

Effect of Different Temperatures on Germination and Early Seedling Growth of Grass Pea (*Lathyrus Sativus* L.)

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Abstract

The research was conducted to determine the effect of different temperatures on germination and early seedling growth of grass pea (*Lathyrus sativus* L.). Two grass pea cultivars (Gürbüz-2001, Karadağ) and a population (Pop-Diyarbakır) were used as experimental materials. The study was conducted in complete randomized split-plot design with four replications in growth chamber. The germination rate, mean germination time, shoot length, root length, root dry weight, root fresh weight, shoot dry weight and shoot fresh weight were determined. The germination rates were varied between 25.00-99.00%. The highest mean germination time was found in 0 °C (12.79 days), Gürbüz-2001 and Karadağ genotypes (5.39 and 5.42 days). The highest shoot length (4.24 cm), and root length (8.85 cm) were found at 15 °C. The highest shoot length was found in Karadağ genotype (3.99 cm) and at 15 °C Gürbüz-2001 and Karadağ interactions (4.79 and 4.64 cm). The root fresh weight, shoot fresh weight, root dry weight and shoot dry weight was decreased by increasing of temperature in all genotypes.

Anahtar kelimeler: Grass pea, temperature, germination, seedling growth

Farklı Sıcaklıkların Mürdümünün (*Lathyrus Sativus* L.) Çimlenme ve Erken Fide Gelişimine Etkisi

Öz

Bu araştırma mürdümünün (*Lathyrus sativus* L.) farklı sıcaklık derecelerinin, çimlenme ve erken fide gelişimi dönemi üzerine etkisini belirlemek amacıyla yürütülmüştür. İki mürdümük çeşidi (Gürbüz-2001, Karadağ) ve Diyarbakır bölgesinden sağlanan popülasyon (Pop-Diyarbakır) materyal olarak kullanılmıştır. Araştırma tesadüf parsellerinde bölünmüş parseller deneme desenine göre dört tekrarlamalı olarak, yetiştirme kabininde yürütülmüştür. Araştırmada çimlenme oranı, ortalama çimlenme süresi, sürgün uzunluğu, kök uzunluğu, kök kuru ağırlığı, sürgün kuru ağırlığı, kök yaş ağırlığı ve sürgün yaş ağırlığı incelenmiştir. Çimlenme oranı % 25.00-99.00 arasında değişmiştir. En yüksek ortalama çimlenme süresi 0 °C' de (12.79 gün), Gürbüz-2001 ve Karadağ çeşitlerinde (5.39 ve 5.42 gün) belirlenmiştir. En yüksek sürgün uzunluğu (4.24 cm) ve kök uzunluğu (8.85 cm) 15 °C'de belirlenmiştir. En uzun sürgün Karadağ çeşidinde (3.99 cm) ve 15 °C'de Gürbüz-2001 ve Karadağ interaksyonlarında (4.79 ve 4.64 cm) belirlenmiştir. Kök yaş ağırlığı, sürgün yaş ağırlığı, kök kuru ağırlığı ve sürgün kuru ağırlığı sıcaklık yükseldikçe azalmıştır.

Key words: Mürdümük, sıcaklık, çimlenme, fide gelişimi

Introduction

Lathyrus L. genus has 187 species and subspecies (Allkin et al., 1983). European flora has 54 (Tutin et al., 1981) and Turkey flora has 18

endemic species (Davis, 1970). *Lathyrus sativus* L., grass pea, is a grain legume species and the most cultivated species of *Lathyrus* sp. (Asmussen, 1998). Grass pea has a potential to be grown as a forage crop in semi-arid regions (Abd El-Moneim

and Cocks, 1993) with it is drought and flooding tolerance (Sinha, 1977; Campbell et al., 1993; Hanbury et al., 1995; Tekeli and Ates, 2011; Zhelyazkova et al., 2016). It is used as forage (herbage, hay and grain), grazing, green manure and food (Karadağ et al. 2004; Karadağ et al., 2010; Ates and Tekeli, 2011). Grass pea seeds has up to 35% protein (Williams et al. 1994) on the contrary there are some substances in its species that have negative effects on nutrition as in many other legume species. The most important of these items is ODAP (β -Nooxalyl-L- α , β -diaminopropionic acid) the amount of which varies according to the genotype, abiotic and biotic stress conditions. One of the most common negative effects of ODAP is that it affects the central nervous system and causes permanent paralysis in the hind legs of humans and animals (Lathyrism) (Chowdhury, 1988; Urga et al. 1995). With it is drought and flooding tolerance and despite the neurotoxin content grass pea will be more important in the future for animal and human consumption.

The abiotic and biotic factors are critical while germination and seedling growth periods than the other vegetation periods of plants. Germination is the most critical stage for seedling establishment (Almansouri et al., 2001). Temperature has an important role in germination and seedling growth of plants with oxygen and moisture, plays an important role in the germination of warm and cool season legume seeds (Butler et al., 2014) and germination rates of legumes are affected by temperature (Bewley and Black, 1982). It occurs within a defined temperature range and will not occur above or below these limits. Besides, temperature affects the speed of germination, primarily influencing water uptake and impacting the biochemical reactions and physiological processes that determine germination. Previous investigations showed that temperature affected germination of different plant species reported that Chinese sprangletop (*Leptochloa chinensis* (L.) Ness.) showed higher germination at 25 °C while field dodder (*Cuscuta campestris* Yunck.) had maximum germination at 30 °C and reduced germination at 10 °C (Benvenuti et al., 2004; Benvenuti et al., 2005; Guma et al., 2010). Germination and emergence performances of some bitter vetch (*Vicia ervilia* L.) lines at different temperatures investigated by Yilmaz et al. (2015), who determined that the best germination rates at 5 °C, 15 °C and 25 °C for bitter vetch.

This research was conducted to determine the germination and early seedling growth of grass pea at different temperatures.

Material and Method

The research was conducted to determine the germination and seedling growth of grass pea on six different temperatures (0, 5, 10, 15, 20 and 25 °C). Two grass pea cultivars (Gürbüz-2001, Karadağ) and a grass pea population (Pop-Diyarbakır) were used. The study was conducted at University of Tekirdağ Namik Kemal, Faculty of Agriculture, Laboratory of Field Crops Department. The experiment was set up in a growth chamber (Mikrotest, -20 +70°C) in petri dishes with four replications, in complete randomized split-plot design. Seeds were sterilized with 1.5% sodium hypochlorite for fifteen minutes (Dhanda et al., 2004; Ates, 2016) and washed with sterilized distilled water three times. Twenty-five seeds were put in 9 mm diameter petri dishes between Whatman No.1 filter paper and 20 ml sterilized distilled water was added in. Petri dishes put in growth chamber at 16 hours light-8 hours dark period for determine at 7 days germination and 14 days early shoot stage (ISTA, 1996). A seed was considered to be germinated when the radicle protruded 1 mm and germinated seeds were counted for 7 days to determine germination rate and mean germination time (Ellis and Roberts, 1980). Ten seedlings were chosen and shoot length, root length, root fresh weight, root dry weight, shoot fresh weight, and shoot dry weight was determined (Tenikecier and Genctan, 2013). At 0, 5 and 10°C germination was determined, but there was not enough growing in the seedlings to get other observations. Therefore, characters were examined at 15, 20 and 25 °C. The results were analyzed using the TARIST statistical computer package. Mstat-C programmer was used for the comparison test (Fisher's Least Significant Difference, LSD) (Düzgüneş et al., 1987).

Results and Discussion

The results are given in tables 1 and 2. The germination rate and mean germination time were influenced significantly by genotype and temperature ($P < 0.01$) and there were no significant differences at $P > 0.05$, 0.01 in genotype x temperature interactions. The root length was influenced significantly by temperature ($P < 0.01$) and there were no significant differences at $P > 0.05$, 0.01 in genotype and genotype x temperature interactions. The shoot length, root fresh weight, shoot fresh weight and root dry weight were influenced significantly by genotype, temperature and genotype x temperature interactions. The shoot dry weight was influenced by temperature ($P < 0.01$) and genotype x temperature interactions ($P < 0.05$).

The germination rates were varied between 25.00-99.00 %. The highest germination rate was in Karadağ (87.67 %) and the lowest was in Pop-Diyarbakır (82.67 %) genotypes. The germination rates were influenced positive by temperature in

all genotypes, the lowest germination rate was obtained from 0 °C (35.33 %) and the highest was obtained from 10 °C (98.33 %), 15 °C (94.67 %), 20 °C (97.67 %) and 25 °C (94.33 %).

Table 1. Germination rates (%) and mean germination times of grass pea genotypes

Temperatures Genotypes	Germination Rate (%)						Mean
	0 °C	5 °C	10 °C	15 °C	20 °C	25 °C	
Pop-Diyarbakır	46.00	86.00	100.00	97.00	99.00	98.00	87.67 a
Gürbüz-2001	35.00	81.00	96.00	91.00	97.00	90.00	81.67 ab
Karadağ	25.00	84.00	99.00	96.00	97.00	95.00	82.67 b
Mean	35.33 c	83.67 b	98.33 a	94.67 a	97.67 a	94.33 a	84.00
LSD %1	Genotype: 5.183, Temperature: 7.330, Genotype x Temperature: ns						
Temperatures Genotypes	Mean Germination Time (day)						Mean
	0 °C	5 °C	10 °C	15 °C	20 °C	25 °C	
Pop-Diyarbakır	12.81	8.46	3.55	2.40	1.97	1.80	5.17 b
Gürbüz-2001	12.75	8.92	4.01	2.53	2.14	1.97	5.39 a
Karadağ	12.81	8.79	4.41	2.38	2.25	1.91	5.42 a
Mean	12.79 a	8.73 b	3.99 c	2.44 d	2.12 e	1.89 e	5.33
LSD %1	Genotype: 0.193, Temperature: 0.273, Genotype x Temperature: ns						

ns: P>0.01

The germination rates of genotypes was influenced by temperature, minimum germination rates obtained from low temperatures (0-5°C). The longest mean germination time was found in 0°C (12.79 day), the shortest was in 25°C (1.89 day). The highest mean germination time was found in genotypes Gürbüz-2001 and Karadağ (5.39 and 5.42 days). According to mean germination time results there were evident decreases with increasing temperature (Table 1). Probert and Thompson (1976) reported that the 21°C was the optimum temperature for germination in sweet pea (*Lathyrus odoratus* L.), at lower temperatures seed coat seeds failed to imbibe. They emphasized that the lower temperatures were slowed germination and seedling growth rate from seeds was decreased. In accordance with Carvalho and Nakagawa (2000), temperatures above or below the optimum temperature tend to reduce the speed of germination, exposing seedlings to longer periods in less favourable environments. According to Cassaro-Silva (2001), the speed of germination is directly dependent on temperature. Marcos Filho (2005) reported that the optimum temperature allows for the most efficient combination of the percentage and speed of germination. Yilmaz et al. (2015) reported that the best germination ratios at 5 °C, 15 °C and 25 °C for bitter vetch. The results of the research were similar with these researchers.

The shoot length was varied between 1.93-4.79 cm and shortest shoot length was measured from Pop-Diyarbakır (1.93 cm) at 25 °C. (Table 2). The highest root length was determined at 15 °C

(8.85 cm) and the lowest were at 25 °C (4.35 cm) and 20 °C (4.70 cm). Temperature treatment caused a significant decrease in root fresh, root dry, shoot fresh and dry weights (Table 2). The maximum root fresh weight (297.14 mg), root dry weight (23.87 mg) and shoot fresh weight (262.00 mg) were found for Karadağ genotype at 15 °C. The lowest shoot dry weight (5.62 mg) was observed for Pop-Diyarbakır at 25 °C compared to other temperature treatments. Temperature is also fundamental for the development of specific parts of seedlings and primary roots, generally the first parts of the plant to protrude during germination. Inadequate temperatures directly affect root growth, a process in which cells are rapidly dividing, and any adverse environmental factor diminishes the capacity of the root for development (Larcher, 2003). Sincik et al. (2004) reported that the cold temperatures reduced seedling and root growth of field pea (*Pisum arvense* L.) genotypes. Germination rate 93.67%, shoot fresh weight 2.06 g, shoot dry weight 0.028 g, radicle dry weight 0.012 g, and radicle length 2.45 cm at 25 °C were found in grass pea by Mahdavi and Modarres-Sanavy (2007). For some species, Haileselesie and Gselasie (2012) were determined germination percentage 100 %, shoot length 14.24 cm, and root length 8.65 cm at room temperature. Tsegay and Gebreslassie (2014) were obtained that the germination rate 99.9 %, mean germination time 2.91 days, leaf number 1.93 pcs., shoot fresh weight 7.40 g, shoot dry weight 3.42 g for grass pea. Barpate et al. (2015) reported that

the low temperatures caused delayed germination and slow seedling growth, increased temperature from 4 to 30° C had positive impact on fresh shoot weight and dry root weight of cotton seeds (*Gossypium hirsutum* L.). Buriro et al. (2011) and Hassan et al. (2004) claimed that the increase in

temperature promoted shoot fresh weight and shoot dry weight of wheat (*Triticum* sp.) seedlings from 10 to 35°C. Tribouillois et al. (2016) reported that the optimum temperature at 26.8 ± 0.7 °C for grass pea germination. The results were similar to those reported by these researchers.

Table 2. Seedlings characters of some grass pea genotypes at different temperatures

Temperatures	15 °C	20 °C	25 °C	Mean	15 °C	20 °C	25 °C	Mean
	Genotypes	Shoot length (cm)				Root length (cm)		
Pop-Diyarbakır	3.31 bc	3.90 ab	1.93 d	3.05 b	8.52	5.45	2.50	5.49
Gürbüz-2001	4.79 a	3.48 b	2.30 cd	3.52 ab	8.70	4.43	3.44	5.52
Karadağ	4.63 a	3.37 bc	3.96 ab	3.99 a	9.32	4.23	7.12	6.89
Mean	4.24 a	3.58 b	2.73 c	3.52	8.85 a	4.70 b	4.35 b	5.97
LSD	Genotype: 0.567* Temperature: 0.440** Genotype x Temperature: 1.073**				Genotype: ns Temperature: 1.526** Genotype x Temperature: ns			
Genotypes	Root fresh weight (mg)				Shoot fresh weight (mg)			
Pop-Diyarbakır	174.12 b	124.15 bcd	40.80 f	113.02 b	164.62 b	120.90 bc	44.70 d	110.07 b
Gürbüz-2001	141.70 bc	63.46 ef	24.30 f	76.49 b	126.22 bc	80.70 cd	46.00 d	84.31 b
Karadağ	297.14 a	71.80 def	103.90 cde	157.61 a	262.00 a	89.65 cd	101.10 c	150.92 a
Mean	204.32 a	86.47 b	56.33 c	115.71	184.28 a	97.10 b	63.93 c	115.10
LSD	Genotype: 39.741** Temperature: 20.931** Genotype x Temperature: 58.126**				Genotype: 33.126** Temperature: 15.733** Genotype x Temperature: 49.720**			
Genotypes	Root dry weight (mg)				Shoot dry weight (mg)			
Pop-Diyarbakır	15.90 b	10.63 cd	4.18 e	10.24 b	19.10 ab	11.67 cde	5.62 e	12.13
Gürbüz-2001	14.17 bc	6.23 de	5.22 e	8.54 b	13.17 bcd	16.07 abc	8.00 de	12.42
Karadağ	23.87 a	7.55 de	10.41 cd	13.95 a	20.25 a	10.60 cde	14.30 a-d	15.05
Mean	17.98 a	8.14 b	6.61 b	10.91	17.51 a	12.78 b	9.31 b	13.20
LSD	Genotype: 2.826** Temperature: 1.785** Genotype x Temperature: 4.806**				Genotype: ns Temperature: 4.037** Genotype x Temperature: 7.088*			

*: P<0.05, **: P<0.01, ns: Not significant

Conclusions

It was concluded that the germination and seedling characteristics of grass pea genotypes were influenced by different temperature treatments. With increasing temperature, the root fresh and dry weights, and shoot fresh weight of Karadağ genotype was determined to be higher than other genotypes. 15 °C air temperature is recommended for strong seedling growth of grass pea genotypes.

Conflict of Interest Statement: The manuscript's authors declare that, they do not have any conflict of interest.

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