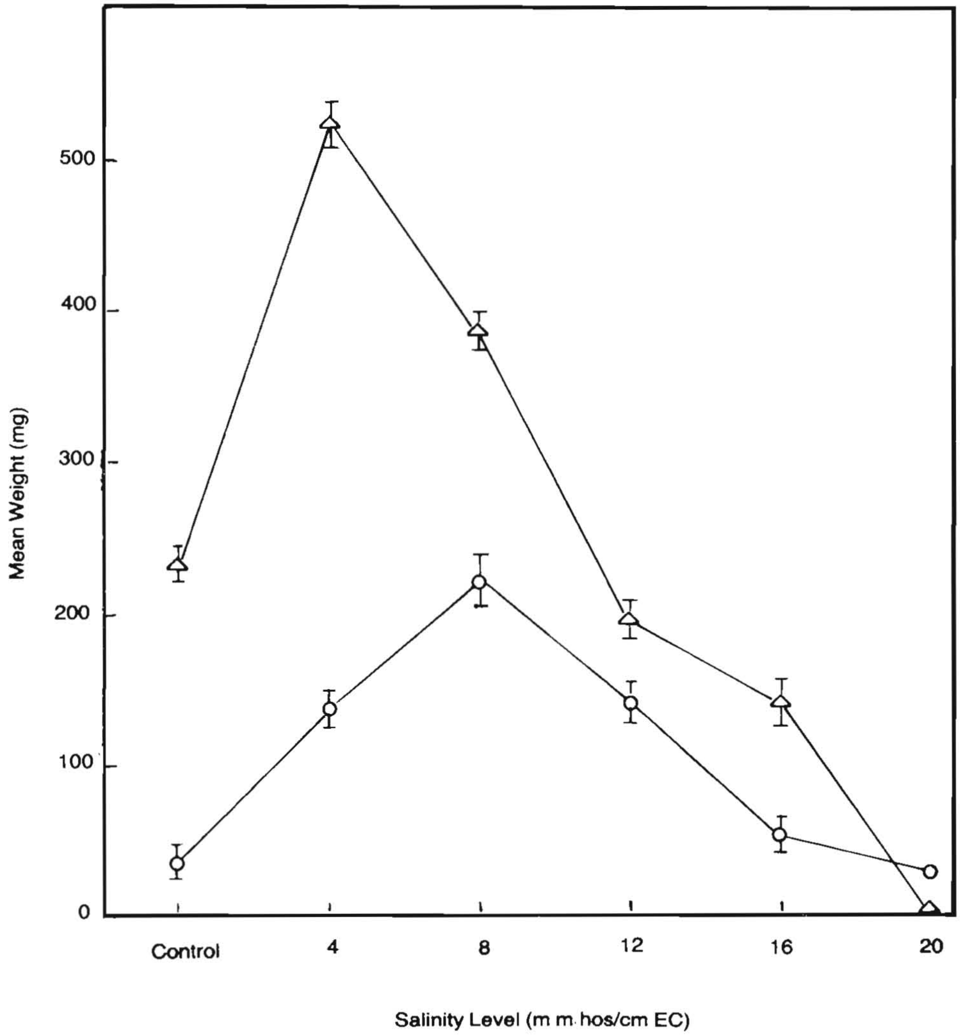

Fig. 3. Fresh weights (mg/seedling) of root o——o and shoot △——△ of squash seedlings grown at different levels of salinity. Vertical lines show the S.D. from the mean values.

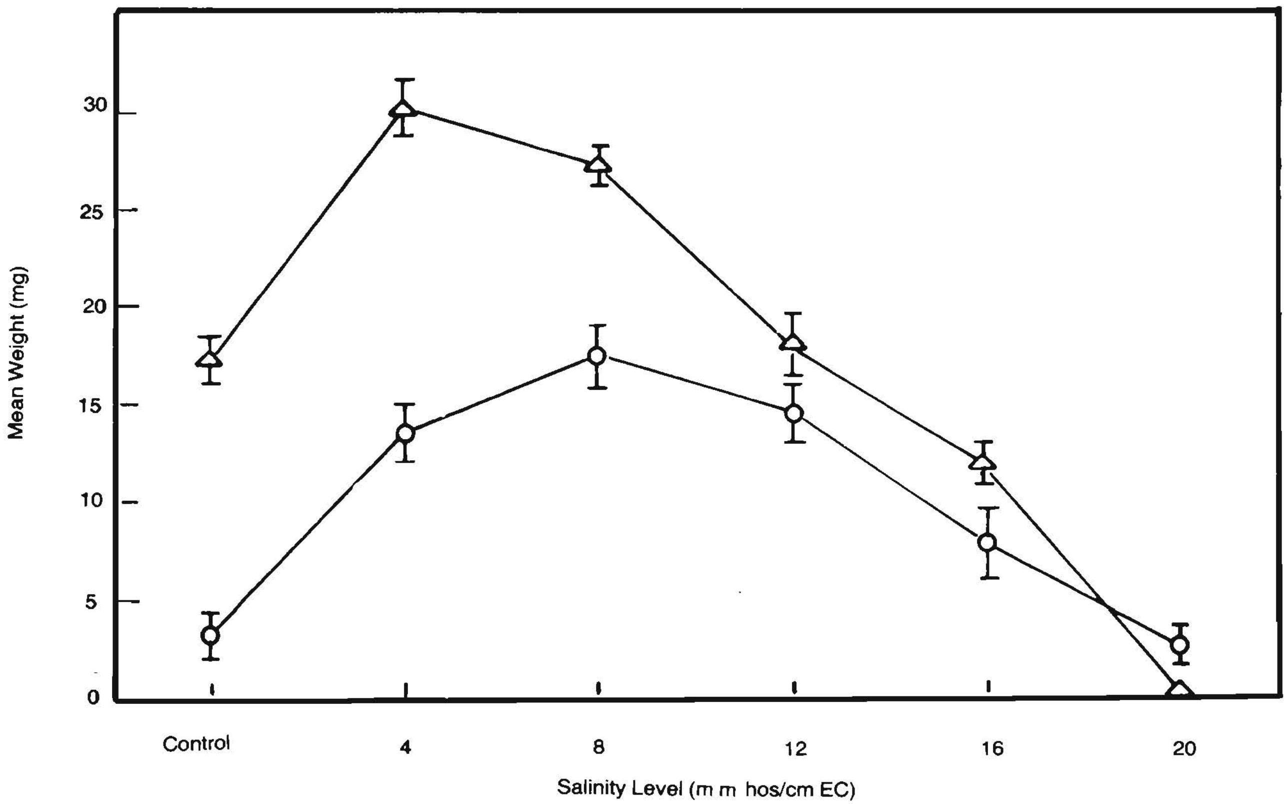

Fig. 4. Dry weights (mg/seedling) of root o——o and shoot △——△ of squash seedlings grown at different levels of salinity. Vertical lines show the S.D. from the mean values.

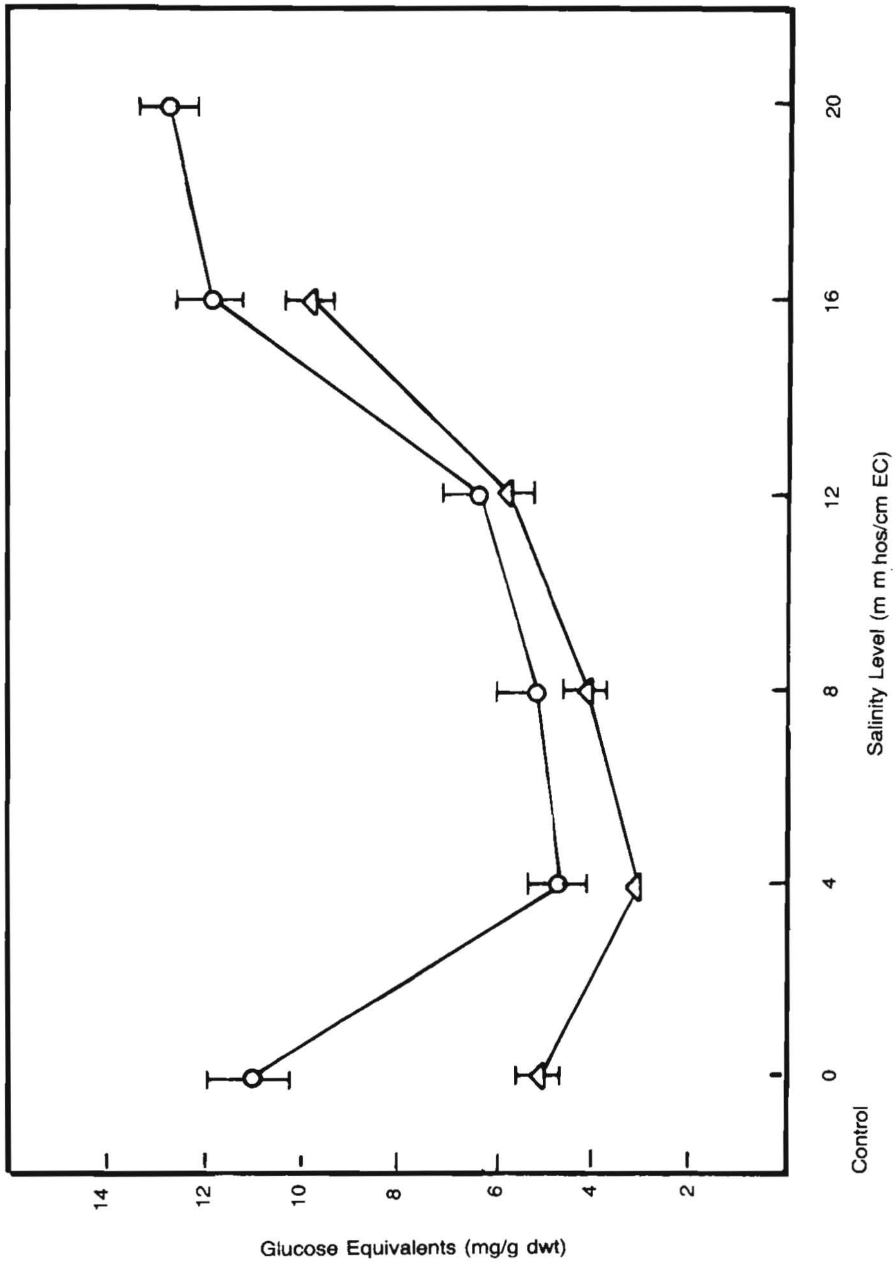

Fig. 5. Soluble reducing sugar contents (as equivalents of glucose in mg/g dwt) of root o——o and shoot △——△ of squash seedlings grown at different levels of salinity. Vertical lines show the S.D. from the mean values.

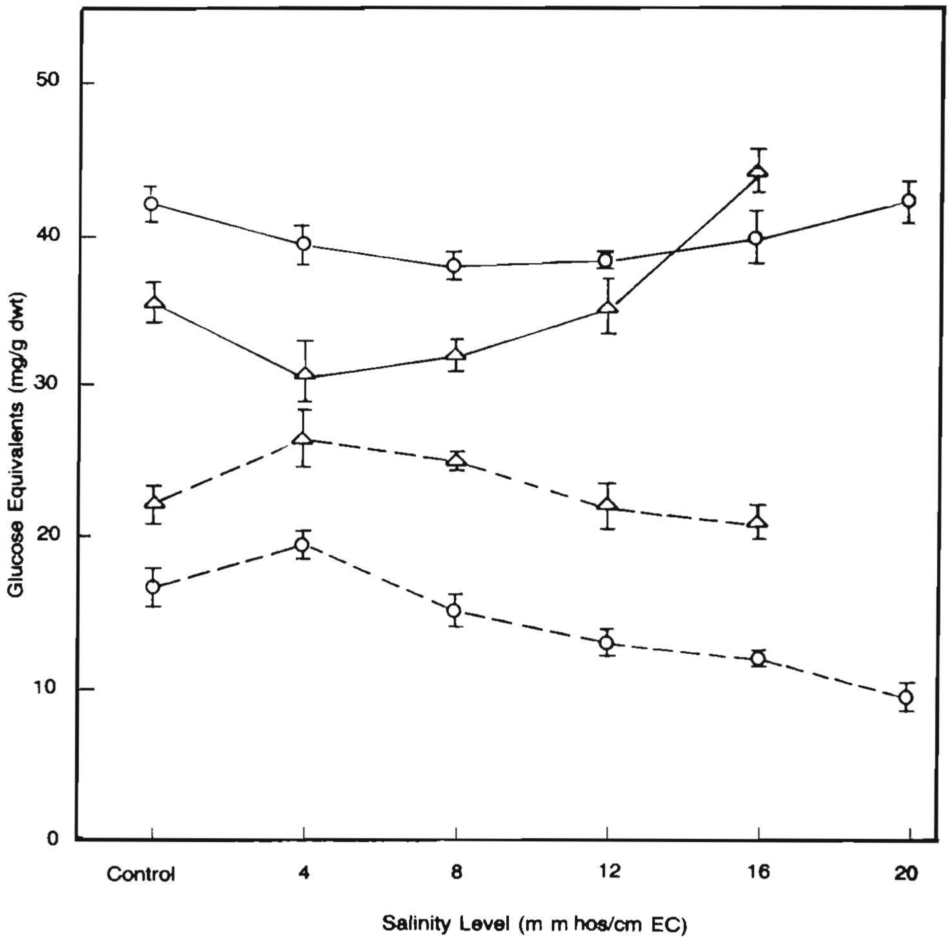

Fig. 6. α-amylase activity in root o---o and shoot △---△ and hydrolyzed polysaccharides contents of root o——o and shoot △——△ (as equivalents of glucose in mg/g dwt) of squash seedlings grown at different levels of salinity. Vertical lines show the S.D. from the mean values.

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تأثير الملوحة على إنبات ونمو بذور الكوسة

محمد عمر باصلاح

قسم النبات والأحياء الدقيقة - كلية العلوم - جامعة الملك سعود
ص . ب : ٢٤٥٥ - الرياض ١١٤٥١ - المملكة العربية السعودية

بدراسة تأثير ستة مستويات من الملوحة على إنبات بذور الكوسة، وأطوال المجموع الجذري والخضري والوزن الجاف والطري للبادرات ومحتوى السكريات ونشاط انزيم الفا أميلاز. وجد أن النسبة المئوية تتناقص بزيادة الملوحة، مع أن بذور الكوسة أبدت مقاومة للملوحة في المراحل الأولية للانبات. فمع زيادة الملوحة زاد طول المجموع الجذري والخضري والوزن الرطب والجاف للبادرات حتى ٨ ملي اومز/سم من التوصيل الكهربي، مما يشير إلى أن البادرات أمكنها تحمل تركيزات عالية من الملوحة. هذا وقد تأثر بالملوحة محتوى السكريات الذائبة وغير الذائبة ونشاط انزيم الفا أميلاز.