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SALINITY INDUCED CHANGES IN SOME GROWTH AND PHYSICO-CHEMICAL ASPECTS OF TWO SOYBEAN [*GLYCINE MAX* (L.) MERR.] GENOTYPES

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Abstract

Effect of salt stress on plant biomass production and some biochemical parameters of two soybean [*Glycine max* (L.) Merr.] genotypes were investigated under three NaCl salinity levels (control and 3.0, 4.5 and 6.5 dsm^{-1}). Salinity induced a marked reduction in plant height and plant biomass production in both genotypes. Chlorophyll a, chlorophyll b and total chlorophyll increased with increase in levels of salinity. A marked increase in sodium (Na^+) and chloride (Cl^-) contents were observed in response to salinity, whereas potassium (K^+) and nitrogen contents of salt stressed plants were lower than that of controls. Genotypes did not differ significantly regarding all the parameters studied.

Introduction

Agriculture has faced the challenge of sustaining its productivity for centuries due to soil salinity. The recent figure for the extent of salt affected soils in Pakistan is 6173.5 thousand hectares (Anon., 1999). Salinity inhibits the growth of the plants by affecting both water absorption and biochemical processes such as nitrogen and carbondioxode assimilation and protein biosynthesis (Cusido *et al.*, 1987). Under saline conditions plants fail to maintain the required balance of organic and inorganic constituents leading to suppressed growth and yield (Gunes *et al.*, 1996).

Leguminous crops are generally regarded as highly salt sensitive species. As for as the nutritional value of soybean is concerned it is considered to be better because of its superior quality oil, being free from cholesterol (Walf & Kippes, 1959). In nodulated plants, salinity not only cause the reduction in N-fixation (Delgado *et al.*, 1994; Akhtar *et al.*, 2002) but also inhibit the process of nodulation (Ali *et al.*, 1996) resulting in stunted growth of plants. Salinity is mostly caused by NaCl, producing defilement of soil particles resulting in decrease in soil permeability and porosity. Saline conditions drastically changes the environment of root aeration, osmotic potential of soil solution and normal equilibrium of the dissolved ions. In view of the above fact, a study was conducted to appraise the effect of different salinity regimes on morphological and physico-chemical aspects of soybean cultivars.

Materials and Methods

Seeds of two soybean (*Glycine max* (L.) Merr.) genotypes, Ertou No. 2 and Soybean 95-1 obtained from Oil Seed Department, Ayub Agrucultural Research Institute (AARI), Faisalabad were used. The study was conducted in earthen pots containing texturely loamy soil under natural environmental conditions. The electrical conductivity of the soil used was 1.5 dS m^{-1} with pH of 8.2 having saturation 32%. The experiment was laid out in a completely randomized design (CRD) with factorial arrangement. Three different salinity regimes i.e., 3.0, 4.5 and 6.0 dS m^{-1} were developed with NaCl at stage.

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Chlorophyll contents (chl. a, chl. b and chl. total) were determined spectrophotometerically (Arnon, 1949). Fresh leaves (2.0 g) were ground in 80% acetone and centrifuged at 12000-x g for 30 minutes. Absorbance of supernatant was measured at 645, 652 and 663 nm and chlorophyll contents calculated using the formula of Davis (1976). For nutrient analysis, oven dried material was digested in sulphuric acid and H_2O_2 (Wolf, 1982). Sodium (Na) and potassium contents was analysed on flame photometer (Jenway, PEP-7). Nitrogen content was estimated by Micro-Kjeldhal method (Bremner, 1965). Chloride contents were worked out in aqueous extract of leaves by Digital Chloride Meter (Model UC-41, Central Kagaku Corp., Japan).

Data collected were subjected to a two-way analysis of variance technique and means were compared by Duncan's New Multiple Range Test (DMRT) at 5% level of probability (Steel & Torrie, 1980).

Results

The results showed that ionic contents of plant viz. Na^+ and Cl^- gradually increased by increasing salinity regimes while plant height, dry weight/plant and K^+ decreased in both the cultivars (Fig. 1abceg). The Na^+ and Cl^- contents were much higher in Ertou No. 2 while K^+ was greater in Soybean 95-1. N content also declined gradually with the increment of salinity (Fig. 1i). The reduction was clear in both cultivars, however, it was more pronounced in Ertou No. 2 as compared Soybean 95-1. The deleterious effect was more pronounced at high salinity level as compared to low.

Chl. a, b and total Chl. contents were highest in higher salinity level while the minimum amount of these contents was observed in control (Fig. 1dfh). Chlorophyll contents increased gradually with the increment of salinity regimes. It is notable that in lower level (3.0 dS m^{-1}) of salinity chl. a in Soybean 95-1 and chl. b and total chl. in Ertou No.2 have very little difference as compared to control, while the higher levels of salinity show remarkable difference among means.

Discussion

Salinity is well known for producing stunted growth of the plants. In our present study salinity induced marked reduction in plant height and dry weight of the plant. It may either be due to the reduction in cell size or to inhibition of the mitotic activity (Khan & Asim, 1998). Salinity also reduced both these attributes inhibiting water uptake due to osmotic potential of culture solution (Lea-Cox & Syvertsen, 1993). The main cause of growth inhibition in NaCl induced plants is the difficulty in uptake of mineral nutrients due to competition with Na^+ (Cachorro *et al.*, 1994; Alam *et al.*, 1999).

Both soybean cultivars responded in a same way to increasing salinity levels. Reduction in dry weight of the plant fairly corresponded with the accumulation of Na^+ and Cl^- in plant tissues (Gunes *et al.*, 1996; Yousef & Al-Saadawi, 1997), which disturbs the plant metabolism resulting in reduced plant growth. Reduced K^+ concentration is due to Na^+ accumulation in root media (Siegel *et al.*, 1980) suggesting an antagonism might be caused by the competitive relation between monovalent cations. Higher Na^+ accumulation creates toxicity (Khan *et al.*, 1995; Ashraf *et al.*, 1999), which ultimately retards plant growth.

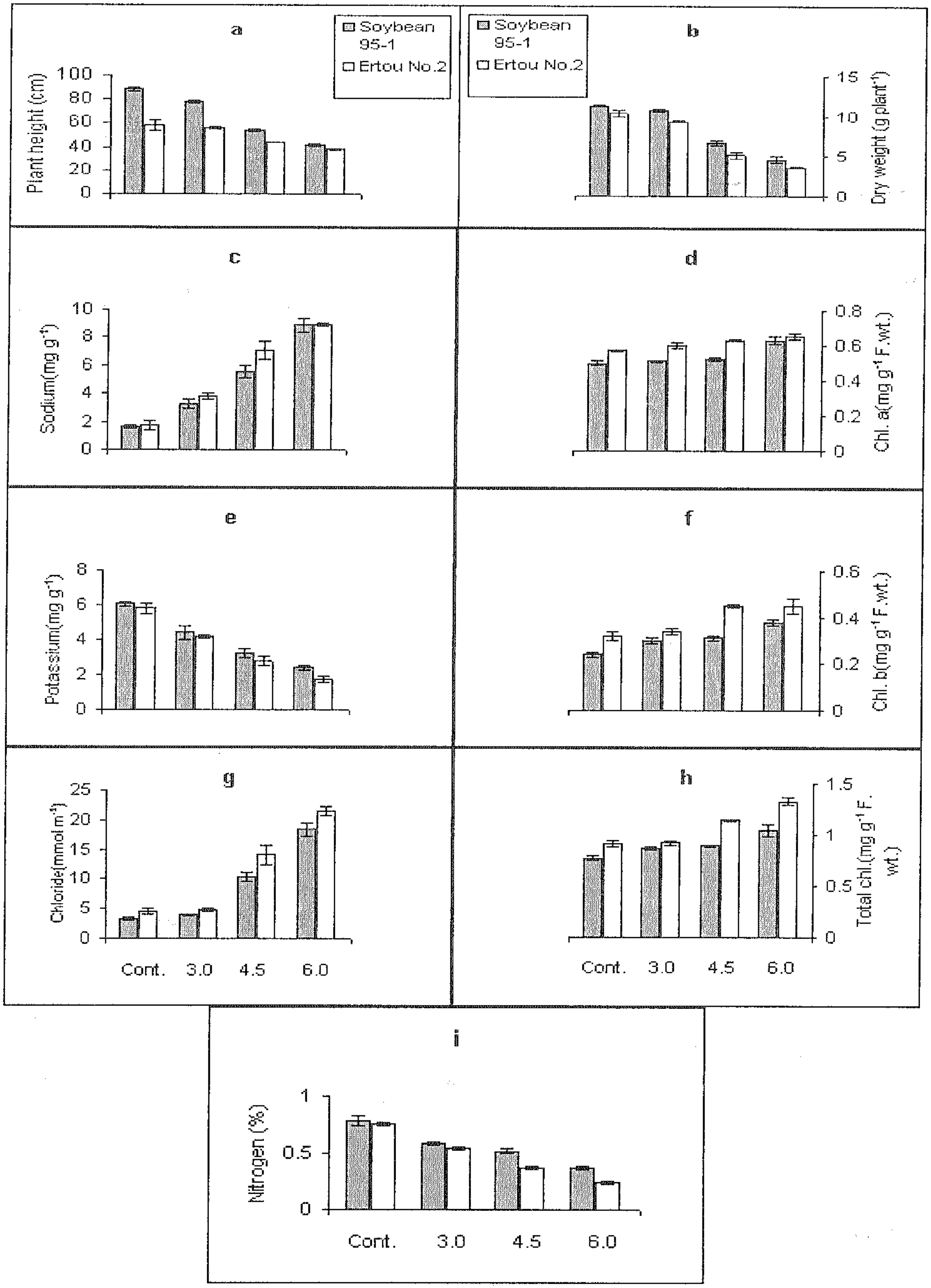

Fig. 1. Different growth and physico-chemical attributes of two soybean genotypes at maturity when subjected to various levels of salinity.

Many reports indicated reduction in N contents due to salinity (Ashraf & Khan, 1993; Qureshi *et al.*, 2000) as also observed in the present study. Salinity disturbed the N metabolism because several enzymes i.e., Nitrate reductase, Ammonia-Lyase and Nitrate reductase failed to maintain their activities under saline conditions which may have inhabited N-fixation and also reduced the process of nodulation (Delgado *et al.*, 1994; Ali *et al.*, 1996; Akhtar *et al.*, 2003). Reduction in growth in present study may possibly be due to above mentioned reasons.

Gradual increase in chl. a, chl. b and total chl. was observed with increasing salinity levels. In contrast to this there are some reports indicating reduction in chlorophyll content due to salinity (Reddy & Vora, 1986; Ashraf & Bharri, 2000) where chlorophyll content estimated on per leaf basis while in the present study the chlorophyll contents was estimated on weight basis. The increase in chlorophyll content may be due to this reason because due to salinity leaf size reduced and one gram of salt affected plants contained more number of leaves, which may be the possible reason of this enhancement however some reports are available in the literature supporting the findings of the present study.

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