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EFFECT OF SEED PRIMING DURATION AND TEMPERATURE ON SEED GERMINATION BEHAVIOR OF BREAD WHEAT (*Triticum aestivum* L.)

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ABSTRACT

In order to evaluate the effect of different seed priming techniques on germination and early growth of two wheat cultivars (Azar-2 and Sardari 101) an experiment was conducted at the Seed and Plant Certification and Registration Research Institute, Karaj, Iran. Seeds were primed for 12, 24 and 36 hours at three temperature (20, 23 and 28°C) in seven priming media (Poly ethylene glycol (PEG_{6000}) 10%, PEG 20%, KCl 2%, KCl 4%, KH_2PO_4 0.5%, KH_2PO_4 1% and distilled water as control). Maximum seed germination percentage in cv.Azar-2 was observed when the seeds primed by PEG 20% for 12h and at 20°C. The most stem length was obtained for seeds osmoprimed with PEG 10% for 24h. Osmoprimed seeds with PEG 20% for 24h produced maximum radicle length of cv. Sardari. Maximum vigor index (VI) of cv. Azar-2 was obtained from seeds primed with KH_2PO_4 0.5% while the lowest germination percent, speed of germination and VI were observed in seeds which subjected to KCl 4% solution. Speed of germination was improved when the seed soaked water and PEG 10%. The most germination percent, VI and speed of germination were observed on 12h. Altogether 20°C treatment had better effects than other temperatures on germination attributes and seedling parameters. None of the interaction between seed priming media × cultivar × temperature and seed priming media × cultivar × priming duration showed the beneficial effects on germination index, speed of germination, dry weight and seedling height.

Keywords: wheat, seed priming, duration, temperature, germination, seedling growth.

INTERODUCTION

Rapid and uniform field emergence is essential to achieve high yield with respect to both quantity and quality in annual crops (Parera and cantliffe, 1994; Subedi and Ma, 2005). Constraints to good crop establishment include improper seedbed preparation (Joshi, 1987), low quality seed, untimely sowing (van Oosterom, *et al*., 1996), poor sowing techniques (Radford, 1983), inadequate soil moisture (Harris, 1996) and adverse soil conditions (Lee *et al*., 1998). Low seed zone water potential, deep planting depth and soil crusting due to rain and before seedling emergence frequently impede winter wheat stands (Giri and Schillinger, 2003). Seed priming has been found a double technology to enhance rapid and uniform emergence, and to achieve high vigor and better yields in vegetables and floriculture (Dear man *et al*., 1987; Parera and Cantliffe, 1994; Bruggink *et al*., 1999) and some field crops (Hartz and Caprile 1995; Chiu *et al*., 2002; Giri and Schillinger 2003; Murungu *et al*., 2004; Basra *et al*., 2005; 2006; Kaur *et al*., 2005; Farooq *et al*., 2006 a, b; 2007 a, b). Priming allows some of the metabolic processes necessary for germination to occur without germination take place. In priming, seeds are soaked in different solutions with high osmotic potential. This prevents the seeds from absorbing in enough water for radicle protrusion, thus suspending the seeds in the lag phase (Taylor *et al*., 1998). Seed priming has been commonly used to reduce the time between seed sowing and seedling emergence and to synchronize emergence (Parera and Cantliffe, 1994).

Average annual rainfall in Iran is about 251mm. In dry years, when seed zone water is inadequate, farmers have to delay planting which will reduce grain yield potential compared with early planting (Donaldson *et al*.,2001). Osmopriming and hydropriming of wheat seeds may improve germination and emergence (Ashraf and Abu-Shakra.1978) and may promote vigorous root growth (Carceller and Soriano, 1972).

On- farm seed priming involves soaking the seed in water, surface drying and sowing the same day. The rational is that sowing the soaked seed decreases the time needed for germination and may allow the seedlings to escape from the deteriorating soil physical conditions.

In addition to better establishment, farmers reported that primed crops grew more vigorously, flowered earlier and yielded higher (Farooq *et al*., 2008). It has also been reported that seed priming improves emergence, stand establishment, tillering, allometry, grain and straw yields, and harvest index (Farooq *et al*., 2008). Potassium hydro phosphate (K_2HPO_4), polyethylene glycol (PEG_{6000}) (Dell Aquila and Taranto, 1986) and potassium chloride (KCl) (Misra and Dwibedi, 1980) have been introduced as the osmoticum which have shown good potential to enhance germination, emergence, growth, and/or grain yield of wheat. Water has also been used successfully as a seed priming medium for wheat (Harris *et al*., 2001). Misra and Dwibedi (1980) found that seed soaking in 2.5% potassium chloride (KCl) for 12 h before sowing increased wheat yield by 15%. Paul and Choudhury (1991) also observed that seed soaking with 0.5 to 1% solution of KCl or potassium sulfate (K_2SO_4) significantly increased plant height, yield attributes, and grain yield in wheat. According to Basra *et al*. (1989) priming of corn seed using polyethylene glycol or

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potassium salt (K_2HPO_4 or KNO_3) resulted in accelerated germination. However Giri and Schillinger (2003) reported that none of the wheat seed priming media benefited field emergence or subsequent grain yield in all cultivars compared with checks. Improved nitrogen uptake and increased total and reductive sugars content in rice (*Oryza sativa* L.), have been related to improved root proliferation and enhanced α-amylase activity in starch hydrolysis due to seed priming (Mahamad and Basra, 2005). In maize (*Zea mays* L.) inbred lines, maximum invigoration was observed in seeds hydro- primed for 36 h as indicated by higher germination rate and longer radical length. Although for most germination parameters of osmoprimed seeds behaved similar to or even poorer than that of control (Moradi Dezfuli *et al*., 2008).

The main objective of this study was to evaluate the effects of different priming media, duration and temperature treatments on seed germination behavior of wheat cultivars.

MATERIALS AND METHODS

The Experiment was conducted in the laboratory of the Seed and Plant Certification and Registration Research Institute, Karaj, Iran in 2008 to determine seed priming effects on germination, and seedling growth of two winter wheat cultivars (Azar-2 and Sardari 101). These cultivars are among widely cultivated bread wheat cultivars under dry land farming conditions in Iran. Three hundred (300) g of each cultivar seeds were placed in individual nylon net bags and then immersed in liquid priming media. Priming media were : (i) Distilled water as control; (ii) 2% Potassium chloride (KCl); (iii) 4% KCl; (iv) 0.5% Potassium hydrogen phosphate (KH_2PO_4); (v) 1% KH_2PO_4; (vi) 10% Poly ethylene glycol (PEG_{6000}); and (vii) 20% PEG_{6000}. All priming media were prepared in distilled water. Seeds were fully immersed in priming media at 20, 23 and 28 ºC for 12, 24, and 36 h. All seeds were removed from priming media at the same time and then rinsed thoroughly with distilled water and hand dried lightly using blotting paper. While still damp, seed including check was treated with Vitawax (Fungicide), and then allowed to dry on paper towels at room temperature.

Experimental units (168 Petri dishes) were arranged factorialy in a completely randomized design with four replications. Fifty seeds from each of the treatments were placed in 90-mm-diameter Petri dishes on whatman No.2 filter paper moistened with 10 ml of distilled water. Seed was kept at room temperature (25°C) under normal light. Seeds were considered germinated when radicle protruded for 5 mm. Germination progress was measured at 12 h intervals and continued until fixed state. Germination percentage (GP) was calculated based on equation 1.

$$GP = \frac{total \quad seeds \quad germination \quad after \quad 8day}{Total \quad number \quad of \quad seeds} \qquad [1]$$

The germination index (GI) and coefficient of velocity (CV) was calculated as described in Scott *et al*. (1984) (equation 2 and 3).

$$GI = \frac{\sum TiNi}{S} \qquad [2]$$

Where *Ti* is the number of days after sowing, *Ni* is the number of seeds germinated on *i*th day, and *S* is the total number of seeds used.

$$CV = 100 \left[\frac{\sum Ni}{\sum TiNi} \right] \qquad [3]$$

Final germination percentage, seedling length, radicle length, stems length, seedling fresh and dry weights were recorded 8 days after cessation of the experiment. The vigor index (VI) was calculated as the product of seedling dry weight by germination percentage. Experimental data were analyzed using SAS (Statistical software, SAS institute, 2002) and treatment means were compared using Duncan's multiple range test at 5% level of probability.

RESULTS AND DISCUSSIONS

Seed priming had significant positive effect on different aspects of seed germination. The highest germination rate was observed in seed soaked in distilled water (control). Both water and PEG_{6000} improved germination rate. Maximum radicle length (Figure-1) and seedling length (Figure-2) were produced by seeds primed with 10% and 20% PEG_{6000} solution respectively. The two cultivars responded differently with respect to GP, GI and radicle length. Azar-2 cultivar showed the highest GP (Figure-3) and VI (Figure-4) compared to cultivar Sardari.

Priming duration significantly affected the germination parameters with highest GP observed in cultivar Azar-2 seeds osmoprimed with 20% PEG_{6000} for 12 h. Seeds osmoprimed with 10% PEG_{6000} solution for 24h had the largest stem. Maximum radicle length of cultivar Sardari was obtained at 20% PEG_{6000} solution primed for 24h. In cultivar Azar-2 maximum VI was obtained from seeds primed at 0.5% KH_2PO_4 solution. Osmopriming the seeds with 4% KCl solution resulted in the lowest GP (Figure-5) and VI (Figure-6).

Maximum seedling, stem and radicle length and seedling fresh weight were obtained from seeds primed for 24 h (Table-1). Priming the seeds at 20ºC treatment had better effects on GP, VI , CV, seedling, stem and radicle length and seedling fresh weight compared with other temperature treatments (Table-2).

The results of the present study are in agreements with observations of Harris *et al*. (2001) who reported that wheat seed soaking in tap water overnight resulted in earlier emergence, deeper roots, earlier flowering and maturity, and higher yield. Findings of Giri and Schillinger (2003) indicated that priming the wheat seed with KCl and PEG_{6000}) could not positively affect germination while priming with water could increase

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germination rate. In present study, PEG_{6000} caused the maximum radicle length (Figure-1), seedling length (Figure-2) and the maximum GP (Figure-5). This result is not agreement with Moradi Dezfuli *et al.* (2008) who reported that PEG6000 soaked seeds did not act well from germination point of view, possibly due to low osmotic potential of the solution or long priming duration. Sharifzadeh *et al.* (2006) also found that osmopriming of wheat had no positive significant effect on germination characteristics. However, Jie *et al.* (2002) reported that osmopriming of the wild rye seeds with PEG_{6000} in resulted in higher Super Oxide Dismotase (SOD) and Peroxidase (POD) activity that ultimately resulted in higher germination rate. Basra *et al.* (1989) found that priming corn seeds by poly ethylene glycol or potassium salts (K_2HPO_4 or KNO_3) resulted in accelerated germination. The PEG_{6000} concentration is chosen in such a way that it dose not allow seed to absorb enough water to germinate.

The three early phases in seed germination are (i) imbibition, (ii) lag phase and (iii) protrusion of the radicle through the testa (Simon, 1984). Priming affects the lag phase and causes early DNA replication (Bray *et al.*, 1983), increased RNA and protein synthesis (Fu *et al.*, 1988), greater ATP availability (Mazor *et al.*, 1984), faster embryo growth (Dahal *et al.*, 1990) and repair of deteriorated seed parts ((Shaha *et al.*, 1990). However, osmopriming has been shown to activate processes related to germination, through affecting the oxidative metabolism such as increasing SOD and POD (Jie *et al.*, 2002) or through activating ATP_{ase} (Mazor *et al.*, 1984) acid phosphatase and RNA synthase (Fu *et al.*, 1988). Seed priming with 4% KCl solution did not affect seed vigor, possibly due to its phytotoxic effects on embryo germination. Our finding agrees with Giri and Schillinger (2003) in such a manner maximum CV and VI were obtained from seeds primed for 12h. Maximum seedling length observed in seeds osmoprimed with 10% PEG_{6000} solution for 24 h. Giri and Schillinger (2003) also reported that wheat seed priming with water for 12 h acted similar or even better than other priming media. Moradi Dezfuli *et al.*, (2008), however reported that maximum maize GP was achieved when seeds hydro primed for 36 h. Other experiments showed that priming of wheat seed in osmoticum or water may improve germination and emergence (Ashraf and Abu-shakra, 1978) and promote vigorous root growth (Carceller and Soriano, 1972) under low soil water potential compared with the untreated seeds.

Results also showed that treating seeds in temperature of 20 ºC improved germination parameters compared to 23 ºC and 28 ºC. Sharif Zadeh *et al.*, (2006) have also reported that vigor, radicle and stem length in wheat seedling were significantly higher at 20ºC than 10 ºC.

Overall it could be concluded that suitable priming the wheat seeds for 12 h in low concentration PEG_{6000} or KH_2PO_4 at the temperature of 20ºC resulted in higher germination percentage and seed vigor.

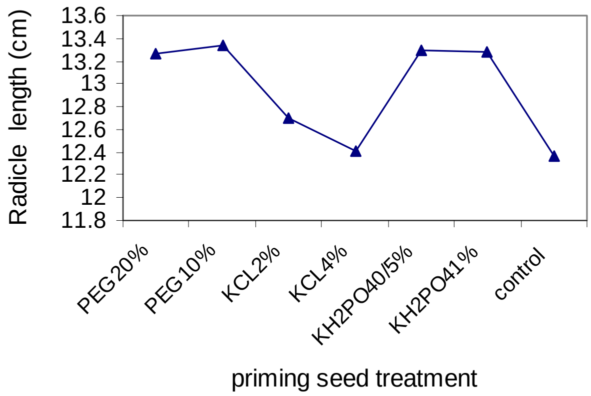

Fig 1. Influence of seed priming treatments on radicle length of wheat (Triticum aestivum L.)

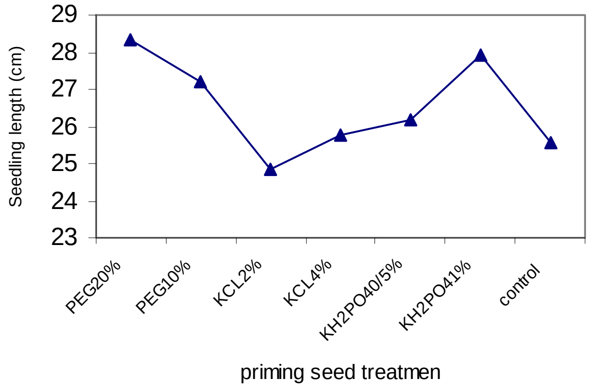

Fig 2. Influence of seed priming treatments on seedling length of w heat (Triticum aestivum L.)

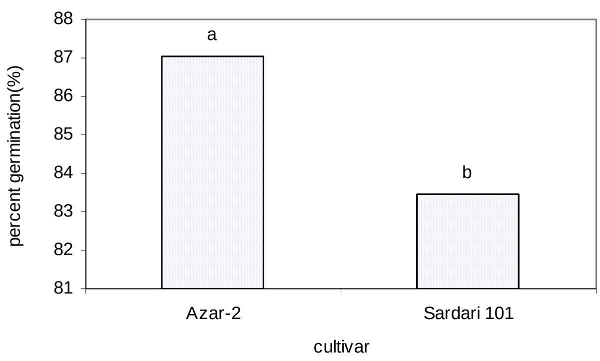

Fig 3. Germination percentage of wheat cultivars

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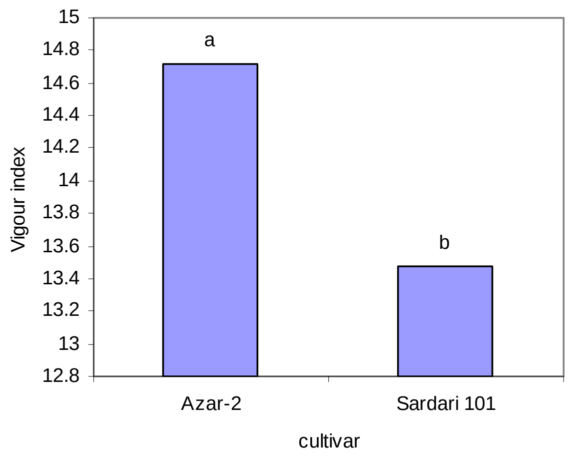

Fig 4. Vigor index of wheat cultivars

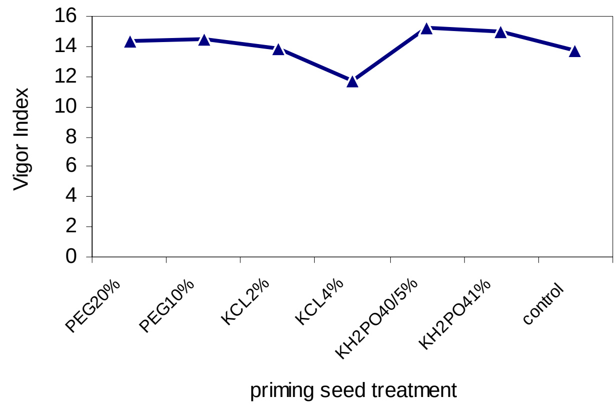

Fig 6. Influence of seed priming treatments on Vigor Index of w heat (Triticum aestivum L.)

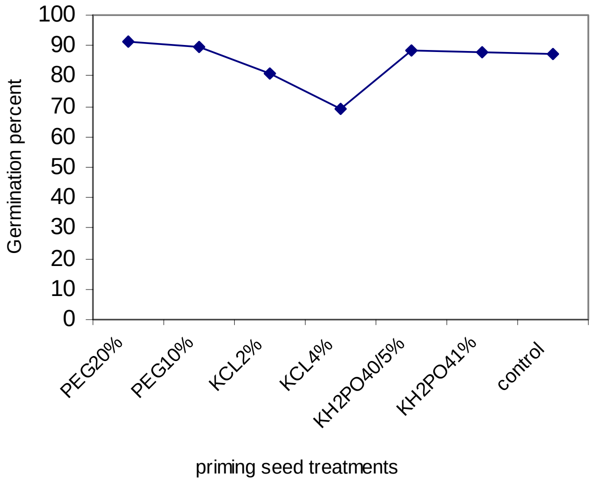

Fig 5. Germination percentage of wheat seed influenced by different priming solutions

Table-1. Effect of priming duration on the germination parameters and vigor index of wheat.

Time (hour)	**GP** (%)	**VI**	**Coefficient of velocity**	**Seedling fresh Weight** (g)	**Seedling length** (cm)	**Stem length** (cm)	**Radicle length** (cm)
12	87.54a	15.57a	48.49 a	1.1 a b	24.56c	13.3a	12.52b
24	83.99b	13.17b	45.79 b	1.14a	27a	13.33a	13.28a
36	84. 24b	13.54b	48.02 a	1.07 b	26.27b	12.03b	12.59a

Table-2. Effect of temperature treatment on the germination parameters and vigor index of wheat.

Temperature (°C)	**GP** (%)	**VI**	**Coefficient of velocity**	**Seedling fresh weight** (g)	**Seedling length** (cm)	**Stem length** (cm)	**Radicle length** (cm)
20	87.28a	15.3a	47.97a	1.14a	26.6a	13.27a	13.3a
23	84.4b	13.64b	47.44ab	1.1ab	26.1a	12.98a	12.8b
28	84.08b	13.3b	46.89b	1.08b	25.1b	12.43b	12.6b

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