

# Germination Behavior of Wheat (*Triticum Aestivum* L.) as Influenced by Polyethylene Glycol (PEG)

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**Abstract** Pre-sowing seed treated with Polyethylene Glycol (PEG) helps to enhance the germination behavior of seed. So, a lab experiment was conducted to find out the effect of various Polyethylene Glycol (PEG) concentrations on the germination behavior of wheat. Wheat seeds of BARI Gom 27 and BARI Gom 28 were pre-soaked in 0, 5, 10, 15 and 20% PEG solution and untreated seeds were served as control. Results revealed that seed priming enhanced germination percentage (GP), vigor index (VI) and germination index (GI) of wheat seed. The highest GP (95.55%), VI (201.00) and GI (43.73) were obtained from seeds of BARI Gom 27 pre-treated with 10% PEG solution compared to BARI Gom 28 (75.55%, 128.71 and 27.12 of GP, VI and GI, respectively) and then decreased gradually with increasing PEG concentration. Therefore, seed priming helps to enhance the germination behavior of wheat seed.

**Keywords** Germination, Polyethylene Glycol, Wheat, Vigor Index

## 1. 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, K<sub>2</sub>SO<sub>4</sub>) and plant growth inducers (CCC, Ethephon, IAA) [3, 4, 5,6].

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].

## 2. Materials and Methods

The experiment was conducted under the laboratory condition of the 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 equipment 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.

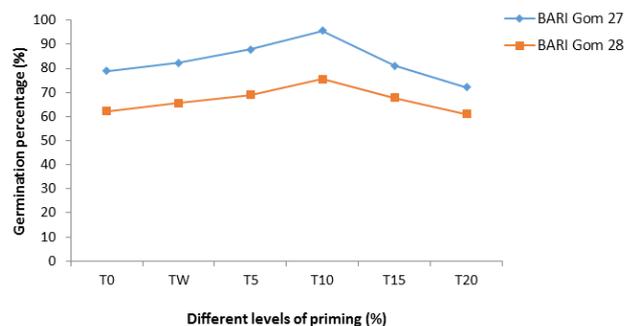
All priming media were prepared in distilled water and duration of soaking for hydro and osmopriming were 12 h. After soaking seeds were air dried and placed in Petridish. For each replicate 30 seeds were placed in 12.5 cm Petridish on a layer of filter paper no. 102 moistened with 8 ml of distilled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

The experiment was conducted in Completely Randomized Design (CRD) with five replications. The first factor was the two wheat varieties viz., BARI Gom 27 (V1) and BARI Gom 28 (V2); second factor was the six priming with Polyethylene Glycol (PEG) viz., Non- primed seeds (T0) Seeds primed with water for 12 h (Tw), Seeds primed with 5% PEG for 12 h (T5), Seeds primed with 10% PEG for 12 h (T10), Seeds primed with 15% PEG for 12 h (T15), Seeds primed with 20% PEG for 12 h (T20). 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.

### 3. Result and Discussion

#### 3.1. Effect on Germination Percentage

Germination percentage of wheat was influenced by various Polyethylene Glycol (PEG) concentrations (Figure 1) and there was completely significant difference between control (non primed seeds) and primed seeds. Germination percentage (GP) was affected by hydro priming and different PEG concentrations. Germination percentage (GP) increases with increasing PEG concentration up to 10% then decreases gradually with increasing PEG concentration. The highest GP (95.55%) of BARI Gom 27 was obtained from seeds pre-treated with 10% PEG solution which is 17.43% and 13.95% higher over control and osmoprimed seeds, respectively. The highest GP (75.55%) of BARI Gom 28 was obtained from seeds pre-treated with 10% PEG solution which is 17.64% and 13.23% higher over control and osmoprimed seeds, respectively. Germination percent of BARI Gom 27 was higher compared to BARI Gom 28.



Note: T0: Non- primed seeds (Control), Tw: Seeds primed with water for 12 h,

T5: Seeds primed with 5% PEG for 12 h, T10: Seeds primed with 10% PEG for 12 h,

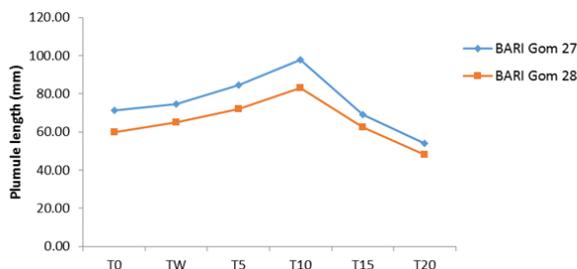
T15: Seeds primed with 15% PEG for 12 h, T20: Seeds primed with 20% PEG for 12 h.

**Figure 1.** Effect of various Polyethylene Glycol (PEG) concentrations on the germination percentage of wheat (LSD<sub>0.05</sub>=8.973, 3.443)

The result of the present study corroborates with the study of previous researchers [15, 16, 17, 18, 19]. According to Ajouri et al. [16] priming induces a range of biochemical changes in the seed that required initiating the germination process i.e., breaking of dormancy, hydrolysis or metabolism of inhibitors, imbibition and enzymes activation. Hydropriming significantly improved germination rate [15] and is a useful technique for improving overall germination viz. tomato variety germination percentage was increased in response to hydro-priming treatment [17]. Farooq et al. [18] suggested that physiological changes produced by osmohardening enhanced the starch hydrolysis and made more sugars available for embryo growth which enhance germination. Sun et al. [19] reported that optimal priming concentrations of PEG were 20% for Gangyou 527 (indica hybrid rice) and 10%–15% for Nongken 57 (conventional japonica rice). Even higher concentrations of PEG had negative effects on seed germination.

#### 3.2. Effect on Plumule Length (mm)

Plumule length (mm) of wheat was influenced by various Polyethylene Glycol (PEG) concentrations (Figure 2) and variance analysis results showed that there was significant difference between control (non primed seeds) and primed seeds. Plumule length was affected by hydro priming and different PEG concentration. Plumule length increases with increasing PEG concentration up to 10% then decreases gradually with increasing PEG concentration. The highest plumule length (97.7 mm) of BARI Gom 27 was obtained from seeds pre-treated with 10% PEG solution which is 27.05% and 23.57% higher over control and osmoprimed seeds, respectively. The highest plumule length (83.20 mm) of BARI Gom 28 was obtained from seeds pre-treated with 10% PEG solution which is 28.24% and 21.63% higher over control and osmoprimed seeds, respectively. Plumule length of BARI Gom 27 was higher compared to BARI Gom 28.



Note: T0: Non- primed seeds (Control), Tw: Seeds primed with water for 12 h,

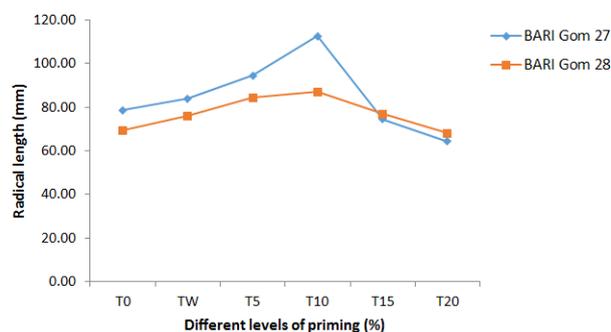
T5: Seeds primed with 5% PEG for 12 h, T10: Seeds primed with 10% PEG for 12 h,

T15: Seeds primed with 15% PEG for 12 h, T20: Seeds primed with 20% PEG for 12 h.

Figure 2. Effect of various Polyethylene Glycol(PEG) concentrations on the plumule length of wheat (LSD 0.05= 0.5979, 1.029)

### 3.3. Effect on Radical Length (mm)

Radical length (mm) of wheat was influenced by various Polyethylene Glycol (PEG) concentrations (Figure 3) and variance analysis results showed that there was significant difference between control (non-primed seeds) and primed seeds. Radical length was affected by hydro priming and different PEG concentrations. Radical length increases with increasing PEG concentration up to 10% then decreases gradually with increasing PEG concentration. The highest radical length (112.7 mm) of BARI Gom 27 was obtained from seeds pre-treated with 10% PEG solution which is 30.19% and 25.46% higher over control and osmoprimed seeds, respectively. The highest radical length (87.17 mm) of BARI Gom 28 was obtained from seeds pre-treated with 10% PEG solution which is 20.38% and 12.89% higher over control and osmoprimed seeds, respectively. Radical length of BARI Gom 27 was higher compared to BARI Gom 28.



Note: T0: Non- primed seeds (Control), Tw: Seeds primed with water for 12 h,

T5: Seeds primed with 5% PEG for 12 h, T10: Seeds primed with 10% PEG for 12 h,

T15: Seeds primed with 15% PEG for 12 h, T20: Seeds primed with 20% PEG for 12 h.

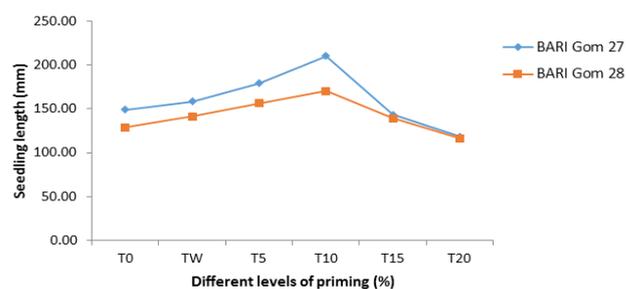
Figure 3. Effect of various Polyethylene Glycol (PEG) concentrations on the radical length of wheat (LSD 0.05= 1.454, 0.7846)

This trend of the present results agrees to the study of previous researcher Sarwar *et al.* [20] who reported that root

length were better when treated with water and mannitol over control.

### 3.4. Effect on Seedling Length (mm)

Seedling length (mm) of wheat was influenced by various Polyethylene Glycol (PEG) concentrations (Figure 4) and variance analysis results showed that there was significant difference between control (non primed seeds) and primed seeds. Seedling length was affected by hydro priming and different PEG concentrations. Seedling length increases with increasing PEG concentration up to 10% then decreases gradually with increasing PEG concentration. The highest seedling length (210.4 mm) of BARI Gom 27 was obtained from seeds pre-treated with 10% PEG solution which is 29.03% and 24.57% higher over control and osmoprimed seeds, respectively. The highest seedling length (170.4 mm) of BARI Gom 28 was obtained from seeds pre-treated with 10% PEG solution which is 24.23% and 17.19% higher over control and osmoprimed seeds, respectively. Seedling length of BARI Gom 27 was higher compared to BARI Gom 28.



Note: T0: Non- primed seeds (Control), Tw: Seeds primed with water for 12 h,

T5: Seeds primed with 5% PEG for 12 h, T10: Seeds primed with 10% PEG for 12 h,

T15: Seeds primed with 15% PEG for 12 h, T20: Seeds primed with 20% PEG for 12 h.

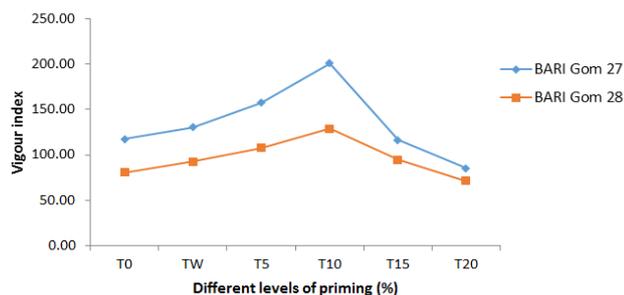
Figure 4. Effect of various Polyethylene Glycol (PEG) concentrations on the seedling length of wheat (LSD 0.05= 1.926, 1.422)

This result is in agreement with the findings of several workers [21, 17]. Jisha *et al.* [21] reported that overall growth of plants was enhanced due to the seed-priming treatments. Maiti *et al.* [17] observed that seed priming increases seedling vigour of several vegetable crops. The priming techniques improved seedling growth of tomato and chilli although varieties showed variation in response to different treatments.

### 3.5. Effect on Vigour Index (VI)

Vigour index (VI) of wheat was influenced by various Polyethylene Glycol(PEG) concentrations (Figure 5) and variance analysis results showed that there was significant difference between control (non primed seeds) and primed seeds. Vigour index was affected by hydro priming and

different PEG concentrations. Vigour index increases with increasing PEG concentration up to 10% then decreases gradually with increasing PEG concentration. The highest vigour index (201) was obtained from seeds of BARI Gom 27 pre-treated with 10% PEG solution compared to BARI Gom 28 (128.71). The highest vigour index of BARI Gom 27 is 41.44% and 37.07% and of BARI Gom 28 is 37.59% and 28.16% higher over control and osmoprimed seeds, respectively.



Note: T0: Non- primed seeds (Control), Tw: Seeds primed with water for 12 h,

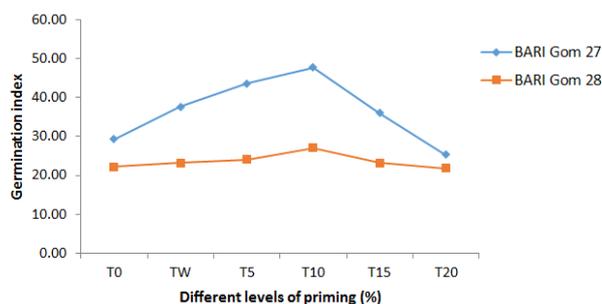
T5: Seeds primed with 5% PEG for 12 h, T10: Seeds primed with 10% PEG for 12 h,

T15: Seeds primed with 15% PEG for 12 h, T20: Seeds primed with 20% PEG for 12 h.

**Figure 5.** Effect of various Polyethylene Glycol(PEG) concentrations on the vigour index of wheat (LSD  $_{0.05}$ = 12.88, 5.07)

This result is consistent with many scientists Maiti et al. [17]; Maiti et al. [22]. Seed priming increases seedling vigour of several vegetable crops [17] and with respect to sponge gourd, osmo-priming increased seedling vigor [22].

### 3.6. Effect on Germination Index(GI)



Note: T0: Non- primed seeds (Control), Tw: Seeds primed with water for 12 h,

T5: Seeds primed with 5% PEG for 12 h, T10: Seeds primed with 10% PEG for 12 h,

T15: Seeds primed with 15% PEG for 12 h, T20: Seeds primed with 20% PEG for 12 h.

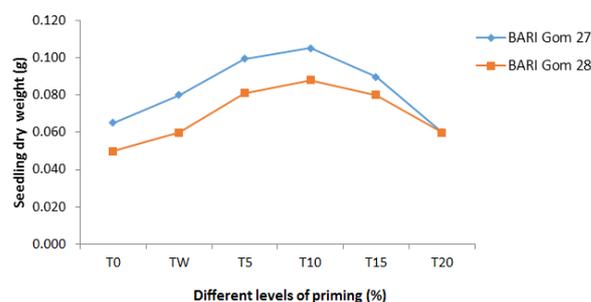
**Figure 6.** Effect of various Polyethylene Glycol(PEG) concentrations on the germination index of wheat (LSD  $_{0.05}$ = 3.182, 1.163)

Germination index (GI) of wheat was influenced by various Polyethylene Glycol(PEG) concentrations (Figure 6) and variance analysis results showed that there was significant difference between control (non primed seeds)

and primed seeds. Germination index was affected by hydro priming and different PEG concentration. Germination index increases with increasing PEG concentration up to 10% then decreases gradually with increasing PEG concentrations. The highest germination index (47.73) was obtained from seeds of BARI Gom 27 pre-treated with 10% PEG solution compared to BARI Gom 28 (27.12). The highest germination index of BARI Gom 27 is 38.63% and 21.12% and of BARI Gom 28 is 17.95% and 14.42% higher over control and osmoprimed seeds, respectively.

This result is in agreement with the findings of Huns and Sung [23] who reported that seed priming resulted anti-oxidant increment as glutathione and ascorbate in seed. These enzymes make more germination speed via reduction of lipid per-oxidation activity.

### 3.7. Effect on Seedling Dry Weight (g)



Note: T0: Non- primed seeds (Control), Tw: Seeds primed with water for 12 h,

T5: Seeds primed with 5% PEG for 12 h, T10: Seeds primed with 10% PEG for 12 h,

T15: Seeds primed with 15% PEG for 12 h, T20: Seeds primed with 20% PEG for 12 h.

**Figure 7.** Effect of various Polyethylene Glycol(PEG) concentrations on the seedling dry weight of wheat (LSD  $_{0.05}$ = 0.05753, 0.05131)

Dry weight (g) of wheat was influenced by various Polyethylene Glycol(PEG) concentrations (Figure 7) and variance analysis results showed that there was no significant difference between control (non primed seeds) and primed seeds. Seedling dry weight was affected by hydro priming and different PEG concentration. Seedling dry weight increases with increasing PEG concentration up to 10% then decreases gradually with increasing PEG concentration. The highest seedling dry weight (0.105 g) of BARI Gom 27 was obtained from seeds pre-treated with 10% PEG solution which is 38.11% and 23.90% higher over control and osmoprimed seeds, respectively. The highest seedling dry weight (0.088 g) of BARI Gom 28 was obtained from seeds pre-treated with 10% PEG solution which is 43.18% and 31.81% higher over control and osmoprimed seeds, respectively. Seedling dry weight of BARI Gom 27 was higher compared to BARI Gom 28.

The result of the present study is also supported by the result of previous researchers [24, 15, 20]. Khalil et al. [24] observed that dry matter yield increased with each increment

of priming. Ghassemi-Golezani et al. [15] showed that hydro-priming significantly improved root weights and Sarwar et al. [20] reported that root length and biomass of roots and shoots were better when treated with water and mannitol.

#### 4. Conclusions

The present investigation showed that seed treated with Polyethylene Glycol (PEG) has a positive effect on germination behavior on wheat seed. Wheat seeds of BARI Gom 27 and BARI Gom 28 were pre-soaked in 0, 5, 10, 15 and 20% PEG solution and untreated seeds were served as control. Results revealed that all the characters viz., germination percentage (GP), plumule length, radical length, seedling length, vigor index (VI) and germination index (GI) were significantly influenced by various PEG concentrations except seedling dry weight for both varieties. All the parameters of both varieties gave the best results when seeds treated with 10% PEG solution compared to nonprimed and hydroprimed seeds and decreased gradually with increasing PEG concentration. The highest germination percentage, plumule length, radical length, seedling length, vigor index, germination index and seedling dry weight were obtained from seeds of BARI Gom 27 pre-treated with 10% PEG solution compared to BARI Gom 28. So, it can be concluded that seed treated with Polyethylene Glycol (PEG) helps to increase the germination behavior on wheat seed.

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