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THE EFFECT OF DIFFERENT PRIMING TREATMENTS AND GERMINATION TEMPERATURES ON GERMINATION PERFORMANCE OF LENTIL (*Lens culinaris Medik*) SEEDS

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ABSTRACT

In order to develop suitable techniques to improve lentil seed germination capacity, a research was conducted with cultivar Local Red lentil cultivar. Seeds were fully soaked in KH_2PO_4 (%1.0), KNO_3 (%1.0) solutions for osmo-priming, and distilled water for hydro-priming treatments, for 12 and 24 hours at a 24°C and untreated seeds as control. After the priming treatments, seeds were germinated at six different (5, 10, 15, 20, 25 and 30 ± 0.5°C) constant temperatures. In terms of both germination percentage and MGT, the highest results were obtained from priming treatment of water at germination temperature of 20°C in priming times of 12 h and 24 h. The best germination synchrony value was obtained from water treatment for 12 h at 15°C. Consequently, seeds treated with water for 12 h produced the highest germination percentage and the least mean germination time and synchrony, in this way this treatment may be recommended for germination of lentil under different germination temperatures.

Keywords: lentil (*Lens culinaris* Medik.), priming, KH_2PO_4, KNO_3, germination temperatures.

INTRODUCTION

Lentil (*Lens culinaris* Medik.) is the fourth most important pulse (legume) crop in the world and used as a cheap source of protein for people since the beginning of agriculture. Major lentil producing countries are India, Canada, America and Turkey (FAO, 2010). Lentil is at the second rank among the grain legumes in Turkey in respect of sowing area and production, being 2.116 000 da and 422 000 tones, respectively (TUIK, 2010). It is an annual grain legume, predominantly grown in the winter and cultivated extensively in rainfed areas of Turkey where rainfall is not only low but also variable. In addition to rainfall, high or low temperatures are the other important limiting factors in its cultivation. In these areas, important abiotic stress such as extreme temperatures, soil crusting, and excess of limitation of water may individually or in combination adversely affect the germination and emergence. The problem is worsened as the length of time to emergence increases. Delayed emergence also increases the seedlings to be infected by damping-off causing pathogens. Thus, obtaining ideal plant stands requires fast and uniform emergence to avoid these problems. The methods to increase plants tolerance to stress include genetic engineering, breeding (Vettakkorumakankav *et al*., 1999), in vitro selection, the use of plant growth regulators (Senaratna *et al*., 2000) and seed priming (Pill, 1995).

Seed priming is a pre-sowing strategy for influencing seedling development by modulating pre-germination metabolic activity prior to emergence of the radicle and generally enhances rapid, uniform emergence and plant performance to achieve high vigor and better yields (McDonald, 2000). During priming, seeds are soaked in different solutions with high osmotic potential so that pre-germinative metabolic activities proceed, while radicle protrusion is prevented, and then seeds are dried back to the original moisture level. Common priming techniques include osmo-priming (soaking seeds in osmotic solutions such as polyethylene glycol), halo-priming (soaking seeds in salt solutions) and hydro-priming (soaking seeds in water). Priming applications contribute to significant improvement in seed germination and seedling growth in vegetables (Dursun and Ekinci, 2010; Korkmaz, 2005; Korkmaz and Pill, 2003) and some field crops (Yari *et al*., 2010; Sağlam *et al*., 2010; Dezfuli *et al*., 2008; Ghassemi-Golezani *et al*., 2008; Sadeghi *et al*., 2011; Saeidi *et al*., 2008; Elkoca *et al*., 2007).

Although, the pervious studies indicate that some benefits are associated with pre-sowing treatments for seed vigor enhancement, there is dearth of information about the germination performance of primed seeds of lentil. So it was imperative to develop suitable techniques in order to improve lentil seed germination capacity.

MATERIALS AND METHODS

This study was conducted in a darkened growth chamber at six different (5, 10, 15, 20, 25 and 30 ± 0.5°C) constant temperatures at Plant Protection Research Institute, Adana, Turkey in 2011.

Seed material

Lentil seeds of cultivar Local Red with 100-seed weight of 33 g that can be grown in all the provinces of southeast Anatolia region were used in the present study. Hand selected seeds were initially treated with a 1.0% solution of sodium hypochlorite for surface sterilization. Residual chlorine was eliminated through washing of the seeds with distilled water.

Priming treatments

For osmo-priming, the sterilized lentil seeds were fully soaked in KH_2PO_4 (%1.0) and KNO_3 (%1.0) solutions. The seeds were soaked in distilled water for

hydro-priming treatments. All priming media were prepared in distilled water. The seeds were immersed in priming media for 12 and 24 hours at a 24°C. The treated seeds were than washed with distilled water and dried on a filter paper at room temperature and back to their original moisture content. Untreated seeds served as control.

Germination studies

Twenty seeds from each of the treatments were germinated in the Petri dishes which were containing two layers of Whatman No. 2 filter papers in 9 mm diameters with distilled water. In order to prevent evaporation, Petri dishes were tightly sealed with an impermeable colourless parafine, than placed in a germination cambers in darkness. Petri dishes were controlled at 8-h intervals and germinated seeds were counted and removed. A seed was considered to have germinated when the emerging ridicule longed 1 mm. Germination percentage (%) was evaluated by counting the number of normal seedlings at the end of the germination test. Mean Germination Time (h) was calculated based on the following equation

$$MGT = \sum Dn / \sum n$$

Where n is the number of seeds which were germinated on day D, and D is the number of days counted from the beginning of germination. Germination Synchrony (h) was calculated as time between 10% and 90% of germination.

Statistical analysis

All data were statistically analysed and comparisons between means were made using least significant differences (LSD) at 0.05 probability level. All statistical analyses were performed using the SAS program (SAS Institute, 1999).

RESULTS

Table-1. Effect of seed priming and priming time on germination percentage (%) of lentil seeds at different temperatures.

	Temperatures (°C)						
Priming treatments	**5**	**10**	**15**	**20**	**25**	**30**	**MEAN**
KH_2PO_4	86.9 c-f	92.5 a-d	96.9 ab	96.9 ab	97.5 ab	84.4 efg	92.5 A
KNO_3	97.5 ab	81.9 fg	90.0 b-e	93.8 abc	90.0 b-e	81.9 fg	89.2 B
Water	93.8 abc	85.0 d-g	97.5 ab	100.0 a	98.1 a	98.1 a	95.4A
Control	68.8 ı	71.3 hı	82.5 efg	85.6 d-g	83.8 efg	78.1 gh	78.3C
MEAN	86.7 B	82.7 C	91.7 A	94.1 A	92.3 A	85.6 BC	
Priming times							
12 h	83.1 cd	88.4 bc	90.0 ab	94.1 a	90.9 ab	82.2 de	88.2
24 h	90.3 ab	76.9 e	93.4 ab	94.1 a	93.8 ab	89.1 ab	89.7
Pt x Pd							
12 h							
KH_2PO_4	82.5 f-k	96.3 a-d	95.0 a-d	96.3 a-d	97.5 abc	76.3 ı-l	90.6 BC
KNO_3	96.3 a-d	88.8 b-h	86.3 d-ı	91.3 a-g	88.8 b-h	80.0 h-k	88.5 C
Water	88.8 b-h	93.8 a-e	97.5 abc	100.0 a	97.5 abc	96.3 a-d	95.6 A
Control	65.0 m	75.0 j-m	81.3 g-k	88.8 b-h	80.0 h-k	76.3 ı-l	77.7 D
24 h							
KH_2PO_4	91.3 a-g	88.8 b-h	98.8 ab	97.5 abc	97.5 abc	92.5 a-f	94.4 AB
KNO_3	98.8 ab	75.0 j-m	93.8 a-e	96.3 a-d	91.3 a-g	83.8 e-j	89.8 C
Water	98.8 ab	76.3 ı-l	97.5 abc	100.0 a	98.8 ab	100.0 a	95.2 A
Control	72.5 klm	67.5 lm	83.8 e-j	82.5 f-k	87.5 c-h	80.0 h-k	79.0 D

Analysis of variance show that germination percentage was significantly influenced by priming treatments and the highest value was obtained from water and KH_2PO_4 treatments in terms of priming treatment and at 15, 20, and 25°C in terms of temperature. All priming treatments induced higher germination percentage compared with un treatment seeds in all of the temperatures.

Priming time had no significant effect on germination percentage but temperature x priming time interaction was significant. Except for priming times of 12 h at 5, 10 and 30°C also that of 24 h at 10°C, all of the temperatures in both priming times increased the germination percentage.

Priming treatment x time interaction had significant effect on germination percentage and the highest values were obtained from water treatment

compared with other priming and control treatments in priming times of 12 h and 24 h.

With regard to priming time x treatment and temperature interaction, at priming time of 12 h and 24 h in all of the temperatures in priming treatment gave better germination percentage than that of control treatment.

In terms of germination percentage, the best result was obtained from priming treatment of water at germination temperature of 20°C in priming times of 12 h and 24 h.

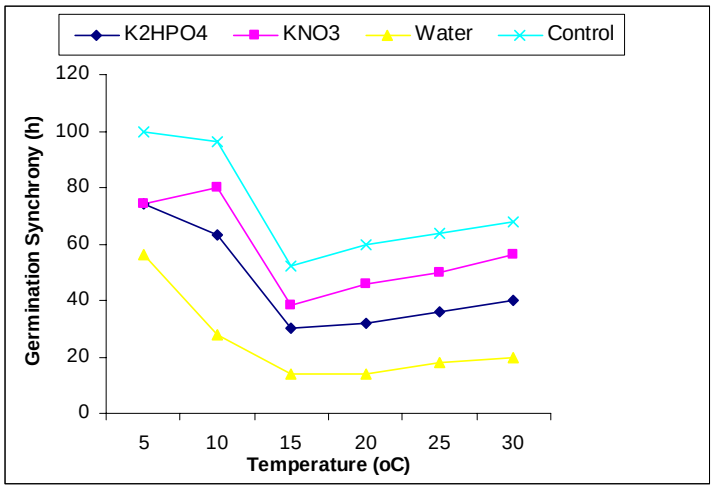

Figure-1. Germination synchrony (h) at different temperature with different priming treatments for 12 h.

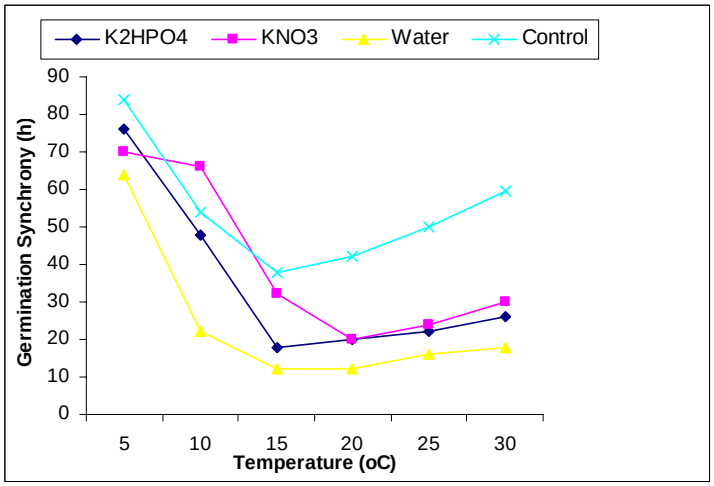

Figure-2. Germination synchrony (h) at different temperature with different priming treatments for 24 h.

All of the priming treatments significantly reduced hours between 10% and 90% germination. The least time was attained from 15 and 20°C at all of the used temperatures. Meanwhile, the interaction between priming and temperature significantly decreased compared with control seeds at all of the combination of priming and temperature. Priming time had no significant effect on germination synchrony, however compared with priming time of 12 h, priming time of 24 h significantly decreased hours between 10 and 90 % germination at 5, 10 and 15°C. Furthermore, germination synchrony was affected by priming and time. Generally, the least value was obtained from hydro-priming treatment compared with other treatments and control. Variance analysis and mean comparison results also show that 10% - 90% germination time was significantly influenced by priming x time x temperature interaction. The best germination synchrony value was obtained from water treatment for 12 h at 15°C. Osmo-priming treatments with KH_2PO_4 and KNO_3 increased hours required to reach 50% germination compare to hydro-priming treatment, whereas, the least MGT was obtained from water treatment. MGT were

significantly decreased by priming treatment at all of the germination temperatures and the least value was obtained from 25 and 30°C of germination temperatures. Priming treatment influenced the MGT compared with control seeds at all of the germination temperatures In generally, seeds primed for 24 h reduced hours required reaching 50 % germination compared with the seeds primed for 12 h, but there was no significant difference between priming durations. Depending on germination temperatures, mean germination time ranged between 30.5 h and 211.1 h in priming time of 12 h, and between 28.2 and 215.1 h in priming time of 24 h. In both priming times, lentil seeds reached the fastest 50% germination time at 25 and 30°C.

The interaction between priming and time was significant for MGT and the least values were obtained from water treatment compared with other priming and control treatments in both priming times.

A three-way interaction was determined for MGT, and the best result was obtained from water treatment of lentil seeds at germination temperature of 25 and 30°C in priming times of 24 h.

Table-2. Effect of seed priming and priming time on mean germination time (h) of lentil seeds at different temperatures.

	Temperatures (°C)						
Priming treatments	**5**	**10**	**15**	**20**	**25**	**30**	**MEAN**
KH_2PO_4	200.0 c	50.9 hı	37.0 jkl	35.1 klm	28.0 n	21.8 o	62.1 C
KNO_3	208.7 b	61.9 f	40.1 j	40.4 j	32.0 mn	22.2 o	67.5 B
Water	193.1 d	48.8 ı	33.2 lm	37.9 jkl	20.8 o	20.8 o	59.1 D
Control	251.3 a	109.7 e	54.9 gh	50.3 hı	38.3 jk	56.2 g	93.5 A
MEAN	213.3 A	67.8 B	41.3 C	40.9 C	29.8 D	30.2 D	
Priming times							
12 h	211.5 b	67.9 c	40.9 d	41.3 d	31.3 e	30.5 e	70.6
24 h	215.1 a	67.8 c	41.7 d	40.5 d	28.2 e	29.9 e	70.5
Pt x Pd							
12 h							
KH_2PO_4	196.7 de	52.8 hıj	40.6 mp	34.8 or	31.1 rst	22.5 uv	63.1 D
KNO_3	203.6 c	61.2 g	40.9 mp	42.6 kn	36.4 nr	23.9 uv	68.1 C
Water	194.5 e	49.8 ıj	31.1 rst	41.3 lo	22.2 uv	21.2 uv	60.0 EF
Control	251.2 a	107.8 f	51.1 ıj	46.7 jm	35.7 or	54.4 hı	91.1 B
24 h							
KH_2PO_4	203.3 cd	49.1 ıjk	33.3 qrs	35.4 or	24.8 tuv	21.0 uv	61.2 DE
KNO_3	213.8 b	62.6 g	39.3 nq	38.2 nq	27.5 stu	20.5 v	67.0 C
Water	191.8 e	47.9 ıl	35.4 or	34.4 pqr	19.5 v	20.3 v	58.2 F
Control	251.6 a	111.6 f	58.7 gh	54.0 hı	41.0 mp	57.9 gh	95.8 A

DISCUSSIONS

It was revealed from this study that different priming treatments can have various effects on germination percentage of lentil. Results showed that hydro-priming was the most effective than osmo-priming (KH_2PO_4 and KNO_3) and un treatment seeds for germination percentage in lentil. This may be related to rapid water uptake in priming treatment with hydro-priming in comparisons untreated seeds. Similarly Yari *et al*., 2010 in wheat, Sağlam *et al*., 2010 in lentil and Dezfuli *et al*., 2008 in maize revealed that priming with water could increase seed germination. Further, Ghassemi-Golezani *et al*., 2008 reported that lentil seeds priming with KNO_3, PEG and water gave the highest germination percentage. Like germination percentage, it has been reported that primed seeds had lower mean germination time than control seeds (Sadeghi *et al*., 2011, Sağlam *et al*., 2010, and Dezfuli *et al*., 2008). In general, seeds primed for 24 h increased the germination percentage and decreased mean germination time compared with seeds primed for 12 h. This result indicated that longer priming time may overcome adverse effects of decreased water potential in osmo-priming treatments. These results are in agreement with Elkoca *et al*., 2007, Sadeghi *et al*., 2011 and Yari *et al*., 2010 who reported that priming duration significantly, affect the germination percentage and mean germination time. Seed priming causes improvement in germination in low temperature. As seen in this research, germination percentage and mean germination time significantly increases by priming treatments at low temperatures. Similar results were obtained by, Elkoca *et al*., 2007 and Dursun and Ekinci 2010, who reported that percentage of germination at different temperatures, was significantly affected by priming treatments.

With comparing primed and control seeds, it is clear that seed priming enhanced seed germination speed and by the way hydro priming treatment is more suitable than osmopriming treatments. This adverse effect of germination synchrony in osmopriming treatments may be related to the decreased water uptake in osmopriming treatments. Tavili *et al*. (2011) reported that speed of germination of Bromus increased with seed priming treatments rather than that of control. Similarly, Elkoca *et al*. (2007) determined that hydro priming treatment in chickpea induced faster and more synchronous germination compared with the unprimed seeds. Furthermore, Korkmaz (2005) for sweet pepper and Korkmaz and Pill (2003) for lettuce reported that priming treatments generally improved the germination synchrony. Besides, in terms of priming duration, priming treatment for 24 h generally reduced the germination synchrony compared with the treatment for 12 h. This result indicated that longer priming duration may overcome effect of decreased water potential in osmopriming treatments of lentil seeds.

Consequently, seeds treated with water for 12 produced the highest germination percentage and the least mean germination time and synchrony. Primed seeds grew more rapidly and showed uniform stand establishment hence this treatment may be recommended for germination of lentil under different germination temperatures

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