www.biodicon.com Biological Diversity and Conservation

ISSN 1308-8084 Online; ISSN 1308-5301 Print 8/3 (2015) 218-222

Research article/Araştırma makalesi

Light effects on seed germination of endemic *Centaurea* L. species in section *Phalolepıs* (Cass.) DC.

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Abstract

While almost 600 species of *Centaurea* L. are common around the world, there are 221 species in Europe. In Turkey, after the genus *Astragalus* L. and *Verbascum* L., which includes the most species, *Centaurea* is the third in terms of the number of species it has. The ratio of endemism is quite high (about 63%). In this study, light effects on seed germination of 8 endemic species belonging to *Centaurea* L. Section *Phalolepis* (Cass.) DC. (*C. cadmea* Boiss., *C. aphrodisea* Boiss., *C. amaena* Boiss. & Bal., *C. lycia* Boiss., *C. luschaniana* Heimerl, *C. wagenitzii* Hub.-Mor., *C. tossiensis* Freyn & Sint., *C. hieropolitana* Boiss.*)*. The effect of light on germination was determined for three photoperiod (16 h light: 8 h dark, 16 h dark: 8 h light, 24 h dark) and 25 ^{0}C ± 1 temperature regime. In every experiment serie, 100 mature seeds were germinated. Experiments were made in petri disches (9 cm wide) and on filter paper. Significant results (p<0,01) were found according to variance analysis in point of germination percentage and germination speed. *C. amaena* has highest germination percantage and germination speed.

Key words: *Centaurea* L., *Phalolepis* (Cass.) DC., germination, light, endemic

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Phalolepıs (Cass.) DC. Seksiyonuna Ait Endemik *Centaurea* L. Türlerinin Tohum Çimlenmesi Üzerine Işık Etkisi

Özet

Dünya'da 600 *Centaurea* L. türü yayılış gösterirken, Avrupa'da 221 tür bulunmaktadır. Türkiye'de *Astragalus* L. ve *Verbascum* L. cinslerinden sonra *Centaurea* en çok türe sahip üçüncü cinstir. Endemizm oranı yüksektir (yaklaşık%63). Bu çalışmada *Centaurea* L. cinsi *Phalolepis* (Cass.) DC.seksiyonuna ait 8 endemik türün tohum çimlenmesi üzerine ışık etkisi araştırılmıştır. (*C. cadmea* Boiss., *C. aphrodisea* Boiss., *C. amaena* Boiss. & Bal., *C. lycia* Boiss., *C. luschaniana* Heimerl, *C. wagenitzii* Hub.-Mor., *C. tossiensis* Freyn & Sint., *C. hieropolitana* Boiss.*)*. Işık etkisi üç farklı fotoperiyotta (16 s aydınlık: 8 s karanlık, 16 s karanlık: 8 s aydınlık, 24 s karanlık) ve 25 ^{o} C sıcaklıkta belirlenmiştir. Her deney serisinde 100 olgun tohum çimlendirilmiştir. Deneyler petri kaplarında ve filtre kağıdında yapılmıştır. Çimşlenme yüzdesi ve hızına bağlı olarak anlamı sonuçlar bulunmuştur (p<0,01). *C. amaena* en yüksek çimlenme yüzdesi ve hızına sahiptir.

Anahtar kelimeler: *Centaurea* L., *Phalolepis* (Cass.) DC., çimlenme, ışık, endemik

1. Introduction

Genus *Centaurea* L. which is an important genus of Asteraceae (Compositae) family, is distributed with about its 700 species in Asia, North Africa, America and Europe (Brummitt, 2004, Tutin, 1976).

According to the species count, *Centaurea* is the third genus in Turkish flora following *Astragalus* and *Verbascum*. The endemism ratio is about 60 % (Davis & Hedge, 1975, Wagenitz, 1975, Davis et al., 1988, Güner et al., 2000). This high endemism ratio supports that the gene center of this genus is Turkey.

Light period is very important factor for seed germination. Many species respond to their environment with optimal development, according to the amount of received light. (Maloof *et al.* 2000). Seeds of some species germinate

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similarly in light and darkness (Baskin & Baskin 1988). On the other hand some seeds readily either under light or darkness conditions (Colbach et al., 2002, Thanos et al., 1989). The light requirement for germination also depends on the temperature.

In this study, light effects on germination of species belonging to *Phalolepis* (Cass.) DC. section of the genus *Centaurea* L. (*C. cadmea* Boiss., *C. aphrodisea* Boiss., *C. amaena* Boiss. & Bal., *C. lycia* Boiss., *C. luschaniana* Heimerl, *C. wagenitzii* Hub.-Mor., *C. tossiensis* Freyn & Sint., *C. hieropolitana* Boiss.) were investigated.

2. Materials and methods

Germination experiments were conducted at the predetermined optimum temperature of 25 oC ± 1 in the plant growth chamber (MLR-350 Model Sony, Japan). A constant temperature (25 ± 1 ○C) and a white light source (Photoperiod I - 8 hours light-16 hours darkness, photoperiod II - 16 hours light- 8 hours darkness, photoperiod III- 24 hours darkness) were used all through the experiments. Experiments were carried out in petri dishes (9 cm diameter lined with discs of filter paper) containing filter paper. For each species, four main experimental series were set up in replicates with 100 seeds per dish. Germination speed is as much important as seed germination percentage. So, germination speed was calculated for each series of experiments according to Yücel (2000). For the statistical evaluation of all data acquired at the end of the germination experiments, *SPSS 10.0 (Statistics Package for the Social Science)* package program was used. Seeds were collected different localities in Turkey (Table 1).

Table 1. Localities of specimens

Species	**Locality**
Centaurea cadmea	**C2 Denizli:** Honaz, National park road, rock, 804 m, 24 vi 2004, N 37^0 $44^{'}$ 58.2" E 29^0 16' 07.3"
Centaurea aphrodisea	**C2Aydın/Denizli:** Geyre-Tavas road, road side, stony slopes, 1022 m, 25 vi 2004, N 37^0 39' 53.0" E 28^0 51' 52.7"
Centaurea amaena	**B5 Kayseri:** Yılanlı mountain, road side, rocky, 1194 m, 14 vii 2004, N 38^0 42' 55.4" E 35^0 25' 18.2"
Centaurea lycia	**C3 Antalya:** Antalya-Korkuteli road, 20. km, road side, rocky, 538 m, 2 vi 2003, N 37^0 01' 35.7" E 30^0 27' 39.6"
Centaurea luschaniana	**C3 Antalya:** Between, Elmalı-Korkuteli, Karaman beli, rocky, 1300 m, 5 vii 2003, N 36^0 56' 52.5" E 30^0 09' 43.8"
Centaurea wagenitzii	**C3 Antalya:** Adrasan, Sazak road, Pinus brutia forest, 18 m, 23 v 2004, N 36^0 18' 52.4" E 30^0 28' 00.0"
Centaurea tossiensis	**A4 Kastamonu:** Between Tosya-Kastamonu, road side, 1048 m, 5 ix 2005, N 41^0 11' 25.0'' E 34^0 01' 40.7''
Centaurea hierapolitana	**B2 Afyon:** Dazkırı, step-Peganum harmala , 870 m, 24 vi 2004, N 37^0 53' 56.7" E 29^0 51' 08.9"

3. Results and discussion

Seed germination of *C. aphrodisea* in three different photoperiods was also almost the same rate. 59.25% on average in the period of 16 hours light, 8 h light period at 49.5% on average, 24 hours in the dark period, the average germination rate were 57% (Table 2).

Germination experiments with *C. amaena* seeds, highest germination percentage and speed in *Phalolepis* section has been identified as such. Over 80% in all three photoperiods germination rate was seen. According to these results *C. amaena* light on germination of seeds may be considered effective. But the light increases the germination rate (Table 2).

C. lycia the seeds in 8 hours light-16 h dark period 67.5% on average, 16 hours light-8 h dark period at 65.25% on average, 24 hours in the dark period, the average germination rate was 39.75%. Germination rate, decreases with decreasing light period (Table 2).

The seed germination experiments with *C. luschaniana*; 16 hours light-8 h dark period 77.75% on average, 8 hours light-16 h dark period average 72.5%, 73.5% the average rate of 24 hours in the dark period germination was determined. According to the results of seeds that germinated in the light period is not too effective. The germination rate decreases with decreasing light period (Table 2)

Table 2. Germination percentage and speed of species

	Germination Percentage												**Germination speed**											
	16L/8D, 25 ºC				**8L/16D, 25 ºC**				**24D, 25 ºC**				**16L/8D, 25 ºC**				**8L/16D, 25 ºC**				**24D, 25 ºC**			
	a	**b**	**c**	**d**	**a**	**b**	**c**	**d**	**a**	**b**	**c**	**d**	**a**	**b**	**c**	**d**	**a**	**b**	**c**	**d**	**a**	**b**	**c**	**d**
C. cadmea	16	76	66	15	86	12	83	12	0	9	13	12	17	31	30	19	32	17	35	21	0	6	21	25
C. aphrodisea	51	59	59	68	49	48	51	50	63	60	57	48	34	33	27	35	36	34	32	27	31	24	28	27
C. amaena	84	89	92	89	86	82	89	88	90	87	93	92	47	47	40	39	36	37	39	40	31	33	35	38
C. lycia	72	66	61	62	70	73	64	63	39	39	48	33	32	23	31	31	7	33	8	22	12	12	10	10
C. luschaniana	74	85	68	84	72	65	75	78	73	80	68	73	27	28	24	29	28	37	22	31	19	25	19	20
C. wagenitzii	7	63	49	54	44	6	8	7	49	46	15	57	8	10	11	11	11	9	7	7	9	9	5	9
C. tossiensis	48	51	51	50	67	57	66	47	34	25	19	47	11	11	12	13	6	7	6	9	17	14	8	13
C. hieropolitana	83	79	76	84	86	89	73	80	75	85	77	72	20	19	20	17	24	20	17	22	15	15	18	14

C. wagenitzii seeds 16 hours light-8 h dark period 43.25% on average, 8 hours light-16 h dark period average 16.25%, a mean of 24 h dark period were germinated at a rate of 41.75%. The highest germination rate at 16 hours light-8 h dark period was observed with decreasing light period decreased the germination rate (Table 2).

C. tossiensis seed best germination showed eight hours light-16 h dark period (average 59.45%), 16 hours light-8 h dark period 50% on average, 24 hours dark period were germinated at a rate of 31.25% on the average. In the dark period of germination up to 24 hours, 16 hours light-8 h dark period and 8 hours light-dark cycle in less than 16 hours (Table 2).

C. hieropolitana seeds germinated at a rate of every three photoperiods was approximately 75-80%. The lowest germination percentage and germination rate was observed 24 h dark period. Accordingly, the light period, germination percentage and speed is proportional to. (Table 2).

Genus *Centaurea* section *Phalolepis* belonging to 8 species, three different conditions in the germination percentage terms compared to the variance analysis results, the germination percentage terms between species ($P < 0.001$) and between tasks ($P < 0.01$) statistical sense difference being statistically significant, germination percentage terms such photoperiod x the statistically significant interaction ($P < 0.01$), photoperiods that have an effect on the germination of the species were found (Table 3).

Germination percentage in terms of types and photoperiods that significant difference in that determination as a result of Duncan test, the homogeneous groups have been created and the results in Table 4 and Table 5 are given.

Table 3. The germination percentage of species according to the results of analysis of variance

Variance Source	Sum of Squares	df	Mean squares	F	Sig. (P)
Speceis	36067,65	7	5152,52	25,8	,000
Photoperiod	2053,52	2	1026,76	5,14	,008
Species *Photoperiod	7421,31	14	530,09	2,65	,004
Error	14375,75	72	199,66		
Total	390681	95			

Germination percentage in terms of species four homogeneous groups were collected. The highest percentage of germination of *C. amaena* and *C. hieropolitana* were collected in group 4 and statistically significant differences between these species is not. *C. luschaniana* and *C. hieropolitana* in group 3 while, *C. tossiensis*, *C. aphrodisea* and *C. lycia* took place in the group 2. *C. cadmea* and *C. wagenitzii* the germination percentage of the weakest took place in the group 1 (Table 4).

Germination rate and germination percentage according to photoperiods (Photoperiod 1: 16 h light-8 h dark, Photoperiod 2: 8 hours light-16 h dark, Photoperiod 3: 24 h dark) between the Duncan test, two different groups were formed. 1 and 2 photoperiods, a group formed a separate group 3 from the photoperiod. Highest germination percentage difference between the first and second photoperiods are allocated is not statistically significant (Table 5, 8)

Table 4. Germination of species related Duncan Group Test Results in Terms of Percentages

Species	Sample number	Homogeneus groups			
		1	2	3	4
C. cadmea	12	32,87			
C. wagenitzii	12	33,83			
C. tossiensis	12		43,03		
C. aphrodisea	12		48,04		
C. lycia	12		49,42		
C. luschaniana	12			59,89	
C. hieropolitana	12			63,57	63,57
C. amaena	12				70,27

Table 5. Duncan test results accordingly germination percantage of photoperiod

Photo period	Sample number	Homogeneus groups	
		1	2
3	32	46,14	
2	32		50,97
1	32		53,23

Germination rate in species to compare the variance analysis compared between species, between photoperiods and the type of *photoperiod interaction terms statistically significant ($p < 0.01$) differences were found (Table 6).

Table 6. Variance analysis results according to germination speed of species

Variance Source	Sum of Squares	df	Mean squares	F	Sig. (P)
Species	3,97	7	0,56	16,06	,000
Photoperiod	0,51	2	0,25	7,2	,001
Species *Photoperiod	1,03	14	7,36	2,08	,023
Error	2,54	72	3,53		
Total	8,06	95			

Germination rate in terms of species, were collected in five different groups. Have the highest germination rate of *C. amaena* and *C. aphrodisea* in group 5, *C. luschaniana* and *C. aphrodisea* in group 4, *C. luschaniana* and *C. hieropolitana* in group 3, *C. cadmea*, *C. lycia C. hieropolitana* groups 2, with the lowest germination rate of *C. wagenitzii* and *C. tossiensis* took place in the group 1 (Table 7).

Table 7. Germination of species related Duncan Group Test Results in Terms of Speed

Species	Sample number	Homogeneus groups				
		1	2	3	4	5
C. wagenitzii	12	0,96				
C. tossiensis	12	1,02				
C. cadmea	12		1,2			
C. lycia	12		1,23			
C. hieropolitana	12		1,27	1,27		
C. luschaniana	12			1,41	1,41	
C. aphrodisea	12				1,49	1,49
C. amaena	12					1,58

Table 8. Duncan test results accordingly germination speed of photoperiod

Photoperiod	N	Homogeneus groups	
		1	2
3	32	1,17	
2	32		1,28
1	32		1,35

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(Received for publication 13 October 2015; The date of publication 15 December 2015)