

Effects of different priming treatments and priming durations on germination percentage of parsley (*Petroselinum crispum* L.) seeds

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ABSTRACT

The effects of different priming treatments and priming durations on germination percentage at different temperatures in parsley seeds were studied. The seeds were treated for 2, 4, 6 and 8 days with the PEG 6000 (-0.5 MPa, -1.0 MPa and -1.5 MPa), KNO₃ (0.30 mol/L and 0.35 mol/L), Mannitol (0.50 mol/L and 0.60 mol/L) and hydropriming (12h, 24h, 36h and 48h) and unprimed (control). Germination studies were made at 5, 10, 15, 20 and 25°C. Percentage of germination at different temperatures was significantly affected by priming treatments. Hydropriming (12h, 24h and 36 h) and mannitol 0.60 mol/L at 2 day generally had the highest germination percentages. In general, the highest germination percentage with priming was determined at 10°C. It may be said that seed priming treatments increased seed germination percentage at both low and high temperatures. The highest germination percentages were observed in both hydropriming and mannitol treatments as compared with PEG and KNO₃ treatments. The PEG and KNO₃ (2 and 4 days) treatments were better than unprimed treatment in all of the temperatures.

Keywords: Parsley; Germination Percentage; Seed Priming; PEG; KNO₃; Hydropriming

1. INTRODUCTION

Vegetables are important for human nutrition and its importance is getting increase in all around of the world. Good and high crop establishment is one of the major challenges to crop production in the world and its importance is recognized by farmers as well as researchers [1,2]. Constraints to good crop establishment include poor seedbed preparation, low quality seed, untimely seed sowing, and adverse weather conditions after sow-

ing [2,3]. To improve vegetable stand establishment, priming techniques including osmopriming, solid matrix priming and hydropriming can be used. Seed priming is a pre-sowing physiological seed enhancement treatment involving the controlled hydration of seeds. Hydration is sufficient to allow pregerminative metabolic activation to take place, but insufficient to allow radicle protrusion through the seed coat [4]. This technique has been used in some vegetable seeds to increase the seed vigor, the germination speed, total germination rate and seedling uniformity, mainly under unfavorable environmental conditions. The technique can lead to better crop stands and higher crop yields [5,6].

Seed germination and emergence of parsley growing period especially in early spring, summer and late autumn are critical. Parsley is one of the most important vegetable that seed germination has taken long time and it is difficult to be germinated it especially under unfavorable environmental conditions [7]. The germination percentage of parsley seed is lower than 55-75% in these kinds of conditions [8]. Thus, slow emergence and low emergence rate lead to smaller seedlings [9]. However, uniformity and rapidity of seed germination and emergence are essential to increase yield, quality and profits in crops [9,10]. For this reason, seed priming techniques have recently been used for many plant species to increase crop stands and higher yields [11]. Also, it is reported that seed priming is a suitable method of shortening the time to early crops and obtain flexibility in processing plant schedules [12].

The aim of this study was to determine the effects of different priming treatments and durations on germination percentage of parsley seeds.

2. MATERIALS AND METHODS

The experiment was carried out at the Horticultural Research Laboratory at the Agricultural Faculty of Ataturk University. D'Giant Italiana parsley seeds were treated at

2, 4, 6 and 8 day with PEG 6000 (–0.5 MPa, –1.0 MPa and –1.5 MPa), KNO₃ (0.30 mol/L and 0.35 mol/L), mannitol (0.50 mol/L and 0.60 mol/L) and hydropriming (12h, 24h, 36h and 48h) and non primed (control). The experiment was conducted in growth cabinet at five temperatures (5, 10, 15, 20, 25°C) with four replicates of 25 seeds placed on two sheets of filter paper and with deionized water. The number of germinated seeds was recorded and removed daily. The experiment was made based on a completely randomized design. All data were subjected to a one-way analysis of variance (ANOVA) and separated by LSD_{0.05}.

3. RESULTS

Seed germination was significantly affected by priming treatments at different temperatures (Table 1, Figures 1-5). Hydropriming (12 h, 24 h and 36 h) and mannitol

0.60 mol/L at 2 day had generally the highest germination percentages. In general, the highest seed germination percentage with priming was determined at 10°C (Table 1, Figure 2). If temperatures were separately evaluated, it could be seen that the highest seed germination percentage was obtained from hydropriming (12h, 24h and 36 h) and mannitol 0.60 mol/L at 2 day at 5°C (Table 1, Figure 1); from hydropriming (12h and 24h), mannitol 0.60 mol/L at 2 day and –1.5 MPa PEG / 2 day at 10°C (Table 1, Figure 2); from hydropriming (48 h) and mannitol 0.50 mol/L (2 day) and 0.60 mol/L (2 day) at 15°C (Table 1, Figure 3); from hydropriming (24 h), –1.0 MPa PEG / 4 day and –1.5 MPa PEG / 2 day at 20°C (Table 1, Figure 4); from hydropriming (24 h and 48 h) at 25°C (Table 1, Figure 5). It was determined that seed priming treatments increased seed germination percentage at both low and high temperatures in the presented study.

Table 1. Effect of seed priming on germination percentage of parsley at different temperatures (%).

Applications	Temperatures					Mean
	5°C	10°C	15°C	20°C	25°C	
Control	30.75 klm***	69.25 fgh ***	77.25 a-d ***	28.00 i ***	49.25 g ***	50.90 jkl ***
Hydropriming 12 h	88.00 a	90.00 a	78.00 abc	61.25 abc	63.00 def	76.05 a
24 h	73.50 cd	83.25 a-d	74.75 a-e	69.25 a	77.25 a	75.60 a
32 h	84.00 ab	81.25 bcd	80.00 ab	62.75 abc	69.25 bcd	75.45 a
48 h	65.50 ef	76.00 def	82.50 a	53.00 de	77.25 a	70.85 bc
–0.5 MPa PEG 2 day	60.00 fg	77.25 cde	69.50 c-g	64.00 abc	72.00 abc	68.55 cde
4 day	32.00 kl	63.25 h	45.25 lm	61.25 abc	61.25 ef	52.60 ijk
6 day	21.00 nop	65.25 gh	56.00 jk	46.75 ef	65.25 cde	50.85 jkl
8 day	9.50 q	40.00 j	26.00 o	37.00 gh	45.25 gh	31.55 o
–1.0 MPa PEG 2 day	59.00 fg	80.75 bcd	73.25 b-f	63.00 abc	71.00 abc	69.4 bcd
4 day	46.75 hij	70.75 e-h	60.00 h-k	66.00 a	68.50 bcd	62.40 h
6 day	28.00 k-n	54.75 i	53.00 kl	41.00 fgh	61.50 ef	47.65 lm
8 day	28.00 k-n	39.00 j	30.00 no	36.00 h	40.00 h	34.60 n
–1.5 MPa PEG 2 day	62.75 ef	84.00 abc	73.00 b-f	68.00 a	72.00 abc	71.95 b
4 day	48.00 hij	65.50 gh	69.00 d-h	63.00 abc	73.00 ab	63.7 gh
6 day	33.25 k	68.00 gh	46.50 lm	52.00 de	70.50 abc	54.05 ij
8 day	25.00 l-o	46.00 j	31.00 no	38.00 gh	42.00 h	36.4 n
KNO ₃ 0.30 mol/l 2 day	65.00 ef	68.00 gh	63.00 g-j	65.25 ab	63.00 def	64.85 fgh
4 day	43.25 ij	70.00 e-h	62.75 g-j	41.00 fgh	51.50 g	53.80 ij
6 day	23.50 mno	44.00 j	46.00 lm	48.00 ef	65.25 cde	45.35 m
8 day	30.00 klm	43.00 j	34.75 n	23.25 i	22.00 j	30.60 op
KNO ₃ 0.35 mol/l 2 day	66.75 def	65.50 gh	64.50 f-j	63.00 abc	70.75 abc	66.10 d-g
4 day	50.00 hi	53.50 i	60.50 g-k	44.50 fg	48.50 g	51.40 jk
6 day	16.00 pq	45.50 j	30.50 no	42.75 fgh	48.50 g	36.65 n
8 day	19.50 op	44.00 j	27.50 no	21.00 i	29.00 i	28.20 p
Mannitol 0.50 mol/l 2 day	69.25 de	77.50 cde	82.75 a	63.00 abc	69.25 bcd	72.35 b
4 day	59.50 fg	81.50 bcd	68.00 e-h	57.50 bcd	69.00 bcd	67.10 def
6 day	69.00 de	72.50 efg	61.50 g-k	57.00 cd	68.50 bcd	65.70 efg
8 day	53.50 gh	71.00 e-h	43.00 m	57.00 cd	50.00 g	54.90 i
Mannitol 0.60 mol/l 2 day	80.50 bc	86.50 ab	83.50 a	65.00 abc	71.00 abc	77.30 a
4 day	73.50 cd	80.00 bcd	67.00 e-i	62.00 abc	59.00 ef	68.30 cde
6 day	65.00 ef	40.00 j	60.50 g-k	57.00 cd	57.50 f	62.00 h
8 day	41.50 j	56.50 i	58.50 ijk	35.50 h	58.50 ef	50.10 kl
LSD %5	6.87	6.73	7.63	6.74	5.90	
Mean (LSD %5: 1.17)	49.11e***	66.17 a	58.77 c	51.91 d	59.98 b	LSD %5: 3.01

***: Significantly important at $p < 0.001$.

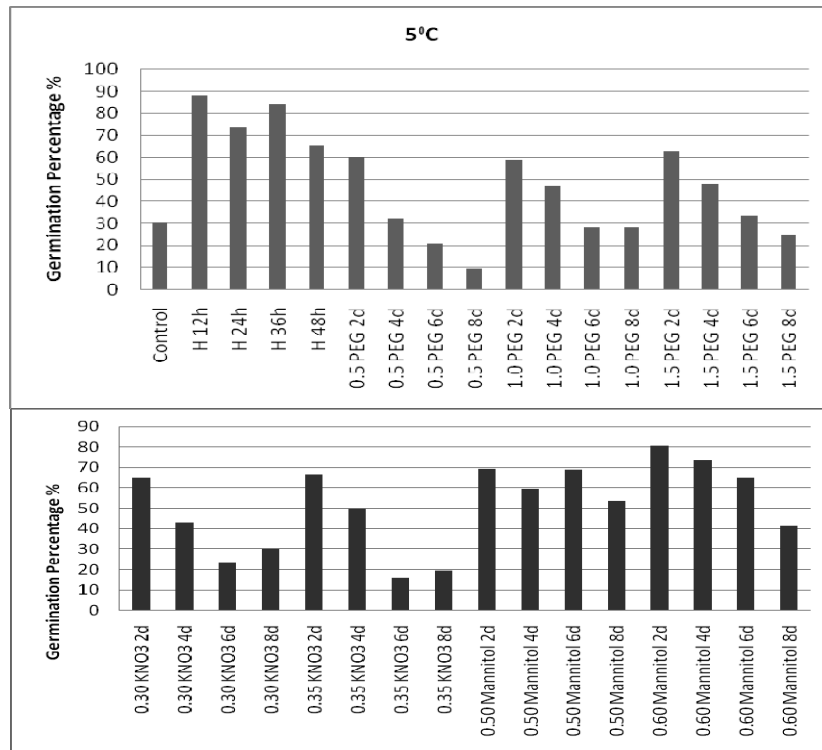


Figure 1. Effect of seed priming on germination percentage of parsley at 5°C.

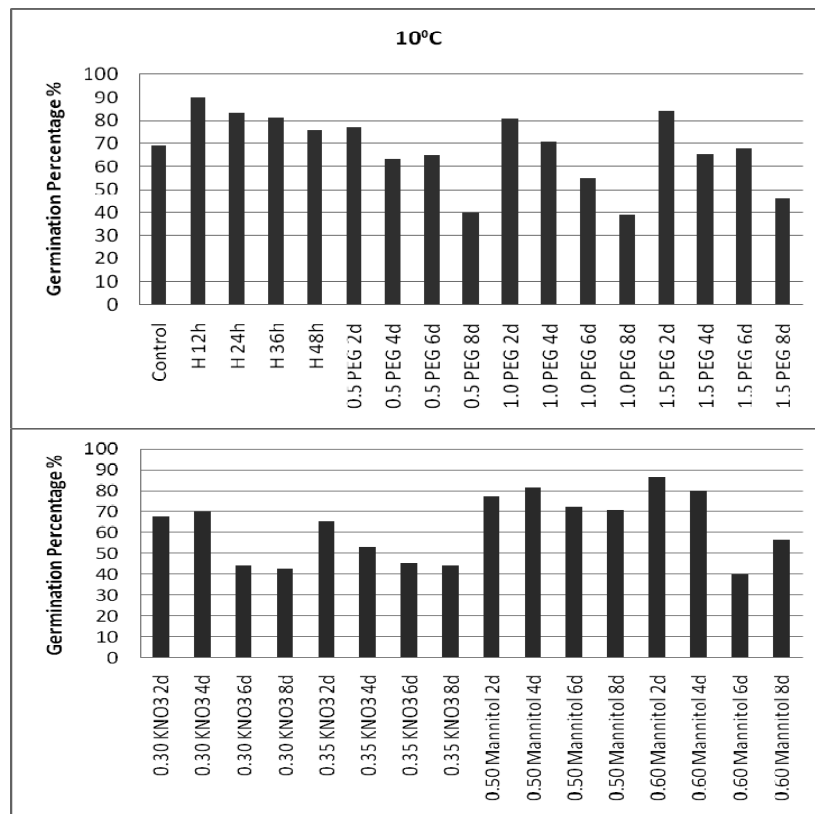


Figure 2. Effect of seed priming on germination percentage of parsley at 10°C.

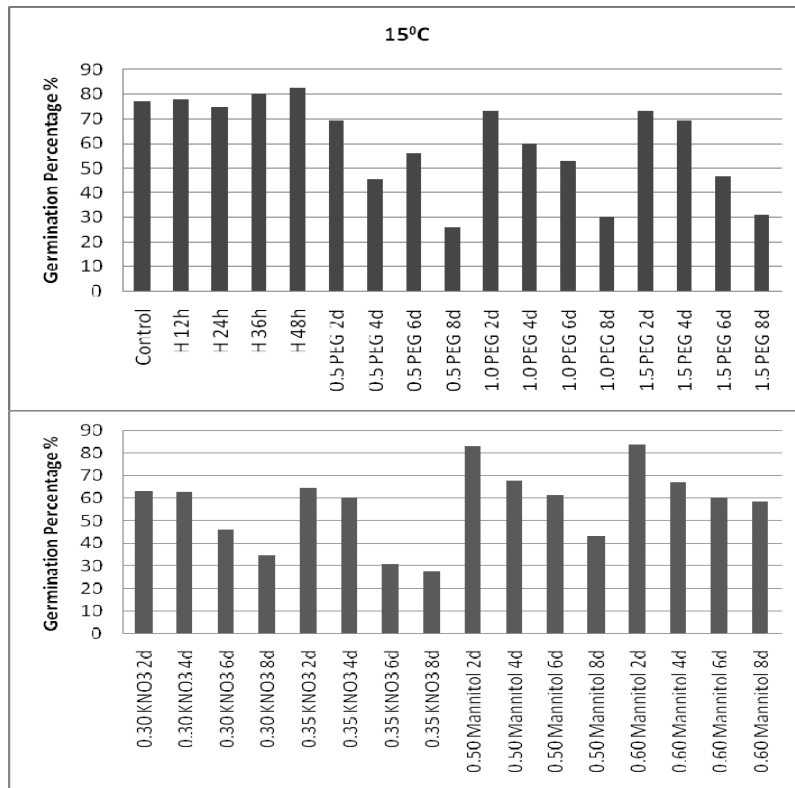


Figure 3. Effect of seed priming on germination percentage of parsley at 15°C.

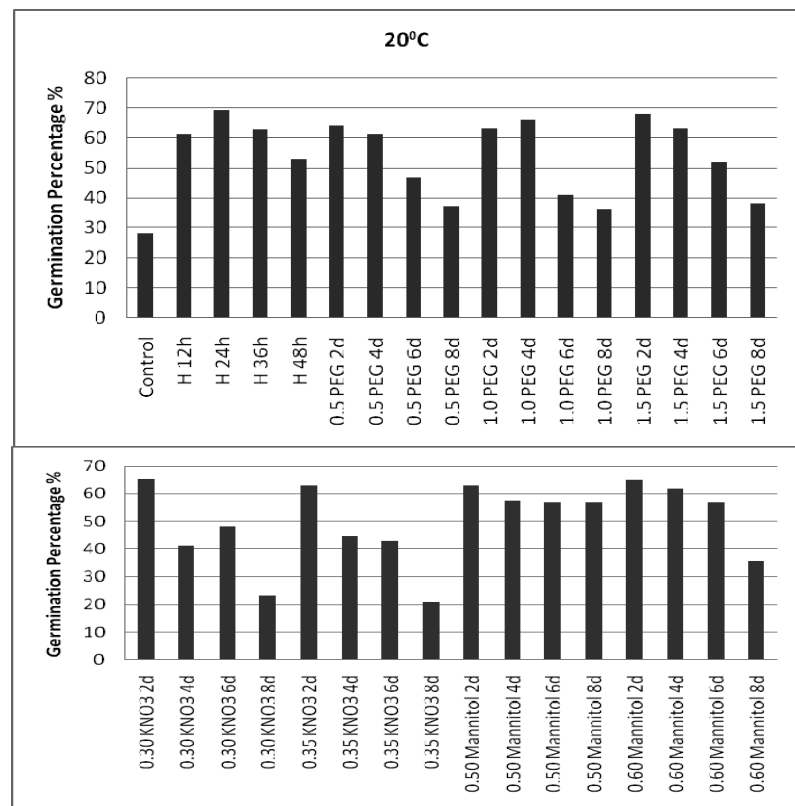


Figure 4. Effect of seed priming on germination percentage of parsley at 20°C.

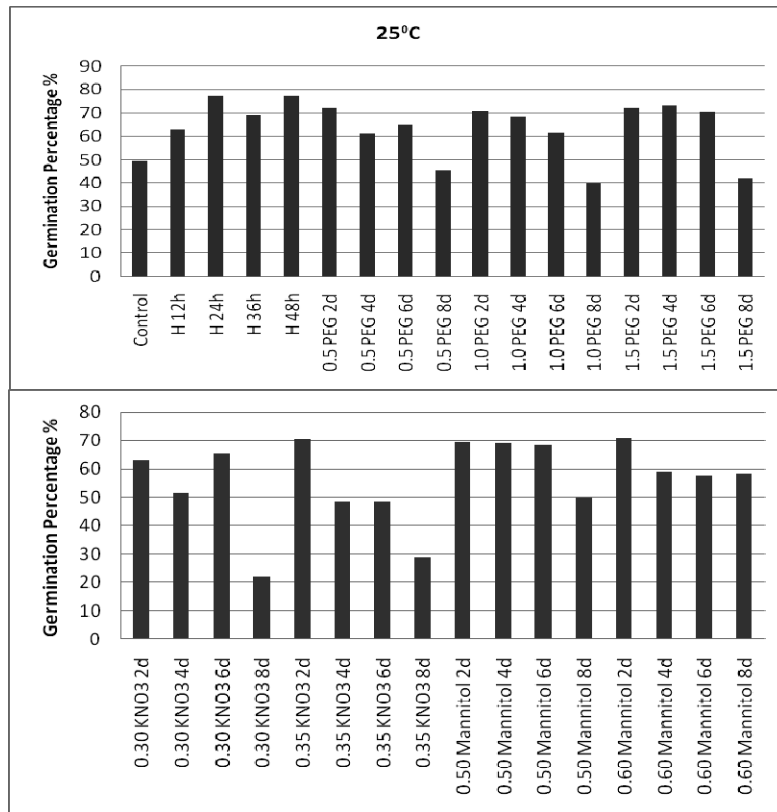


Figure 5. Effect of seed priming on germination percentage of parsley at 25°C.

4. DISCUSSION

The findings presented on seed germination of parsley in this research showed similar results with different researches being made on priming treatment at different plant seeds so far. As matter of fact that, Zheng *et al.* [13] for canola, YeonOk *et al.* [14] for salvia, YeonOk *et al.* [15] for carrot, lettuce and onion, Nascimento [16] and Nascimento and Aragao [4] for muskmelon reported that priming treatments affected on seed germination at different temperatures in different plant species. Perezgarcia *et al.* [17] detected that the highest germination percentages for celery seeds were obtained from 15°C and 25/15°C (day-night temperatures). Nascimento [18] also observed that primed melon, watermelon, eggplant and tomato seeds had higher germination rate at low temperature degrees. In addition, Elkoca *et al.* [19] reported that osmopriming and hydropiriming treatments increased chickpea seed germination rates at different temperatures ranging from 5 to 32°C.

When the treatments used in this study were evaluated, the highest germination percentage was observed in hydropriming and mannitol treatments as compared with PEG, KNO₃ and the control. Hence, it could be said that PEG and KNO₃ (2 and 4 day) treatments were better than unprimed treatment in all of the temperature regimes. Our results are good to fit those of Olszewski *et*

al. [20] who reported that osmotic priming (−1.5 or −1.0 MPa for 7, 14 or 21 at 20 deg C) increased parsley germination rates, but decreased germination percentage depending on treatments. Olszewski *et al.* [21] also found that when increasing priming duration (−1,0 MPa for 7, 14 or 21 at 20 deg C), it quadratically increased parsley germination rate and additionally increased linearly seed moisture content. Pill and Kilian [22] reported that priming treatments (osmotically in polyethylene glycol or matrally in fine, exfoliated vermiculite at −0.5 MPa for 4 or 7 days at 20 or 30 deg C with 0 or 1 mM GA3) have stimulated and hastened parsley seed germination. Duman and Eşiyok [10] reported that germination percentage of carrot seed increased in using PEG (81%) or KH₂PO₄ (79%) compared to control (75%). Similarly, Duman [23] and Yıldırım *et al.* [24] determined that PEG, KNO₃ and NaCl treatments had significantly increased on germination percentage of onion seeds compared that of the control. Demir and Mavi [25] reported that the pepper seed germination was higher and sensivity index were lower in NaCl than in PEG treatments in both water potential and harvest. In the another research, they reported that the salt priming (KNO₃, 3%, 6 day, 20°C) increased watermelon emergence and produce well-developed seedlings particularly in early spring sowings at low temperatures in greenhouse conditions [26]. Elkoca *et al.* [19] reported that

hydropriming for 12 h or osmopriming with -0.5 MPa PEG for 24h resulted in the highest seed germination of chickpea. Arin and Kiyak [27] stated that priming of tomato seeds (especially KNO_3) improved emergence and seedling growth under stress (low temperature, drought and salinity) conditions. Osmopriming (PEG-6000) treatments had the best conditions for leek seeds in 7-10 days at 15°C and -15 bars [28]. Similarly, PEG solution (-1.1 and -1.8 MPa) improved germination soybean seed compared to control [29]. And also Pazdera and Hosnedl [30] reported that the osmopriming was suitable method for lettuce seed germination. Sivritepe and Eriş [31] detected that priming treatments (-0.25 , -0.50 and -0.75 MPa with PEG-8000, 10^{-3} M and 10^{-4} M with ABA and 2, 4 and 6 days with distilled water (H_2O)) at 16°C increased the germination percentage and decreased the mean germination time in pea seeds. Sadeghian and Yavari [32] reported that the highest concentration of mannitol decreased seedling growth and germination rates on sugar beet seed. Nascimento [16] suggested that salt solutions (0.30 mol/L or 0.35 mol/L potassium nitrate KNO_3 ; 0.30 or 0.40 mol/L potassium dihydrogen phosphate (KH_2PO_4); 0.15 or 0.20 mol/L potassium nitrate +0.15 or 0.20 mol/L potassium dihydrogen phosphate; 0.50 or 0.60 mol/L mannitol; and 0.04 or 0.05 mol/L polyethylene glycol/liter) had better germination rate on seeds of muskmelon. It was also reported that the best treatment to seed of muskmelon for germination and emergence at low temperature was 2.5% KNO_3 for 16 h in dark [33]. Demir et al. [34] reported that GA_3 and KNO_3 treatments influenced on eggplant seed germination and rate of germination respect comparing that of the control. In addition, Brocklehurst et al. [35] stated that PEG gave suitable results for different vegetable species such as onion, leek, and celery and KH_2PO_4 had effect of reducing in percentage germination and emergence in leek and celery. According to another research, 0.1 M KNO_3 and 0.1 M KH_2PO_4 pre-storage treatments were the most effective for delaying viability loss due to ageing in onion seed [36]. Sivritepe et al. [37-39] indicated that priming of melon seeds with NaCl resulted in increased salt tolerance in seedling, total germination and mean germination time. Results of presented research were similar and confirmative to the mentioned studies above.

In conclusion, the effects of seed priming depend on the crop species. Seed priming is safe, effective and easily adopted by farmers. It also has the potential to benefit such farmers in many ways and hence, its importance is recognized by farmers as well as researchers. Priming increased the percentage of germination of parsley in this study. Therefore, parsley seed should be primed in order to perform better under unfavorable environmental conditions.

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