Water relations responses to salinity during early vegetative stage in common bean (*Phaseolus vulgaris* L.)

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Physiological processes such as water status are highly sensitive to salinity and are, therefore, dominant in determining the plant's response to stress. Water stress induced by salinity may influence plant growth by adverse effects on dry matter partitioning, cell extension, cell division, leaf photosynthesis and/or transpiration (Munns, 2003). The objectives of this study was to understand the salt-stress-induced mechanisms, at the whole plant level, that cause growth reduction by analyzing how salinity affects plant water relations in *P. vulgaris*.

MATERIALS AND METHODS

Two wild (PI325687 and G11024) and two cultivated genotypes (G4017 and G21981) of common bean were used. Plants were grown in nutrient solution under greenhouse conditions at Universidad Michoacana de San Nicolás de Hidalgo, Mexico between May and August 2004. Seedlings were allowed to grow with no salinity stress until the emergence of the first trifoliate leaf, when several NaCl treatments were added to the solutions (0, 30, 60 and 90 mM). A randomized complete block design with a split-plot arrangement of salt treatments and four replications was used. Predawn water potential (Ψ_w) at 9, 14 and 19 days after transplanting was measured with a pressure chamber. Leaf solute potential (Ψ_π) was measured with a Wescor-5500 vapor pressure osmometer. Readings were converted to pressure units by using the van't Hoff equation. Turgor potential (Ψ_p) was determined using the relationship: $\Psi_p = \Psi_w - \Psi_\pi$. Plants were harvested at 10, 15 and 20 days after transplanting and separated into roots, stem and leaves. Data were analyzed using the GLM procedure (SAS Institute, Cary, NC, 1985). Four replicates per salinity treatment per species per harvesting date were used for growth analyses and water relations. Two-way analysis of variance was used to determine significant differences among accessions for various traits. Treatment means were compared using protected LSD test at $P \leq 0.05$.

RESULTS AND DISCUSSION

Salinity significantly affected leaf water, osmotic and water potentials (Fig. 1). Differences among cultivated and wild accessions were significant at any salt concentration, except for osmotic potential. Overall, wild accessions (PI325687, G11024) had less negative values of water potential at 0, 30 and 60 mM NaCl than cultivated accessions. At 90 mM NaCl cultivated G4017 and G21981 had significantly lower water potential than wild accessions. Osmotic potential was unaffected by increased salinity. Osmotic potentials of all accessions ranged between –0.82 to –1.24 MPa at the same salt concentration. Leaf turgor potential was unaffected by 30 and 60 mM NaCl, but was increased between 0.26 and 0.48 MPa at 90 mM NaCl. Leaf water potential (Ψ_w) gradually declined during the first 14 days after salinization (-0.47 to –0.78 MPa), thereafter, a steady state was attained, and except at 90 mM NaCl, which decreased Ψ_w further. Salinity also decreased leaf osmotic potential. This difference was reflected in average turgor potentials which increased at 90 mM NaCl. Water status is highly sensitive to salinity and is, therefore, dominant in determining the plant responses to stress. Our data indicate that the decrease in leaf osmotic potential always exceeded that of leaf water potential. As turgor potential was maintained or enhanced by salinity, osmotic adjustment was maintained. Although there is not a rigorous mechanistic analysis of salt tolerance in these species, it appears that salt tolerance in *P. vulgaris* is associated a better stomatal control through osmotic adjustment. This generalization appears to hold for *Phaseolus* species because of accumulation of high levels of inorganic ions, predominantly Cl^-, Na^+ and K^+ in their leaves (Bayuelo-Jiménez et al., 2003). In these leaves, the osmotic potential decreased as the concentration of total inorganic ions rose. However, higher inorganic ion concentrations could also lead to problems of ion compartmentation and a decline in leaf function.

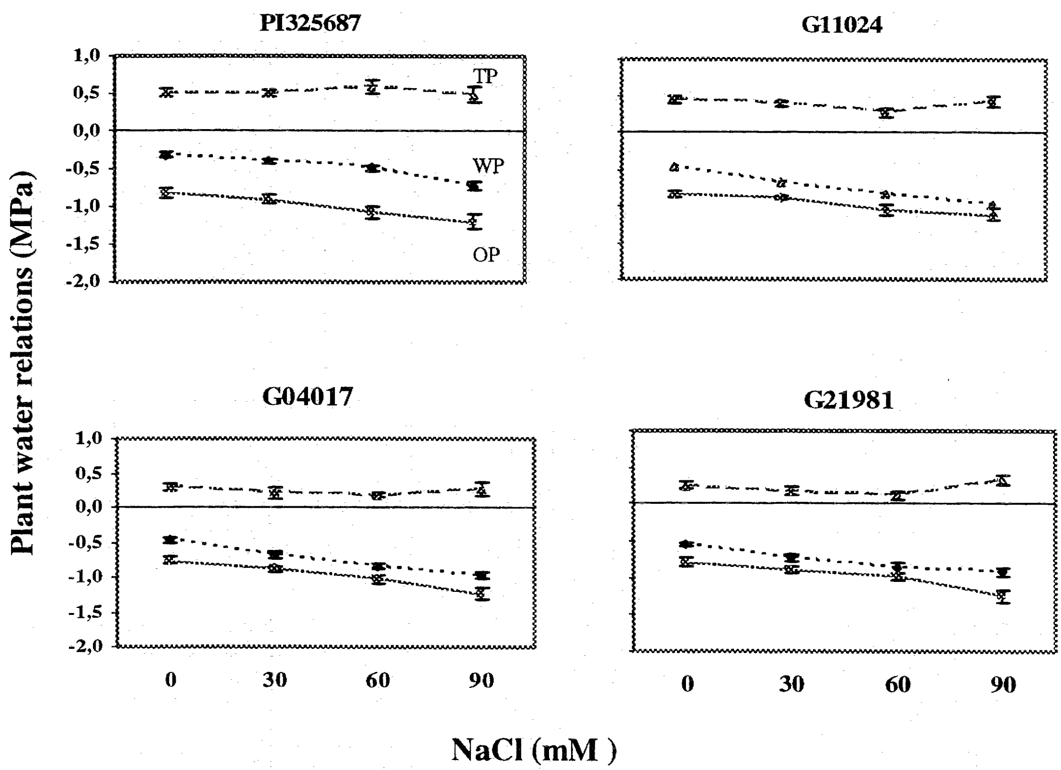

Fig. 1. Effects of increasing NaCl concentrations in the growth medium on leaf water potential: (.....) WP; osmotic potential, OP (—); turgor potential, TP (---) (in MPa) of *Phaseolus* species. Data correspond to the average of four measurements on different individual plants. Standard errors, when larger than symbols, are shown as vertical bars.

REFERENCES

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