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Growth and proline accumulation in mungbean seedlings as affected by sodium chloride

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Abstract

Mungbean (*Vigna radiata* L. Wilczek cv. Sujata and cv. K851) seedlings were grown in paper towelins in dark under 0, 0.5, 1, 2 and 3 % (m/v) NaCl salinity. Germination percentage, shoot and root length, fresh mass of both cultivars decreased with salinity. Total soluble saccharides and proline accumulated in the root and shoot of salt stressed seedlings. The proline accumulation in the root was four to five times higher than that of the shoot of NaCl treated etiolated mungbean seedlings.

Additional key words: germination, etiolated seedlings, salinity, *Vigna radiata.*

Introduction

Seedling emergence and growth is negatively affected by salinity. The shoot growth is more severely reduced in salt sensitive plants by salinity than the root growth. Soluble saccharides, proline and free amino acids are reported to be important osmolytes accumulated in salt and water stressed cells, and are responsible for salt tolerance in plants (*e.g.* Flowers *et al.* 1977, Greenway and Munns 1980, Kalaji and Pietkiewicz 1993, Mass and Niemann 1978).

Mungbean is reported to be a salt susceptible crop. Because the salt tend to concentrate in the upper soil layer where seeds are planted, many studies have concentrated on the effects of salinity on germination (Poehlman 1991). Delayed and reduced germination under salinity due to reduced water availability or toxic effects of salts were reported (More and Ghoniskar 1982, Paliwal and Maliwal 1980, Reddy 1982, Sharma *et al.* 1971) and retardation in mungbean seedling growth (Hug and Larher 1983, Kumar and Bharadwaj 1981) was reported. Shoot

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emergence takes 4 - 5 d in the field. In the present study, we report the effect of NaCl on mungbean seedlings in pre-emergence stage. The conditions are simulated by growing the seedlings in darkness for 5 d.

Materials and methods

Mungbean (*Vigna radiata* L. Wilczek, cv. Sujata and cv. K851) seeds were obtained from Pulse Research Centre, Nayagarh. Seeds were germinated using the towelin roles kept in buckets filled with distilled water (control), 0.5, 1, 2 and 3 % (m/v) NaCl solutions in a dark chamber at 26 ± 1°C. Germination, and length, fresh and dry mass of shoot and root were recorded at 5 d. These observations were repeated four times. Statistical analysis was done by Randomized Block Design and analysis of variance (*ANOVA*).

Amino acid, saccharides, phenol and proline contents were measured colorimetrically by ninydrin reaction, arsenomolybdate (for reducing sugars) and anthrone reagent (for total sugars), Folin and Ciocalteu reagent, and toluene fractionation methods, respectively (for details see Das *et al.* 1990).

Results and discussion

Salinity showed significant effect on mungbean seed germination (Fig. 1). Seed germination of cv. Sujata decreased comparatively at 1.0 % (m/v) NaCl and at 3 % in cv. K851. Similar observations on the cultivar differences in seed germination was reported earlier (More and Ghoniskar 1982, Paliwal and Maliwal 1980, Reddy 1982).

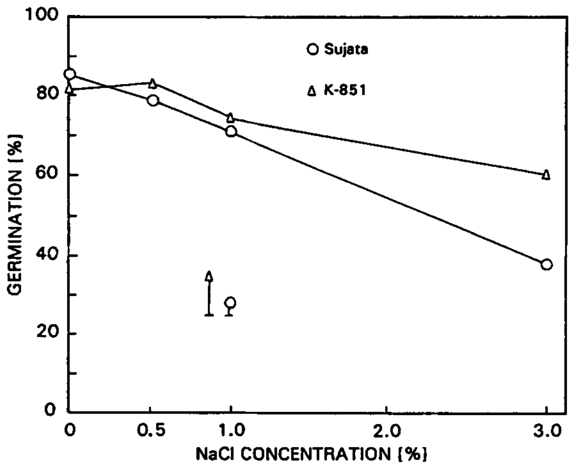

Fig. 1. Salinity induced changes in the mungbean (cv. Sujata and cv. K851) seed germination [%] after 5 d of treatment. *Vertical bars* denote least significant difference.

At 3 % NaCl seeds germinated, but the shoot growth was completely inhibited. Shoot growth was reduced to 50 % of control values at 0.5 % NaCl in both cv. Sujata and cv. K851 (Fig. 2*A*). However, root elongation was reduced to 50 % of control values at 1 % NaCl (Fig. 2*B*). There was a stimulation in root growth of cv. K851 at 0.5 % NaCl treatment. Kumar and Bharadwaj (1981) observed that low concentrations of salinity stimulated root elongation in some mungbean genotypes. However, Hug and Larher (1983) reported a salinity induced progressive reduction in root and shoot length in mungbean seedlings.

Fresh mass of either shoot or root of both cv. Sujata and cv. K851 decreased with salinity (Fig. 2*C,D*). Dry mass of shoot of cv. K851 decreased but that of cv. Sujata increased with salinity (Fig. 2*E*). Salinity induced decrease in the dry mass of cv. K851 corroborates with the observation of Gulati and Jaiwal (1994). Salinity induced changes in dry mass of root in both the cultivars were not significantly different from the control ones (Fig. 2*F*) suggesting that root growth was relatively less affected than shoot growth in *Vigna radiata*. The shoot growth of salt sensitive

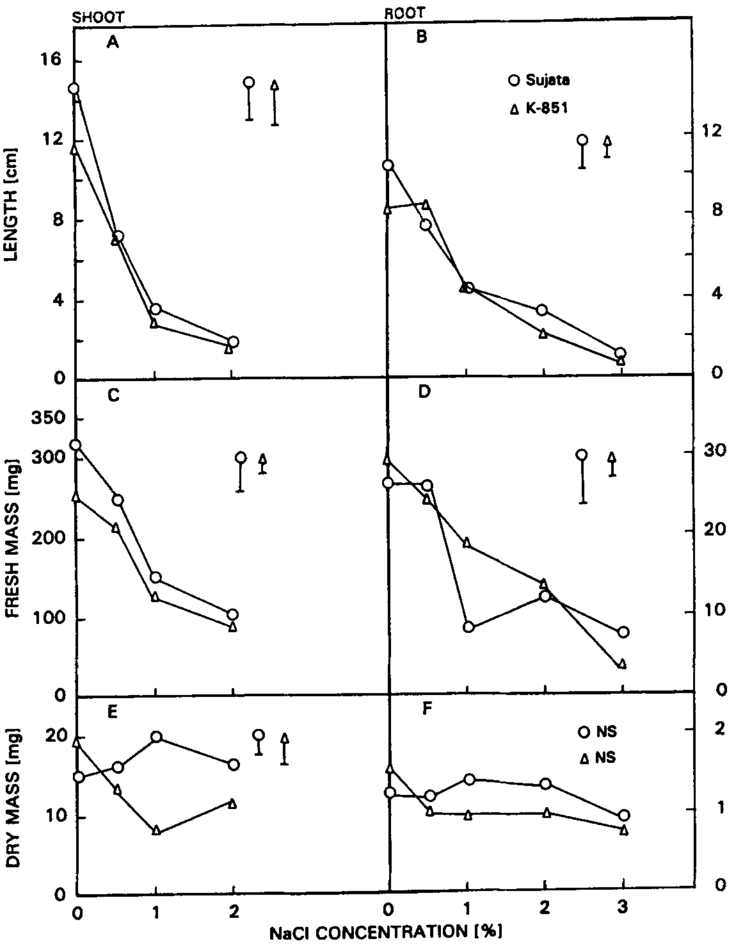

Fig. 2. Salinity induced changes in the shoot and root length, fresh mass and dry mass of 5-d-old etiolated mungbean seedlings. *Vertical bars* denote least significant difference.

plants were reported to be more affected by salinity than the root growth (Khavari-Nejad and Najafi 1990, Munns and Termaat 1986, Niemann *et al.* 1988). The underlying mechanims of avoidance of the severity of salt stress by the accumulation of free osmotic solutes in roots of etiolated seedlings are investigated.

Under NaCl salinity the total saccharides, proline and phenol contents of roots showed a gradual increase over control values in both the cultivars. The proline content of salt stressed roots increased 20× and 27× in cv. Sujata and cv. K851, respectively. The reducing sugar content in the cv. K851 also increased gradually with the salt treatments. However, in the cv. Sujata the reducing sugar content decreased at 0.5 % NaCl and increased over control value at 2 % NaCl in the root. The amino acid content of roots showed variable responses in the salinized roots

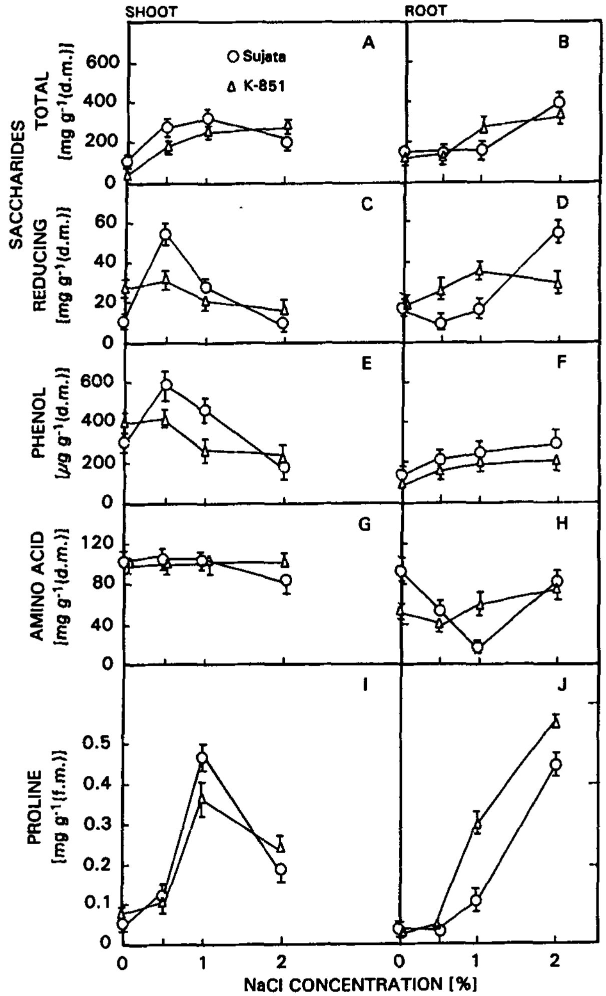

Fig. 3. Sodium chloride induced changes in the free solutes of root and shoot of 5-d-old etiolated seedlings. The data are means of 3 separate experiments. The *vertical bars* represent S.E.

with an increase in cv. K851 and a decrease in cv. Sujata. Total saccharide content of the shoots increased with an increasing salinity (Fig. 3). Low (0.5 %) concentrations of NaCl stimulated and higher concentration (2 % NaCl) reduced the reducing sugar and phenol accumulation in cv. Sujata. In cv. K851 similar trend was observed with a reduction in phenol and reducing sugar at 1 % NaCl. The amino acid content of the shoot remained unchanged during salinity treatments. The proline content in the shoot, however, increased upto four to five times that of the control values, at 1 % NaCl in both cultivars.

Increase in the free solute contents in stressed tissues indicates a decrease in osmotic potential (Das *et al.* 1990, Sánchez-Blanco *et al.* 1991, Torrecillas *et al.* 1994). The proline and total saccharide content increased gradually with salinity both in the shoot and root (Fig. 3). However, proline accumulation was relatively higher in roots than in shoots during salt stress. Proline plays an important role in the osmoregulation and acts as a reserve nitrogen in plants subjected to salt or water stress (Kalaji and Pietkiewicz 1993). The higher amount of proline accumulation pattern in the roots of NaCl stressed etiolated *Vigna radiata* seedlings along with no significant growth reduction, suggests that the mungbean strategy under saline conditions is *1*) the use of accumulating proline for cellular osmoregulation and *2*) the sustained root growth.

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