Interaction of salinity and boron toxicity on ion relations, antioxidative system and soluble protein pattern of wheat leaves

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Background
Salinity and boron (B) toxicity stress often occur together. In the first phase of salinity, the reduced osmotic potential of the soil solution reduces the water availability for plants, while in the second phase, the accumulation of ions such as Na\(^+\), Cl\(^-\) or B to excess concentrations induces ion toxicities [1, 2]. Moreover, abiotic stress conditions cause the accumulation of reactive oxygen species (ROS) [3] which are strong oxidizing species that cause oxidative damage to membrane lipids and proteins [4]. Therefore, it is possible that higher apoplastic B concentrations affect apoplastic proteins and membrane functions, respectively.

Objectives
We designed the following objectives for our study:
1. To find out the affects of simultaneous occurrence of salt and high B stresses on subcellular distribution of different ions in wheat which may depend on overall B supply level.
2. To highlight that which stress factor pronounce more oxidative stress than the other under multiple stresses of salinity and B toxicity and to gain comprehensive view of all antioxidants with new assay.
3. To identify 2D gel apoplastic protein pattern under combined stresses through the changes in ion pattern.

Methodology
Wheat (Triticum aestivum L. cv. Thasos) plants were grown in nutrient solution for 6 weeks. Four treatments; control, 200 µM B, 75 mM NaCl and 200 µM B + 75 mM NaCl were applied after one week of plant cultivation. Apoplastic and symplastic fluids were collected through infiltration-centrifugation technique. Boron concentrations were measured spectrophotometrically according to a miniaturized curcumin method, while cations were measured by AAS and anions by ion chromatography. Antioxidant enzymes activities were quantified via luminescence assays, while apoplastic proteins were separated using two dimensional gel electrophoresis (2D-PAGE).

Results

Figure 1. Influence of salinity and B toxicity on (A) Na\(^+\) and (B) Cl\(^-\) concentrations in wheat leaves n=3

Figure 2. Influence of salinity and B toxicity on (A) subcellular B concentration and (B) whole leaf B concentration n=3

Figure 3. Percentage change in antioxidative activity of total antioxidant capacity (TAC), luminol converting peroxidase (LUPO), superoxide scavenging activity (SOSA), glutathione reductase (GR), and catalase (CAT) in wheat leaves as influenced by salinity and B toxicity compared to control n=4

Conclusion
At an adequate B supply, salt increases Na\(^+\), Cl\(^-\), soluble B concentrations and antioxidative activity of all enzymes, whereas additional high B reduces the Cl\(^-\) and soluble B concentrations and increases the low molecular weight total antioxidant capacity (TAC) and luminol converting peroxidase (LUPO). It is suggested that stress factor “salt” mainly produces more oxidative stress than that of stress factor “B”. Furthermore, we were able to present 2D gel apoplastic protein pattern through the changes in apoplastic ion pattern of wheat leaves.

References

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