DÜZCE ÜNİVERSİTESİ
Original Research Article
Düzce Üniversitesi Ziraat Fakültesi Dergisi
(Journal of Agriculture Faculty of Düzce University)
https://dergipark.org.tr/tr/pub/jafdu

Determination of polyethylene glycol doses affecting germination percentage, germination index and seedling length of different basil (Ocimum basilicum L.) genotypes

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ARTICLE INFO

Article history:
Received: 12.06.2024
Accepted: 15.06.2024
Available online: 30.06.2024

Keywords:
Drought
Polyethylene glycol
Genotype
Ocimum basilicum L.

ABSTRACT

Among the developmental stages of the basil plant, germination and seedling development periods are the most sensitive periods to stress, so increasing the resistance of this plant to germination, emergence and seedling development stages in drought stress is known as an important element. In this study, the drought resistance of different basil lines in Turkiye was investigated, and characteristics such as germination percentage, germination index and seedling length of seeds under drought stress were examined. The experiment was conducted in Bingöl University, Faculty of Agriculture, Department of Field Crops Laboratories, as a factorial study, in three repetitions according to the completely randomized design. In the study, five different populations (Elâzığ, Kahramanmaraş, Hatay, Denizli and Istanbul) and five different PEG 6000 concentrations (0%-2.5%-5.0%-7.5% and 100%) were used, and seed germination and Its effects on seedling growth were investigated. According to the data obtained, it was determined that *Ocimum basilicum* L. genotypes responded differently to abiotic stress conditions. Under drought stress, *Ocimum basilicum* L seeds gave better results in the Hatay variety, while the lowest germination percentage and germination index were observed in the Elazığ variety. In addition, in terms of seedling length under drought stress, the shortest seedling length was observed in the Denizli population, and the highest seedling length was observed in the Elazığ population.

Farklı fesleğen (*Ocimum basilicum* L.) genotiplerinin çimlenme yüzdesi, çimlenme indeksi ve fide uzunluğunu etkileyen polietilen glikol dozlarının belirlenmesi

MAKALE BİLGİSİ

Makale Geçmişi:
Geliş: 12.06.2024
Kabul: 15.06.2024
Çevrimiçi mevcut: 30.06.2024

Anahtar Kelimeler:
Kuraklık
Polietilen glikol
Genotip
Ocimum basilicum L.

ÖZET

Fesleğen bitkisinin gelişim aşamaları arasında, çimlenme ve fide gelişim dönemleri, strese en hassas dönemler olduğundan dolayı bu bitkinin kuraklık stresinde çimlenmesi, çıkışı ve fide gelişim evrelerinde dayanaklılığının artırılması, önemli bir unsur olarak bilinmektedir. Bu çalışmada Türkiye'de bulunan farklı fesleğen hatlarının kuraklığa dayanıklılığı incelenmiş olup, tohumların kuraklık streslerinde çimlenme yüzdesi, çimlenme indeksi ve elde edilen fidelerin uzunluğu gibi özellikler incelenmiştir. Deneme Bingöl Üniversitesi Ziraat Fakültesi Tarla Bitkileri Bölümü Laboratuvarlarında, faktöriyel çalışması olarak, tesadüf parselleri deneme desenine göre üç tekrarda yürütülmüştür. Araştırmada, beş farklı popülasyon (Elâzığ, Kahramanmaraş, Hatay, Denizli ve İstanbul) ve beş farklı PEG 6000 konsantrasyon (%0-%2,5- %5,0- %7,5 ve %100) kullanılmış olup, tohum çimlenmesi ve fide büyümesine olan etkileri araştırılmıştır. Elde edilen verilere göre, *Ocimum basilicum* L. genotiplerinin abiyotik stres koşullarına farklı tepkiler verdiği belirlenmiştir. Kuraklık stresinde *Ocimum basilicum* L tohumları, Hatay çeşidinde daha iyi sonuçlar verirken, Elazığ çeşidinde en az çimlenme yüzdesi ve çimlenme indeksi görülmüştür. Ayrıca kuraklık stresinde fide uzunluğu bakımından Denizli popülasyonunda en az ve Elazığ popülasyonunda en çok fide uzunluğu gözlemlenmiştir.

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1. Introduction

In recent years, the demand for herbal medicines for treatment purposes, the fact that fragrant plants constitute the main raw material of the perfumery, food and cosmetics industries, and the emergence of new areas of use have increased the demand for medicinal and aromatic plants (Kan et al., 2006). The Lamiaceae (Labiatae) family, found in the flora of Turkiye and many genera of which are used for medicinal and aromatic purposes, is represented by approximately 224 genera and 5600 species in the world (Hickey & King, 1997). Türkiye constitutes one of the important gene centers for the Lamiaceae family. Additionally, there are 45 genera, 565 species and 735 taxa belonging to this family in Turkiye (Güner et al., 2000). Plants belonging to the Lamiaceae family are distributed in a wide area as far as America (Heywood, 1996). One of them, belonging to the genus *Ocimum*, grows in annual or perennial herbaceous and woody forms throughout the world; It is *Ocimum basilicum* L. species found naturally in the warm and temperate regions of Asia, Africa and South America (Baydar, 2013). Basil (*Ocimum basilicum* L.) is one of the world's popular and fragrant herbs. This plant has great variation in morphology and essential oil components (Paton et al., 1999). In addition, *Ocimum basilicum* L. species is traded in many countries and is one of the world's important essential oil-containing plants. *Ocimum campechianum, Ocimum fruticulosum, Ocimum gratissimum, Ocimum kilimandscharicum and Ocimum tenuiflorum*, which are other species of the *Ocimum* genus, are normally distributed in nature. It is reported that the origin of the basil plant is South Asia, especially India, and according to information obtained from some sources, Iran (Omidbaigi, 2004). The essential oil of basil is widely used in medicine, perfumery, food industry and spices (Telci et al., 2006). As seen with other plants, different results can be obtained from basil in different climate and ecological conditions. Especially plants rich in essential oils are more sensitive to environmental conditions and show great variation in the quantity of basic components according to different geographical origins (Arabacı & Bayram, 2004). Considering their usage areas, medicinal and aromatic plants have a wide distribution according to their properties. However, abiotic stresses have negative effects on medicinal and aromatic plants, affecting their cultivation and therefore their economy. Under abiotic stress conditions such as low and high temperatures, salinity, drought and heavy rainfall, plants react with physiological and metabolic changes in a way that will be minimally affected during their development periods (Kalefetoğlu & Ekmekçi, 2005). Despite many years of work to develop more tolerant and resistant varieties, the resistance mechanisms of plants to abiotic stress factors have not been fully determined (Öz & Ekinci, 2015). Because, not only genetic factors are effective in abiotic stress conditions, but also the developmental period in which the plant is exposed to these conditions is important (Çulha & Çakşır, 2011).

Increasing the resistance of the basil plant to drought stress during germination, emergence and seedling development stages plays an important role in the cultivation of this plant. Among all the growth stages of the basil plant, the germination and seedling development periods are known to be the most sensitive periods to stress. In this study, the responses of germination percentage, germination index and seedling fresh weight characteristics of different basil lines to drought were investigated.

2. Materials and Methods

The seed material used in the study was obtained by Bozok University faculty member, Prof. Dr. Khalid Mahmood KHAWAR. The experiment was conducted in Bingöl University,

Faculty of Agriculture, Department of Field Crops Laboratories, as a factorial study, in three repetitions according to the completely randomized design. In the study, five different populations (Elâzığ, Kahramanmaraş, İstanbul, Denizli and Hatay) and five different PEG 6000 concentrations (0.0%-2.5%-5.0%-7.5% and 10.0% PEG) were used and the effects of drought on germination percentage, germination index and seedling fresh weight were investigated. Distilled water was used as a control in the experiment. Germination experiments were carried out between petri dishes and blotting paper at a temperature of 20±1°C, and were set up in a completely dark incubator, in three replicates, with 30 seeds in each repetition. Every two days, the papers were changed and 10 ml of solution was added again, and the germination of the seeds was monitored. In addition, basil seeds were counted every day, and seeds with a radicle length of 2 mm were considered germinated. Germination trials were continued for 14 days, which was the last counting day for basil, according to ISTA (2018). To determine the Germination Percentage, the number of seeds germinating on the fourteenth day was calculated as a percentage (%) by proportioning it to the total number of seeds. To determine the Germination Index; The formula GI = $(10 \times n_1 + 9 \times n_2 + \ldots 1 \times n_{10})$ / (total number of days of germination × number of seeds used in germination) was used (Mares & Mrva, 2001). In this formula, the number "n" indicates the number of seeds that germinated on the xth day. To determine the length of the seedlings, the lengths of 10 seedlings chosen randomly on the fourteenth day from each repetition were measured with a ruler and written in cm. The evaluation of the last obtained data was made through the SAS package program. Additionally, the LSD test was used to determine the significance levels of differences between applications.

3. Results and Discussion

3.1. Germination percentage (%)

In the experiment, the number of seeds that germinated on the 14th day was proportional to the total number of seeds and was determined as a percentage (%), and the data obtained is given in Table 1. According to Table 1, a statistically significant difference was observed between populations in terms of germination percentage. It was observed that there was a statistically significant difference in terms of germination percentage between different PEG doses. Additionally, no statistical difference was detected on the germination percentage in terms of the interaction of different populations and different PEG doses. According to Table 1, Elazığ and Hatay populations were determined as the populations with the least and highest germination, at 40.4% and 59.8%, respectively. Additionally, the minimum and maximum germination percentages of *Ocimum basilicum* L. seeds were observed at 10% and 0% (control) doses.

Table 1. Effects of different populations and different PEG doses used to determine the germination percentage of *Ocimum basilicum* plant seeds

Populations	**PEG Doses**					
	Control	**2.5**	**5.0**	**7.5**	**10.0**	**Average**
Elâzığ	51.1	47.8	40.0	26.7	36.7	**40.4 C**
Kahramanmaraş	64.4	58.9	50.0	62.2	34.4	**54.0 AB**
Hatay	65.6	63.3	57.8	61.1	51.1	**59.8 A**
Denizli	60.0	47.8	42.2	50.0	31.1	**46.2 BC**
İstanbul	64.4	61.1	51.1	57.8	55.6	**58.0 A**
Average	**61.1 A**	**55.8 AB**	**48.2 BC**	**51.6 ABC**	**41.8 C**	

** Letters in the same column indicate different groups according to the LSD test at the 0.01 level.

Yurgiden (2019), in his thesis study examining the germination and emergence performances of black cumin genotypes, stated that the germination percentage

decreased in increasing drought levels. Almansuri (2001), in his study on Durum wheat (*Triticum durum*), investigated the resistance of drought stress on germination and reported that germination percentages decreased at different PEG concentrations. In another study, the effect of drought stress induced by PEG on some germination parameters of pumpkin (*Cucurbita pepo* L.) and basil (*Ocimum basilicum* L.) was investigated and it was found that basil seeds were extremely sensitive to water deprivation and could not germinate in 2.5% PEG solution (Ashraf, 2021). This study is consistent with the findings of Gheidary & Pessarakli (2017) and Tilki (2002).

3.2. Germination index

The data obtained regarding the germination index are given in Table 2. According to Table 2, a statistically significant difference was observed in the germination index in terms of both populations, PEG doses and the interaction of the two factors. According to Table 2, Elazığ and Hatay populations were determined as the populations with the lowest and highest germination indexes of 0.8 and 2.0, respectively. In addition, the minimum and maximum germination index data of *Ocimum basilicum* L. seeds were observed at 10% and 0% (control) PEG doses.

Table 2. Effects of different populations and different PEG doses used to determine the germination index of *Ocimum basilicum* plant seeds

Populations	**PEG Doses**					
	Control	**2.5**	**5.0**	**7.5**	**100**	**Average**
Elâzığ	1.7 cdefg	1.6 efgh	0.3 ij	0.1 j	0.3 ij	**0.8 C**
Kahramanmaraş	2.8 abc	3.1 ab	2.6 abcde	0.7 ghij	0.1 j	**1.9 AB**
Hatay	3.4 a	2.6 abcde	2.8 abcd	0.6 ghij	0.4 ij	**2.0 A**
Denizli	2.5 abcde	1.4 fghi	0.5 ghij	0.4 hij	0.1 j	**1.0 C**
İstanbul	2.8 abc	2.0 bcdef	1.6 defg	1.0 fghij	0.4 ij	**1.6B**
Average	**2.7 A**	**2.1 B**	**1.6 C**	**0.6 D**	**0.3 D**	

** Letters in the same column indicate different groups according to the LSD test at the 0.01 level.

Harmancı (2020) reported in his study that the germination index decreased due to increasing drought in poppy varieties and populations. Increasing drought stress in damson varieties significantly reduced the germination index (Aslan, 2018). Berg and Zeng (2006) created drought stress on South African native grasses and found that PEG doses significantly reduced germination percentages. These studies support the experiment and prove that drought and germination index are inversely proportional.

3.3. Seedling length (cm)

In the experiment, the height of 10 randomly selected seedlings on the fourteenth day of each repetition was measured with a ruler and determined in cm, and the obtained data are given in Table 3. According to Table 3, there was a statistically significant difference between the populations, PEG doses, and seedling lengths in terms of the interaction of the two factors. According to Table 3, in terms of seedling length, Denizli and Elazığ were determined as the populations with the minimum and maximum seedling length of 0.5 and 1.2 cm, respectively. In addition, the minimum and maximum seedling length data of *Ocimum basilicum* L. seeds were 0.30 and 1.6 cm, respectively, at 10% and 0% (control) PEG doses.

Table 3. Different population and different doses of PEG used to determine the effects of *Ocimum basilicum* plant seeds on seedling length

Populations	PEG Doses					
	Control	**2.5**	**5.0**	**7.5**	**10.0**	**Average**
Elâzığ	1.19 b	1.45 b	1.31 b	1.66 ab	0.19 c	**1.2 A**
Kahramanmaraş	1.45 b	1.58 ab	0.16 c	1.66 ab	0.16 c	**1.0 AB**
Hatay	1.67 ab	1.37 b	0.36 c	0.26 c	0.43 c	**0.82 B**
Denizli	1.34 b	0.46 c	0.22 c	0.34 c	0.21 c	**0.5 C**
İstanbul	2.10 a	1.61 ab	0.46 c	0.50 c	0.54 c	**1.0 A**
Average	**1.6 A**	**1.3 B**	**0.5 D**	**0.9 C**	**0.3 E**	

** Letters in the same column indicate different groups according to the LSD test at the 0.01 level.

Akyürek (2020), in drought study on exotic vegetable species such as coriander, basil, molehiya, Japanese mustard, komatsuna, mibuna, mizuna, found that there were serious decreases in seedling plant height due to lack of water. In the drought dose study conducted on plant and root height in potato varieties, it was stated that as drought stress increases, decreases in plant height are observed (Nazirzadeh, 2018). In order to see the effects of drought stress on seedling height in wheat forage crops, PEG-6000 doses were given and a decrease was determined (Rouhi et al., 2011).

4. Conclusion

Considering the results, it was determined that basil genotypes responded differently to abiotic stress conditions. Under drought stress, *Ocimum basilicum* L seeds gave better results in the Hatay variety, while the lowest germination percentage and germination index were observed in the Elazığ variety. In addition, in terms of seedling length under drought stress, the shortest seedling length was observed in the Denizli population and the highest seedling length was observed in the Elazığ population. As a result, although Elazığ and Denizli are tolerant to low PEG stresses during germination and seedling development periods, it has been observed that Hatay variety is more resistant to drought, and it is thought that these may be genotypes that should be taken into consideration in breeding studies for this purpose.

Acknowledgement

This article was produced from a master's thesis completed at Bingöl University Graduate Education Institute, Department of Field Crops.

Author Contribution

The authors' contributions to the study are equal.

Conflict of Interest Declaration

There is no conflict of interest.

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To cite: Hacan M., Mokhtarzadeh, S., & Kokten K. 2024. ***Determination of Polyethylene Glycol Doses Affecting*** *Germination Percentage, Germination Index and Seedling length of Different Basil (Ocimum basilicum L.) Genotypes. Journal of Agriculture Faculty of Düzce University*, 2(1):14-20.

Alıntı için: Hacan M., Mokhtarzadeh, S., & Kökten K.. 2024. Farklı Fesleğen (*Ocimum basilicum* L.) Genotiplerinin Çimlenme Yüzdesi, Çimlenme İndeksi ve Fide Uzunluğunu Etkileyen Polietilen Glikol Dozlarının Belirlenmesi. *Düzce Üniversitesi Ziraat Fakültesi Dergisi*, 2(1):14-20.