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Study of Osmotic Priming Effects on Wheat (*Triticum aestivum*) Germination in Different Temperatures and Local Seed Masses

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Abstract: Early and late cold stress in fall and spring, saline, drought and heat stress are also some important factors for decreasing percent and rate of germination in wheat. Osmotic priming increases the rate of germination and monotonousness of emergence and decrease undesirable effects of stress by changing on activity of some seed enzymes. In present study, we investigated effects of osmotic priming treatments in different osmotic potential and period of priming, in two temperatures (10 and 20°C) and two local seed masses of Sardary wheat (*Triticum aestivum*) cultivar. Experiment was planned on base of Randomized complete block design in form of factorial with three replications and three factors in seed laboratory of agricultural collage of Tehran University. Some germination characters such as rate of germination, length of radicle and caulicle, dry weight of seedling and vigor were measured. Results showed the significant effect of temperature and osmotic priming treatments in addition, interactions between them for measured characters were significant. Results of comparing means showed that osmotic priming treatments had no positive significant effects on germination characters, it is possible because of high osmotic potential and long priming period that cause prevention of water absorption and produce free radical of oxygen that destroys the cell membrane. In this situation LEA (late embryogenesis abundant) protein was also degraded so all of this cases cause decrease of the rate of germination.

Key words: Germination, osmotic potential, osmotic priming, temperature, wheat (*Triticum aestivum*)

INTRODUCTION

Sowing date of dry land wheat depend on occurrence of the first rainfall in spring or in fall. In some areas, fall rainfall occurs late that it causes early chilling of seedling. Increasing time of seedling emergence due to unsuitable seedbed, land preparation and environmental conditions cause weak seedling establishment and ultimately decreases yield. In semi arid area, the ability of germination at low temperature let us sow in fall and it allow semiarid root system to absorb a lot of water so the root continues its growth whenever top soil is arid (Wade *et al.*, 1993).

Increasing seed size due to plant breeding and increasing genetic potential for improvement of seed vigor is not enough thus other strategies that increase seed quality such as germination rate and synchrony and strong seedling in unfavorable conditions have emphasized. After two decade of knowing of seed priming mechanism, nowadays seed priming is common action for increasing the resistance of seedling against unfavorable environmental conditions that is used for many crops (Ashraf and Foolad, 2005).

In priming, seed is exposed to osmotic solution such as Poly Ethylene Glycol (PEG), Manitol then priming seed is sowed. In this condition, the seed absorbs limited water due to osmotic potential of solution and some metabolic processes start but radicle does not protrude because of osmotic condition and priming period (Pill and Necker, 2001). In pea (*Pisum sativum*) seeds, it have been reported that priming treatment with PEG increased the final germination and decreased the Mean Germination Time (MGT). Most of the benefits for improvement of ageing damage occurred during the first 3 day with PEG or ABA and during the first 5 day with distilled water (Sivritepe and Dourado, 2002). About *Pinus sylvestris* and *Larix deciduas* seeds, it was reported that priming with PEG + 200 mg kg⁻¹ gibberelic acid (GA₃) resulted in appreciably higher free radical contents than in unprimed control sample (Naglireiter *et al.*, 2005). In grass seeds, seed priming enhanced both germination and emergence rate with the greatest effect occurring during the earlier, cooler planting dates (Hardegree and Vanvector, 2000). In Norway spruce (*Picea abies* (L.) Karst.), low osmotic potential with PEG affected germination of the embryos negatively (Find, 1997).

Suitable period of priming varies according to a kind of osmotic matter, potential of osmotic solution, temperature and a kind of plant. Priming period is important because if it becomes long, the radicle emerges so priming benefits disappear. About lettuce (*Lactuca sativa*) seeds, suitable period for priming with PEG have been reported about a few hours but in parsley (*Petroselinum crispum*), it have been reported about 5 days in saline solution and about 3 weeks in PEG solution and it have reported 14 days for spinach (*Spinacia oleracea* L. (Nascimento and West, 1998). About Purple coneflower seeds (*Echinacea purpurea* (L.) Moench), it have been reported that osmotic or matric priming for 10 days at -0.4 MPa and 15°C resulted in higher germination rate and percentage than shorter (5 day) exposure or lower (-1.5 MPa) water potential. Seedling emergence rate, synchrony and percentage from osmotically or matrically primed seeds were similar in both cool (23-27°C day) and warm (35-40°C) glasshouse regimes (Pill *et al.*, 1994).

The purpose of this study was to evaluate the effect of different treatments of osmotic priming and different temperatures and local seed masses on some characters of germination of dry land wheat.

MATERIALS AND METHODS

This experiment studding the effect of different osmotic priming treatments and two temperatures on germination of Sarddari wheat; a factorial arrangement of a randomized complete block design with three replications was conducted in 2004 at Seed Laboratory, College of Agriculture, the Tehran University, Iran.

Three factors including priming treatments, various temperatures and various local seed masses were applied. Priming treatments including seven levels of osmotic potential, T₀ (control, distilled water), T₁ (-12 bar and 24 h), T₂ (-12 bar and 48 h), T₄ (9-14 bar and 96 h), T₅ (-17 bar and 96 h), T₆ (-16 bar, 192 h). Temperature factors including two levels, 10, 20°C and local seed mass factors including

two levels, Azarbaijan and Gazvin were applied. Vant-hoef rule was used for preparation of osmotic solution. There were 25 seeds in every Petri dish and 6 cc of PEG solution was added them. After completing seed priming period, seeds were washed and relatively dried then 6 cc of distilled water was added to them and fungicide was used against fungal diseases. Two germinators that were regulated at 16 h lightness and 8 h darkness and 80% of relative humid were used. Two millimeters growth of coleoptile was the criterion for germination. Following formula estimated germination rate:

$$MGT = \sum T_i \cdot N_i / S$$

Where MGT is mean germination time, T_i is day number after trial beginning, N_i is germinated seed number in i th day and S is whole number of germinated seeds. Vigor was estimated by this formula: [(radicle length + caulicle length). germination percent]. Data of seedling weight were not normal therefore inverse sin transformation was used for normalizing. The data analyzed by MSTATC and Excel software and means comparisons was done by Duncan's test.

RESULTS AND DISCUSSION

Results showed that the effect of temperature and priming treatments on all measuring characters were significant. Temperature and priming treatment interaction for germination rate and radicle length in addition, vigor and local seed masses interaction for caulicle length and vigor was significant (Table 1).

Mean comparisons of studding characters wholly showed that when priming period and osmotic potential of solution increase, the amount of the characters decrease. Mean comparisons of priming treatment and temperature interaction for germination rate showed that priming treatments in contrast to control, in both local seed masses have a low germination rate and in both seed masses, priming treatments, T₆, also has the lowest germination rate. Whereas temperature and treatment

Table 1: Variance analysis of the effect of priming treatments, temperatures and local seed masses on some germination characters of wheat

Source of variation	Degree of freedom	Caulicle length (cm)	Radicle length (cm)	Germination rate (day)	Vigor (cm day)	Seedling weight (g)
Replication	2	8.53*	7.31ns	0.066ns	30.65ns	0.02ns
Local seed mass	1	0.02	3.42ns	0.005n	2.82ns	0.05**
Temperature (°C)	1	1154.78**	1490.71**	79.63**	4653.33**	0.11**
Priming treatment	6	17.26**	43.89**	16.95**	114.81**	0.03**
Local seed mass × temperature	1	0.17ns	0.14ns	0.055ns	0.62ns	0.009ns
Local seed mass × primng treatment	6	7.44*	9.41ns	1.55ns	29.00*	0.007ns
Primng treatment × temperature	6	2.69ns	16.38*	1.72**	26.46*	0.004ns
Local seed mass × Priming treatment × temperature	6	8.38**	7.01ns	3.72ns	7.02ns	0.003ns
Error	54	2.52	6.11	0.196	11.40	0.007
CV (%)	-	24.53	34.25	11.61	19.21	31.06

*, **: significance at the 0.01, 0.05 level of probability, respectively; ns = not significant

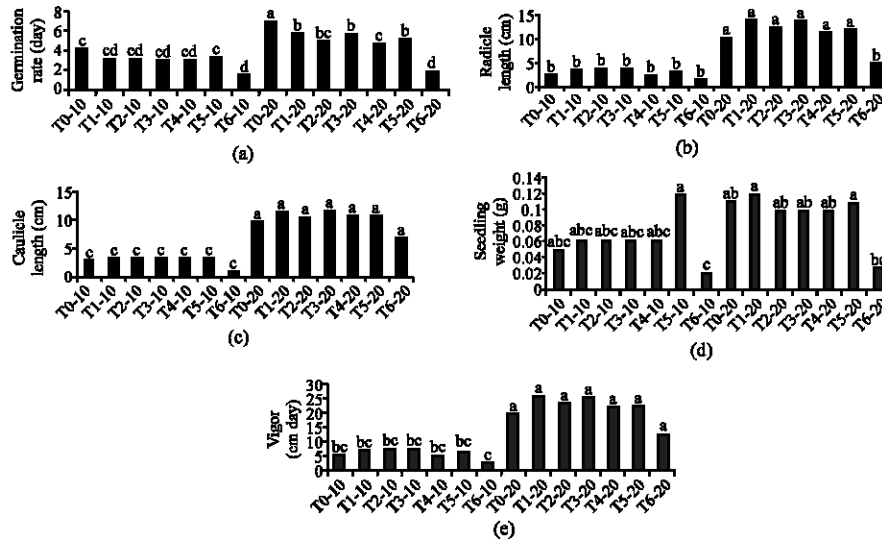


Fig. 1: The effect of osmotic priming treatments and temperatures on germination rate (a) radicle length (b) caulicle length (c) seedling weight (d) vigor and (e) of wheat (means of two local seed masses) (Duncan multiple range test).

interaction for vigor, radicle length and caulicle length in both seed masses showed that at 20°C temperature, amount of these characters were significantly higher than that of 10°C but did not observe difference among priming treatments (Fig. 1).

It is probable that the lack of effect of priming treatments on seed germination rate was due to elongation of priming period and due to high osmotic potential as previous experiments have shown that in long period priming (more than 2 h), germination rate reduced. Probably due to degradation of LEA (late embryogenesis abundant) protein (Ashraf and Foolad, 2005) and probably high osmotic potential does not let seed absorb required water for starting metabolic activities and probably production of oxygen free radicle at this condition can also damage cell membrane thus advantage effect of priming disappears. Whereas suitable conditions of osmotic priming with PEG in wild rye resulted in higher Super Oxide Dismotase (SOD) and Proxidase activity that ultimately resulted in higher germination rate (Jie *et al.*, 2002)

The results of previous experiments showed that application of suitable priming treatments can result in higher germination rate and vigor for seeds of tomato (Ali *et al.*, 1990; Argerich and Bradford, 1989; Liu *et al.*, 1996; Muhyaddin and Wieble, 1989), onion (Ali *et al.*, 1990; Gray *et al.*, 1990), leek (Gray *et al.*, 1990), sunflower (Smok *et al.*, 1993) and pepper (Halpin-Ingram and Sundstrom, 1992). Enzymes such as amylase, protease and lipase 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. As Singh *et al.* (1999) reported that osmotic priming of muskmelon with PEG result in higher amylase and dehydrogenase activity and germination rate in saline condition increased.

In oil crops, glyoxalate pathway in which the lipids is converted to sugar has an important role at maturity and growth of embryo. Every increase in the activities of the enzymes that involve in this pathway can has the role on faster rate of embryo and at germination stage, too (Taiz and Zeiger, 2002).

In relation to the effect of temperature on priming, it has reported that temperature and high concentration of oxygen in osmotic priming of sugar beet resulted in faster metabolism of 11-s-globulin protein therefore germination rate improved. whereas along with increase of priming period, metabolism of this protein reduced and it resulted in reduction of germination rate in tomato in contrast to control (Carpon *et al.*, 2000). Some experiments have also shown that improvement of germination rate of tomato is because of creation a space in priming seeds that this action facilitates water absorption (Argerich and Bradford, 1989).

By result of this experiment and other experiments, we can conclude that suitable priming period and osmotic potential at higher temperature on optimum temperature range can result in higher germination rate and emergence

synchrony whereas high priming periods and osmotic potential result in reduction of amount of germination characters.

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