



Boron Seed Priming Impacts on Germination Percentage and Seed Boron Content under Controlled Conditions

Ayushi Singh, Pardeep Kumar*, Nagender Pal Butail, Himshikha and Pratibha Thakur

Department of Soil Science, CSK Himachal Pradesh Agriculture University, Palampur-176 062, India
E-mail: drpardeep1968@gmail.com

Abstract: Okra, a crop with high boron (B) demand, faces low germination due to hard seed coat, limiting yield potential. This study evaluated the impact of B seed priming on the germination percentage and seed B content of okra under controlled conditions. Seeds were primed with graded B concentrations (1.0%, 0.5%, 0.1%, 0.05%, and 0.01%) and hydroprimed (distilled water) for three durations (12, 24, and 36 hours). B seed priming significantly enhanced germination and seed B content, except at higher B concentrations, where toxicity inhibited germination. The highest germination percentage (96.7%) was achieved with 0.05% B for 24 hours, aligning with the calculated optimum concentration of 0.048% B. Longer durations (36 hours) resulted in higher B content (up to 787.9 mg kg⁻¹ with 0.1% B), germination percentage declined due to toxicity. These findings highlight the potential of B seed priming at optimal concentrations to address B deficiencies and improve okra germination, particularly in B-deficient soils.

Keywords: Germination percentage, Nutrient seed priming, Seed B content

Okra (*Abelmoschus esculentus* (L.) Moench) crop thrives well in tropical, subtropical, and warm temperate regions (Singh et al., 2014). The crop recognized for its nutritional value and culinary purpose has annual production of around 9.96 million tons (FAOSTAT 2020). However, its hard seed coat leads to low germination, hindering the crop from reaching its full yield potential. Seed priming is a cost-effective method for even uniform germination, fast emergence, and improved seedling vigour (Mondal and Bose 2019) leading to enhanced yields under stressed environments (Singh et al., 2015). Nutrient priming is a distinctive technique employed under nutrient-stressed conditions to improve germination rates and provide an initial boost to crops facing specific nutrient deficiencies.

Globally, major nutrients are commonly applied for crop production in fertilizer form, while the use of other nutrients is often overlooked, leading to widespread multi-nutrient deficiencies. Among micronutrients, B is the most deficient nutrient not only in India but throughout the world. B plays indispensable role in plants for translocation of sugars, synthesis of nucleic acid, carbohydrate and nutrient metabolism, cell division and disease resistance (Shireen et al., 2018). Furthermore, B stimulates seed germination and seedling emergence (Iqbal et al., 2017), suggesting that nutrient priming with B in okra seeds could address the issue of low germination. To evaluate this premise, an experiment was conducted to assess the impact of graded doses and durations of B seed priming on okra germination and nutrient content.

MATERIAL AND METHODS

Seed priming: Experiment was conducted on okra var.

Palam Komal in the laboratory of Soil Science Department of CSKHPKV, Palampur during 2021. Initially the moisture content was determined by grinding the seeds, drying at 130°C for 4 hours and was 9.8% on a fresh weight basis. For priming, the okra seeds were soaked in boric acid concentrations (1.0, 0.5, 0.1, 0.05, and 0.01%), and hydro-priming (distilled water) for 12, 24 and 36 hours duration, respectively. The hydro-priming treatment, containing 0% boric acid, served as the control. After completion of priming, the treated seeds were washed with distilled water and air-dried back to their original moisture content.

Germination and seed B content: Ten seeds were arranged in each petri plate on moist seed germination paper arranged according to completely randomized design with three replications. Water was uniformly applied using a pipette to avoid non uniformity among the treatments in terms of moisture. The seeds were incubated at 25 ± 2°C up to 8 days. Seed was considered germinated when the radical pierced the coats up to 2 mm.

Okra seeds with and without priming were analyzed for their B content taking 1g oven dried (at 60°C) and crushed seeds using Azomethine-H method as outlined by Datta et al. (1998).

Statistical analysis: The laboratory data were analyzed statistically using analysis of variance (ANOVA) for a factorial completely randomized design.

RESULTS AND DISCUSSION

Germination percentage: Seed priming with different B concentrations significantly impacted the germination percentage, that varied between 8.9 and 90%. Among the

treatments, 0.05% B priming exhibited the highest germination percentage, significantly outperforming all other treatments. This was followed by 0.01% B, which also showed a significant improvement over the hydropriming treatments. Hydropriming resulted in moderate germination, statistically comparable to 0.1% B, but significantly lower than 0.05% B and 0.01% B. Conversely, higher concentrations of B (0.5% and 1.0%) led to a significant decline in germination, with 1.0% B showing the lowest. No significant differences were observed among the overall means, indicating that the duration of priming did not significantly influence germination percentage when averaged across all concentrations.

The metabolic processes involved in early phases of germination are stimulated by seed priming, resulting in faster and more uniform germination in B-primed seeds (Iqbal et al., 2017). The role of seed priming in enhancing germination percentages has been well-documented in various crops. Studies by Keshavarz et al. (2011), Noor-un-Nisa et al. (2013), and Geetha et al. (2018) provide evidence of the effectiveness of seed priming in improving germination and early seedling vigour, supporting the findings of the present study. Furthermore, low germination percentages at

higher levels of B seed priming may be attributed to its toxicity, arising from the narrow range between optimal and toxic levels of B.

Seed B content: The significant variation in the seed B content at varying levels was observed, ranging between 38.5 and 643.4 mg kg⁻¹ (Table 2) with different priming concentrations and durations. Hydropriming (0% B) resulted in the lowest seed B content across all durations. Among the B treatments, 0.1% B consistently produced the highest seed B content, significantly outperforming all other concentrations. This was particularly evident at the 36-hour duration, which showed the highest B content overall. At 0.05% B, seed B content was significantly higher than 0.01% B and hydropriming, with 36-hour duration, yielding better results compared to shorter durations. However, at higher concentrations (0.5% and 1.0% B), B content decreased due to potential toxicity, although it remained significantly higher than hydropriming. When comparing durations, the 36-hour priming consistently led to the highest seed B content across most treatments, followed by 24 and 12 hours. The increase in seed B content resulted in increased germination of soybean (Cirak et al., 2006). However, the positive relationship between seed B content and germination existed

Table 1. Effect of priming concentrations and durations on the germination percentage

Treatments	Priming duration (hour)			Mean
	12	24	36	
0 % B (Hydropriming)	70.0 ^f	76.7 ^{ef}	83.3 ^{ode}	76.7 ^C
0.01 % B	76.7 ^{ef}	86.7 ^{bcd}	90.0 ^{abc}	84.4 ^B
0.05 % B	80.0 ^{de}	96.7 ^a	93.3 ^{ab}	90.0 ^A
0.1 % B	70.0 ^f	80.0 ^{de}	76.7 ^{ef}	75.6 ^C
0.5 % B	30.0 ^g	20.0 ^h	0.0 ^j	16.7 ^D
1.0 % B	20.0 ^h	6.7 ⁱ	0.0 ^j	8.9 ^E
Mean	57.8 ^{ns}	61.1 ^{ns}	57.2 ^{ns}	

Note: Values followed by different lowercase letters across durations indicate significant differences, while different uppercase letters represent significant differences in the respective means. "ns" denotes non-significant differences within the means

Table 2. Effect of priming concentrations and durations on seed B content (mg kg⁻¹)

Treatments	Priming duration (hour)			Mean
	12	24	36	
0 % B (Hydropriming)	39.3 ^j	40.0 ^j	40.5 ^j	39.9 ^F
0.01 % B	120.5 ^k	142.5 ^k	227.0 ^j	163.3 ^E
0.05 % B	349.5 ⁱ	493.9 ^e	652.7 ^b	498.7 ^B
0.1 % B	530.9 ^d	611.4 ^c	787.9 ^a	643.4 ^A
0.5 % B	514.0 ^e	466.8 ^f	407.9 ^h	462.9 ^C
1.0 % B	494.5 ^e	436.6 ^g	353.8 ⁱ	428.3 ^D
Mean	341.4 ^C	365.2 ^B	411.6 ^A	

Note: Values followed by different lowercase letters across durations indicate significant differences, while different uppercase letters represent significant differences in the respective means

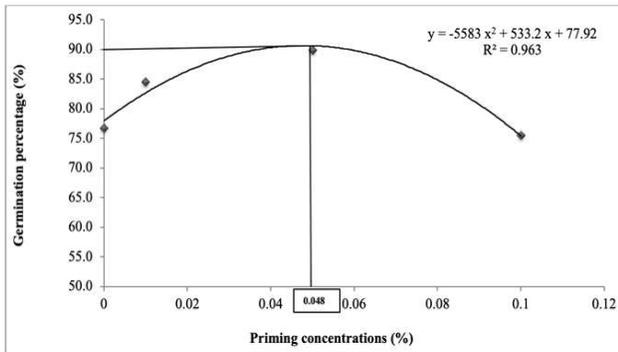


Fig. 1. Optimum priming concentration under controlled conditions

up to a certain B level, emphasising an optimal B content for priming the seeds. Contrarily, the evident decline in seed germination at high B priming concentration may be due to higher accumulation in the seed leading to toxicity. Khan et al. (2006) suggested that very little quantity of B is needed to regulate the meristematic growth, therefore, excessive B becomes toxic which impedes the normal growth (Bonilla et al., 2004). High B concentration was reported to decrease the germination percentage and germination rate of wheat (Ashagre et al., 2014). Thus, underlining the necessity of an optimum seed priming concentration for B due to a narrow range of deficiency and toxicity.

Optimum B priming concentration under laboratory conditions: The quadratic curve was obtained with R^2 value of 0.963 which was higher compared to the linear model. The equation generated was subjected to the first derivative and then equated to zero (Fig. 1). The optimum concentration of B required for attaining the maximum germination of okra was B @ 0.048% under controlled conditions

CONCLUSIONS

B priming at optimal concentrations significantly enhanced seed germination and B content, with the highest germination percentage observed at 0.05% B for 24 hours. However, higher concentrations led to toxicity, underscoring the narrow margin between deficiency and toxicity. The optimal concentration for maximum germination was determined to be 0.048% B. Additionally, longer priming durations (36 hours) resulted in higher seed B content, highlighting the efficacy of B priming in addressing B deficiencies in okra. Future field studies are essential to validate these findings and explore their

practical applicability in diverse agro-ecological conditions.

REFERENCES

- Ashagre H, Ibrahim HA, Fita U and Nedesa W 2014. Influence of boron on seed germination and seedling growth of wheat (*Triticum aestivum* L.). *African Journal of Plant Science* **8**(2): 133-139.
- Bonilla I, El-Hamdaoui A and Bolaños L 2004. Boron and calcium increase *Pisum sativum* seed germination and seedling development under salt stress. *Plant and Soil* **267**(1): 97-107
- Cirak C, Odabas MS, Kevseroglu K, Karaca E and Gulumser A 2006. Response of soybean (*Glycine max*) to soil and foliar applied boron at different rates. *Indian Journal of Agricultural Sciences* **76**(10): 603-606.
- Datta SP, Bhadoria PBS and Kar S 1998. Availability of extractable boron in some acid soils, West Bengal, India. *Communications in Soil Science and Plant Analysis* **29**: 2285-306.
- FAOSTAT 2020. *Food and Agricultural Organization Statistics*. <https://www.fao.org/faostat/en/#data/QCL> (assessed September 2020).
- Geetha KN, Goudar KM, Lingaraju N, Raddy R and Shankar AG 2018. Seed priming with nano boron nitride increases the performance of sunflower (*Helianthus annuus* L.) seedlings. *International Journal of Current Microbiology and Applied Sciences* **7**(11): 503-508.
- Iqbal S, Farooq M, Cheema SA and Afzal I 2017. Boron seed priming improves the seedling emergence, growth, grain yield and grain biofortification of bread wheat. *International Journal of Agriculture and Biology* **19**(1): 177-182.
- Keshavarz K, Vahdati K, Samar M, Azadegan B and Brown PH 2011. Foliar application of zinc and boron improves walnut vegetative and reproductive growth. *Hort Technology* **21**(2): 181-6
- Khan RA, Gurmani AH, Gurmani AR and Zia MS 2006. Effect of boron application on rice yield under wheat rice system. *International Journal of Agriculture and Biology* **8**(6): 805-808.
- Mondal S and Bose B 2019. Impact of micronutrient seed priming on germination, growth, development, nutritional status and yield aspects of plants. *Journal of Plant Nutrition* **42**(19): 2577-2599.
- Noor-un-Nisa M, Gandahi MB, Pahoja VM and Nasim S 2013. Response of seed priming with boron on germination and seedling sprouts of broccoli. *International Journal of Agricultural Science and Research (IJASR)* **3**(2): 183-194.
- Rerkasem B, Bell RW, Lodkaew S and Loneragan JF 1997. Relationship of seed boron concentration to germination and growth of soybean (*Glycine max*). *Nutrient Cycling in Agroecosystems* **48**(3): 217-223.
- Shireen F, Nawaz MA, Chen C, Zhang Q, Zheng Z, Sohail H, Sun J, Cao H, Huang Y and Bie Z 2019. Boron: Functions and approaches to enhance its availability in plants for sustainable agriculture. *International Journal of Molecular Science*. **19**(7): 1856.
- Singh H, Jassal RK, Kang JS, Sandhu S, Kang H, Grewal K 2015. Seed priming techniques in field crops: A review. *Agricultural Reviews* **36**(4): 251-264.
- Singh P, Chauhan V, Tiwari B K, Chauhan S, Simon S, Bilal S and Abidi A B 2014. An overview on okra (*Abelmoschus esculentus*) and it's importance as a nutritive vegetable in the world. *International Journal of Pharmacy and Biological Sciences* **4**(2): 227-233.