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EFFECT OF SEED PRIMING ON GRAIN YIELD AND YIELD COMPONENTS OF BREAD WHEAT (*Triticum aestivum* L.)

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ABSTRACT

In order to evaluate the effect of seed priming on seedling emergence, grain yield and yield components of wheat, a 2-year experiment was conducted at Seed and Plant Certification & Registration Institute (SPCRI) in Karaj, Iran, from 2008-2010. Two cultivars (Azar-2, Sardare-101) × four priming media and control (unsoaked) were used in this experiment in field. Seeds were primed for 12 hour and 20°C in four priming media (PEG 10%, KCl 2%, KH_2PO_4 0.5%, distilled water) and control. Results of comparing means showed that osmotic priming with PEG10% had positive significant effects on emergence percentage, straw, grain and biological yield compared to other seed priming treatments (KCl 2%, KH_2PO_4 0.5% and distilled water). It was recognized that the maximum straw, biological yield, kernel weight, number of spikes per m^2 was obtained from Sardari-101 meanwhile the highest number of kernels per spike was achieved from Azar-2. Results of interaction between year × seed priming treatment showed that maximum seed yield was obtained from PEG 10% and Sardari-101 (with average of 420 gr/m2).

Keywords: bread wheat, seed priming, emergence percentage, yield, yield components.

INTRODUCTION

Osmotica have shown good potential to enhance germination, emergence, growth, and grain yield of wheat include solution of potassium pyrophosphate (KH_2PO_4), monobasic (Das and Choudhury, 1996), poly ethylene glycol (PEG) (Dell' Aquila and Taranto, 1986), and potassium chloride (KCL) (Misra and Dwibedi, 1980). Seed priming with potassium salts (1%) for 18 h increased wheat yield under dry land condition (Paul and Choudhury, 1991). According finding above, seed priming has positive effect on germination, emergence, seedling growth and yield in wheat. Dell-Aquila and Tritto (1990) reported that primed seeds emerged 12h earlier than non primed seeds. This may be due to increase in activity of enzymes such as amylase, protease and lipase which have great role in break down of macromolecules for growth and development of embryo that ultimately resulted in early and higher seedling emergence. On-farm seed priming involves soaking the seed in water, surface drying and sowing the same day. The rational is that sowing soaked seed decrease the time needed for germination and may allow the seedling to escape from deteriorating of soil physical condition. Besides better establishment, farmers have reported that primed crops grew more vigorously, flowered earlier and yielded higher. In wheat, researchers have recorded mean yield increases in six large series of on-farm trials of 5% to 36% (Harris *et al*., 2001). Kant *et al*., (2006) reported that priming seed improves stand establishment, growth and yield of late sown wheat in rice-wheat systems. Poor stand establishment results in less tillers and ultimately reduced grain yield. Seed priming improves the germination rate, speed and uniformity even under less than optimum field condition (lee *et al*., 1998, kant *et al*., 2006) thus enabling the establishment of uniform and good crop stand establishment. Due to readily available food during germination (Farooq *et al*., 2006), primed seed are better able to complete the process of germination in a short time and cope with environmental stresses including low temperature (Kant *et al*., 2006, Farooq *et al*., 2007). Zheng *et al*., (2002) also reported significantly higher and more rapid germination of osmoprimed rice seeds at low temperature (5°C). Another manifestation of seed priming was the substantial increase in the number of total and fertile tillers. As compared with osmopriming, hydro priming clearly improved speed of emergence, vigor index and seedling dry weight (Ahmadi *et al*., 2007). It has been reported that wheat seed hydro priming for less than 12 h is more effective than other methods (Giri and Schillinger, 2003) so it can increase the rate and extent of emergence, improve seedling vigor, earlier flowering and maturity and increase the yield (Harris, 2006). Although some priming methods enhance germination and emergence in the laboratory and greenhouse, they may have limited practical values for promoting seedling emergence under field condition (Giri and Schillinger, 2003). Effect of on-farm seed priming on consecutive daily sowing occasions showed that priming increased final emergence in all sowing occasions, leading to a 14% increased in crop stand. Priming decreased mean time to 50% emergence. There was little effect of priming on growth, time to flowering and maturity, or yield of plants that had emerged on the same day from primed or non-primed seed (M urung *et al*., 2004). On-farm seed priming (soaking seeds in water prior to sowing) has been shown effective in producing earlier germination, better establishment and increased yields in range of crops in many diverse environments. On-farm seed priming for barley was found to increase yields of both grain and straw (Rashide *et al*., 2006). Investigation of seed priming on some germination aspects of different canola cultivars showed that priming with different solution (KCl 2%, KCl 4%, KH_2PO_4 0/5%, KH_2PO_4 0/1%, distilled water), increasing the mean stem and root dry weight or mean germination rate at suitable priming times, can cause better and faster seedling establishment in the early season and thus can improve the plant tolerance against unfavorable environmental conditions (Saeidi *et al*., 2008).

MATERIALS AND METHODS

A 2-year experiment was conducted at Seed and Plant Certification and Registration Institute (SPCRI) in Karaj, Iran, from 2008-2010. Experimental design was a two-factor factorial wheat cultivar (Azar-2, sardare 101), priming media (PEG 10%, KCl 2%, KH_2PO_4 0/5%, distilled water plus a check) using randomized complete blocks with four replications. Seed was fully immersed in priming media at 20°C temperature, duration of 12h. All seed was then rinsed thoroughly with distilled water and lightly hand dried using blotting paper. Then allowed to dry on paper towels at room temperature (24°C) until seed water content was 120 g kg $^{-1}$ as measured with a grain moisture meter. Seed was stored at 8+_2 °C. Planting rate was 200 seeds row-1 per individual 5m long plot. A four-row deep-furrow with 35 cm row spacing was used for planting in summer fallow. A 13cm deep soil layer covered the seed. Average annual precipitation during the experiment was 159 mm and 216 mm for 2009 and 2010, respectively. Emergence was measured by counting all individual seedlings from the two center rows at 7 and 45 day after planting (DAP). Whole plots were harvested with laborer by using hand. Finally yield and components of yield were measured. Experimental data were analyzed using SAS (statistical software, SAS institute, 2002) and treatment means were compared using Duncan's multiple range tests at 5% level of probability.

RESULTS AND DISCUSSIONS

Seedling emergence, number of spikes in m^2, straw rate, grain and biological yield were significantly affected by Seed priming techniques ($p<0.01$). The maximum and minimum seedling emergence percentage was attained from applied PEG 10% and KCl 2% priming media, respectively. The seedling emergence percentage was increased as 69.95% by using PEG 10% which was 12.7% more than control treatment meanwhile it was decreased 10.5% less than unprimed control by using KCl 2% treatment. The highest grain yield (346 gr/m^2), straw rate (977.6 gr/m^2) and biological yield (1323.9 gr/m^2) was attained from PEG 10% priming media. Also the highest and lowest numbers of spikes in m^2 was attained from PEG 10% (466.69 P/m^2) and control (369 p/m^2), respectively (Table-1).

Table-1. Means comparison of characteristics by using Duncan multiple range test in seed priming treatment.

Seed priming treatments	Percent emergence	Grain yield (g/m^2)	Straw (g/m^2)	Biological yield (g/m^2)	Numbers of spikes in m^2	Number of spikelet in spikes in m^2	Number of kernels spike^{-1}	Kernel weight
10 PEG %	69.95a	346.38a	977.61a	1323.98a	466.69a	15.09a	27.46a	46.73a
KH_2PO_4 0/5%	57.54b	298.13b	661.37b	959.50b	452.56a	14.88a	27.37a	44.25a
KCL_2%	54.62b	293.32b	964.16a	1257.48a	442.88a	14.84a	27.07a	47.98a
distilled water	55.01b	322.03ab	876.25a	1198.27a	383.00b	14.97a	27.13a	46.15a
control	61.05ab	340.61a	909.41a	1250.02a	369.06b	15.11a	27.61a	46.74a

These findings are in line with Harris *et al*., (2001) who states that priming of wheat seed in osmoticum or water may improve germination and emergence and promote vigorous growth, improve tillering, earlier flowering, earlier maturity and producing higher grain yield. Dell-Aquila and Tritto (1990) reported that wheat seed primed as 12 h duration had earlier emergence compared to untreated control which might in order to increment of enzymes activity such as amylase, protease and lipase that have a great role in initial growth and development of embryo. Every increase in activity of these enzymes results in faster initial growth of seedling therefore its establishment improvement result in higher yield. Osmotica have shown good potential to enhance germination, emergence, growth, and grain yield of wheat include solution of potassium hydro phosphate (KH_2PO_4), polyethylene glycol (PEG) (Dell-Aquila and Taranto, 1986), and potassium chloride (KCL) (Misra and Dwibedi, 1980). Seed priming has been more effective at second stage of seed germination (breaking down the storages and transition the nutrients to embryo axis) which makes RNA ratio increment, protein synthesis improvement and ATP increment for faster growth of deteriorated embryo and improvement in seed emergence (Ruan *et al*., 2002; Giri and Schillinger, 2003; Basera *et al*., 2005; Farooq *et al*., 2006; Dahal *et al*., 1990; Fu *et al*., 1988). Furthermore it has been shown that osmopriming (PEG) activates some phenomena in relation to germination via effect on Super Oxide Desmotase (SOD) and Peroxide Desmotase (POD) (jie *et al*., 2002). Ahmadi *et al*., (2007) reported improvement in emergence speed, vigor index and seedling dry weight while the effects of PEG on mentioned traits compared to hydropriming was less. Giri and Schillinger (2003) reported that no one of priming media (H_2O, KCL, PEG) had priority than unprimed control from the aspect of grain yield. These findings are not in line with our results. Misra and Dwivedi (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. Meanwhile in this research KCL treatment had positive and significant effect on biological yield but it showed descending trend (negative) in the respect of grain yield compared to unprimed control treatment. The effect of cultivar on Number of kernels in spike, 1000 grain weight and number of spikes in m^2 was significant ($p<0.01$). The highest 1000 grain weight, number of spikes in m^2, straw and biological yield was achieved from Sardari-101 while highest number of spikelet in spikes was attained from Azar-2. Furthermore the effect of cultivars on straw and biological yield was significant ($p<0.05$). There was not observed any difference between cultivars in the respect of emergence percentage and grain yield (Table-2).

Table-2. Means comparison of characteristics by using Duncan multiple range test in two wheat cultivar.

Cultivar	Percent emergence	Grain yield (g/m^2)	Straw (g/m^2)	Biological yield (g/m^2)	Numbers of spikes in m^2	Number of spikelet in spikes in m^2	Number of kernels $spike^{-1}$	Kernel weight
Azar-2	59.88a	318.11a	841.84b	1159.95b	393.35b	14.98a	29.10a	44.47b
Sardare-101	59.38a	322.10a	913.68a	1235.75a	452.30a	14.98a	25.57b	48.28a

Interaction effects of priming treatment*cultivar on grain yield, straw and biological yield was significant ($p<0.01$). Meanwhile Interaction effects of priming treatment*cultivar on spikelets number in spike, number of kernels in spike, number of spikes in m^2 and percent of emergence was not significant. The highest grain yield (with average 367.97 gr/m^2) was belonged Azar-2 by applying distilled water treatment while lowest grain yield (with average 247.8 gr/m^2) was attained from Azar-2 by applying KH_2PO_4 0/5% treatment. Evaluating the interaction effects showed more positive effect of water on yield improvement than the other seed priming treatments. The highest and lowest biological yield was attained from Sardari-101 by using KCl 2% treatment and Azar-2 by applying KH_2PO_4 0/5%, respectively. Interaction effect of cultivar* year was significant on spikelets number in spike, number of spikes in m^2, percent of emergence and seed yield ($p<0.01$). The highest and lowest spikelet number in spike was achieved from Sardari-101 in second and first year, respectively. This result displays different reaction of Sardari-101 during two consecutive years and recognizes its instability at this weather condition. Furthermore the interaction effect among cultivar*seed treatment priming* year was significant on emergence percent, grain yield ($p<0.01$) and number of spikes in m^2 ($p<0.05$). The highest and lowest emergence percent was achieved from Sardari* PEG 10%* first year (87.6%) and azar-2* KCl 2%* second year (40.8), respectively. The findings of some previous researchers about effect of seed priming on seed emergence rate in seed rape, bean and wheat are in agreement with our results (Saeidi *et al.*, (2008); Kant *et al*., (2006); Harris *et al*., (2001). But Ahmadi *et al*., (2007) reported that the positive effect of PEG on wheat had been less than water. Eavaluating the hydro priming and osmopriming effect on germination and seed emergence on lentil resulted in better effect of hydro priming treatment on germination speed and radicle weight. Also it was recognized that the PEG treatment had better condition compared to unprimed control treatment (Ghassemi-Golezani *et al*., 2008). The highest seed yield was achieved from Sardari-101* PEG 10%* first year (420 gr/m^2 in average). Some previous researchers found significant effect of seed priming on seed yield at barely, bean and wheat (Rashide *et al*., 2006; Kant *et al*., 2006; Harries *et al*., 2001). Also the Farooq *et al*., (2006) reported that osmohardening with $CaCl_2$ and KCl in rice makes physiological changes in seed and causes increment of starch hydrolysis and more sugar would be available for embryo fed and finally resulted in vigorous seedling, progress in plant growth, improvement in seed yield and making more quality.

Greater efficiency of osmohardening with $CaCl_2$ and KCl is possibly related to the osmotic advantage that both K^+ And Ca^{2+} Have an improving cell water status, and also in that they act as cofactors in the activities of numerous enzymes (Taiz and Zeiger, 2002), most which are active when reserve metabolization and radical protrusion are in prpogress (Farooq *et al*., 2006). Highest and lowest number of spikes in m^2 was produced from Sardari-101* PEG 10%* first year and Azar-2* unprimed control* first year, respectively. Harris *et al*., (2001) and (Zheng *et al*., 2002) found increasing of tillers number in rice and wheat via applying seed priming treatment. There was significant difference and positive correlation among percent of emergence, biological yield, and grain yield and kernel number in spike. Also significant difference and positive correlation was observed between kernel number in spike, spikelet number in spike but there was negative correlation between spikelet number per spike and percent of emergence ($p<0.05$). Furthermore there was negative correlation among biological yield, kernel number in spike and 1000 grain weight. In conclusion the result of the study have shown that PEG 10% treatment is a better treatment to increase emergence percent, grain yield, straw rate and biological yield. Present data also suggest that Sardari-101 produced highest straw rate, 1000 grain weight, biological yield and numbers of spikes in m^2 among cultivars. In addition Azar-2 had priority in the respect of numbers of kernel in spike than other cultivars. Furthermore there was not observed significant difference between Sardari-101 and Azar-2 about grain yield. Also Highest grain yield was attained from Sardari-101* PEG 10%* first year (420g/m^2) (Figure-1, 2).

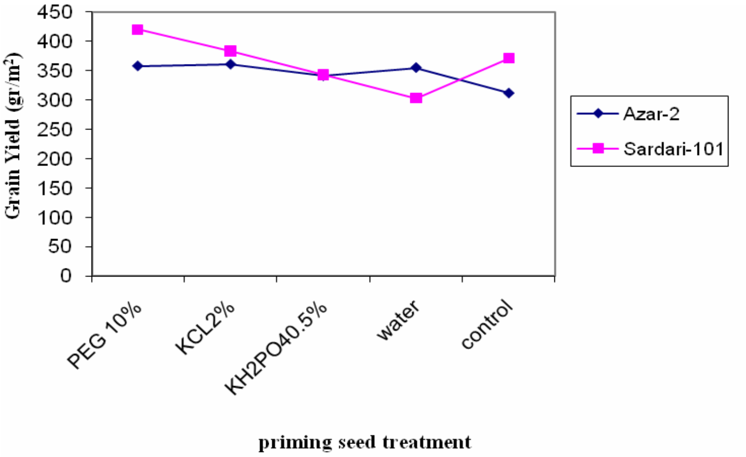

Fig 1.Interaction effect of seed priming and cultivar on grain yield in first year

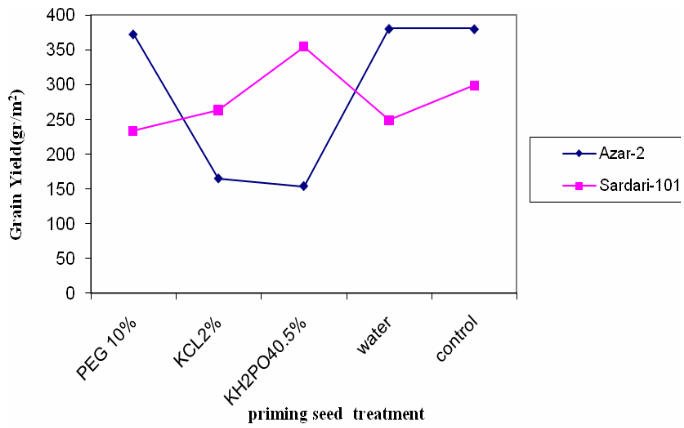

Fig 2.Interaction effect of seed priming and cultivar on grain yield in second year

The emergence percent, biological yield, straw rate, 1000 grain weight and numbers of spikes per m^2 characteristics were different in two consecutive years. Also it was observed that above traits had good condition in first year than second year. Furthermore it was recognized that the number of spikelet in spikes in m^2 and Number of kernels in spike in second year was more than first year (Table-3).

Table-3. Means comparison of characteristics by using Duncan multiple range test in two year experiment.

Year	Percent emergence	Grain yield (g/m^2)	Straw (g/m^2)	Biological yield (g/m^2)	Numbers of spikes in m^2	Number of spikelet in spikes in m^2	Number of kernels spike^{-1}	Kernel weight
1	67.53a	355.03a	1100.02a	1455.05a	444.77a	13.83b	25.16b	47.98a
2	51.73b	285.20b	655.50b	940.65b	400.90b	16.13a	29.51a	44.75b

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