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PLANT PHYSIOLOGY

Evaluating the Effects of Borax as Priming Agent on Germination and Seedling Parameter

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ABSTRACT

In agriculture, the seed is the most important and primary input, and it must be of excellent quality. One dependable and affordable method for improving seed germination and seedling establishment in crops is seed priming. This investigation was done to ascertain the results of seed priming with borax on seedling germination and growth in two wheat (*Triticum aestivum* L.) types i.e., HUW-468 and HUW510. The seeds used for experimentation were pre-soaked in different borax concentrations for seed treatment. The treatments included B1, B2, B3, B4, B5, and B6 (control, hydro-primed, seeds primed with 0.5, 1.0, 1.5, and 2.0 mM concentrations of borax, respectively) for variety HUW-468, and D1, D2, D3, D4, D5 and D6 (control, hydro-primed, seeds primed with 0.5, 1.0, 1.5, and 2.0 mM concentration of borax, respectively) for variety HUW-510. Parameters like germination percentage, radicle length, plumule length, seedling length, fresh and dry weights of radicle and plumule, and seedling vigor index I and II were observed and calculated 10 days after sowing. Among all the parameters, primed sets performed better, followed by hydro-primed and control. However, HUW-510 performed slightly better than variety HW-468 after nutripriming with borax salt.

HIGHLIGHTS

- Seed priming involves carefully hydrating seeds to a point where pre-germinative metabolic activity can take place.
- Seed priming boosts crop performance, increases potential yield, and makes seed germination easier, even in challenging circumstances.
- Boron promotes the growth and retention of flowers, the lengthening and germination of pollen tubes, and the development of seeds and fruits.
- Borax had a considerable impact on germination characteristics as a nutripriming agent.

Keywords: Borax, Germination, Priming, Seedling vigor index

Wheat is a significant cereal in developed and developing nations worldwide (*Triticum aestivum* L.). From sea level to an elevation of 3500 m in the Himalayas, it is grown across India. Establishing stands is crucial for maximizing any crop plant's field productivity. Poor seed germination and subsequent poor field establishment are frequent occurrences in environments with substandard circumstances. According to reports, one of the most significant barriers to high yield and crop plant development is the lack of synchronized crop establishment caused by unfavorable weather and soil conditions (Mwale *et al.* 2003). However, because of the lack of rainfall at the time of sowing, seeds are occasionally put in seedbeds with adverse moisture, which leads to poor and asynchronous seedling emergence (Angadi and Entz 2002). The germination and establishment of robust seedlings, which are necessary to provide a large yield, are greatly influenced by seed size. Cereal germination,

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in particular, tends to be erratic and can last for extended periods in drought-prone regions (Bougne *et al.* 2000). Some germination-related metabolic activities can take place without germination, thanks to priming. Seeds are immersed in various high osmotic potential solutions during priming. To coordinate emergence and shorten the interval between seed sowing and seedling emergence, seed priming has been frequently used (Sharma and Bose 2006).

The development of several seed priming methods, such as hydro-priming, halo-priming, osmo-priming, and hormone priming, had a favorable impact on seed germination and improved seed quality to produce a more robust and better crop stand (Chakraborty and Dwivedi 2021). Numerous variables, including plant species, priming media, concentration, length, temperature, and storage conditions, among others, have an impact on the improvement in seed quality brought on by priming. When properly prepared, seeds are more able to germinate and emerge because the inorganic salts increase the treated seed's germination and growth properties (Anaytullah and Bose 2012). Boron priming often enhances seedling germination and establishment (Chakraborty and Bose 2020). Taking into account the information above, this research experiment was conducted to determine the best borax concentrations in two different wheat varieties and the changes in the physiological and anatomical status of wheat seedlings as these developed in comparison to non-primed seeds.

MATERIALS AND METHODS

Study Area

The present study was conducted on wheat varieties HUW-468 and HUW-510 procured from the Department of Genetics and Plant Breeding, Institute of Agricultural Sciences, Banaras Hindu University, and an experiment was conducted on the lab of the Department of Plant Physiology of the same Institute.

Experimental Procedure and Treatments

Seeds were first sterilized with 0.1% $HgCl_2$ and then washed 2-3 times with running water. For priming purposes, seeds were immersed in different concentrations of borax salt, i.e., 2.0, 1.5, 1.0, and 0.5 mM represented as B6, B5, B4, and B3 for variety HUW-468 (V1), and D6, D5, D4 and D3 for variety HUW-510 (V2), respectively; whereas, B2 and B1 represented hydro-primed and control sets, respectively for variety HUW-468; D2 and D1 presented hydro-primed and control sets, respectively for variety HUW-510. After 12 hours of priming treatment, seeds were dried under a fan to bring them back to the initial dried stage and placed in Petri plates containing germination paper for the purpose of the study with the following parameters observed at 10 DAS.

Germination Percentage

Germination percentage calculated by the formula:

$$\text{Germination} = \text{number of seeds germinated} / \text{number of seeds present in Petri dish} \times 100\%$$

Plumule and Radicle Length (cm)

Plumule and radicle lengths of 10^{th} day's old seedlings were measured from the base to tip of both plumule and radicle of the germinated seedling using a scale, and obtained values were expressed in centimeters (cm).

Fresh Weights of Plumule and Radicle

Fresh weights of plumule and radicle were measured via a Sartorius BT-224S Electronic Balance, and measured values were expressed in mg g^{-1}.

Dry Weights of Plumule and Radicle

Freshly weighed samples were placed in envelopes, after which these were placed in a Hot Air Oven for one hour at 100°C, then the temperature was decreased to 65°C until constant weights of the samples could be achieved.

Seedling Vigour Index I and II

The seedling vigor index was calculated by using the formula:

$$\text{Seedling vigor I (SVI)} = (\text{Shoot length} + \text{Root length}) \times \text{Germination\%}.$$

$$\text{Seedling vigor II (SVII)} = \text{Germination\%} \times \text{Seedling dry weight}$$

Statistical Analysis

The experiment was laid down in a Completely

Randomized Design (CRD) with three replications. Data were analyzed using analysis of variance (ANOVA) using SPSS 26.0 for the windows software package.

RESULTS AND DISCUSSION

Seed invigoration techniques are pragmatic approaches to achieve the proper seedling stand establishment and improving seed quality. Seed priming has been commonly used to reduce the time between the seed sowing and the seedling's appearance (Bose *et al.* 2018). Table 1 presented seedling growth and germination parameters related to variety HUW-468 (V1), whereas Table 2 showed data regarding variety HUW-510 (V2) at 10 DAS. Germination percentage (G%) is the most crucial trait that reveals the germination capacity; in Table 1, D6 showed the best germination percentage, followed by D3, D5, D4, D2 and D1, whereas in Table 2, B6 has more germination percentage among all other treatments. Overall for both the varieties V1 and V2, primed sets performed better than the non-primed ones. This study matches the work of Kumar *et al.* (2016). D6 and B6 had the highest plumule and radicle length for both the varieties HUW-468 and HUW-510. D6 and B6 showed the best result for fresh weights of plumules for both the varieties V1 and V2; whereas in the case of fresh weights of radicles, for variety V1, B6 performed better, but for variety V2, D4 performed better than the other treatments. In terms of dry weights of plumules, B4 and D6 showed highest result for varieties V1

Table 1: Effect of seed priming with different concentrations of borax salt on germination percentage and seedling growth parameters of wheat variety HUW-468 at 10 DAS

Treatments	Germination Percentage (%)	Plumule Length (cm)	Radicle Length (cm)	Fresh weight of Plumule (mg)	Fresh weight of Radicle (mg)	Dry weight of Plumule (mg)	Dry weight of Radicle (mg)	Seedling Vigour Index I	Seedling Vigour Index II
B1	93.33	7.18	8.26	46.54	43.44	6.54	4.15	1,441.07	997.407
B2	94.67	7.33	8.86	49.29	45.25	6.74	4.27	1,532.96	1,042.91
B3	95.33	8.25	9.14	51.46	49.35	6.85	4.56	1,657.53	1,088.06
B4	96.00	8.44	9.44	53.66	47.26	7.36	5.34	1,717.12	1,208.00
B5	95.67	8.67	9.25	56.58	50.28	6.97	5.44	1,714.66	1,118.66
B6	97.33	8.82	9.75	58.33	52.38	7.25	5.42	1,807.47	1,246.18
C.D.	0.95	0.03	0.03	0.20	0.04	0.04	0.03	14.76	8.92
±SE(m)	0.30	0.01	0.01	0.07	0.01	0.01	0.01	4.73	2.86

Data presented are means from four replicates with standard errors. Where: B1, B2, B3, B4, B5 and B6 represented non-primed (control), hydro-primed, seeds primed with 0.5, 1.0, 1.5, and 2.0mM concentration of borax, respectively.

Table 2: Effect of seed priming with different concentrations of borax salt on germination percentage and seedling growth parameters of wheat variety HUW-510 at 10 DAS

Treatments	Germination Percentage (%)	Plumule Length (cm)	Radicle Length (cm)	Fresh weight of Plumule (mg)	Fresh weight of Radicle (mg)	Dry weight of Plumule (mg)	Dry weight of Radicle (mg)	Seedling Vigour Index I	Seedling Vigour Index II
D1	94.33	7.94	8.58	48.36	44.18	6.88	4.66	1,558.39	1,092.71
D2	95.33	8.05	8.72	52.56	48.37	7.18	4.92	1,599.04	1,153.53
D3	97.00	8.56	9.33	55.77	53.45	7.55	5.13	1,735.65	1,229.94
D4	96.33	8.47	10.33	54.24	56.42	7.76	5.43	1,810.43	1,270.62
D5	96.67	8.74	10.57	57.78	55.63	7.62	5.63	1,866.63	1,253.13
D6	97.67	8.96	10.76	59.62	56.17	7.84	5.61	1,925.33	1,315.57
C.D.	1.19	0.04	0.03	0.09	0.07	0.04	0.03	21.41	13.54
±SE(m)	0.38	0.01	0.01	0.03	0.02	0.01	0.01	6.87	4.34

Data presented are means from four replicates with standard errors. Where: D1, D2, D3, D4, D5 and D6 represented non-primed (control), hydro-primed, seeds primed with 0.5, 1.0, 1.5, and 2.0 mM concentration of borax.

and V2, respectively. B5 and D5 recorded maximum weights for dry weights of radicles for both varieties. The quality of the seed was significantly impacted by different pre-sowing seed priming treatments in terms of seed germination, plumule and radicle lengths, and fresh and dry weights of seedlings. Similar findings were found by Harris *et al*. (2001), Farooq *et al.* (2006), Tian *et al*. (2014), Giri *et al*. (2003), and Toklu *et al*. (2015). In case of seedling vigor index I and II, B6 and D6 performed better for varieties V1 and V2, respectively. Seedling vigor (SV) is one of the decisive parameters that direct seedling establishment and its further growth towards progressive development. These results are in accordance with the findings of Basra *et al.* (2005), and Dezfuli *et al*. (2008).The influence of seed priming on germination and crop development rate has been the subject of numerous studies. Seed germination and seedling emergence can be greatly accelerated if this time is reduced. The simplest way to do this is to hydro-prime (i.e., soak the seeds in water before planting) the seeds; whereas if salts of macro or micro-nutrients were dissolved in this pre-soaking solution and then seeds were dipped into it, it was known as halo-priming; if the seeds were immersed in hormonal solutions then, it was termed as hormonal priming. Similarly, if the immersing media were osmoticums then they were known as osmo-priming. The use of potassium hydro phosphates (KH_2PO_4) as the osmoticum has demonstrated good potential to improve wheat germination, emergence, growth, and grain production (Misra and Dwivedi 1980). Gibberellic acid (GA_3), the most crucial growth regulator required for seed germination, mobilization of food in seed storage cells, cell elongation, the permeability of cell membrane, apical bud dormancy, blooming, and fruiting growth, was used by several research workers to prime the seeds (Ajirloo *et al.* 2013). Similarly, seeds primed with salts of boron have also been shown to enhance seed germination, seedling growth and establishment, and uniform and maximum seed emergence with the highest number of healthy and vigorous seedlings stand (Chakraborty and Bose 2020; Rehman *et al.* 2012; Iqbal *et al.* 2017; Rehman *et al.* 2022).

CONCLUSION

A study based on the lab experimentation conducted for 10 days concludes that priming with either of the boron salts improved seed germination and early seedling establishment in wheat varieties HUW-468 and HUW-510. For variety V1, overall B6 performed better except for parameters dry weight of plumule and radicle where B4 and B5 performed better for variety V1 and V2, respectively; whereas, for variety V2, D6 showed the highest result for maximum studied parameters except fresh and dry weights of radicles where D4 and D5 recorded best result for variety V1 and V2, respectively. Seed priming treatments improved the seed germination parameters, seedling vigor, and seedling growth in terms of plumule and radicle lengths, fresh and dry weights of plumules and radicles, etc. Studies showed that nutripriming with micro-nutrient boron helps in early emergence, vigorous growth and better seedling establishment compared to non-primed and hydro-primed seeds.

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