Induction of Drought Tolerance: Optimization of Pre-Sowing Priming Time on the Germination Behavior of BARI Gom 27 (*Triticum aestivum*)


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**Abstract:** Pre-sowing seed treated with Polyethylene Glycol (PEG) helps to enhance the germination behavior of wheat seed. So, a lab experiment was conducted to find out the optimization of pre-sowing priming time on the germination behavior of BARI Gom 27. BARI Gom 27 was primed in 0 to 18 hours under 10% PEG solution and distilled water. The highest germination percentage (GP) (87.77%), vigor index (VI) (142.31) and germination index (GI) (41.23) were obtained from seeds pre-soaked in 12 hours with 10% PEG solution compared to hydro-priming (84.44%, 133.83 and 36.62 of GP, VI and GI, respectively) and untreated control (57.77%, 84.85 and 29.75 of GP, VI and GI, respectively), and then decreased gradually with increasing priming time. Therefore, seed priming helps to enhance the germination behavior of wheat seed.

**Key words:** Drought stress • Germination • Wheat • Polyethylene Glycol • Vigor index

**INTRODUCTION**

Plants create some defense mechanism on itself during the stress condition as a result yield of crops reduce but helps to increase the seed quality [1]. Though stress has this positive impact on seed, but it is not good for seed germination especially for drought stress. And for this reason seed priming is considered as a promising approach to increase stress tolerance capacity of crop plants including drought. Seed priming is the induction of a particular physiological state in plants by the treatment of natural and synthetic compounds to the seeds before germination. The physiological state in which plants are able to faster or better activate defense responses or both is called the primed state of the plant [2]. Seed priming can be accomplished through different methods such as hydro-priming (soaking in DW), osmo-priming (soaking in osmotic solutions such as PEG, potassium salts, e.g., KCl, K₂SO₄) and plant growth inducers (CCC, Ethephon, IAA) [3-6].

Seed priming is also widely used to synchronize the germination of individual seeds [7]. Seed-priming technology has twofold benefits: enhanced, rapid and uniform emergence, with high vigor and better yields in vegetables and floriculture [8] and some field crops [9,10]. According to McDonald [11], primed seeds acquire the potential to rapidly imbibe and revive the seed metabolism thus enhancing the germination rate.

In many crops, seed germination and early seedling growth are the most sensitive stages of water limitation and the water deficit may delay the onset and reduce the rate and uniformity of germination, leading to poor crop performance and yield [12]. Therefore, the beneficial effects of priming may be more evident under unfavorable rather than favorable conditions [13]. Primed seeds usually exhibit an increased germination rate, greater germination uniformity and at times, greater total germination percentage [9]. These attributes have practical agronomic implications, notably under adverse germination conditions [11]. Therefore, there is a strong...
interest in the seed industry to find suitable priming agent(s) that might be used to increase the tolerance of plants under adverse field conditions [14].

RESULTS AND DISCUSSION

MATERIALS AND METHODS

The experiment was conducted under the laboratory condition of Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka from August 2013 to February 2014. Temperature range of the laboratory during the experiment was 26.2°C-33.4°C and the relative humidity was 56-84%.

In this research work, seeds of the Wheat variety BARI Gom 27 and BARI Gom 28 collected from Bangladesh Agricultural Research Institute were used as planting material. Different priming chemicals such as PEG and distilled water were utilized for osmo and hydro priming. Different equipments such as growth chamber, electric balance, Petri dish, filter paper, micro pipette etc. were used for this study.

All seeds were surface sterilized with 2% Safex solution for 5 minutes, then rinsed with sterilized water and air dried at room temperature. After that seeds were used for priming.

All priming media were prepared in distilled water and duration of soaking for hydro and osmopriming were 12 h. After soaking seeds were air dried and placed in Petridish. For each replicate 30 seeds were placed in 12.5 cm Petridish on a layer of filter paper no. 102 moistened with 8 ml of distilled water.

The experiment was conducted in Completely Randomized Design (CRD) with five replications. Treatment considered as a eleven priming levels with water and Polyethylene Glycol (PEG) viz., Non primed seed (dry seed) (T₀), Seed primed with water for 6 h (T₁), Seed primed with 10% PEG for 6 h (T₂), Seed primed with water for 9h (T₃), Seed primed with 10% PEG for 9 h (T₄), Seed primed with water for 12 h (T₅), Seed primed with 10% PEG for 12 h (T₆), Seed primed with water for 15 h (T₇), Seed primed with 10% PEG for 15 h (T₈), Seed primed with water for 18 h (T₉), Seed primed with 10% PEG for 18 h (T₁₀). After that data collected on various parameters and mean data of germination percentage, plumule length, radical length, seedling length, vigour index, germination index and seedling dry weight were recorded and analyzed using statistical computer software MSTAT-C and mean were separated using least significance difference (LSD) at 5% level of probability.

Effect on Germination Percentage: Germination percentage of wheat was influenced by different priming time (Table 1) and there was significant difference between control (non primed seeds) and primed seeds. Germination percentage (GP) was increased with increasing priming time up to 12 h then decreased gradually. The highest GP (87.77%) was obtained from T₅ treatment, seeds pre-treated with 10% PEG solution for 12 h, which is statistically similar with treatment T₆ (84.44%), seeds pre-treated with water for 12 h. The GP given by T₅ treatment is 34.18 % higher over control.

The result of the present study corroborates with the study of Yari et al. [15] Sadeghi et al. [16], Dastanpoor et al. [17], Moradi et al. [18], Ajirloo et al. [19] and Ahammad et al. [20] Yari et al. [15] reported that maximum seed germination percentage in cv. Azar-2 was observed when the seeds primed by PEG 20% for 12h. Priming duration had significant effect on germination percentage, mean germination time. It was observed that 12 h priming duration had most effect on these traits [16]. Hydropimring (12 h at 30°N) was most effective in improving seed germination of Salvia officinalis L. that final germination percentage (FGP) was increased by 25.5% as compared to that of non-primed seeds [17]. Moradi et al. [18] reported that lower priming duration (i.e., 12 and 24 h) improved germination under normal condition, while a higher priming duration (i.e., 36 and 48 h) provided more protection when the seeds were exposed to drought stress. Increasing of seed soaking duration improved rate of germination [19, 20].

Effect on Plumule Length (mm): Plumule length (mm) of wheat was influenced by different priming time (Table 1) and variance analysis results showed that there was significant difference between control (non primed seeds) and primed seeds. Plumule length was increased with increasing priming time up to 12 h then decreased gradually. The highest plumule length (80.2 mm) was obtained from T₅ treatment, seeds pre-treated with 10% PEG solution for 12 h, which is followed by treatment T₆ (77.67 mm), seeds pre-treated with water for 12 h. The plumule length given by T₅ treatment is 20.36% longer over control.

This trend of the present results agrees to the study of Yari et al. [15], Moghanibashi et al. [21]. Yari et al. [15] reported that most stem length was obtained for seeds
Table 1: Effect of various level of priming time on the germination behavior of BARI Gom27

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Germination percentage (%)</th>
<th>Plumule length (mm)</th>
<th>Radical length (mm)</th>
<th>Seedling length (mm)</th>
<th>Vigour index (VI)</th>
<th>Germination index (GI)</th>
<th>Seedling dry weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>57.77f</td>
<td>63.87h</td>
<td>64.33g</td>
<td>128.20j</td>
<td>84.85k</td>
<td>29.75 g</td>
<td>0.058g</td>
</tr>
<tr>
<td>T1</td>
<td>67.77e</td>
<td>70.60g</td>
<td>70.27f</td>
<td>140.87g</td>
<td>96.96h</td>
<td>30.07g</td>
<td>0.065f</td>
</tr>
<tr>
<td>T2</td>
<td>76.66c</td>
<td>73.33ef</td>
<td>72.63e</td>
<td>145.97f</td>
<td>108.24 g</td>
<td>31.20ef</td>
<td>0.080bc</td>
</tr>
<tr>
<td>T3</td>
<td>81.11b</td>
<td>75.43 cd</td>
<td>75.60d</td>
<td>151.03dc</td>
<td>116.82f</td>
<td>32.45 d</td>
<td>0.083b</td>
</tr>
<tr>
<td>T4</td>
<td>82.22b</td>
<td>76.07c</td>
<td>79.33b</td>
<td>155.40bc</td>
<td>128.89 c</td>
<td>33.83e</td>
<td>0.078b</td>
</tr>
<tr>
<td>T5</td>
<td>87.77a</td>
<td>80.20a</td>
<td>82.03a</td>
<td>162.23a</td>
<td>141.31 a</td>
<td>41.23a</td>
<td>0.088a</td>
</tr>
<tr>
<td>T6</td>
<td>84.44 ab</td>
<td>77.67b</td>
<td>78.07bc</td>
<td>155.73b</td>
<td>133.83b</td>
<td>36.62b</td>
<td>0.075c</td>
</tr>
<tr>
<td>T7</td>
<td>83.33b</td>
<td>76.10c</td>
<td>77.00 ed</td>
<td>153.10cd</td>
<td>126.23 d</td>
<td>36.18b</td>
<td>0.075c</td>
</tr>
<tr>
<td>T8</td>
<td>82.22b</td>
<td>74.40de</td>
<td>75.61d</td>
<td>150.01e</td>
<td>121.00 e</td>
<td>33.77 c</td>
<td>0.073de</td>
</tr>
<tr>
<td>T9</td>
<td>72.22d</td>
<td>72.60 f</td>
<td>65.40 g</td>
<td>138.00 h</td>
<td>90.66 g</td>
<td>31.65de</td>
<td>0.073e</td>
</tr>
<tr>
<td>T10</td>
<td>64.44e</td>
<td>69.40g</td>
<td>64.13g</td>
<td>133.53i</td>
<td>88.28 j</td>
<td>29.01 g</td>
<td>0.072e</td>
</tr>
</tbody>
</table>

LSD 3.55 1.365 1.823 2.463 1.215 1.139 0.005386

CV (%) 2.73% 1.09% 1.46% 0.99% 0.63% 2.01% 1.60%

In column, figures followed by different letter(s) indicate significantly different at 5% level of significance.

Note: T0: Non primed seed (dry seed), T1: Seed primed with water for 6 h, T2: Seed primed with 10% PEG for 6 h, T3: Seed primed with water for 9h, T4: Seed primed with 10% PEG for 9 h, T5: Seed primed with water for 12 h, T6: Seed primed with 10% PEG for 12 h, T7: Seed primed with water for 15 h, T8: Seed primed with 10% PEG for 15 h, T9: Seed primed with water for 18 h, T10: Seed primed with 10% PEG for 18 h

The effect of osmopriming with PEG 10% for 24h. The effect of hydropriming for 24 h increased shoot length of sunflower as compared with the control [21].

**Effect on Radical Length (mm):** Radical length (mm) of wheat was influenced by different priming time (Table 1) and variance analysis results showed that there was significant difference between control (non primed seeds) and primed seeds. Radical length increases with increasing priming time up to 12 h for osmopriming then decreases gradually. The highest radical length (82.03 mm) was obtained from T5 treatment, seeds pre-treated with 10% PEG solution for 12 h. Treatment T5 is followed by treatment T6 (155.73 mm), seeds pre-treated with water for 12 h which is statistically similar with treatment Ws (155.40 mm). The radicle length given by T7 treatment is 20.97% longer over control.

Similar results were found by Ajirloo et al. [19], who reported that increasing of seed soaking duration improved seedlings length.

**Effect on Seedling Length (mm):** Seedling length (mm) of wheat was influenced by different priming time (Table 1) and variance analysis results showed that there was significant difference between control (non primed seeds) and primed seeds. Seedling length increased with increasing priming time up to 12 h then decreased gradually. The highest seedling length (162.23 mm) was obtained from T9 treatment, seeds pre-treated with 10% PEG solution for 12 h. Treatment T9 is followed by treatment T8 (155.73 mm), seeds pre-treated with water for 12 h which is statistically similar with treatment Ws (155.40 mm). The seedling length given by T10 treatment is 20.97% longer over control.

**Effect on Vigour Index (VI):** Vigour index (VI) of wheat was influenced by different priming time (Table 5). Results showed that there was significant difference between control (non primed seeds) and primed seeds. Vigour index was increased with increasing priming time up to 12 h then decreased gradually. The highest vigour index (141.31) was obtained from T5 treatment when seeds pre-treated with 10% PEG solution for 12 h, followed by T9 (133.83) in which seeds pre-treated with water for 12 h. The vigour index obtained in T10 treatment is 39.96% higher over control.

This result is in agreement with the findings of Yari et al. [15] and Sadeghi et al. [16]. Sadeghi et al. [16] mentioned that priming duration had significant effect on seed vigor and also it was observed that 12 h priming duration had most effect on the studied trait. The highest VI was observed on 12 h [15].
Effect on Germination Index (GI): Germination index (GI) of wheat was influenced by different priming time (Table 1). Results showed that there was significant difference between control (non primed seeds) and primed seeds. Germination index was increased with increasing priming time up to 12 h then decreased gradually. The highest germination index (41.23) was obtained from T1 treatment (seeds pre-treated with 10% PEG solution for 12 h) followed by treatment T4 (36.62) in which seeds pre-treated with water for 12 h which is statistically similar with treatment T3 (36.18). The germination index obtained with T1 treatment is 27.84% higher over control.

This result of the study is consistent with the finding of Yari et al. [15], Sadeghi et al. [16] and Moghanibashi et al. [21]. Yari et al. [15] reported that speed of germination was improved when the seed soaked in water and PEG 10%. The most speed of germination was observed on 12h. Priming duration had significant effect on germination index and it was observed that 12 h priming duration had significant effect [16]. Moghanibashi et al. [21] reported that the effect of hydropriming for 24 h increased germination index of seed sunflower as compared with the control.

Effect on Seedling Dry Weight (g): Seedling dry weight (g) of wheat was influenced by different priming time (Table 1). The results showed that there was significant difference between control (non primed seeds) and primed seeds. Dry weight (g) was increased with increasing priming time up to 12 h for osmopriming then decreased gradually. The highest seedling dry weight (0.088 g) was obtained from T1 treatment (seeds pre-treated with 10% PEG solution for 12 h) followed by treatment T4 (0.083 g) where seeds pre-treated with water for 9 h which is statistically similar with treatment T3 (0.081 g). The seedling dry weight obtained by T1 treatment is 34.09% higher over control.

The result of the present study is also supported by Moghanibashi et al. [21], who reported that the effect of hydropriming for 24 h increased root and shoot weight of seed sunflower as compared.

CONCLUSION

The present investigation showed that seed treated with Polyethylene Glycol (PEG) has a positive effect on germination behavior on wheat seed. BARI Gom 27 was primed in 0 to 18 hours under 10% PEG solution and distilled water. Results revealed that all the characters viz. germination percentage, plumule length, radical length, seedling length, vigor index, germination index and seedling dry weight were significantly influenced by different priming time. All the parameters increased with increasing priming time up to 12 h then decreased gradually. The highest GP, plumule length, seedling length, vigor index and germination index were obtained from seeds pre-treated with 10% PEG solution for 12 h which is followed by seeds pre-treated with water for 12 h. Whereas the highest radical length and seedling dry weight were obtained from seeds pre-treated with 10% PEG solution for 12 h which is followed by seeds pre-treated with water for 9 h. So, it can be concluded that seed treated with Polyethylene Glycol (PEG) helps to increase the germination behavior on wheat seed.

REFERENCES


