

## Effect of different constant and alternative temperatures and light situations on germination behavior of two Purslane (*Portulaca oleracea* L.) populations

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### ABSTRACT

This study was carried out to investigate the germination behavior of two purslane populations (Karaj and Ahvaz), the effect of constant temperatures under two light regimes (12 hrs light/dark and continuous dark), alternative temperatures (day/night) and the lighting/darkness periods on purslane germination. The study was conducted in a randomized complete blocks design with four replications. The results showed that the highest percentage and germination rate in constant temperatures under two light regimes in Karaj mass (continuous darkness) and Ahvaz (12/12 hrs light/darkness), respectively at 25 and 30 °C (Optimum temperature) was observed. Purslane percentage and germination rate changes in alternating temperature (day/night) showed, the maximum values of both masses achieved at 30/20°C alternative temperature. According to result, by getting away from the optimum temperature, the germination percentage and its rate tends to have a descending process in both thermal experiments (alternative and constant temperature tests). Also the effect of different darkness/light periods on purslane percentage and germination rate showed, at (0/24) constant darkness treatment these traits got to the lowest point. The highest percentage and germination rates in Karaj and Ahvaz populations, respectively observed at 0/24, 12/12, 10/14 and 8/16 treatments; which had no statistical difference. Radicle length, shoot length and fresh weight of seedlings in both populations at constant temperatures under both light regimes at 20 to 30 °C and alternative temperatures (light/dark) at 30/20 °C had the highest values.

**Key words:** Purslane, Germination, Constant temperatures, alternating temperatures.

### INTRODUCTION

Purslane is an annual weed from *Portulacaceae* family, which develops appropriately in the warm and drought situations. Dominantly it generates with seed, but if the soil humidity be well, it can spread by stalk fragments. Purslane is able to develop in a different regional situations and extent ranges of the soil condition. The succulent traits of purslane made it able to be alive when it lost its roots; even it can complete its productive growth to generate seeds. Hence, controlling and abolishing of purslane is so exhausting [1].

Seed germination is the main factor to thrive weed in the ecological niche, because it is the initial stage for weeds competition [2]. Furthermore seedling establishment is the sensitive point in plants life cycle and the first stage of this cycle is germination, which has determinant role on seedling establishment and development in ecosystem [3, 4]. Germination is the consequence of complex interactions between some interior and exterior factors [5]. Weeds germination associated to different factors like soil circumstances, regional and physiological situation; but there are immense reports which emphasized on different temperature and light situation effects on weeds germination [6, 7 & 8]. To improve the agriculture management systems, recognizing the seed dormant characteristics, germination patterns and seeds alternation between weeds population is so crucial.

The germination of 42 weed species under different lightning/darkness patterns showed that 26 species of total population after 5 second exposing on light situation obtained the higher germination percentage compared to the constant darkness situation. Also 76% of summer, 56% of winter and uncategorized annual weeds presented the higher germination percentage when under briefly light situation pattern compared to constant darkness condition. 17% of species under the constant light had low or no significant different germination compared to the light treatment [9]. *Campsis radicans* germination rate under the light absence situation was less than 15%, the highest germination rate achieved at 12 hrs of lightning periods [10]. The light is a common necessity for weeds germination [11]. The light exposing treatment stimulate weeds germination, however there are species that never react to light; in some cases it can procrastinate their germination. *Rumex obtusifolius* and *Silenen octiflora* would have a dull germination rate if they exposed under the light situation before [12]. Lightning/darkness and constant darkness situation on *Ceratocarpus arenarius* had the same effect on its germination [13].

The temperature alternation might affect on some of these pivotal metabolic process. Not only the winter or early spring's cool temperatures detriment the active seeds metabolism, but also it prevents the seed germination; however it eliminates the seed dormancy in some species. Conversely, the warm

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spring and summer's temperatures increase the seeds metabolism by anticipating or stimulating the necessary biochemical reaction for germinating the active seeds [14].

Alternative temperatures play a major role in some weeds germinating process [15]. The effect of temperature fluctuations associated with fluctuation ranges (the difference between maximum and minimum temperature), temperature average and temperature periods; the reason of this is still obscure [16]. Evidence showed the alternative temperature alters the large seed molecules construction that directly inhibits germination process and balance the aspiration products through the high temperature cycle [17]. At 10/25, 15/30 and 5/20 °C *Salsola villosa* had the highest germination percentage; also the highest germination rate devoted to 15/30 and 10/25 °C. The lowest percentage and germination rate pertained to 40/25 °C alternative temperature [18]. Hence, purslane is one of the tenth dangerous weeds in the world, this study aimed to recognize the effects of lightning and different temperature situations on purslane germination to get the appropriate way to control it.

## MATERIALS AND METHODS

### Investigation of seed viability

Purslane seeds population randomly aggregated in 2011 from abundant shrubs of around five square kilometer at Karaj and Ahvaz. Then seeds disinfected with carbendazim fungicide at 1:1000 for 5 minutes, afterward seeds rinsed with sterilized water and settled in the room temperature in order to be dried [19]. Purslane seeds viability was determined by tetrazolium chloride test. Hence, 50 unites of each two purslane populations arranged in four replications to treat with tetrazolium chloride solution 1% at 30 °C in darkness for 48 hrs [20]. Alive seeds, which became red through the tetrazolium chloride test distinguished away.

### Determining the main temperatures of germination

To assess the main temperatures on germination percentage of two purslane populations (Karaj and Ahvaz), experiment conducted on constant temperatures at (5, 10, 15, 20, 25, 30, 35, 40 and 45 °C) under the two light regimes (12/12 hrs light/darkness and permanent darkness). To investigate the permanent darkness effect on seeds germination, they (petri dishes) wrapped by twofold of aluminum papers.

### Investigation of alternative temperatures on germination

In this research the behavior of two purslane populations (Karaj and Ahvaz) was studied under the alternative temperatures (day/night) at 15/5, 20/10, 25/15, 30/20, 35/25, 40/30, 20/5, 25/10, 30/15 and 35/20 °C.

### Investigation of light rotation on germination

Hence, the thermal rotation of 30/20 in two populations showed the highest germination

percentage, the effect of different light/darkness periods (0/24, 24/0, 12/12, 14/10, 10/14, 16/8 and 8/16) on germination percentage of two aforementioned populations is assessed on 30/20 °C.

All experiments arranged in a randomized complete block design with four replications. To investigate the germination capability on different thermal and lightning situations, 25 unites of seeds settled in 8 cm petri dishes, which contained sieve papers and 6 ml of sterilized water. Afterward, they transmitted to the germinator under predetermined thermal and lightning situations; then after fourteen days the seed germination percentage assessed. The seeds, which had 2 mm radicle length or rather, distinguished as germinated seeds. Ultimately after initial data analyzing and evaluation of their distribution, data analysis was done with utilizing the SAS software ver. 9.1. The comparison means assessed with Duncan's multiple-range test and graphs were draw with Excel software.

## RESULTS AND DISCUSSION

### Investigation the viability and 1000 grain yield of purslane

In this study the viability of Karaj and Ahvaz seeds respectively calculated about 95 and 97% (there was no statistical difference). According to ISTA process, thousand seeds randomly selected and scaled accurately by digital scale to assess the 1000 grain weight of seeds. The 1000 grain weight of Karaj and Ahvaz population respectively recorded about 0.47 and 0.49 g (difference statistically was insignificant).

### Purslane percentage and germination rate

Generally the Karaj germination percentage was rather than Ahvaz population in the term of constant temperatures. Compression mean result of the constant temperature and light rotation effects on seeds germination showed at 5 and 45 °C neither of the both populations germinated; also the maximum germination percentage of Karaj (permanent darkness) and Ahvaz (12/12 hrs light/darkness) population respectively observed at 25 and 30 °C (optimum temperature) (Figure 1). Furthermore, it is reported *Rumex obtusifolius* seeds under the light and darkness regimes germinated at the immense range of temperature (10 to 35 °C) [21]. The maximum germination occurred at 20 and 25 °C, also at the bare minimum temperature (5°C) and maximum temperature (40 °C) no germination occurred. By investigating the constant temperatures (15, 20, 25, 30 and 35 °C) on *Amaranthus retroflexus*, *Datura stramonium* and *Echinochloa crus-guli* germination it is cleared that at the ranges of 25 to 30 °C the germination percentage of *A. retroflexus* and *D. stramonium* was at the highest point; whereas in either of the five different temperatures, *E. crus-guli* germination percentage was at the lowest point. Moreover, the higher germination percentage is pertained to the high seed weight in weeds [22]. Reaction to the temperature is in conjunction with factors like species, environmental circumstances, seed quality and passed time after the maturity stage

[23]. As figure 2 presented the alternation of germination rate in 9 different temperatures, the highest germination rate in Karaj (permanent darkness) and Ahvaz (12/12 hrs light/darkness) population achieved at 25 and 30 °C and also the lowest rate pertained to 5 and 45 °C (Figure 2). By investigating the thermal treatments (5, 10, 15, 20, 25, 30, 35, 40 and 45 °C) it is founded that the highest germination rate of *Portulaca oleracea*, *Chenopodium album* and *Digitaria sanguinalis* achieved at 25 to 35 °C temperature ranges, which support the current study [24]. Hence, the accurate recognition of purslane seed's optimum germinating

temperature leads to determine the appropriate pre-emergence herbicide application time to control it. The variations of alternative temperature (day/night) on purslane germinating percentage showed, by increasing temperature subsequently the germination rate increased; so that the maximum germination percentage under the 30/20 °C alternative temperature in Karaj and Ahvaz population respectively attained to 91 and 93.5%. However by increasing temperature to 35/20, 35/25 and 40/30 °C the germination percentage of Karaj and Ahvaz population decreased respectively about 5/68, 42 and 75/75% (Karaj) and 5/82, 75/61 and 14% (Figure 3).

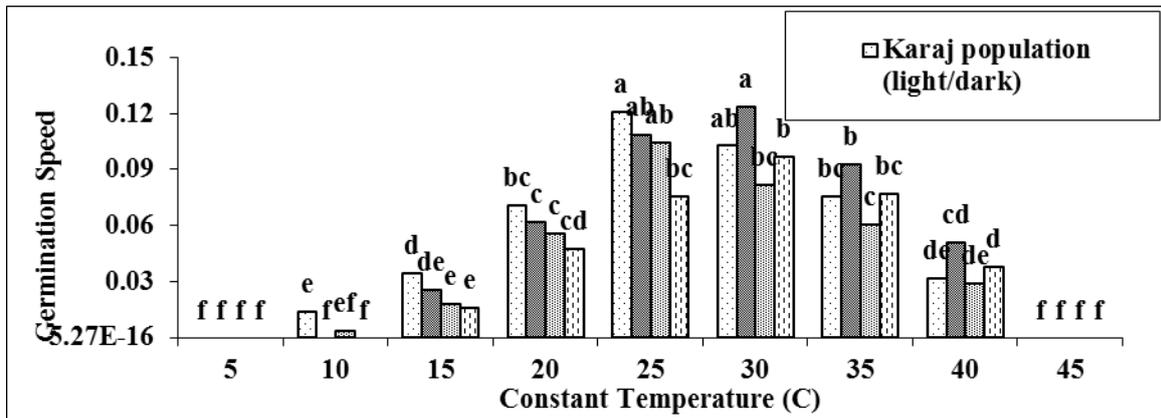


Figure 1-Effect of constant temperatures on germination percentage of two purslane populations (Karaj and Ahvaz) under two light regimes (12/12 hrs light/darkness and continuous darkness)

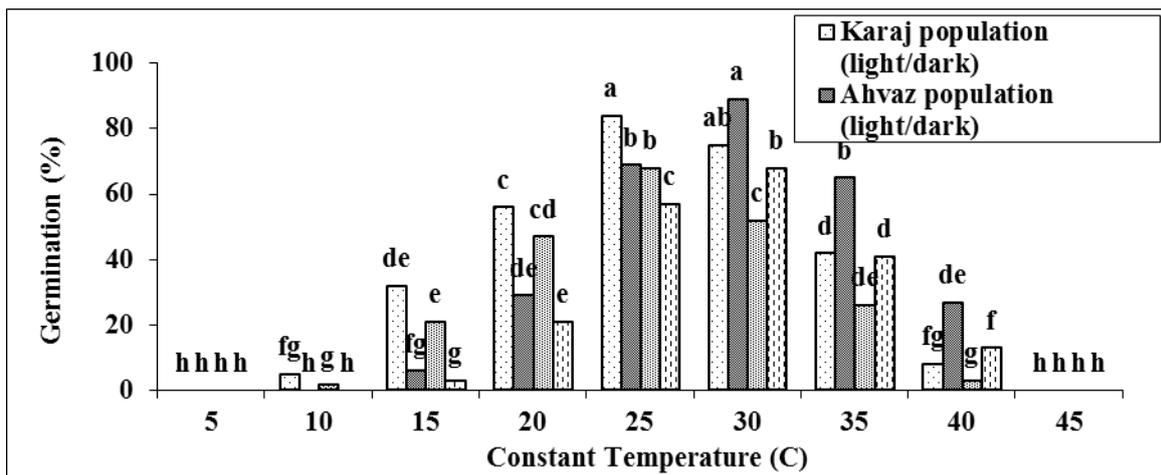


Figure 2-Effect of constant temperatures on germination rate of two purslane populations (Karaj and Ahvaz) under two light regimes (12/12 hrs light/darkness and continuous darkness)

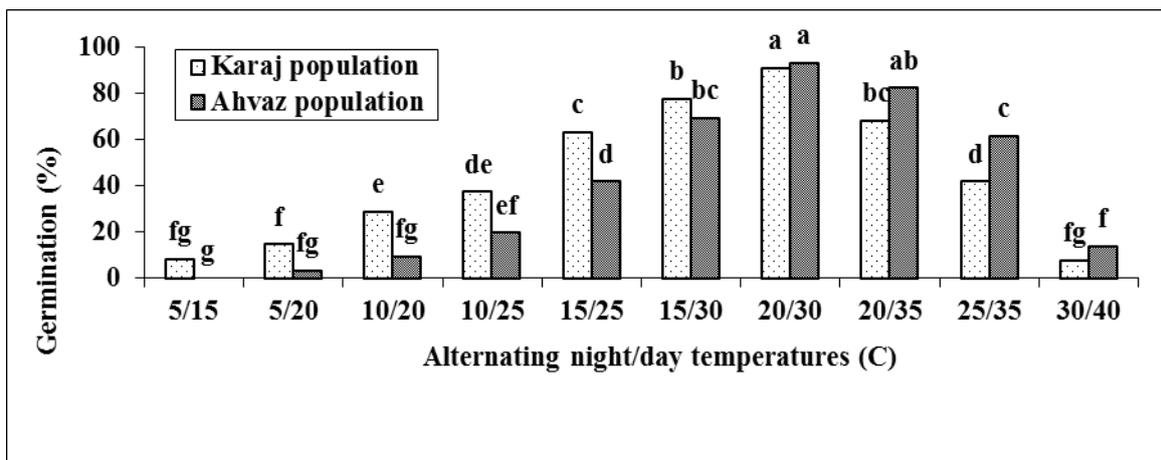


Figure 3- Effect of alternating temperatures on germination percentage of two purslane populations (Karaj and Ahvaz)

So reaction to temperature might be differed among germinating process [25]. In the same research it is reported that the highest germination rate (60%) of *Hibiscus trionum* seeds achieved at 20/30 °C alternative temperature; also at constant temperatures of 10 and 45 °C neither of seeds germinated [26]. Researchers reported 25/20 to 35/30 °C (day/night) is the appropriate temperature for *Biden spilosa* germination. They also added at lower temperatures from 15/10 °C and higher temperatures from 45/40

°C germination had descending rates [27]. In the most situations, when the seeds simultaneously exposed to the light and alternative temperature the percentage and the ultimate germination rate increase [28]. It is reported the optimum germination of *Solanum sarrachoides* occurred at 27 and 33 °C [29]. Conversely, the optimum temperature for *Beckmannia syzigachne* germination is about 10 °C reported by [30]. Also the alternative temperatures effect on germination rate was similar to germination

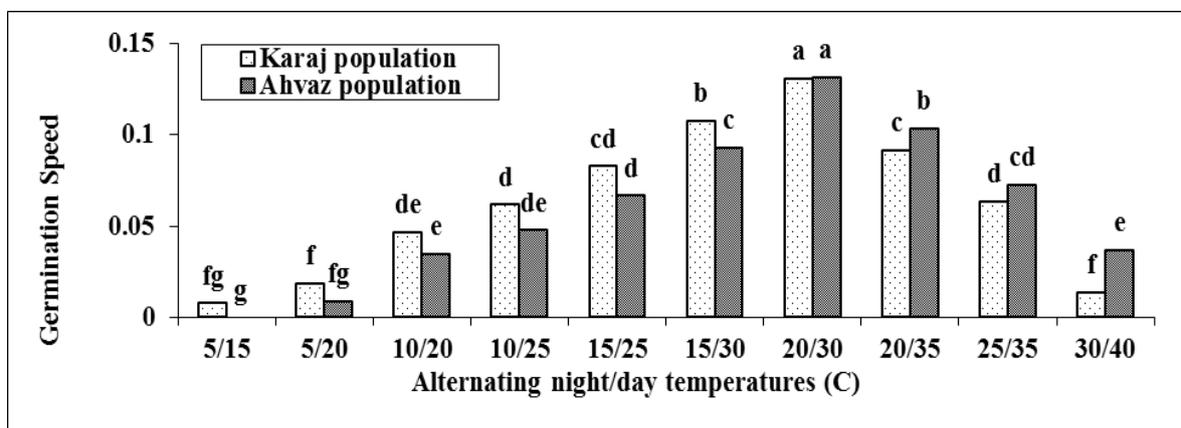


Figure 4- Effect of alternating temperatures on germination rate of two purslane populations (Karaj and Ahvaz)

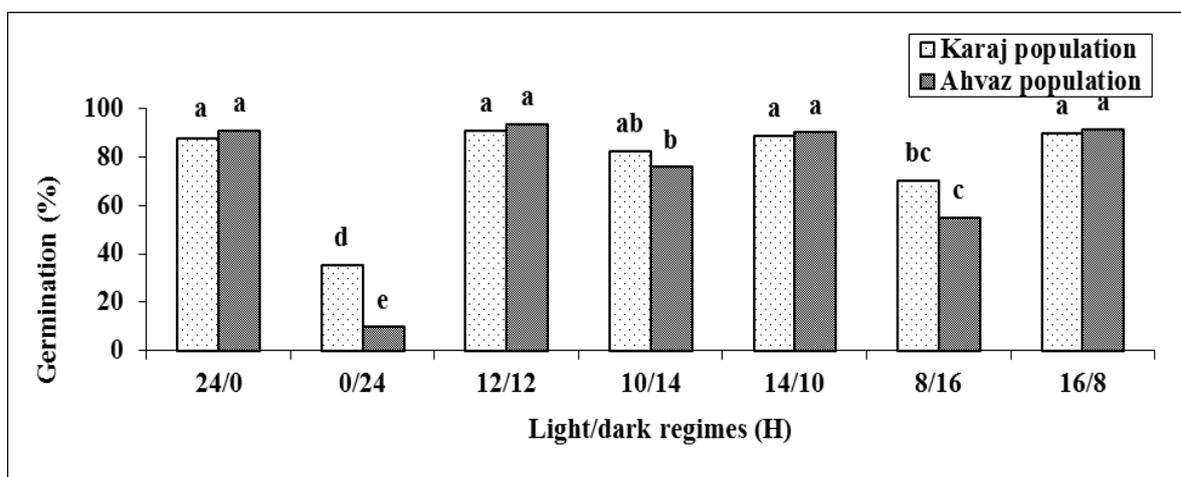


Figure 5- The effect of different periods of dark / light on germination percentage of two purslane populations (Karaj and Ahvaz)

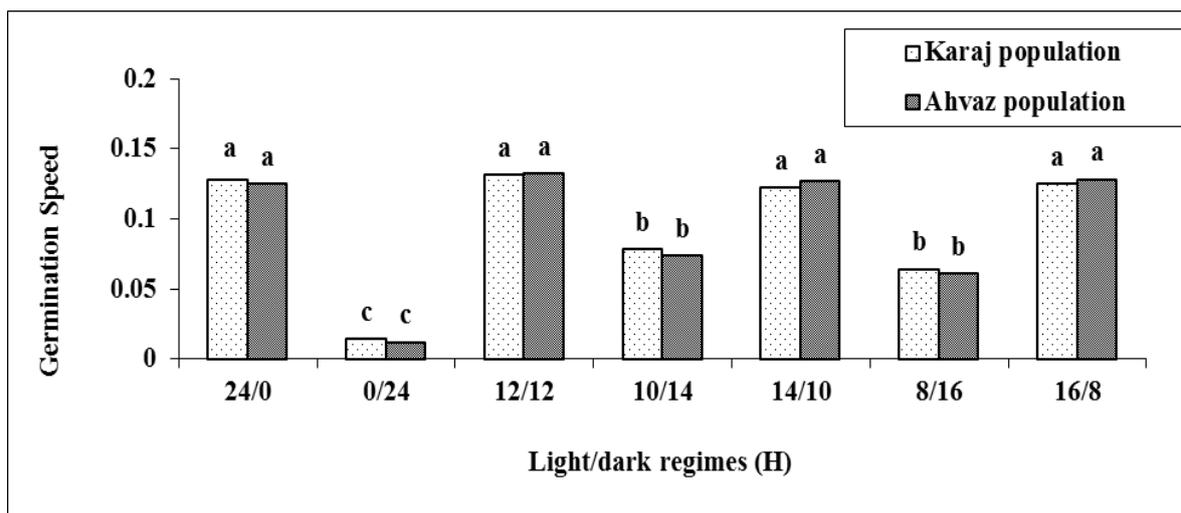


Figure 6- The effect of different periods of dark / light on germination rate of two purslane populations (Karaj and Ahvaz)

percentage; so that, at 20/30 °C alternative temperature both of populations had the highest germination percentage but at 40/30 and 15/5 °C the lowest value of this trait achieved for both (Figure 4). By investigating the alternative temperature effect (light/darkness) 16/8 (20 °C constant temperature) and 16/8 (16hrs at 25 °C and 8 hrs at 30 °C) on four *Amaranthus* species (*A. deflexus*, *A. hybridus*, *A. spinosus* and *A. viridis*), the highest rate of germination percentage in four species recorded at alternative temperature of 8/16 (16 hrs at 25 °C and 8 hrs at 30 °C); this increasing ratio was more conspicuous for *A. deflexus* and *A. spinosus* species [31]. It is reported, the high germination rate of *Conyza Canadensis* occurred at alternative temperature of 24/20 °C (day/night) under the light situation. Although *C. Canadensis* could germinate under the two situations of light/darkness (13 hrs light period) and permanent darkness, it germinated

just about 15% under the darkness situation compared to lightning situation of about 0 to 61% [6]. Usually alternative temperatures increased the germination rate of *E. crus-guli*, *C. album* and *A. retroflexus* [32].

Also the effect of different dark/light periods on purslane germinating percentage showed the lowest germinating percentage in permanent darkness (24/0) in Karaj and Ahvaz population respectively was 35.5 and 9.75%; the highest germinating percentage in two populations respectively observed at 0/24, 12/12, 10/14 and 8/16 treatments, which had no statistical different with each other (Figure 5). It seems that light rotation is essential for purslane germination. On the other hand light rotation plays a major role to motivate the seed germination. The positive response of purslane seeds to light reveals its photoblastic trait. So being under the plant remnants or lying in the soil (plough) prevents purslane germination. The

Table 1-Effect of constant temperatures of two populations (Karaj and Ahvaz) under two light regimes (12/12 hrs light/dark and continuous dark) on seedling emergence of purslane

Treatment	Karaj population (light/dark)	Karaj population (dark)	Ahvaz population (light/dark)	Ahvaz population (dark)
Constant Temperature(C)		Radicle length (mm)		
5	0.0 h	0.0 h	0.0 h	0.0 h
10	3.12 fg	1.37 g	0.0 h	0.0 h
15	8.63 de	6.44 e	4.16 f	2.85 fg
20	13.96 bc	10.72 d	8.42 de	5.26 ef
25	17.42 a	15.53 ab	14.73 b	10.22 d
30	16.31 ab	13.96 bc	17.68 a	14.65 b
35	12.74 c	8.34 de	13.87bc	10.23 d
40	4.52 f	3.11fg	7.35 e	4.67 f
45	0.0 h	0.0 h	0.0 h	0.0 h
Constant Temperature(C)		Shoot length (mm)		
5	0.0 h	0.0 h	0.0 h	0.0 h
10	2.87 f	1.12 g	0.0 h	0.0 h
15	5.26 e	3.28 f	3.43 f	2.11 fg
20	11.46 bc	7.31 de	9.61cd	5.32 e
25	15.23 a	12.54 bc	13.24 b	10.46 c
30	13.71 b	9.63 cd	15.8 a	13.89 b
35	8.95 d	6.77 de	11.96bc	8.56 d
40	3.22 f	2.65 f	6.32 e	3.07 f
45	0.0 h	0.0 h	0.0 h	0.0 h
Constant Temperature(C)		Seedling fresh weight (g)		
5	0.0 h	0.0 h	0.0 h	0.0 h
10	0.011 g	0.007 g	0.0 h	0.0 h
15	0.046 e	0.031 f	0.023 f	0.018 fg
20	0.095 c	0.075 cd	0.075 cd	0.46 e
25	0.14 a	0.12 b	0.12 b	0.1 bc
30	0.12 b	0.089 c	0.15 a	0.13 ab
35	0.063 d	0.048 c	0.094 c	0.073 cd
40	0.024 f	0.018 fg	0.047 e	0.029 f
45	0.0 h	0.0 h	0.0 h	0.0 h

Means within a column followed by the same letters are not significantly difference at the  $\alpha=0.05$  (Duncan's multiple-range test).

large numbers of weeds germinate at permanent temperature, but their germination rate increase in alternative temperatures [29]. For example, *A. retroflexus* and *Cortaderia selloana* germination is thrived from 30% to 90% in the alternative

germinated rather than 80% under the light periods of 8, 12 and 16 hrs and 24 hrs darkness [36]. The maximum germination rate (92%) recorded at 12 hrs of light period. At constant temperature of 15 °C the *Poa pratensis* germination rate under the light

Table 2- Effect of alternating temperatures on purslane seedling emergence

Alternating night/day temperatures (C)	Radicle length (mm)		Shoot length (mm)		Seedling fresh weight (g)	
	Karaj population	Ahvaz population	Karaj population	Ahvaz population	Karaj population	Ahvaz population
5/15	2.08 h	0 i	1.01gh	0 h	0.011ef	0 f
5/20	3.71 g	0.86 hi	2.93 g	0.08 gh	0.028 e	0.012 ef
10/20	6.34 fg	4.14 g	5.16 f	2.27 g	0.056 d	0.031 e
10/25	7.12 f	5.83 fg	7.47 e	5.13 f	0.074 cd	0.063 d
15/25	12.45 cd	10.95 d	10.75 d	9.82 de	0.096 c	0.082 cd
15/30	15.68 b	13.86 c	13.b	12.54 c	0.132 b	0.121 bc
20/30	17.42 a	18.1 a	15.72 a	16.1 a	0.158 a	0.161 a
20/35	13.69 c	16.08 d	12.69 c	14.73 ab	0.105 c	0.129 b
25/35	9.25 e	11.55 d	9.25 de	10.45 d	0.075 cd	0.084 cd
30/40	1.73 h	3.13 gh	1.67 g	3.21 f	0.026 e	0.041 de

Means within a column followed by same letters are not significantly difference at the  $\alpha=0.05$  (Duncan's multiple-range test)

temperature [33]. *Rumex obtusifolius* and *Silene noctiflora* seeds when placed utterly in the darkness had the duller germination rate [12]. *Amaranthus retroflexus*, *Chenopodium album* and *Ambrosia artemisiifolia* seeds in the light situation had the higher germination percentage compared to darkness [34]. It should be considered that the light response differs between weed species. The seed of some species germinate equally under the light and darkness situations [35]. For example, Macdonald et al. perceived *Eupatorium capillifolium* seeds are intensively photoblastic and neither of them germinated in darkness; whereas *Eupatorium compositifolium* seeds were moderately photoblastic and germinated about 12% in the darkness. Also the two broadleaf and tropical species of *Corchorus olitorius* and *Melochia concatenate* do not response to light treatments reported by [4]. According to result, the different light/dark periods effect on germination rate showed, the lowest germination rate between Karaj and Ahvaz population under the permanent darkness (0/24), which statistically was no significant difference between two populations (Figure 6). *Hyparrhenia hirta* as a C<sub>4</sub> grass was briefly eager to germinate under the light situation, however the light period length was not effective on germination rate in this term; so that their seed

situation was rather compared to darkness reported by [37].

#### Purslane radicle length

The compression mean result of constant temperatures effect on radicle length under the two light regimes showed at 5 and 45 °C, there was no record about radicle length increase in two populations under the two light regimes (12/12 hrs light/darkness and permanent darkness); whereas by increasing temperature from 10 to 30 °C, radicle length linearly increased in two populations under the aforementioned light regimes. Increasing temperature from the optimum level of length development (25 to 30), make a significant alternation in radicle length development rate; so that 30 °C can be set as maximum radicle length temperature for weeds. The temperature ranges of 10 to 30 °C are biologic inhibitors for radicle length development and the ranges of 25 to 30 °C are distinguished as optimum temperatures for radicle length development (Table 1). According to study about constant temperatures effect on *Hordium spontaneum* Koch radicle length it is founded that by increasing temperature from 5 to 25 °C, the radicle length consecutively showed ascendant development; this ascending ratio collapsed when the temperature

increased from 25 to 40 °C [38]. The result of alternative temperatures effect on radicle length showed at 30/20 °C (light/darkness) treatment, Karaj and Ahvaz population respectively had the highest radicle length (about 17.42 and 18.1 mm). The lowest radicle length in two populations was 2.08 and 0 mm at 15/5 °C (Table 2). According to these results by getting away from the optimum temperature (30/20) the variations between radicle lengths tends to decrease. Radicle length at 15/5, 20/5, 20/10, 25/10, 25/15 and 30/15 compared to 35/20, 35/25 and 40/30 showed the rather reduction. Different darkness/light period's effect on radicle length showed the lowest radicle length in two populations pertained to permanent darkness (24/0); which respectively had 91 and 95% reduction in aforementioned trait compared to constant lightning (0/24). Among different darkness/light periods (24/0, 12/12, 10/14 and 8/16) there were no statistical difference in the term of radicle length (Table 3). The Purslane root production potential in the immense light ranges made it able to develop in various seasons if the environmental situation be appropriate.

16.1 mm at 30/20 °C (Table 2). According to the result the shoot development reduction in lower temperatures was more conspicuous than the higher ones. This reduction rate addressed the lower temperatures as a natural thermo-ecologic solution to control shoot length in this plant. In this research the highest shoot length in different light periods (dark/light) at 12/12, 10/14, 8/16 and 0/24 respectively achieved to 15.72, 15.23, 14.75 and 13.65 mm in Karaj population and 16.1, 15.78, 14.25 and 14.11 mm in Ahvaz population, which statistically had no significant difference with each other. Also the lowest recorded shoot length was respectively pertained to Karaj (2.46 mm) and Ahvaz (1.75 mm) population under the permanent darkness (0/24) (Table 3). The more blatant shoot length reduction under the permanent darkness compared to dark/light situation in *S. rebaudiana*, *S. scalrea*, *Tagetes minutia* and *Xanthium strumarium* L is reported by [8, 39].

#### Purslane fresh seedling weight

The result showed the highest fresh seedling weight in both populations under the two light regimes and

Table 3 - The effect of different periods of dark / light on purslane seedling emergence

Light/dark regimes (H)	Radicle length (mm)		Shoot length (mm)		Seedling fresh weight (g)	
	Karaj population	Ahvaz population	Karaj population	Ahvaz population	Karaj population	Ahvaz population
24/0	17.4 a	17.1 a	13.65 a	14.11 a	0.141 a	0.152 a
0/24	1.58 c	0.94 c	2.46 d	1.75 d	0.048 bc	0.022 b
12/12	17.42 a	17.32 a	15.72 a	16.1 a	0.158 a	0.161 a
10/14	9.42 b	8.34 b	11.17 b	10.34 b	0.095 b	0.075 bc
14/10	16.84 a	17.56 a	15.23 a	15.78 a	0.138 a	0.141 a
8/16	8.75 b	6.32 b	7.35 c	5.98 c	0.062 bc	0.052 bc
16/8	16.83 a	17.21 a	14.75 a	14.25 a	0.143 a	0.138 a

Means within a column followed by the same letters are not significantly difference at the  $\alpha=0.05$  (Duncan's multiple-range test).

#### Purslane shoot length

The result showed the shoot length developing rate altered considerably under the different temperatures and light regimes. So that by increasing temperature from 5 to 30 °C, the shoot length subsequently increased; but by adding the temperature degree from 30 °C to higher levels under the light situation decreased the shoot length of two populations. Furthermore at 45 °C the shoot length utterly ceased (Table 1). It is reported there is ascending correlation between increasing the shoot length and increasing temperature from 10 to 30 °C, but the more increasing temperature from 30 to 35 °C had a converse effect on shoot length [39]. According to result (Table 1) Karaj population (dark) showed the rather shoot development at temperatures of about 5 to 25 °C under the darkness/light situation compared to Ahvaz population (dark and dark/light); but in rather temperatures (over 25 °C) Ahvaz population (dark/light) obtained the greater value. In the term of alternative temperatures the lowest shoot length in Karaj and Ahvaz population respectively was 1.01 and 0 mm at 15/5 (light/dark) °C. Also the highest shoot length in both populations was about 15.72 and

constant temperatures achieved at 25 to 30 °C (optimum temperature); so that the highest recorded of fresh seedling weight respectively pertained to Ahvaz (dark/light) and Karaj (dark/light) population just about 0.15 and 0.12 g, which statistically had no significant difference with each other. Karaj populations under the two light regimes (dark/light and permanent darkness) in the lower temperatures from the optimum level consecutively made the higher fresh weight compared to Ahvaz population; in the higher temperatures from the optimum level showed the converse process (Table 1). At 5 and 45 °C no fresh seedling weight recorded in two populations.

Since the purslane seeds postpone its germination through the lower temperatures of the early developing season, by anticipating the target crops plantation, their competitive capability will increased opposed to weed species. It should be considered the late purslane germination make it able to elude the management operations. Hence most of the weed management strategies especially herbicide utilization accomplished at the early time of the developing season. The variations of purslane fresh

seedling weight followed a quadratic course of action; so that the fresh seedling weight begins from 15/5 °C (day/night) as a fundamental temperature and picked to its highest level at 30/20 °C (optimum temperature) and then had a descending process (Table 2). The compression means result of light rotations effect on fresh seedling weight showed by increasing the darkness period amount of produced biomass from both populations reduced; the lowest biomass value respectively pertained to light rotation periods (dark/light) of 24/0, 14/10 and 16/8, also other treatments had no significant difference with each other (Table 3).

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