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*Research Article*

# Standardization of Concentration and Duration of Nutripriming with Boric Acid for Seed Quality Enhancement in Blackgram

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**ABSTRACT**

*The present investigation was carried out to optimize the concentration and duration of nutripriming with boric acid for seed quality enhancement in the blackgram variety, Tulasi. The experiment was conducted in the Department of Seed Science and Technology, Advanced Post Graduate Centre, Lam, Guntur, during 2019-20 using Factorial Completely Randomized Design (FCRD) with four replications. Seeds were subjected to nutripriming with various concentrations (0, 0.01, 0.05, 0.1 and 0.5 %) of boric acid for different durations (0, 2, 4, 6 and 8 h). Primed and unprimed blackgram seed were tested for germination and seedling growth using the between-paper method. Analysis of variance of the results showed that nutripriming with boric acid was quite effective in improving Tulasi seed quality. Among all the concentrations, 0.1 % boric acid was found effective in recording the highest germination (%), seedling length (cm) and seedling vigour index. Irrespective of concentration, priming for 6 h showed maximum improvement in all the seed quality parameters. Nutripriming with 0.1% boric acid for 6 h resulted in better enhancement of germination and seedling quality parameters in blackgram.*

***Keywords:*** *Blackgram, Germination, Nutripriming, Seedling length, Seedling vigour index, boric acid.*

## INTRODUCTION

Blackgram is an important short duration pulse crop. It is one of the richest source of protein (25-28%). There are various reasons for the low production of crops, such as susceptibility to biotic and abiotic stresses, and growing on marginal areas of farming. So, it is necessary to augment blackgram production by adopting improved management techniques.

Seed germination is a key step in crop growth and development. This is constrained by several factors, such as biotic and abiotic stresses, which lead to poor crop stand and yield losses.

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Seed priming emerged as a potential technique to improve seed performance under stress conditions or in freshly or aged seeds that might fail to germinate. Apart from soaking in water alone, soaking seeds in a micronutrient solution (nutripriming) at a specific concentration for a specific duration helps provide the deficit micronutrients at the early stages of the crop to attain uniform germination and vigour. Seed priming and treatment with micronutrients have the potential to meet crop micronutrient demand, improve seedling emergence and stand establishment, enhance grain micronutrient enrichment, and improve yield (Mukherjee & Bordolui, 2022).

Boron plays a crucial role in mobilizing the seed nutrients from the source to the sink during seed germination. It controls dormancy the same as $GA_3$. Boron plays a key role in the translocation of metabolites from source to sink, flower retention, pollen tube development, seed formation and setting (Tanaka & Fuiwar, 2008) and boric acid equivalent to 86.48 mg l-1 of boron in boric acid solution can improve the germination process of wheat variety via facilitating the solubilization and mobilization of sugar in endosperm which may be due to the presence of micronutrient boron (Chakraborty et al., 2023). It is actively associated with processes of calcium utilization, cell division, flowering, fruiting, carbohydrate and nitrogen metabolism, increases the rate of respiration, disease resistance and acts as a catalyst for several processes. It is the second most micronutrient deficiency problem after zinc. Deficiency of boron leads to shortened internodes, heart rot, hollow heart, flower and fruit drop. With this background, the present investigation aimed to determine the optimum concentration of boric acid and duration of priming to improve germination and seedling vigour in the blackgram variety, Tulasi.

## MATERIAL AND METHODS

The present laboratory experiment was conducted in the Department of Seed Science and Technology, Advanced Post Graduate Centre, Lam, Guntur, Andhra Pradesh, India, during 2019-20. The experiment was laid out in a Factorial Completely Randomized Design (FCRD) with four replications. The seed of blackgram variety, Tulasi (LBG-787), were soaked in either water (hydropriming – without boric acid) or various concentrations (0.01, 0.05, 0.1 and 0.5 %) of boric acid solution for different durations (2, 4, 6 and 8 h) by maintaining the seed to solution ratio of 1:2 (w/v). After priming, seeds were thoroughly washed with distilled water and dried to a safe moisture content (9 %) in the shade. Seeds with an initial germination of 82.75 %, a seedling length of 21.38 cm and a seedling vigour index of 1770 served as the control. Four replicates of 100 seeds from each treatment were kept for the germination test by the between-paper method. After 7 days of the test period, observations were recorded on the following parameters as per the details mentioned below:

**Germination (%):** The normal seedlings were counted and expressed as germination (%) as per the following formula:

$$\text{Germination (\%)} = \frac{\text{Number of normal seedlings}}{\text{Total number of seed sown}} \times 100$$

**Seedling Length (cm):** The total distance from the tip of the primary leaf to the root tip of ten randomly selected seedlings from each replication of each treatment was measured with a scale, and their mean was expressed as seedling length in centimetres.

**Seedling Vigour Index:** It was computed using the following formula, as suggested by Abdul-Baki and Anderson (1973), and expressed as a whole number.

Seedling Vigor Index = Germination (%) × [Mean root length × mean shoot length (cm)]

The data were analyzed using SPSS (version 16.0) software after subjecting the obtained data to appropriate transformations. The differences among the means of concentrations of micronutrient and duration of priming were compared by using Duncan's multiple range test at the 5% level of probability.

## RESULTS AND DISCUSSION

### Nutripriming with Boric acid

Analysis of variance (Table 1) of the results revealed that nutripriming with boric acid at different concentrations and durations, and their interaction, showed highly significant variation for all the seed quality parameters, *viz.*, germination (%), seedling length (cm), and seedling vigour index.

**Germination (%):** Nutripriming with boric acid significantly improved the mean germination of blackgram variety, Tulasi, with increase in concentration from 0% (83.90 %) to 0.1 % (87.95 %) and thereafter decreased with further increase in concentration up to 0.5% (85.00 %) (Table.2). Nutripriming with 0.1 % boric acid improved the mean by 6.28 % over control (Fig.1).

Duration of priming had a significant effect on germination in the blackgram variety, Tulasi. Nutripriming for 6 h recorded the highest mean germination (87.95 %), whereas unprimed seed showed the lowest mean germination (82.90 %). Further increase in duration of seed priming up to 8 h (86.30 %) caused a significant decline in mean germination (Table 2). The increment in mean germination for 6 h of priming over the control was 6.28 % (Fig.2).

The highest germination (92.00 %) was observed with seed priming in 0.1 % boric acid for 6 h, whereas the lowest germination (82.75%) was recorded with unprimed seed. The grand mean germination was 85.58 % (Table 2).

Mondal et al. (2018) reported that seed priming with 4 mM boric acid for 18 h resulted in higher germination in lentil. Iqbal et al. (2017) stated that seed priming with 0.01 M and 0.05 M boric acid for 12 h resulted in the highest germination. Further increase in concentration reduced the germination in wheat. Similar findings were observed in broccoli (Memon et al., 2013), papaya (Deb et al., 2010) and stevia (Shahverdi et al., 2017), 8 mM concentration of boric acid equivalent to 86.48 mg l-1 of boron in boric acid solution can improve the germination process of wheat variety via facilitating the solubilization and mobilization of sugar in endosperm which may be due to the presence of micronutrient boron (Chakraborty et al., 2023) and among all the priming treatments, priming with 4 mM boric acid (B2 ), 2 mM zinc sulphate heptahydrate (Zn1) and 2 mM of zinc sulphate + 4 mM of boric acid (T1 ) significantly improved the germination percentage, plumule and radicle lengths, fresh and dry weights of lentil seedlings over other treatments (Sananda et al., 2024), where as in all treatments seed priming with ZnSO4 1% for 6 hours recorded higher germination (98%) than control under laboratory experiment in Blackgram (Midhul Rana & Sathiyanarayanan, 2024).

**Seedling length (cm):** Nutripriming with boric acid showed an increase in mean seedling length from 24.07 cm (0 %) to 27.48 cm (0.1%) (Table 2). Seed priming with 0.1 % of boric acid showed 28.53 % improvement in mean seedling length in comparison to the control (Fig.1).

The duration of priming significantly enhanced seedling length in the blackgram variety Tulasi. Nutripriming with boric acid improved the mean seedling length from 21.65 cm (0 h) to 28.86 cm (6 h) (Table 4.6). The mean seedling length for 6 h of priming showed a 34.98 % improvement over the control (Fig. 2).

Maximum (31.70 cm) and minimum (21.38 cm) seedling length were observed upon seed priming with 0.1 % boric acid for 6 h and unprimed seed, respectively. The overall mean seedling length was 25.50 cm (Table 2).

Improvement in root length and shoot length was observed after seed priming with 4 mM boric acid for 18 h by Mondal et al. (2018) in lentil. Iqbal et al. (2017) observed that seed priming with boric acid at 0.01M and 0.05 M for 12 h resulted in significantly higher seedling length in wheat. Similar enhancement in root length and shoot length was observed in broccoli (Memon et al., 2013), stevia (Shahverdi et al., 2017) and wheat (Chakraborty et al., 2023) and Among all

treatments seed priming with ZnSO4 1% for 6 hours recorded longest root length (22.17 cm), shoot length (19.15 cm) than control under laboratory experiment in Blackgram (Midhul Rana & Sathiyanarayanan, 2024).

**Seedling vigour index:** Nutripriming with boric acid enhanced the mean seedling vigour index from 2020 (0 %) to 2426 (0.1 %). Later, it decreased with an increase in concentration up to 0.5 % (2205) (Table 2). The percentage increase in mean seedling vigour index with 0.1 % boric acid over the control was 37.06 % (Fig.1).

Duration of nutripriming with boric acid showed progressive increase in mean seedling vigour index from 1795 (0 h) to 2542 (6 h) (Table 2). The per cent improvement in mean seedling vigour index at 6 h of priming in comparison to control was 43.61 % (Fig.2).

Nutripriming with 0.1 % boric acid for 6 h recorded the highest seedling vigour index (2916). The lowest seedling vigour index (1770) was recorded with unprimed seed (Table 2). The grand mean seedling vigour index was 2188 (Table 2).

Rehman et al. (2012) reported that the seedling vigour index was enhanced after seed priming with 0.01 % and 0.001 % boric acid for 24 h in aromatic rice. The highest seedling vigour index was reported by Memon et al. (2013) for 0.01% boric acid priming for 24 h in broccoli. Similar findings were observed in cabbage and cauliflower (Gandahi et al., 2017) and stevia (Shahverdi et al., 2017) and Seed priming with 0.5% ZnSO4 at 1/3rd seed to solution ratio for 3 hours recorded higher germination (96%) and vigour index (3811) than control which recorded 84% seed germination and 2528 of vigour index under laboratory experiment (Kavitha & Srimathi, 2022).

Boron priming has a positive effect on seed quality parameters at lower concentrations for short duration. The enhancement in seedling characters is due to boron in the priming medium, which activates the boron transporter to maintain homeostasis in the cell during later stages of growth (Mondal & Bose, 2019). The improvement of root and shoot length from seed priming with boron indicates that it may be involved in the meristematic growth of radicle and plumule primodia (Bohnsack & Albert, 1977). Higher concentration of boron, greater than 5 mM, causes damage to the cell membrane. This type of damage increases the membrane permeability and malondialdehyde content of the cell in barley (Karabal et al., 2003). Over-priming of seeds for an extended duration leaches out certain chemicals from the seed to the priming solution that may inhibit germination (Samad et al., 2014). An increase in boric acid concentration beyond 0.1% and a priming duration of more than 6 h negatively affected seed quality parameters. The treatment T3 which depicts 8 mM concentration of boric acid equivalent to 86.48 mg l-1 of boron in boric acid solution was found to be the best concentration among the all five treatments (4 primed+1 non primed) in wheat (Chakraborty et al., 2023) and Of all treatments seed priming with ZnSO4 1% for 6 hours recorded higher seedling dry matter production (0.93 g seedlings-10), fresh weight (8.93 g seed lings-10) and vigor index (4004) than control under laboratory experiment in Blackgram (Midhul Rana & Sathiyanarayanan, 2024).

**Table.1. Analysis of variance for seed quality traits in blackgram variety, Tulasi, as affected by seed priming with different concentrations of boric acid for various durations**

| Source | Degrees of freedom | Germination (%) | Seedling length (cm) | Seedling vigor index |
|---|---|---|---|---|
| **Concentration** | 4 | 33.00** | 33.50** | 453.380.92** |
| **Duration** | 4 | 47.43** | 140.03** | 1497264.96** |
| **Duration × Concentration** | 16 | 3.13** | 3.53** | 41740.17** |
| **Error** | 75 | 0.97 | 0.739 | 6171.21 |

****** Significant difference at 1% probability level

**Table.2. Influence of seed priming with different concentrations of boric acid for various durations on seed quality parameters of blackgram variety, Tulasi**

| Duration (h) | Germination (%) | | | | | | Seedling length (cm) | | | | | | Seedling vigour index | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Concentration of boric acid (%) | | | | | | Concentration of boric acid (%) | | | | | | Concentration of boric acid (%) | | | | | |
| | 0# | 0.01 | 0.05 | 0.1 | 0.5 | Mean | 0# | 0.01 | 0.05 | 0.1 | 0.5 | Mean | 0# | 0.01 | 0.05 | 0.1 | 0.5 | Mean |
| 0 | 82.75 (65.44) | 82.75 (65.44) | 83.00 (65.63) | 83.00 (65.63) | 83.00 (65.63) | **82.90$^{D}$ (65.55)*** | 21.38 | 21.83 | 21.50 | 21.85 | 21.70 | **21.65$^{D}$** | 1770 | 1806 | 1785 | 1814 | 1801 | **1795$^{D}$** |
| 2 | 83.75 (66.21) | 84.75 (67.00) | 85.00 (67.19) | 87.75 (69.49) | 83.50 (66.01) | **84.95$^{C}$ (67.18)** | 23.60 | 24.11 | 24.40 | 26.27 | 24.49 | **24.57$^{C}$** | 1976 | 2043 | 2074 | 2305 | 2045 | **2089$^{C}$** |
| 4 | 84.00 (66.40) | 85.50 (67.60) | 86.50 (68.54) | 88.00 (69.71) | 85.00 (67.19) | **85.80$^{B}$ (67.89)** | 24.58 | 25.89 | 26.14 | 28.87 | 25.59 | **26.21$^{B}$** | 2065 | 2213 | 2260 | 2540 | 2175 | **2251$^{B}$** |
| 6 | 85.75 (67.80) | 87.25 (69.05) | 87.50 (69.29) | 92.00 (73.54) | 87.25 (69.05) | **87.95$^{A}$ (69.75)** | 25.93 | 27.65 | 28.71 | 31.70 | 30.33 | **28.86$^{A}$** | 2223 | 2413 | 2513 | 2916 | 2646 | **2542$^{A}$** |
| 8 | 83.25 (65.82) | 86.00 (68.02) | 87.00 (68.86) | 89.00 (70.61) | 86.25 (68.26) | **86.30$^{B}$ (68.31)** | 24.84 | 24.43 | 25.73 | 28.73 | 27.31 | **26.21$^{B}$** | 2068 | 2101 | 2239 | 2557 | 2357 | **2264$^{B}$** |
| **Mean** | **83.90$^{d}$ (66.33)** | **85.25$^{bc}$ (67.42)** | **85.80$^{b}$ (67.90)** | **87.95$^{a}$ (69.80)** | **85.00$^{c}$ (67.23)** | **85.58 (67.74)** | **24.07$^{d}$** | **24.78$^{c}$** | **25.30$^{c}$** | **27.48$^{a}$** | **25.88$^{b}$** | **25.50** | **2020$^{d}$** | **2115$^{c}$** | **2174$^{b}$** | **2426$^{a}$** | **2205$^{b}$** | **2188** |
| | | | | | | | | | | | | | | | | | | |
| **S Em ±** | D 0.22 | | C 0.22 | | D × C 0.49 | | D 0.19 | | C 0.19 | | D × C 0.43 | | D 17.57 | | C 17.57 | | D × C 39.28 | |
| **CD (5%)** | 0.62 | | 0.62 | | 1.39 | | 0.54 | | 0.54 | | 1.21 | | 49.59 | | 49.59 | | 110.88 | |
| **CV (%)** | 1.45 | | | | | | 3.37 | | | | | | 3.59 | | | | | |

# Hydropriming (seed priming with distilled water without any micronutrient)

*Values in the parenthesis indicate arc-sine transformed values

The values in the same column with the same alphabet are not significantly different as per DMRT (P < 0.01).

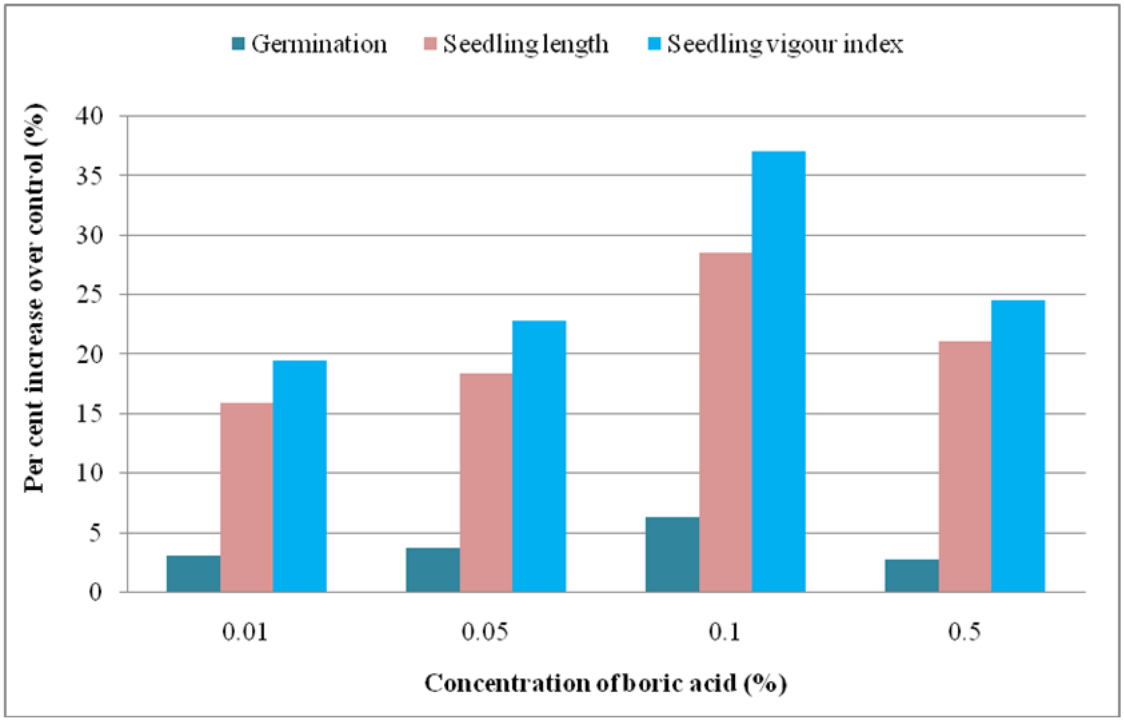


**Figure 1: Per cent increase over control on seedling parameters after seed priming with boric acid for various concentrations in blackgram variety, Tulasi**

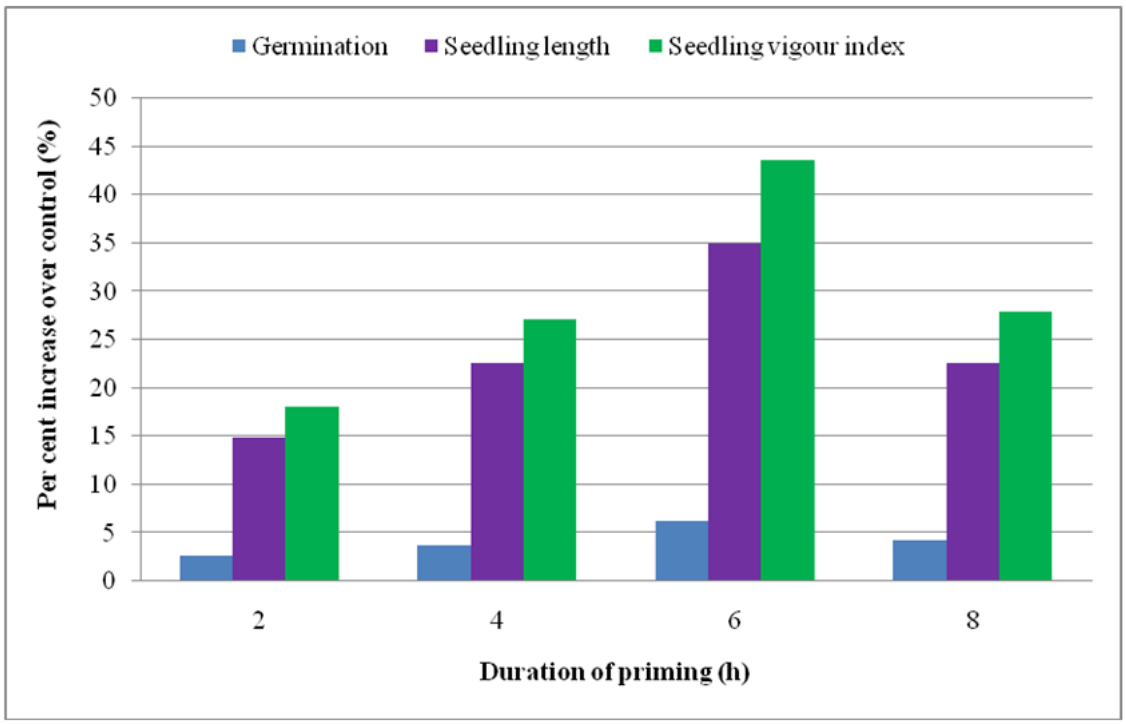


**Figure 2: Per cent increase over control on seedling parameters after seed priming with boric acid for different durations in blackgram variety, Tulasi.**

## CONCLUSION

The experimental results indicate that nutripriming with boric acid was quite effective in improving Tulasi seed quality. Among all the concentrations, 0.1 % boric acid was found to be effective in recording the highest germination (%), seedling length (cm), and seedling vigour index. Irrespective of concentration, priming for 6 h showed maximum improvement in all the seed quality parameters. Nutripriming with 0.1 % boric acid for 6 h resulted in better enhancement of germination and seedling quality parameters in blackgram.

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**Conflict of Interest:**

There is no such evidence of conflict of interest.

**Author Contribution:**

All authors have participated in critically revising of the entire manuscript and approval of the final manuscript.

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