Title
Salinity and boron interaction in wheat (Triticum aestivum L.)

Authors
Saqib, Muhammad, Dr.
Aftab, Muhammad
Sajjad, Sharif
et al.

Publication Date
2009-04-30

Peer reviewed

Introduction

Boron (B) is an essential element for higher plants with a narrow concentration range between deficiency and toxicity limits (1). B deficiency is a widespread agricultural problem (2) where as salinity, another common agricultural problem, aggravates B toxicity in plants. NaCl salinity increases B toxicity symptoms on plants and soluble B concentration in inter- and intracellular compartments in leaves (3). In many cases, salinity and high soil B occur together making the conditions more hostile for the plants e.g. the San Joaquin Valley, California.

Earlier it was believed that B transport in plants occurs passively as boric acid (4). However, recently it has been demonstrated in *Arabidopsis thaliana* that B translocation from root-to-shoot at the xylem-parenchyma level is through BOR1 transporter (5) and a posttranscriptional regulation of BOR1 exists to avoid accumulation of toxic levels of B in shoots under high-B supply while protecting the shoot from B deficiency under low B conditions (6). It has been suggested that endocytosis and degradation of BOR1 is regulated by B availability and BOR1 is transferred from the plasma membrane via the endosomes to the vacuole for degradation (6).

In addition to direct effects, salinity also strongly interferes with the uptake and metabolism of the mineral nutrients and, as seen from previous references, B is an important nutrient affected by salinity. This study investigates the interactive effects of boron toxicity and different salts including NaCl, Na_2SO_4 and $CaCl_2$.

Materials and Methods

This study was conducted in a wire house at the Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad, Pakistan. The wire house has glass roof with no control over temperature, humidity and light as the sides were open having only a wire net to control birds. Seeds of three wheat genotypes were collected from Saline Agriculture Research Centre, University of Agriculture, Faisalabad, Pakistan. This study comprised of three experiments. Boron treatment was developed by adding boric acid in each experiment where as salinity was developed by NaCl, Na_2SO_4 and $CaCl_2$ in experiment no. 1, 2 and 3, respectively. A detailed methodology on the germination of seeds and transplantation of the seedlings has been given in (7). Salinity and boron treatments were developed in the respective treatments in three equal installments, starting after two days of transplanting. The pH of the solution was monitored daily and adjusted at 6.0 ± 0.5, when needed. The substrate solutions were changed fortnightly. The experiments were harvested after 21 days of growth in the treatment solutions. Shoot and root growth parameters were noted at the time of harvest and ionic composition of the dry ashed samples was determined following referred analytical methods.

Results and Discussions

Salinity x boron significantly reduced shoot as well as root growth of wheat irrespective of the salt used to develop salinity. Table 1 to 3 show average values of fresh and dry weights of shoot and roots for three wheat genotypes. Addition of 2.5 mM boron alone also significantly reduced shoot and root fresh and dry weights except the shoot dry weight in case of Experiment 1. NaCl salinity (100 mM) significantly reduced shoot fresh and dry weights and root dry weight (Table 1). Na_2SO_4 (50 mM) significantly reduced shoot as well as root growth (Table 2) where as $CaCl_2$ salinity reduced shoot fresh and dry weights only (Table 3).

Sodium sulphate salinity alone and in combination with boron caused a higher percent reduction in shoot fresh and dry weights followed by sodium chloride and calcium chloride salinity. It shows a differential interaction of these salts with boron that may be due to their differential effect on the uptake of boron or vice versa. Earlier researchers have reported increased uptake of boron, Na^+ and Cl^- under salinity x boron treatment as compared to separate treatments of salinity and boron for cucumber (8) where as decreased for maize (9).

Table 1 Effect of NaCl and boron on shoot and root growth (g per plant) of wheat

Growth parameters	**Control**	**Salinity** (100 mM NaCl)	**Boron** (2.5 mM B)	**Salinity x Boron**
Shoot fresh weight	2.84 A	1.73 C (61)	2.12 BC (75)	0.88 D (31)
Shoot dry weight	0.331 AB	0.252 C (76)	0.281 BC (81)	0.155 D (47)
Root fresh weight	1.39 AB	1.19 BC	1.07 C	0.69 D
Root dry weight	0.215 A	0.163 B	0.13 C	0.064 D

Table 2 Effect of Na_2SO_4 and boron on shoot and root growth (g per plant) of wheat

Growth parameters	**Control**	**Salinity** (100 mM Na_2SO_4)	**Boron** (2.5 mM B)	**Salinity x Boron**
Shoot fresh weight	3.57 A	1.88 B (53)	2.07 B (58)	0.79 C (22)
Shoot dry weight	0.43 A	0.27 B (62)	0.28 B (64)	0.14 C (31)
Root fresh weight	1.89 A	1.22 B	1.04 B	0.49 C
Root dry weight	0.108 A	0.082 B	0.065 C	0.032 D

Table 3 Effect of $CaCl_2$ and boron on shoot and root growth (g per plant) of wheat

Growth parameters	**Control**	**Salinity** (50 mM $CaCl_2$)	**Boron** (2.5 mM B)	**Salinity x Boron**
Shoot fresh weight	2.66 A	1.61 B (61)	1.65 B (62)	1.10 C (42)
Shoot dry weight	0.33 A	0.25 B (76)	0.24 B (73)	0.20 B (62)
Root fresh weight	1.35 A	1.06 AB	0.87 BC	0.68 C
Root dry weight	0.083 A	0.075 A	0.059 B	0.053 B

References

1. Marschner H. (1995) Mineral Nutrition of Higher Plants, 2nd ed. (Acad. Press, San Diego, CA).
2. Shorrocks VM. (1997) Plant Soil 193: 121-148.
3. Wimmer MA. et al. (2003) Plant, Cell & Environ. 26: 1267-1274.
4. Brown PH. et al. (2002) Plant Biology 4: 205-223.
5. Takano J. et al. (2002) Nature 420: 337-340.
6. Takano J. et al. (2005) Proc. Nat. Acad. Sci. USA.
7. Saqib et al. (2005) Plant Sci. 169: 125-130.
8. Alpaslan and Gunes (2001) Plant and Soil 236: 123-128.
9. Martinez-Ballesta et al. (2008) Physiologia Plantarum ISSN 0031-9317.