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Grain soaking presowing in ascorbic acid or thiamin versus the adverse effects of combined salinity and drought on wheat seedlings

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Soaking of wheat grains presowing for 6 hrs in 100 ppm of either AsA or B_1 synergistically enhanced the stimulatory effects of moderate salinity and drought on net photosynthesis as well as on photosynthetic pigments. On the other side the rate of respiration was comparatively lowered by the application of any of the two vitamins. In addition these vitamin treatments exerted some favorable effects on growth and transpiration of wheat seedlings counteracting the inhibitory effects of relatively high salinity and drought stress.

Introduction

Water and salt stresses are of particular significance for irrigated crops (Fowden *et al*., 1993). Therefore many trails are now made to help crop plants overcome the noxious effects of these stresses (Al-Hakimi and Hamada, 2001; Khan and Srivastava, 1998). However, the role of vitamins in counteracting the inhibitory effects of combined salinity-drought stress is rarely investigated.

Thus the aim of the present work was to follow the role of grain soaking presowing in vitamins versus the interactive stressing effects of salinity-drought on photosynthesis and some related activities of wheat seedlings.

Materials and methods

The grains of wheat (*Triticum aestivum* L.) before sowing were soaked for 6 hrs in solutions containing 100 ppm of ascorbic acid (AsA) or thiamin (B_1). After sowing the grains, the plastic pots were then irrigated with the different saline solutions to reach the desired salinization levels (40, 80, 120 and 160 mM NaCl) and the water content of the soil was adjusted regularly near to the field capacity. The seedlings were left for 15 days. Thereafter, the pots were watered to the desired soil moisture content and salinity (70%, 50% and 30% field capacity, each under 40, 80, 120 and 160 mM NaCl). Some pots were left untreated (100% field capacity and 0.0 vitamins) and regarded as absolute control. On the other side, salinized-droughted plants but non-treated with vitamins were regarded as reference control. At the end of the experimental period (30 days) fresh shoots and roots were then dried in an aerated oven at 70C. Transpiration rate was measured as described by Bozcuk (1975). The contents of chlorophylls a, b and carotenoids were determined spectrophotometrically (Metzner *et al*., 1965). Net photosynthetic rate and dark respiration rate were determined manometrically (Umbreit *et al*., 1959).

Results

The fresh and dry matter yield of shoot and root systems of test wheat seedlings showed a marked decrease as the concentration of NaCl was raised and soil moisture content was lowered (Fig. 1). The highly adverse effects of salinity-drought stress were clearly demonstrated in wheat plants treated with the highest level of NaCl and the lowest level of field capacity. On the other side, soaking presowing of wheat grains in AsA or B_1 was generally effective in alleviating, partially or completely, these inhibitory effects of salinization and drought treatments.

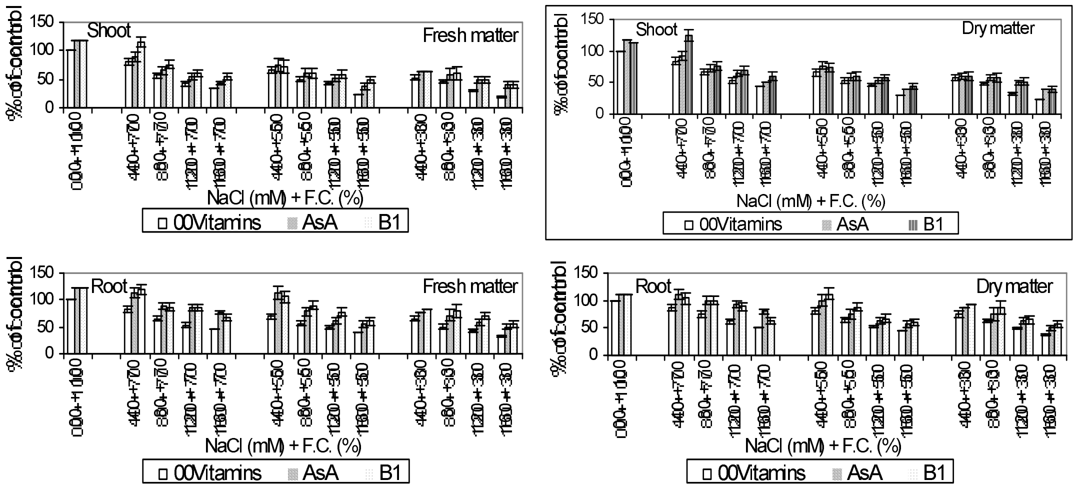

Fig. 1: The action of AsA and B_1 treatments in amelorating the adverse effects of NaCl-drought stress (40-160 mM and 70-30 % field capacity) on fresh and dry matter of shoots and roots of wheat plants. Values in parentheses represent $\pm$ SD.

The results presented in fig. 2 reveal that the transpiration rate of the experimental plant seedlings was gradually lowered with the rise of salinity-drought stress. This retarding effect of salt-drought stress was partially or completely alleviated as the grains were soaked presowing in any of the applied vitamins.

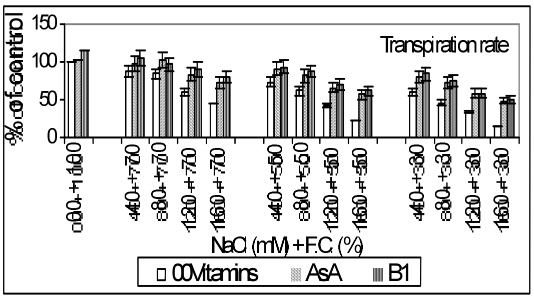

Fig. 2: The action of AsA and B_1 treatments in ameliorating the adverse effects of NaCl-drought stress (40-160 mM NaCl and 70-30 % field capacity) on transpiration rate of wheat plants. Values in parentheses represent $\pm$ SD.

It is interesting to notice that at this plant age most of the applied salinity-drought levels with or without vitamin treatments were of stimulatory effects on the biosynthesis of photsynthetic pigments and also on net photosynthetic rate (Figs. 3; 4). Dark respiration showed a tendency to increase with increasing salt-drought stress. Soaking of wheat grains presowing in AsA or B_1 was generally effective in alleviating partially or completely, the stimulatory effects of salinization and drought treatments on the dark respiration.

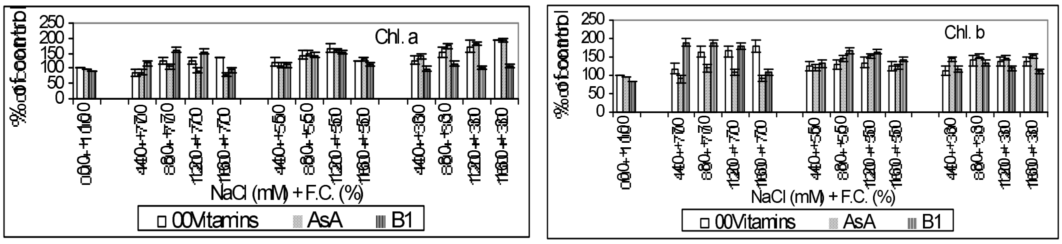

Fig. 3: The action of AsA and B_1 treatments in ameliorating the adverse effects of NaCl-drought stress (40-160 mM NaCl and 70-30 % field capacity) on photosynthetic pigments (chl. a, chl. b and carotenoids) of wheat plants. Values in parentheses represent $\pm$ SD.

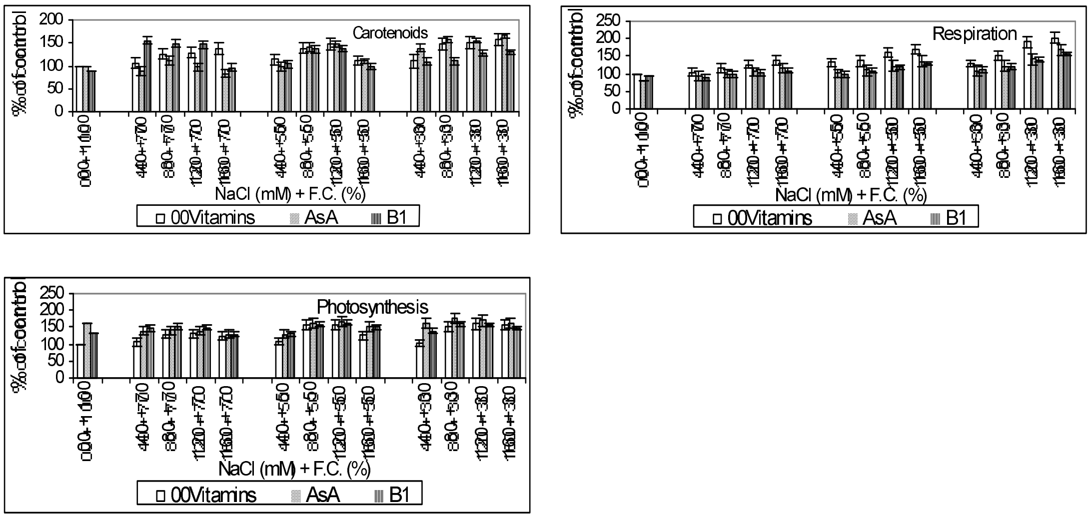

Fig. 4: The action of AsA and B_1 treatments in ameliorating the adverse effects of NaCl-drought stress (40-160 mM and 70-30 % field capacity) on net photosynthesis and dark respiration of wheat plants. Values in parentheses represent $\pm$ SD.

Discussion

The response of wheat plant seedling to various levels of salinity-drought was reflected in a decrease in shoot and root growth. This reduction could be attributed to the reduction in cell division and or in cell enlargement (Terry *et al*., 1971). The beneficial effects of the two applied vitamins (AsA and B_1) were clearly exhibited with this test plant. Such promoting effects of vitamins on growth were also, obtained by some other authors (Khan and Srivastava, 1998; Al-Hakimi and Hamada, 2001).

The response of the test plants to salinity-drought stress was reflected also in an inhibited transpiration rate, which could be attributed to a reduction in leaf area (West *et al*., 1979) and/or to impairment of water uptake by roots (Hagemeyer and Waisel, 1989). Grain soaking presowing in any of the applied vitamins ameliorated these inhibitory effects on water uptake and on concomitant water loss *via* transpiration (Hamada, 1998).

Salinity-drought levels up to 160 mM NaCl and 30% field capacity with or without AsA or B_1 treatment were in this plant age (30 day-old), of stimulatory effects on the biosynthesis of photosynthetic pigments (calculated as mg g^{-1}dry matter) as well as on net photosynthetic rate (Fig. 3). In this respect, Rawson (1986) suggested that net photosynthetic rate was less sensitive to salinity than transpiration. Moreover, Choudhury *et al*. (1993) attributed positive effects of vitamins to stabilizing and protecting the photosynthetic pigments and photosynthetic apparatus from being oxidized.

Dark respiration was stimulated at all investigated salinity-drought levels, which could be responsible for the reduction of growth under stress conditions (Schwarz, 1985). The applied vitamins were generally effective in antagonizing partially or completely this stimulatory effects of salt-drought stress on dark respiration, which could be in concomitance with the improvement in growth criteria of the treated wheat seedlings.

From the preceding results and discussion, it can be concluded that grain soaking presowing in AsA or B_1 could alleviate the inhibitory effects of salt-drought stress in this plant age *via* enhancement of the photosynthetic rate and retardation of dark respiration, which consequently stimulate the plant growth.

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