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How Salinity Affect Emergence of Garden Cress (Lepidium sativum L.) Cultivars?

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Çıkış oranı, Lepidium sativum L., tuz toleransı, Erzurum

Abstract

Salinity has been a major problem for world agriculture in recent years, limiting plant production. This study was carried out to determine the effect of salt stress on seedling emergence parameters of Dadaş and Helen garden cress cultivars. Three doses (S0: 0 mM NaCl (control), S1: 30 mM NaCl and S2: 60 mM NaCl) of salinity level were applied as irrigation and their effects on seedling emergence (emergence percentage, emergence speed, mean emergence time, mean daily emergence, peak value and emergence value) were investigated. In the study, there were generally significant decreases in the emergence parameters of both cultivars with increasing salt level. It was observed that the emergence parameters of Dadaş cultivar were not affected much under 30 mM salt, but there were significant decreases in emergence parameters at 60 mM salt level. It was determined that Helen cultivar was more sensitive to salt stress and its emergence parameters decreased significantly even at the lowest salt level (S1:30 mM). The findings of the study showed that the emergence percentage, mean daily emergence, peak value and emergence values of Dadaş variety were higher than Helen variety in all salinity levels. In addition, Dadaş garden cress was the variety with mean emergence time. In conclusion, there were significant differences between cultivars and cultivars under salt stress, and Dadaş cultivar more resistance to salinity stress during emergence test than the Helen cultivar. In order to obtain a clear idea about the salt resistance of these cultivars, it is necessary to determine the response to salt stress during plant development.

Tuzluluk tere (Lepidium sativum L.) çeşitlerinin çıkışını nasıl etkiler?

Özet

Tuzluluk, son yıllarda dünya tarımı için önemli bir sorun haline geldi ve bitkisel üretimi sınırladı. Bu çalışma, tuz stresinin Dadaş ve Helen tere çeşitlerinin fide çıkış parametreleri üzerine etkisini belirlemek amacıyla yapılmıştır. Sulama olarak tuzluluk seviyesinin üç dozu (S0: 0 mM NaCl (kontrol), S1: 30 mM NaCl ve S2: 60 mM NaCl) ve fide çıkışına etkileri (çıkma yüzdesi, çıkış hızı, ortalama çıkış zamanı, günlük ortalama) çıkış, tepe değeri ve çıkış değeri) incelenmiştir. Çalışmada, artan tuz seviyesi ile her iki çeşidin çıkış parametrelerinde genel olarak önemli düşüşler olmuştur. Dadaş çeşidinin çıkış parametrelerinin 30 mM tuz altında fazla etkilenmediği ancak çıkış parametrelerinde 60 mM tuz seviyesinde önemli düşüşler olduğu görülmüştür. Helen çeşidinin tuz stresine daha duyarlı olduğu ve çıkış parametrelerinin en düşük tuz seviyesinde bile (S1:30 mM) önemli ölçüde düştüğü belirlenmiştir. Çalışmanın bulguları, Dadaş çeşidinin çıkış yüzdesi, ortalama günlük çıkış, tepe değeri ve çıkış değerlerinin tüm tuzluluk seviyelerinde Helen çeşidinden daha yüksek olduğunu göstermiştir. Sonuç olarak, tuz stresi altındaki çeşitler arasında önemli farklılıklar bulunmuş ve Dadaş çeşidi çıkış testinde tuzluluk stresine Helen çeşidine göre daha fazla tolerans göstermiştir. Bu çeşitlerin tuza dayanıklılıkları hakkında net bir fikir edinmek için bitki gelişimi sırasında tuz stresine karşı tepkinin belirlenmesi gerekmektedir.

1. INTRODUCTION

Garden cress (Lepidium sativum L.) belonging to the Cruciferae family is a type of vegetable whose spicy leaves are consumed (Yanmaz et al., 2010; Jorkesh and Aminifard 2019). Although native to Southwest Asia and Egypt, it is a cool climate vegetable widely cultivated around the world for a variety of culinary and medicinal uses (Shabbir et al., 2018). This vegetable is known by different local names in different countries (Vaishnavi and Choudhary, 2020). It is widely grown and consumed in all regions of Turkey. Garden cress, an annual herb, is among the aromatic vegetables used in soups, appetizers, salads and side dishes due to its unique aroma and pleasant smell (Yağmur et al., 2019). The seeds of cress are also used by people for problems such as diuretic, sedative and carminative (Jorkesh and Aminifard 2019). The production of such vegetables is restricted by many environmental factors. One of the most important environmental factors limiting plant productivity is salinity (Ashraf and Harris 2004). Salinity in both water and soil is one of the most important abiotic factors in world agriculture. Salinity seriously affects crop production in an area of around 800 million hectares worldwide (Muns and Tester 2008). Today, 1 million hectares of land in the world, in other words about 7 percent of the world, is under the threat of salinity, and it is predicted that it will reach 50% by 2050 if no measures are taken (Demirkaya 2014). The majority of vegetables are glycophytes, and due to this feature, they can be highly affected by soil salinity even at low electrical conductivity (Colla et al., 2010). Moreover, the damage of salinity may vary depending on salt concentration, exposure time, climatic factors, plant type or soil type (Munns 2002; Tang et al., 2015). High salinity increases cell deformation and affects many morphological and physiological mechanisms in plants. In general, it adversely affects seed germination, emergence percentage, growth of above-ground and underground (root) organs in plants (Zhang et al., 2016). The tolerance of some plants to salt may differ due to the genetic structure of the cultivars. Germination, emergence and seedling development stages in salty environments are the most critical periods in the life cycle of the plant (Balci and Boydak 2021). For this reason, it is extremely important to determine garden cress varieties with high salt resistance that can provide economic efficiency in cress cultivation. In addition, there are not enough studies on the effects of salt stress on germination in garden cress. The aim of this study is to determine the salt response of Dadaş and Helen garden cress cultivars, which are exposed to different salt stress, on some characteristics, during the emergence periods.

2. MATERIALS and METHODS

The research was carried out in greenhouses of Atatürk University, Faculty of Agriculture. Dadaş and Helen garden cress (Lepidium sativum. L.) cultivars were used as plant materials in the experiment. Pot culture cultivation technique was used in the study. For this purpose, plastic pots (60 cm long, 15 cm wide and 15 cm deep) were used. A mixture of 3/5 soil, 1/5 peat and 1/5 sand was used as the growing medium.

Experiment was laid out in completely randomized design (CRD) with 3 replications. Arrangements were made to have 1 plastic pot and 150 cress plants in each replication.

Garden cress seeds were sown in October 2021. After sowing, the first irrigation was done with 0 mM (S0), 30 mM (S1) and 60 mM (S2) NaCl solutions according to the repetitions. Irrigation was continued at certain days and intervals until the last day of the observations. Plant emergence was observed for 14 days from sowing. The calculation of the emergence parameters was made based on the formulas in the germination studies of Ellis and Roberts (1981) and Gairola et al. (2011). The investigated parameters are given below.

Emergence percentage (%): The total number of seeds that germinated and emerged (the emergence of cotyledon leaves to the soil surface) was proportional to the number of seeds planted and calculated as a percentage.

Emergence percentage (%) = (Number of seeds emerging /Total number of seeds) x 100

Emergence speed (ES): The emergence percentage of the seeds on the soil surface, which was counted daily, was calculated according to the following formula.

Emergence speed = n1/d1+n2/d2+n3/d3+----------

n = the number of seeds emerging, d= day

Mean emergence time (MET): Mean emergence time was calculated according to the formula below.

MET = n1 x d1 + n2 x d2 + n3 x d3 + --------/ Total day

n = the number of seeds emerging, d =day

Mean daily emergence (MDE): Mean daily emergence is calculated according to the formula below.

MDE = the total number of seeds emerging / Total day

Peak value (PV): Emergence peak value is calculated with the following formula.

PV= Highest emergence/ Number of days

Emergence value (EV): Emergence value is calculated with the following formula.

EV = PV X ADE

Statistically analysis was made by SPSS. Statistical analysis was made after the arcin transformation of the percentage values. The mean of the obtained data was taken and the comparison was made according to the Duncan Multiple comparison test.

3. Results

According to the statistical analysis results, it was determined that the emergence parameters differed significantly between applications (Table 1). The differences between the emergence percentages (EP) showed a very significant difference, and the highest emergence percentages in Dadaş and Helen cultivars were obtained from S0 application with the percentages of 94.67% and 75.33%, respectively. As a result of the research, it was determined that as the salt concentration increased, there was a significant decrease in the emergence percentage. The lowest emergence percentage was observed in S2 application, which is the highest salt concentration in both garden cress cultivars. With increasing salt concentration, there was a decrease of 34.5% in Dadaş and 49.55% in Helen in terms of emergence percentage. According to this feature, it was determined that Dadaş cultivar was highly tolerant to salt stress. Increasing salt concentration significantly decreased the emergence percentage at all salt doses. Compared to the control (S0) salt application appears to cause a significant decrease in garden cress cultivars. While S1 salt application did not cause a significant decrease in emergence speed (ES) in Dadaş variety, there was a significant (approximately 48%) decrease in S2 application. In Helen cultivar, a decrease of 33% and 57% occurred in S1 and S2 applications, respectively (Figure 1).

Mean emergence time in the control group; It was determined as 3.51 in Dadaş variety and 4.4 in Helen variety. It was observed that the mean emergence times (MET) of the Helen variety were generally prolonged after saltwater applications. In Dadaş variety, it was determined that the emergence period was shortened (3.29) after S1 application and prolonged (4.32) in S2 application. It was determined that the mean daily emergence performance of Dadaş cultivar (4.30) was better than Helen cultivar (3,42) under normal irrigation conditions (S0). It was determined that the mean daily emergence performance (MDE) of Dadaş cultivar was better than Helen cultivar under normal irrigation conditions (S0). In addition, according to this parameter, it was revealed that the most affected variety from the applications was Helen. There was a decrease of approximately 49.4% in the mean daily emergence value of the variety compared to the control (Figure 2). In Dadaş variety, this decrease was 34.4%. In the evaluation made according to the peak value (PV), it was determined that Dadaş variety was higher than Helen variety in all applications. Peak values in S0, S1 and S2 applications were 3.58, 3.18 and 1.42 in Dadaş variety, respectively. It was determined as 1.27, 0.79 and 0.70 in Helen cultivar. Significant differences in emergence values were observed between cultivars. Significant differences in emergence values (EV) were observed between cultivars. At the same time, it was determined that Helen cultivar was significantly affected by salt applications. While emergence value decreased by 14.1% in S1 application compared to control, there was a very significant decrease of 73.8% in S2 application. In Helen cultivar, it was determined that the emergence value was 4.36 in S0 application, 2.06 in S1 application and 1.20 in S2 application (Figure 3).

Table 1. The effect of salt stress on the emergence parameters of Dadaş and Helen garden cress seeds

Dadaş						
App	EP	ES	MET	MDE	PV	EV
S0 (Control)	94,67 a	14,69 a	3,51 b	4,30 a	3,58 a	15,39 a
S1	91,33 b	14,21 a	3,29 b	4,15 b	3,18 b	13,21 b
S2	62,00 c	7,54 b	4,32 a	2,82 c	1,42 c	4,02 c
Helen						
App	EP	ES	MET	MDE	PV	EV
S0 (Control)	75,33 a	9,23 a	4,40 b	3,42 a	1,27 a	4,36 a
S1	57,33 b	6,15 b	5,33 a	2,61 b	0,79 b	2,06 b
S2	38,00 c	3,94 c	5,15 a	1,73 c	0,70 b	1,20 b

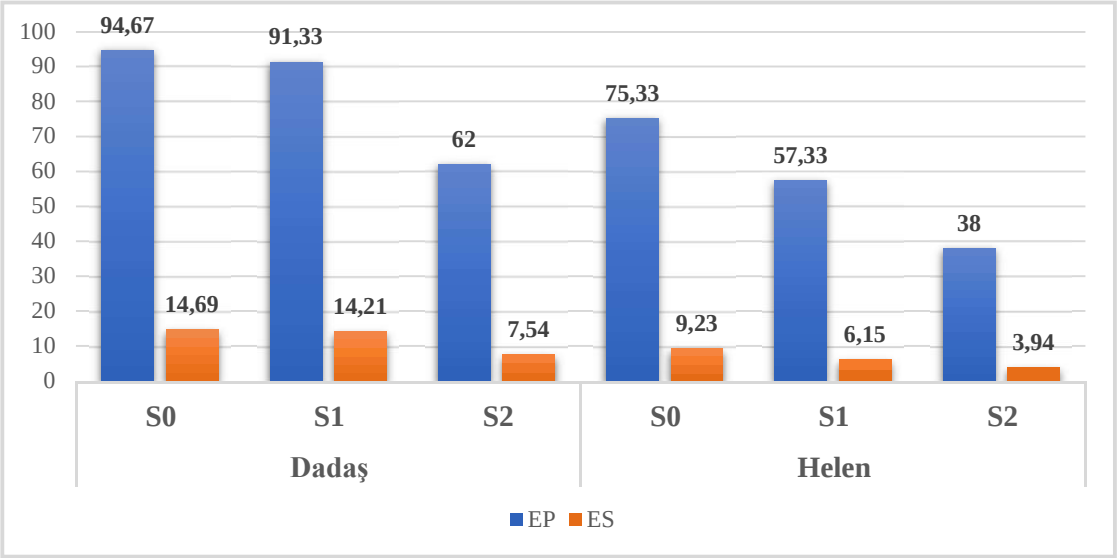

Figure 1. Effects of different applications on garden cress cultivars on EP and ES

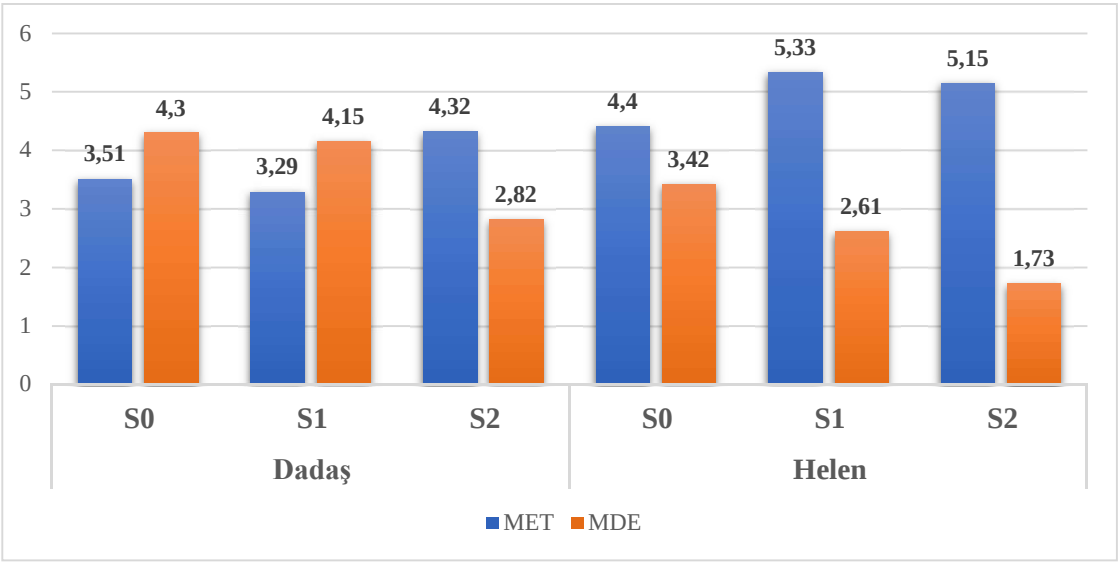

Figure 2. Effects of different applications on garden cress cultivars on MET and MDE

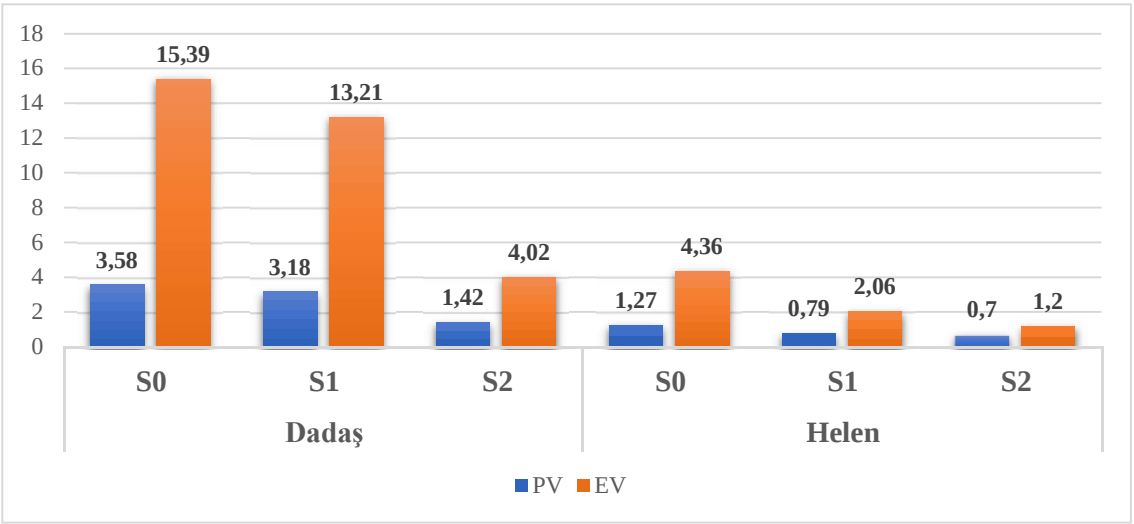

Figure 3. Effects of different applications on garden cress cultivars on PV and EV

DISCUSSION

Salt stress is one of the most important abiotic factors affecting germination and seedling emergence, plant growth and development. In the study, there was a significant decrease in the emergence percentage with the increasing salt concentration. Salt stress affects seedling emergence, germination and germination percentage (Singh et al., 2012). Delayed germination and emergence can be due to increases in salinity levels and increased osmotic stress of the seed medium (Khajeh-Hosseini et al., 2003). In a similar study, it was determined that the germination percentage of garden cress decreased with increasing salt concentration at different salinity levels of 0, 0.6, 1.75, 2.9, 3.9 and 4.9 ds m-1 (Dawd and Abdulla 2020). Earlier researchers reported that the emergence percentage and speed decreased in different plant species with the increase in salinity stress (Akhtar and Hussain 2009; Carpıcı e al., 2009). The emergence ability of seed under salt stress indicates that it has genetic potential for salt tolerance at this stage of its life cycle. However, this does not mean that a plant that germinates under salt stress can grow and survive under salt stress (Blanco et al., 2007). Salinity prolongs the time required for emergence and completion of germination in many plant species (Nawaz et al. 2011). Varieties with a shorter emergence percentage and duration under salt stress are assumed to have better tolerance and can be used as parents or potential donors in breeding programs against salinity (Kaveh et al., 2011). In this study, significant differences were observed in terms of tolerance to salinity stress according to the emergence characteristics of the cultivars. In general, the application of 30 mM NaCl (S1) did not significantly affect emergence properties of the Dadaş variety while did those of Helen cultivar. There are important differences in terms of family, genus and species regarding the salt resistance of plants. Even varieties within the same species may differ in their resistance to salinity (Dajic, 2006). In addition to the salt concentration, the exposure time to the salt also changes the effect on the plant (Acosta-Motos et al., 2017). Seed germination period is the stage when plants are most sensitive to salinity. Salt ions cause both physiological and biochemical changes in seeds during the germination stage. With this change, the structural organization of proteins is affected, and germination of seeds is delayed or prevented (Dadaşoğlu et al., 2020). In many studies, differences were found between the germination characteristics of varieties under salt stress conditions. However, these studies revealed that the results obtained from the emergence or germination parameters are not sufficient alone in the evaluation of tolerance to salinity (Noreen and Ashraf 2007).

CONCLUSION

In this study, salt stress response parameters of two different garden cress (Dadaş and Helen) cultivars were investigated during the emergence period. In general, Dadaş variety was found to be superior to Helen variety in terms of emergence characteristics both in control application and after salt applications. According to the findings, it can be thought that cultivation of Dadaş cultivar under salt stress conditions would be more advantageous. However, based on the results obtained, it will be useful to determine the responses to salt stress, especially during the plant development period of the cultivars.

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