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Optimizing Boron Seed Priming Treatments for Improving the Germination and Early Seedling Growth of Wheat

SABA IQBAL, MUHAMMAD FAROOQ[1], AHMED NAWAZ, ATIQUE-UR-REHMAN AND ABDUL REHMAN
Department of Agronomy, University of Agriculture, Faisalabad-38040, Pakistan
[1]Corresponding author's e-mail: farooqcp@gmail.com

ABSTRACT

Boron (B) plays important role in plant growth and development. This study was conducted to optimize the seed priming treatments, with B, in improving the germination and early seedling growth of wheat. Seeds of wheat cultivars Mairaj-2008 and Faisalabad-2008 were soaked in aerated B solution of various concentrations (0.001, 0.01 & 0.1% w/v) 12 h. Seeds soaked in aerated water for 12 h (hydropriming) and untreated dry seeds were taken as control. Wheat seeds primed in 0.001 and 0.01% B solutions decreased the time to 50% germination and mean germination time, however did not affect the final germination. Beyond this concentration, there was adverse effect on the germination and seedling growth of both wheat cultivars. Seed priming with 0.001% B also improved the root and shoot length and seedling dry weight. Wheat seeds may be primed with 0.001% B to have better and uniform stand and early seedling growth of wheat.

Key Words: Boron; Germination; Seed priming; Wheat; Seedling growth

INTRODUCTION

Boron (B) is one of the important essential mineral elements (Warington, 1923; Loomis & Durst, 1992), which regulates several vital physiological processes including cell division and elongation, carbohydrates metabolism, assimilate translocation and of cell wall development (Marschner, 1995; Siddiky *et al.,* 2007; Herrera-Rodriguez *et al.,* 2010). Boron also plays a key role in pollen germination, pollen tube growth, floret fertility and grain development (Marschner, 1995; Oosterhuis, 2001; Wang *et al.,* 2003).

Like other micronutrients, B fertilizer may be through foliar spray, fertigation, seed treatment and soil dressing. Although, each of the above methods of fertilizer application has its merits and de-merits, micronutrient application as seed treatments is gaining popularity in recent years (Farooq *et al*., 2012).

In seed priming, seeds are soaked in solutions of low water potential for a certain period of time seeds are then re-dried to permit routine handling (Farooq *et al*., 2006). Primed seeds show uniform and early germination and sometimes greater total germination percentage over a range of environmental conditions (Farooq *et al*., 2009). Improvement in germination followed by better stand establishment and grain yield are attributed to a buildup of germination-promoting metabolites (Farooq *et al*., 2006), osmotic adjustment (Bradford, 1986) and metabolic repair during imbibition (Burgass & Powell, 1984).

With the use of nutrient sources and commercial fertilizers as a priming, the positive effects of seed priming with an improved nutrient supply (Al-Mudaris & Jutzi, 1999; Farooq *et al*., 2012). However, the beneficial effects often depend on the nutrient concentration in the priming solutions. Previously, we have optimized the boron seed priming treatments for improving the germination and early seedling growth of rice (Farooq *et al*., 2011). However, B has rarely been tried as priming agent in wheat. This study was therefore conducted to optimize the seed priming treatments with B in improving the germination and early seedling growth of wheat.

MATERIALS AND METHODS

Seed materials: Seeds of wheat cultivars Mairaj 2008 and Faisalabad 2008, used in this study, were collected from Regional Agriculture Institute, Bahawalpur, Pakistan and Wheat Research institute, Ayub Agriculture Research Institute, Faisalabad, Pakistan, respectively.

Seed priming treatments: Seeds, of both wheat cultivars, were soaked in solutions of boric acid [0.1, 0.01 & 0.001% (w/v) boron]. Seeds soaked in aerated water and untreated seeds were taken as control. In both cases, soaking was done for 12 h in aerated solution (nutripriming) or water (hydropriming) keeping seed to solution ratio 1:5 (w/v). Aeration was provided by aquarium pump. After removing from the respective solution, seeds were thoroughly rinsed

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with water and dried in forced air under shade till original weight.

Experimental details: Treated and un-treated seeds of both wheat cultivars were sown between two layers of moist Whatman 42 filter paper in Petri plates (10 seed in each) placed at room temperature (20°C±3). Experiment was conducted in completely randomized design with factorial arrangement with five replications.

Measurements: Experiment was visited daily to record germination following Association of Official Seed Analysts (AOSA, 1990) until a constant count was achieved. Time to 50% germination (T_{50}) was calculated following Farooq *et al.* (2005). Mean germination time (MGT) was calculated following Ellis and Roberts (1981) and final germination count was expressed in percentage. After the constant count, plants were thinned to maintain 3 plants per Petri plate. Number of leaves counted daily, shoot and root lengths were measured with a ruler daily till the final harvest. The experiment was terminated 10 days after sowing and seedling dry weight was recorded after oven-drying the plant material.

Statistical analyses: Experimental data were analyzed statistically using statistical software MSTAT-C. Analysis of variance was used to test the significance of variance sources, while the difference among treatment means were compared using LSD test (p=0.05) (Steel *et al.*, 1996). Standard errors were computed by MS-Excel and data were presented graphically using the same program.

RESULTS

Seeds priming with B significantly affected the time to 50% germination (Fig. 1), mean germination time (Fig. 2) and final germination (Fig. 3) in both tested wheat cultivars. In both wheat cultivars, except for seed priming with 0.1% B, seed priming significantly decreased the time to 50% germination (Fig. 1) and mean germination time (Fig. 2). However, there was no difference amongst seed priming with 0.01 and 0.001% B and hydropriming for the time to 50% germination (Fig. 1). In cultivar Miaraj-2008, seed priming with 0.01 and 0.001% B had minimum mean germination time; however in cultivar Faisalabad-2008, minimum mean germination time was observed from seed priming with 0.001% B and hydropriming (Fig. 2). Although none of the seed priming treatments improved the final germination, seed priming with 0.1% B significantly decreased the germination in both wheat cultivars (Fig. 3).

In both tested cultivars, leaves emerged earlier from seeds primed with 0.001% B solution. In cultivar Mairaj-2008, more number of leaves was noted from seed priming with 0.001% B from start to end; however in cultivar Faisalabad-2008, initially number of leaves was more from seed priming with 0.001%, whereas at later stages more number of leaves were recorded from hydropriming (Fig. 4). In cultivar Mairaj-2008, initially more root length was recorded from seeds primed in 0.01 and 0.001% B solution,

Fig. 1: Influence of seed priming with boron on time to 50% germination of wheat cultivars Mairaj-2008 and Faisalabad-2008 ± S.E

(HP = Hydropriming; 0.1, 0.01, 0.001 = Seed priming in solution of respective percent solution of B)

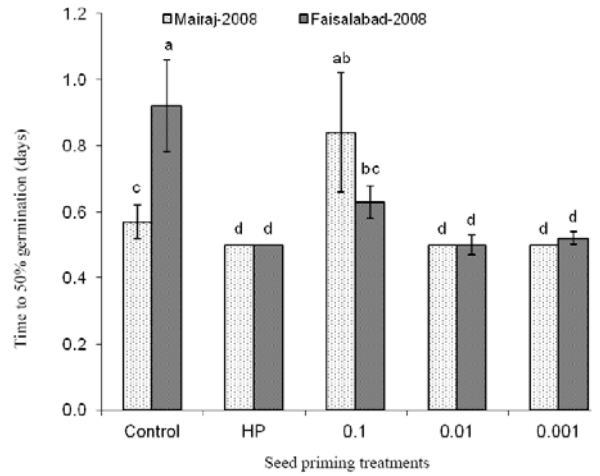
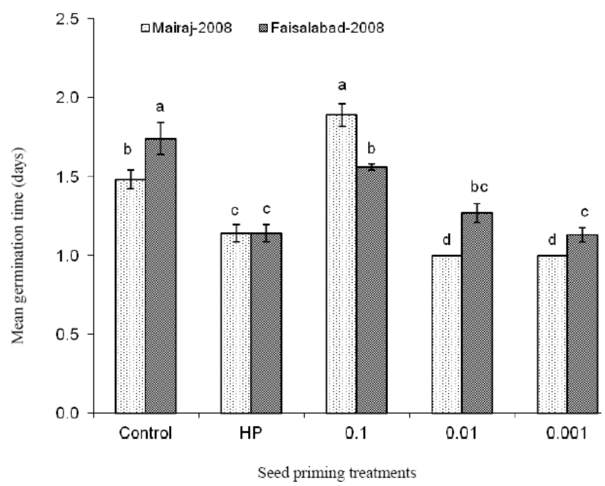


Fig. 2: Influence of seed priming with boron on mean germination time of wheat cultivars Mairaj-2008 and Faisalabad-2008 ± S.E

(HP = Hydropriming; 0.1, 0.01, 0.001 = Seed priming in solution of respective percent solution of B)



while at later stages; it didn't differ from untreated control. In cultivar Faisalabad-2008, seeds primed in 0.01 and 0.001% B solution had more root length than control from start to end. However, seed priming with 0.1% B decreased the root length in both cultivars (Fig. 5). For shoot length likewise, in cultivar Mairaj-2008 initially more shoot length was recorded in seeds primed with 0.001% B, whereas at the end shoot length was similar in all traetments except seeds primed in 0.1% B solution (Fig. 6). In cultivar Faisalabad-2008, however, initially more shoot length was recorded in hydroprimed seeds followed by seeds primed in 0.01 and 0.001% B solution while at later stages root length

Fig. 3: Influence of seed priming with boron on final germination of wheat cultivars Mairaj-2008 and Faisalabad-2008 ± S.E

(HP = Hydropriming; 0.1, 0.01, 0.001 = Seed priming in solution of respective percent solution of B)

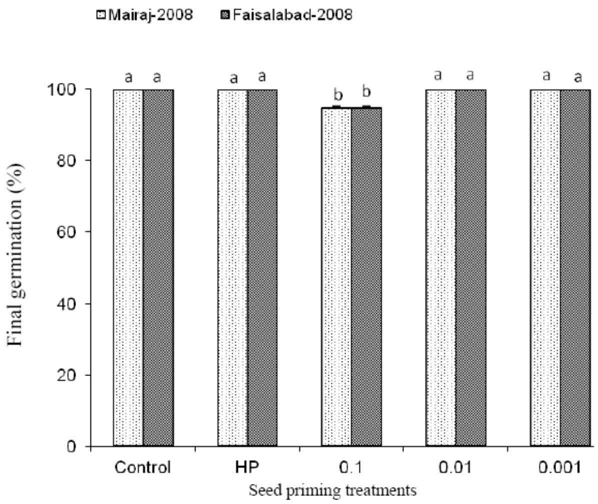


Fig. 4: Influence of seed priming with boron on number of leaves in wheat cultivars (a) Mairaj-2008 and (b) Faisalabad-2008 ± S.E

(HP = Hydropriming; 0.1, 0.01, 0.001 = Seed priming in solution of respective percent solution of B)

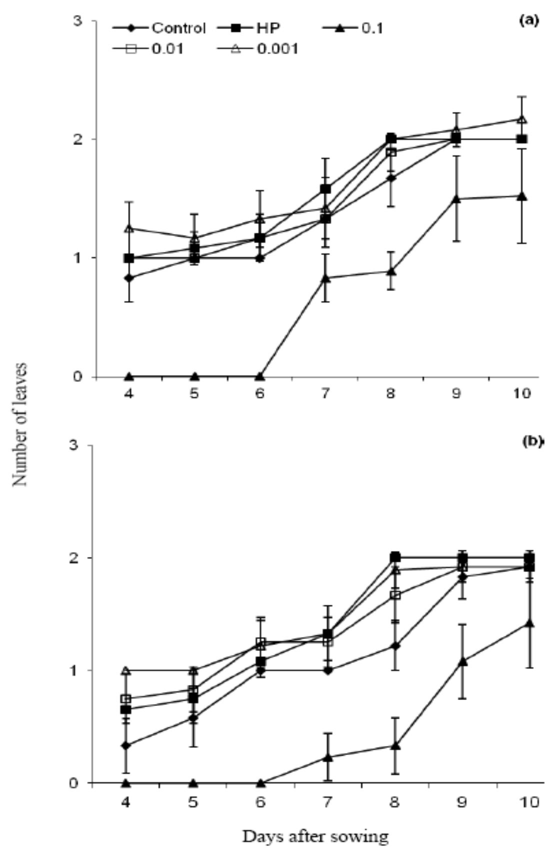
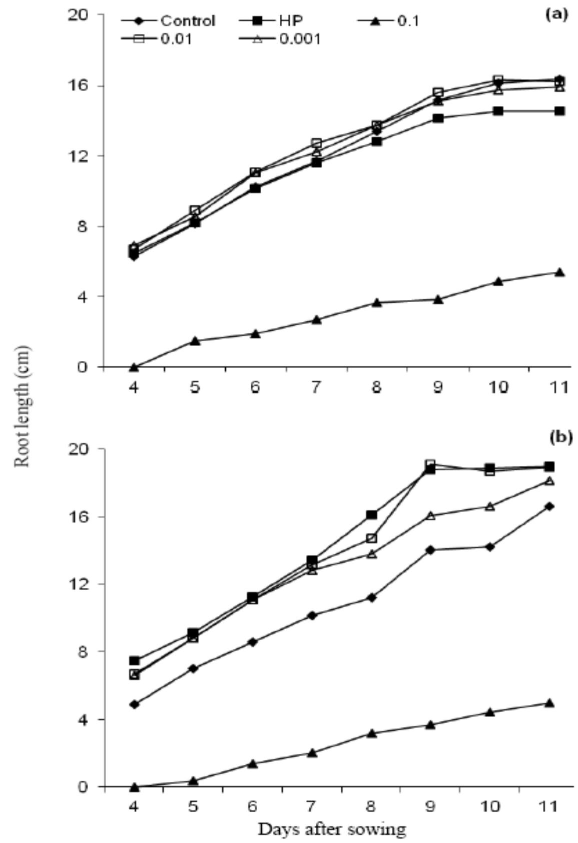


Fig. 5: Influence of seed priming with boron on root length in wheat cultivars (a) Mairaj-2008 and (b) Faisalabad-2008 ± S.E

(HP = Hydropriming; 0.1, 0.01, 0.001 = Seed priming in solution of respective percent solution of B)



was almost similar in all treatments except seeds primed in 0.1% B solution. In both cultivars, seed priming with 0.1% B decreased the shoot length (Fig. 6).

In both wheat cultivars, hydropriming and seed priming with 0.01 and 0.001% B significantly improved the seedling dry weight than untreated control, seed priming with 0.001% B being the best (Fig. 7). However, seed priming with 0.1% B significantly decreased the seedling dry weight than untreated control (Fig. 7).

DISCUSSION

This study reveals that B seed priming, particularly at lower concentrations, has significant potential to improve the stand establishment and early seedling growth of wheat. Seed priming in B solution of low concentration decreased the time to 50% germination (Fig. 1) and mean germination time (Fig. 2), which indicates the possible involvement of B in starch metabolism in very low amount. Both time to 50% germination and mean germination time are important indicator of seed vigor. Seed priming triggers the hydrolytic enzymes and altered the physiology of embryos, so that

Fig. 6: Influence of seed priming with boron on shoot length in wheat cultivars (a) Mairaj-2008 and (b) Faisalabad-2008 ± S.E

(HP = Hydropriming; 0.1, 0.01, 0.001 = Seed priming in solution of respective percent solution of B)

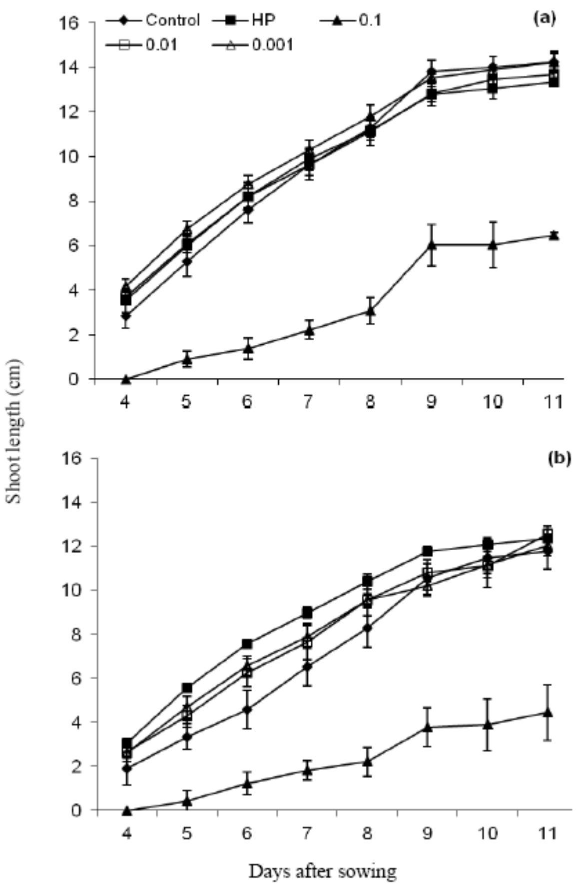
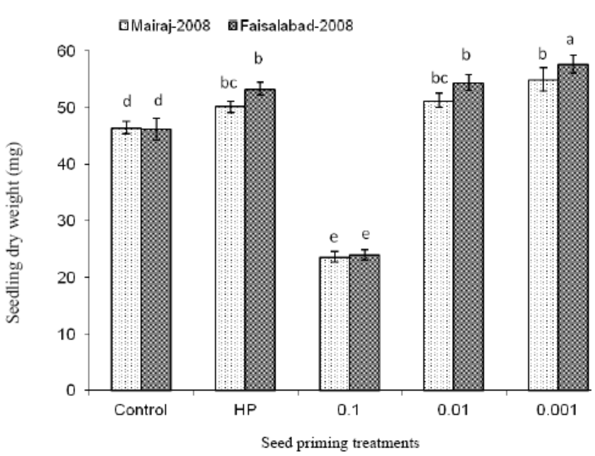


Fig. 7: Influence of seed priming with boron on seedling dry weight of wheat cultivars Mairaj-2008 and Faisalabad-2008 ± S.E

(HP = Hydropriming; 0.1, 0.01, 0.001 = Seed priming in solution of respective percent solution of B)



germination metabolism may take place rapidly than normal (Bam *et al*., 2006). However, priming with higher concentration of B was toxic for plant growth (Figs. 1-7).

Earlier start of leaf emergence (Fig. 4) from with seed priming with B at lower concentration might be the result of earlier start of emergence (Figs. 1 & 2). This also indicate the involvement of B in regulation of plant hormones, cell division and its essentiality for actively growing regions of plants such as root tips, new leaf and bud development (Bohnsack & Albert, 1977). The improvement of root and shoot lengths (Figs. 5 & 6) from seed priming with B indicates that B may be involved in the meristematic growth of radicle and plumule primodia (Bohnsack & Albert, 1977). Earlier start of germination (Figs. 1 & 2) and improvement in root and shoot length (Figs. 5 & 6) contributed for increase in seedling dry weight (Fig. 7) from seed priming with 0.001% B.

In conclusion, seed priming with 0.001% B improved the earliness and uniformity of germination, root and shoot length, and seedling dry weight. Primed wheat seeds with 0.001% B may be helpful to get better and uniform stand and early seedling growth.

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