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ORIGINAL ARTICLE

Study of Germination behavior of two populations of *Centaurea depressa* under different temperature and lighting condition

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ABSTRACT
This study investigated the germinating behavior of two Centaurea depressa populations (Karaj and Ahvaz). The study carried out on effects of constant temperatures under two light regimes (12 h light/dark and continuous dark), alternate temperatures (day/night) and of course the lighting / Darkness on Centaurea depressa seed germination. All tests are conducted in a randomized complete blocks design with four replications was observed. The highest percentage and germination percentage in constant temperatures under the two light regimes at 25° C in Karaj and Ahvaz population was about 82 and 74%. This value under the alternative temperature and various fluctuations achieved at 35/25 °C of about 82 and 89% for Ahvaz and Karaj population. Seeds of two populations were able to germinate at a wide range of temperatures. Different periods of dark/light showed no significant effect on seed germination of two populations. Result indicated the high invasion power of Centaurea depressa; invasion power recognition plays a major role to control weeds like this.
Key words: *Centaurea depressa, Germination, Constant temperatures, alternating temperatures, light regimes*

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INTRODUCTION

Weeds are named to sort of plants that can damage the quality and quantity of annual crops yield (1). *Centaurea depressa* is perceived as a dangerous one for crops. *C. depressa* seeds emergence from March till April, and its blooming occur on June to August. In the term of developing growth it can be extended in the one crop's season. In the recent years the cycle of germination response of weeds in order to biological control of them is considered (1). So the recognition of effective environmental factors on their germination seems essential. Germination step is the initial competitive point of weeds in the ecologic niche. Emergence and seedling establishment of weed in the germination step can highly determine the achievement of that plant in natural and arable ecosystems. Among entire alive creatures the rate of metabolic processes and growth rate is determined by temperature. Temperature changes might influence on a few factors which determine the ability of seeds germination (2). Either of weed's seed needs a minimum temperature for germinate inception. By increasing temperature amount of germination will increase till to reach to suitable temperature which involved maximum percent of germination. Subsequently by increasing temperature up to the point which is called the maximum germination temperature, germinating is stopped (3).

The alternative temperatures are essential for germination of some weeds (4). According to the research (5) the effect of fluctuations in temperature is concerned to fluctuation's amplitude (difference between minimum and maximum temperature degree), the average of temperature and thermal period. The germination of some varieties in non-arable and humid lands is stimulated by alternative temperatures (6). For instance, it is reported according to increase the daily thermal fluctuations, the germination of *Phragmites australis* subsequently increased (7). The optimal temperature for *Cassia iccidentalis* was about 25 °C and at 12.5 to 30 °C the percentage of germination was in its higher level. The minimum thermal threshold for germination was between 10 to 12.5 °C and the maximum thermal threshold was nearly 45 °C (8). In the lower degree temperatures metabolic activities relatively decrease and respectively interrupt the plant's reaction (9). It is reported the maximum germination of *polygonum persicaria* without dormancy was occur at 12 to 25 °C and the rate of germination respond relatively by decreasing and increasing temperatures (10). The tolerance range of germination concern to the type of variety and the environmental circumstances where, the maternal plant grown. Moreover the temperature, the crucial adjustment factor in germination of some plant species is the light. This necessity is faded when seeds settle into the light exposure for the less minute or split second duration. The light signals are the main environmental regulator factor for the plant development (11). Light is the vital and crucial element for germination in wide range of weed species. The reaction of seeds to light can be contributed to chromo proteins family which is called phytochrome. Plant tissues are involved two different kinds of permanent phytochrome concise of passive (P_r) which absorbs wave frequencies of 665 nanometers and active (P_{fr}) phytochrome which absorbs wave frequencies of 735 nanometers (12). The light response differs through the interspecies of weeds variety. For instance it is founded seeds of *Eupatorium capillifolium* are intensively photoblastic and no germination occurred through darkness. Whearas, the seeds of *Eupatorium compositifolium* moderately have photoblastic characteristic so that 12% of those germinat in the darkness (13). According to the study which was conducted on 42 species of weed in the light, darkness and short flash term of light. Result showed from 42 of experimental species just 26 species after 5 second period of light exposuring significantly have the higherratr of germination compered to those which treated in the darkness (14). It is reported the germination of *Campsis radicans* in the dark situation was less than 15% and the maximum rate of germination devoted to 12 hour light period treatment (15). The light necessity is common for weed germination (16).

MATERIAL AND METHODS

Centaurea depressa seeds were randomly gathered from several farms in Karaj and Ahvaz. Then they treated with Carbendazim fungicide at 1 per thousand proportions for 5 minute and rinsed with sterilized water and placed in the room temperature for a while in order to be dried (17). The vitality of *Centaurea depressa* seeds was determined with Tetrazolium chloride test. According to this test 50 seeds of each population in four repetitions soaked in Tetrazolium chloride solvable 1% for about 48 hour and settled at 30 °C temperature in darkness (18). The seeds which became red were alive. In this experiment the vitality rate of Karaj and Ahvaz population was respectively calculated about 94 and 92% (the statistical difference was insignificant). To determine 1000-grain weight according to ISTA process, one thousand of seeds were randomly selected and their accurate weight was recorded by the sensitive digital scale. The thousand grain weight of Karaj and Ahvaz population was respectively 2.318 and 2.303 g (the statistical difference was insignificant). In this research the germination response of two populations of *Centaurea depressa* seeds from farms in Karaj and Ahvaz under permanent temperatures (5, 10, 15, 20, 25, 30, 35, 40 and 45 °C) and alternative temperatures (5.15, 10.20, 15.25, 20.30, 25.35, 30.40, 5.20, 10.25, 15.30 and 20.35 °C) were assessed. Investigation of permanent temperatures effect on percent of seeds germination was done under the two light period which involved 12/12 (12 hour lightning /12 hour darkness) and permanent darkness. To investigate of permanent darkness effect on seeds germination, Petri dishes wrapped with twofold layer of aluminum sheets. Investigation of alternative temperature effects was determined under the light period (12 hour lightning /12 hour darkness). Afterward, to concern that at 25.35 °C both of populations presented the higher rate of germinating, the effect of lightning/darkness period (0/24, 24/0, 12/12, 14/10, 10/16, 14/8, 16/8 hour) on percent of both populations germination was determined at that temperature. To investigate the ability of seeds germination under different lightning and thermal conditions, in each treatment 50 seeds placed in Petri dishes (11 cm length) which contains of sieve paper and 8 ml sterilized water. Then they conveyed to germinator and kept in advised lightning and thermal conditions. After 14 days the percent of germination calculated. Radicles which have 2 mm length were accepted. Ultimately the percent of germination was determined according to the below formula.

$$GP = \frac{N_i}{S} \times 100$$

GP: Percentage of germinating; Ni: The number of germinated seeds in i^{th} day; S: Total number of cultivated seeds.

At least, all of the experiments repeated threefold at different times. After initial data analyzing and evaluation of their distribution process, the hypothesis of normal data distribution is investigated. The abnormal data was regulated by logarithmic formula. At least data analysis was done with utilizing the

SAS ver. 9.1 Software. The comparison means is assess with Duncan test and graphs were draw with Excel Software.

RESULT AND DISSCUSION

The effect of constant temperatures on germination behavior of *Centaurea depressa*

The result showed neither of the *Centaurea depressa* seeds population at 5 and 45 °C germinated. Germinating of Karaj and Ahvaz seeds population debuted at 10 °C. By increasing temperature till 25 °C the percent of germinating, radicle′s length, seedling′s length and dry weight matter of both seedling population was increased (figure 1-4). The maximum germination of Karaj and Ahvaz seeds population was respectively observed about 82 and 74% at 25 °C. Then the percentage of germination decreased in both seeds population by increasing temperature. Somehow, the seeds population of Karaj and Ahvaz lost the ability of germination respectively at 40 and 45 °C (figure 1-4). It is reported the maximum germinating rate of common chickweed (*Stellaria media*) achieved at 15 to 20 °C (19). *Rumex obtusifolius* seeds under the two lightning and darkness and at 10 to 35 °C had the higher rate of germination and at 20 to 25 °C the maximum rate of germination occurred. At the minimum and maximum temperature (5 and 40 °C) no germination recorded (20). In the research about the effect of temperature on *Abutilon theophrasti* germination; it is found that the minimum and optimum temperature for *A. theophrasti* is respectively about 8 and 24 °C (21). In the constant temperature of about 25 °C and lower, the percent of germination, radicle′s length, seedling′s length and the dry weight matter of Karaj population was significantly more than Ahvaz. Whereas, at the 30 °C and higher germination of Ahvaz population was dominant (figure 1-4). Since the seed characteristics adapted by regional circumstances (22), Ahvaz population dominancy at higher temperatures and Karaj population dominancy in lower temperatures can be contributed to the different regional circumstances from these regions with different environmental circumstances. In the same research in order to investigate the germination of *Sonchus oleraceus* L. at constant temperatures showed that in the higher temperatures the seed germination of Ahvaz population was more than Birjand and in the lower temperature the result was vice versa (23).

The effect of alternative temperatures on germination behavior of *Centaurea depressa*

Among alternative temperatures with different fluctuations, the maximum Ahvaz and Karaj germination was respectively about 82 and 89% at 25.35. Neither of Ahvaz seeds population germinated at 5.15 and 5.20 °C of alternative temperatures. The alternative temperature of 25.35 °C was the best thermal treatment in both regions (Karaj & Ahvaz) which achieved the highest germinating percentage, radicle′s length, seedling length and the dry matter of seedling (figure 5 to 8). Without thermal alternation consideration which, occurred no germination in Ahvaz population, the lowest germinating percentage of Ahvaz was about 18% at 10.20 °C and subsequently the lowest rate of Karaj population achieved 9% at 5.20 °C. As it mentioned plant adaptation to environment situation of maternal plant severely effects on germination characteristics and plant development like percent of germinating, seedling weight, radicle′s length, and seedling′s length and so forth (24, 25 & 26).

The effect of lightning periods on germination behavior of two *Centaurea depressa* populations

In different periods of lightning/darkness (24/0, 12/12, 14/10 and 16/8 hour) the highest percent of germination, seedling′s and radicle′s length and dry weight of seedling in both *Centaurea depressa* populations was observed. At aforementioned periods there were no significant differences between Karaj and Ahvaz populations (figure 9 to 12). The lowest percent of germination, seedling′s and radicle′s length and dry weight of seedling in both *Centaurea depressa* pertained to 0/24 (lightning/darkness) hours. However, there were no significant differences between Karaj and Ahvaz populations (figure 9 to 12). Some of the varieties equally germinate in the same situation of lightning and darkness periods (27). It is reported *Bidens pilosa* seeds in lightning/darkness and permanent darkness conditions had the same vitality for germination (28). The germination of *Campsis radicans* in the darkness condition was less than 15% and the higher rate of germination achieved at 12 hours of lightning periods (15).

Table 1. Effect of Constant temperatures on seed germination radicle and shoot length and seedling dry weight of two *Centaurea depressa* populations.

Constant temperatures (°C)	Population	Germination (%)	Radicle length (mm)	Shoot length (mm)	Seedling dry weight (gr)
5	Karaj	0 l	0 j	0 k	0 j
	Ahvaz	0 l	0 j	0 k	0 j
10	Karaj	23.25 i	6.42 g	3.55 g	0.101 g
	Ahvaz	17.5 j	4.34 h	2.45 gh	0.078 h
15	Karaj	46.5 f	9.28 f	5.75 e	0.184 f

	Ahvaz	39 g	7.14 g	4.12 g	0.142 e
20	Karaj	69 c	13.78 c	8.53 c	0.266 c
	Ahvaz	61 d	11.02 e	7.75 cd	0.247 cd
25	Karaj	82 a	17.25 a	10.02 a	0.344 a
	Ahvaz	74 b	15.32 b	8.54 b	0.314 b
30	Karaj	46.5 f	8.16 fg	6.04 e	0.196 e
	Ahvaz	51.75 e	8.83 f	7.28 d	0.225 d
35	Karaj	24.75 i	4.72 h	3.77g	0.108 g
	Ahvaz	32.75 h	6.21 g	4.85 f	0.147 f
40	Karaj	0 l	0 j	0.98 i	0.042 i
	Ahvaz	11 k	2.05 i	1.86 h	0.082gh
45	Karaj	0 l	0 j	0 k	0 j
	Ahvaz	0 l	0j	0 k	0 j

Means within a column followed by the same letters are not significantly different at the %1 level according to Duncan's multiple range tests.

Table 2. Effect of alternating temperatures on seed germination radicle and shoot length and seedling dry weight of two *Centaurea depressa* populations.

Alternating temperatures (°C)	Population	Germination (%)	Radicle length (mm)	Shoot length (mm)	Seedling dry weight (gr)
5/15	Karaj	11 j	2.17 i	1.12 i	0.052 ij
	Ahvaz	0 k	0 j	0 j	0 k
10/20	Karaj	25 h	6.32 g	3.27 g	0.097 h
	Ahvaz	18 i	4.57 h	2.25 h	0.066 i
15/25	Karaj	44 f	8.87 f	5.32 e	0.178 f
	Ahvaz	36 g	6.91 g	4.35 f	0.138 g
20/30	Karaj	75 c	13.05 c	7.69 c	0.257 c
	Ahvaz	64 d	11.84 d	6.56 d	0.214 e
25/35	Karaj	89 a	16.49 a	9.89 a	0.311 a
	Ahvaz	82 b	15.12 b	8.75 b	0.288 b
30/40	Karaj	54 e	8.79 f	5.12 e	0.176 f
	Ahvaz	65 d	10.12 e	6.02 de	0.218 e
5/20	Karaj	9 j	2.08 i	0.9 i	0.029 j
	Ahvaz	0 k	0 j	0 j	0 k
10/25	Karaj	27 h	6.24 g	3.09 g	0.094 h
	Ahvaz	21 i	4.13 h	2.14 h	0.071 i
15/30	Karaj	45 f	8.64 f	5.28 e	0.167 f
	Ahvaz	37 g	6.85 g	4.21 f	0.131 g
20/35	Karaj	76 c	12.89 c	7.52 c	0.241 d
	Ahvaz	67 d	11.48 d	6.46 d	0.219 e

Means within a column followed by the same letters are not significantly different at the %1 level according to Duncan's multiple range tests.

Table 3. Effect of Different light regimes on seed germination radicle and shoot length and seedling dry weight of two *Centaurea depressa* populations.

Different light regimes (H)	Population	Germination (%)	Radicle length (mm)	Shoot length (mm)	Seedling dry weight (gr)
24/0	Karaj	85 ab	14.57 a	8.87 a	0.292 a
	Ahvaz	91 a	15.75 a	9.72 a	0.314 a
0/24	Karaj	63 b	7.32 b	5.43 b	0.188 b
	Ahvaz	59 b	6.19 b	4.57 b	0.164 b
12/12	Karaj	89 ab	16 a	10.24 a	0.31 a
	Ahvaz	93 a	17.8 a	11.04 a	0.331 a
10/14	Karaj	79 ab	11.62 ab	7.87 ab	0.247 ab
	Ahvaz	76 ab	10.41 ab	7.53 ab	0.228 ab
14/10	Karaj	87 ab	15.32 a	10.32 a	0.287 a
	Ahvaz	93 a	16.1 a	10.87 a	0.292 a
8/16	Karaj	77 ab	12.12 ab	8.01 ab	0.231 ab
	Ahvaz	74 ab	10.24 ab	7.43 ab	0.214 ab
16/8	Karaj	85 ab	14.86 a	9.74 a	0.28a
	Ahvaz	91 a	15.53 a	9.94 a	0.298 a

Means within a column followed by the same letters are not significantly different at the %1 level according to Duncan's multiple range tests.

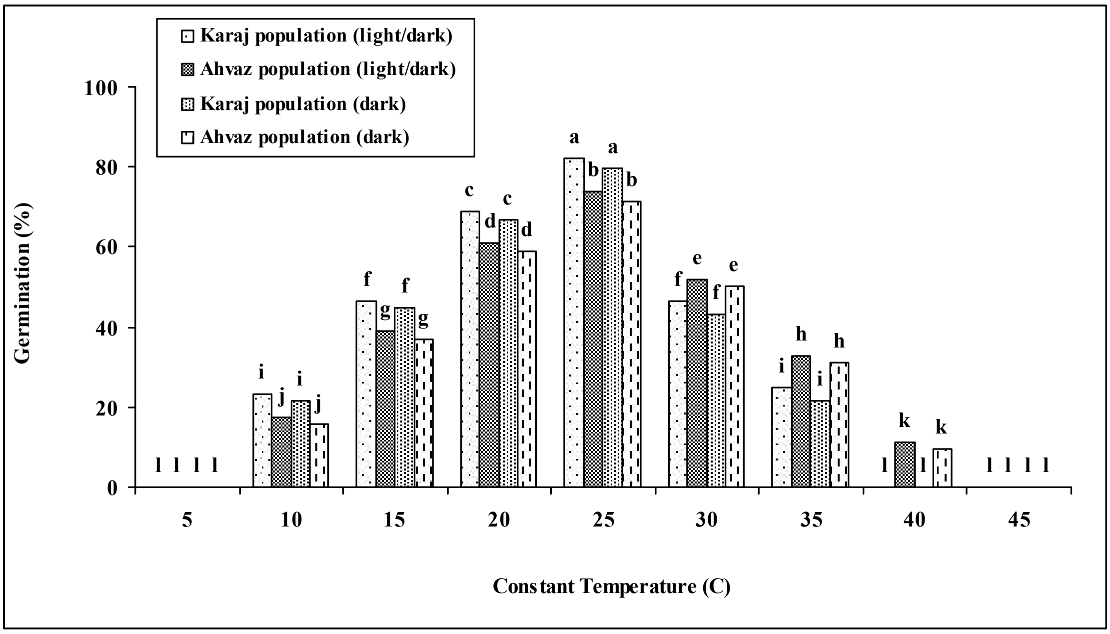

Figure 1. The effect of constant temperatures on *Centaurea depressa* germination in Karaj and Ahvaz population.

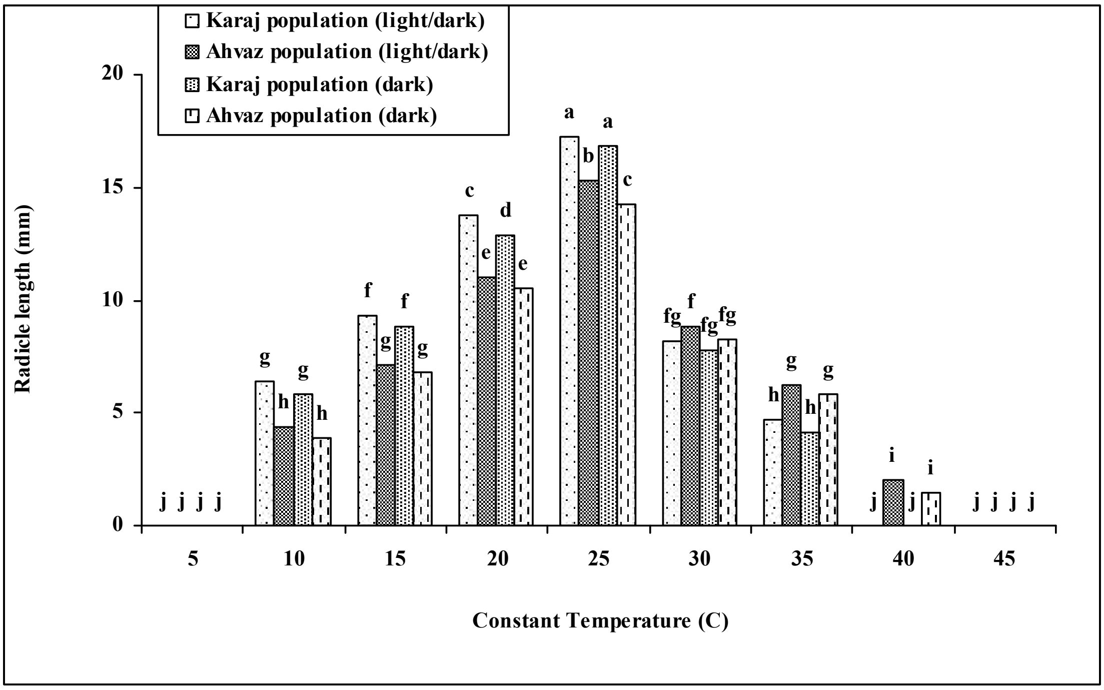

Figure 2. Effect of constant temperatures on *Centaurea depressa* radicle's length in Karaj and Ahvaz population.

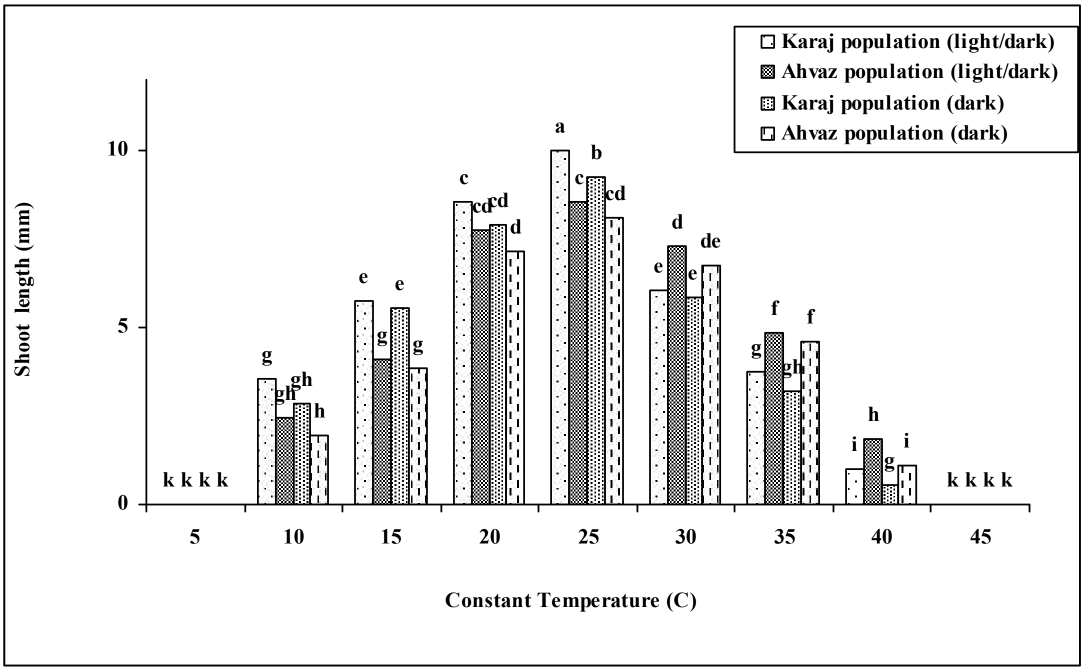

Figure 3. The effect of constant temperatures on *Centaurea depressa* shoot's length in Karaj and Ahvaz population.

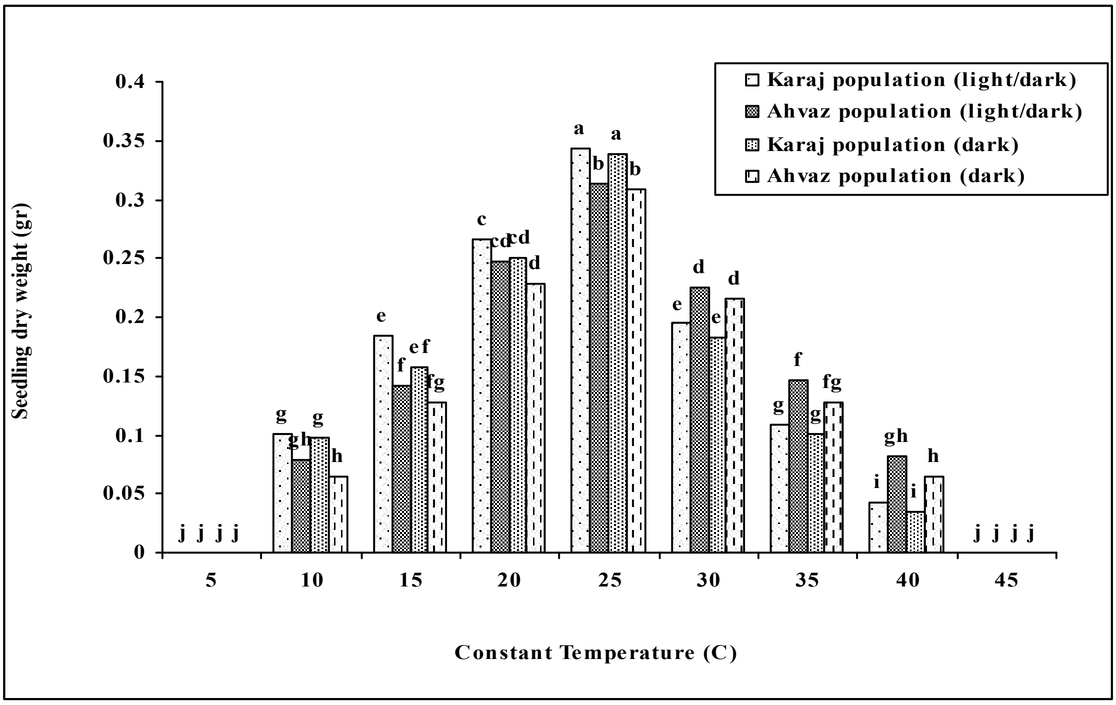

Figure 4. The effect of constant temperatures on *Centaurea depressa* seedling dry weight in Karaj and Ahvaz population.

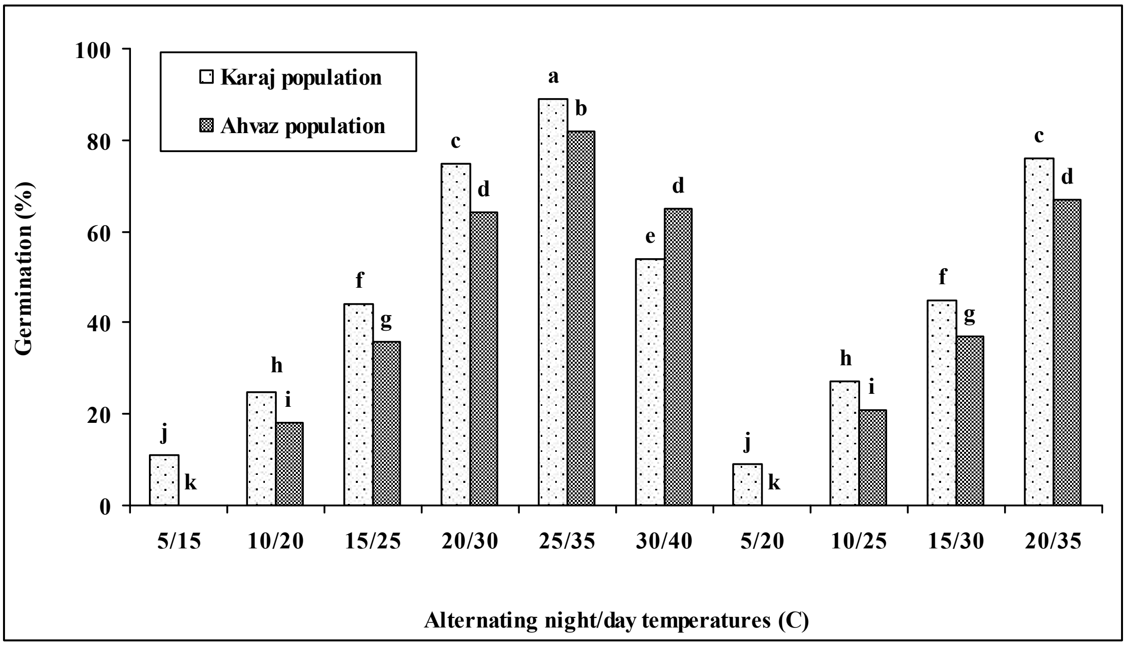

Figure 5. The effect of alternative temperatures on *Centaurea depressa* germination in Karaj and Ahvaz population.

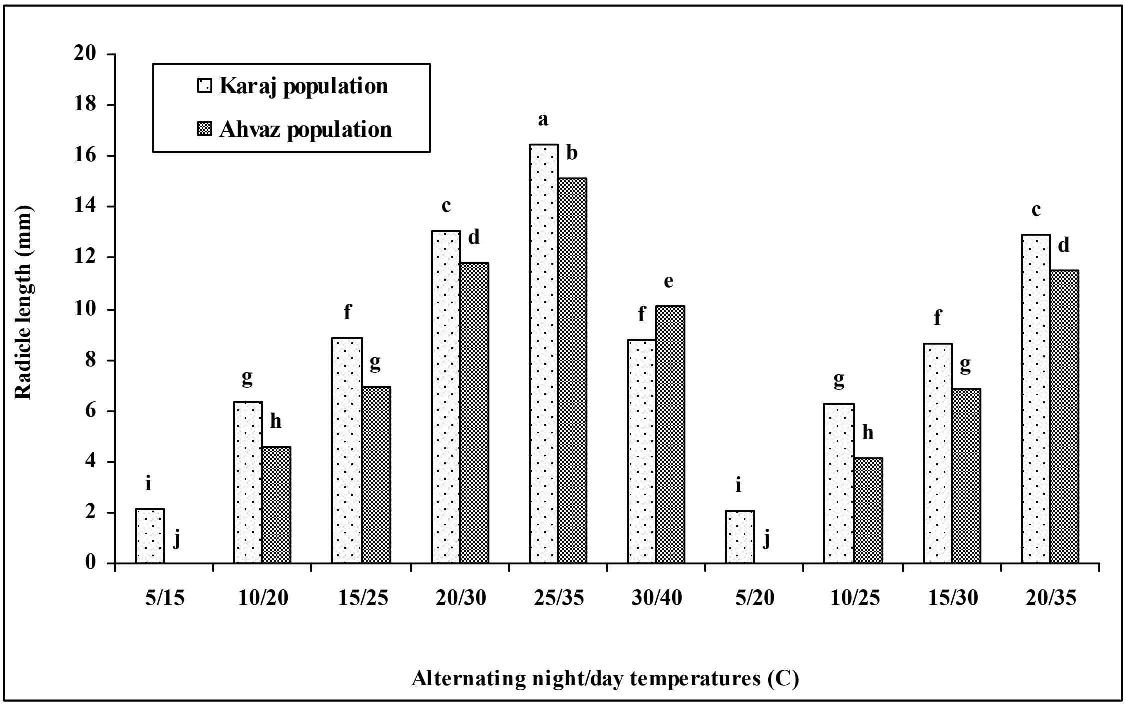

Figure 6. The effect of alternative temperatures on *Centaurea depressa* radicle's length in Karaj and Ahvaz population.

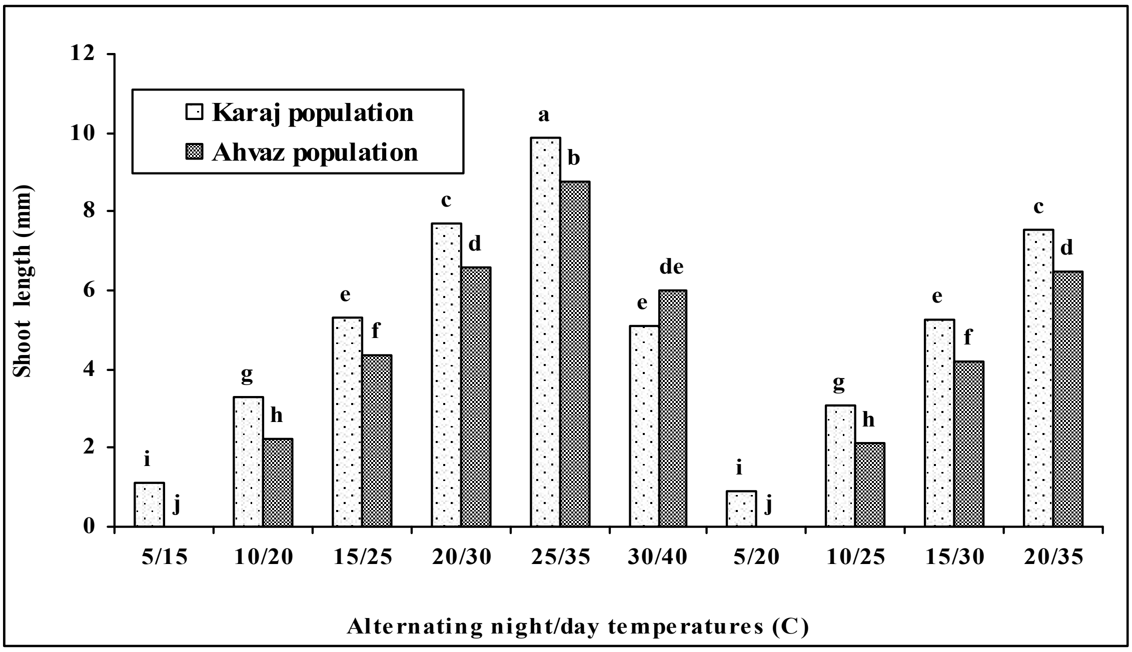

Figure 7. The effect of alternative temperatures on *Centaurea depressa* shoot′s length in Karaj and Ahvaz population.

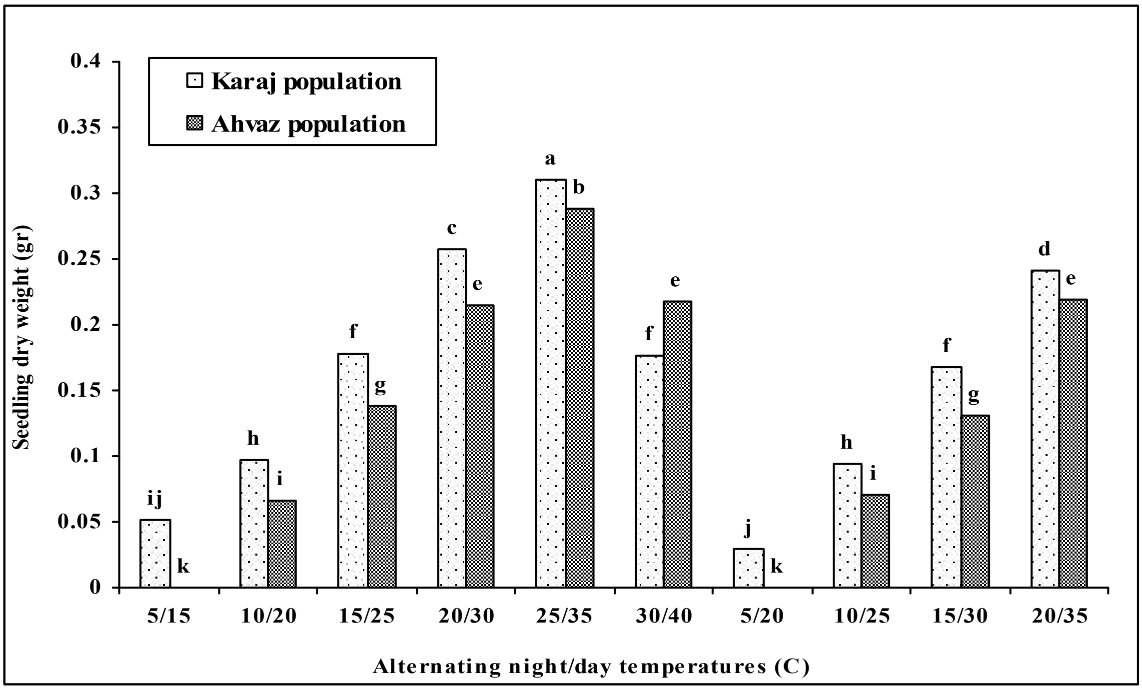

Figure 8. The effect of alternative temperatures on *Centaurea depressa* seedling′s dry weight in Karaj and Ahvaz population.

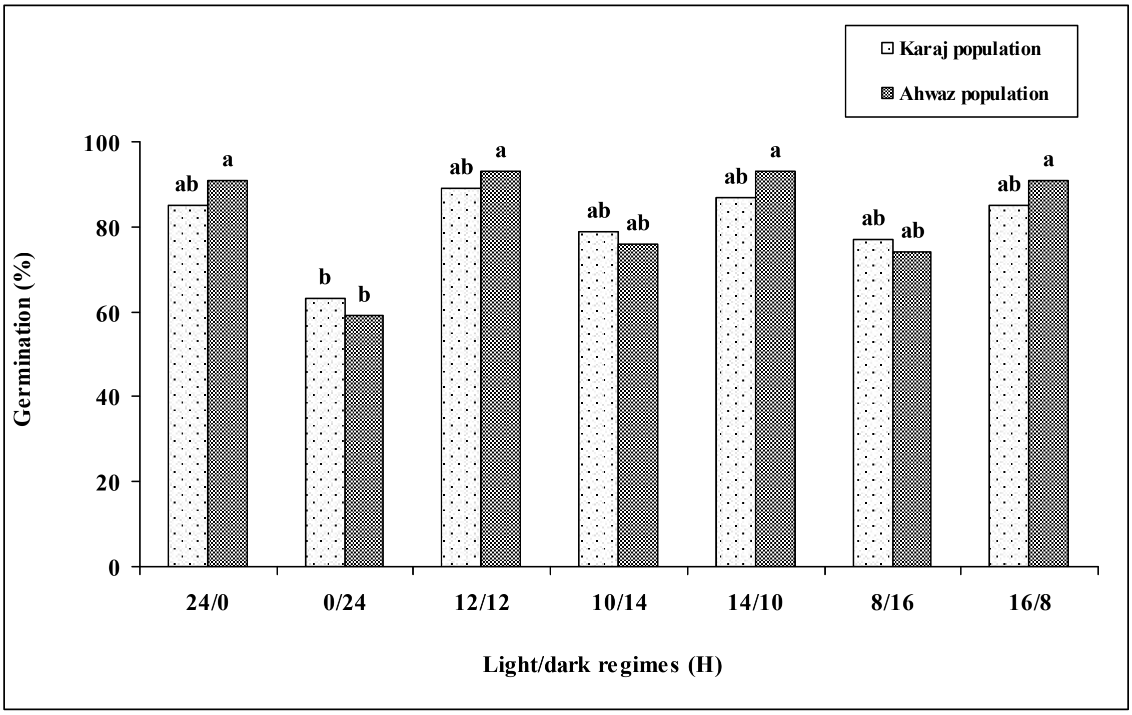

Figure 9. The effect of light regimes on *Centaurea depressa* germination in Karaj and Ahvaz population.

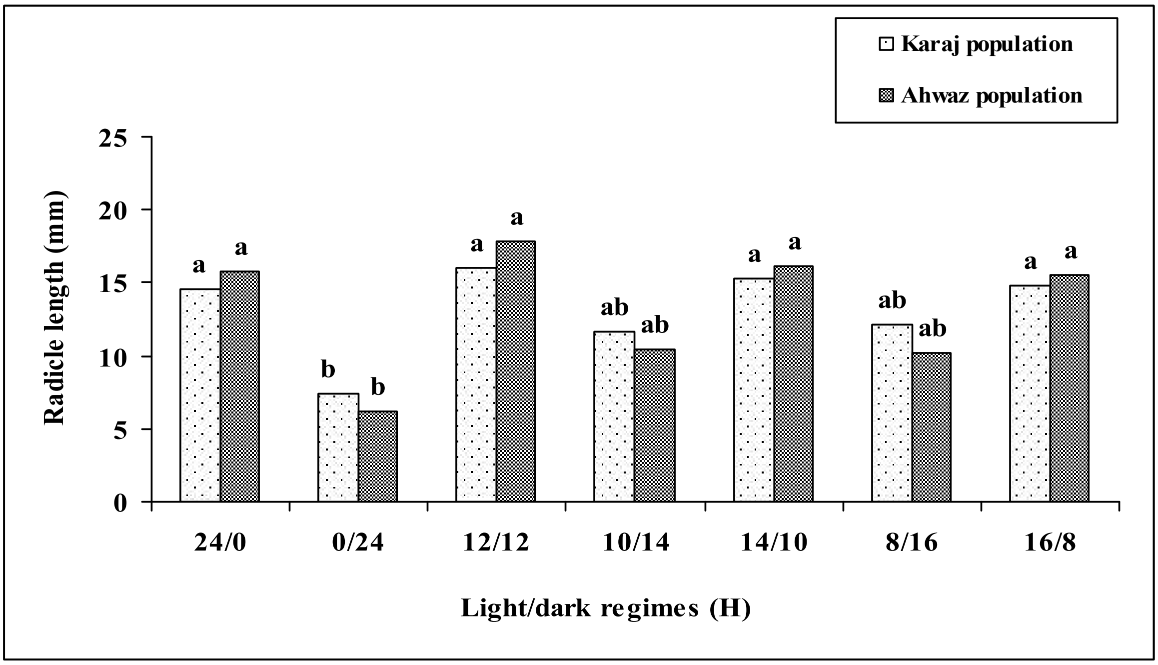

Figure 10. The effect of light regimes on *Centaurea depressa* radicle's length in Karaj and Ahvaz population.

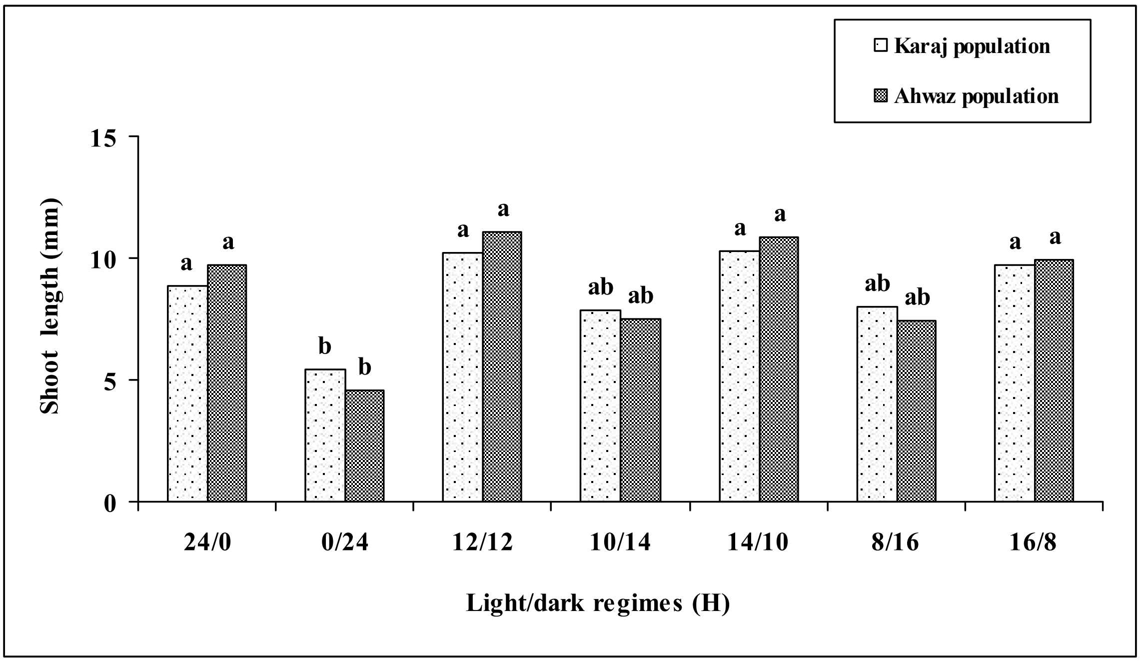

Figure 11. The effect of light regimes on *Centaurea depressa* shoot's length in Karaj and Ahvaz population.

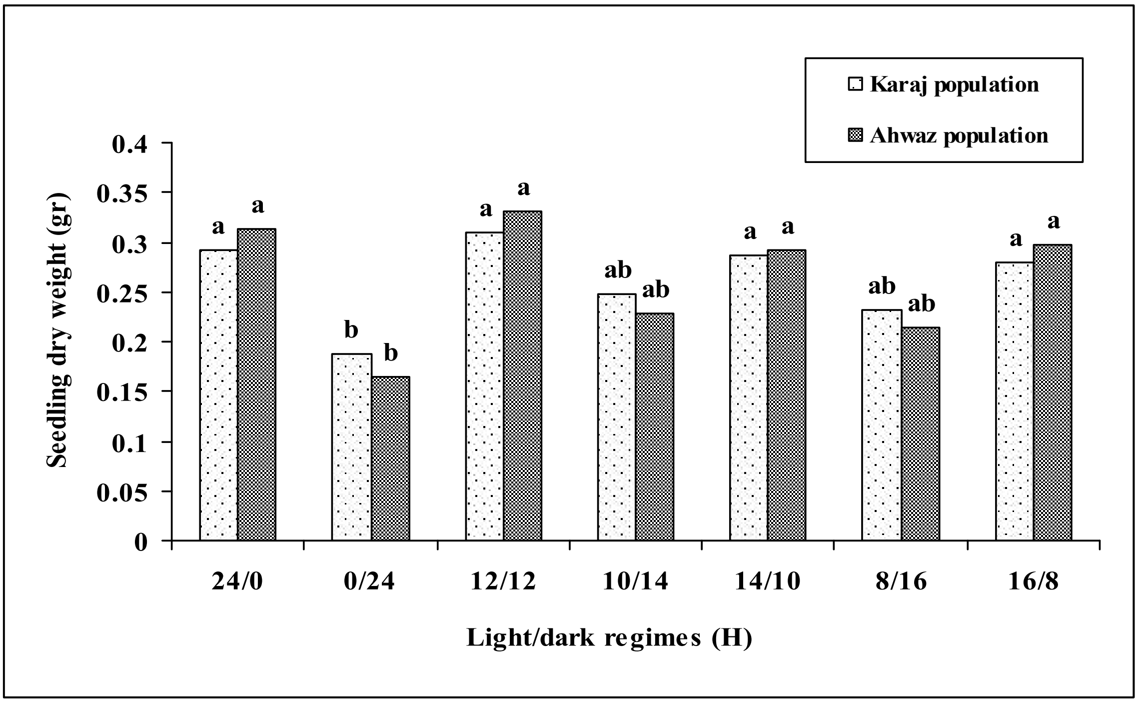

Figure 12. The effect of light regimes on *Centaurea depressa* seedling dry weight in Karaj and Ahvaz population.

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