Selcuk Journal of Agriculture and Food Sciences
SJAFS
http://sjafs.selcuk.edu.tr/sjafs/index
(2021) 35 (2), 170-175
e-ISSN: 2458-8377
Research Article
DOI:10.15316/SJAFS.2021.245

Determination of Salinity Tolerances during Germination Period of Some Lentil (*Lens Culinaris* Medic.) Cultivars

Cansu ÇAKIR[1], Ercan CEYHAN[2,*]

[1]Selçuk University, The Graduate School Of Natural And Applied Science, Department of Field Crops, Konya, Turkey
[2] Selçuk University, Faculty of Agriculture, Department of Field Crops, Konya, Turkey

ARTICLE INFO

Article history:
Received date: 18.06.2021
Accepted date: 26.07.2021

Keywords:
Germination
Lentil
NaCl
Salt stress
Salt tolerant

ABSTRACT

In this study, in order to determine the resistance of registered lentil varieties to different salt concentrations during germination periods, this study was carried out in 2020 in University of Selçuk Faculty of Agriculture Department of Field Crops Laboratory in 4 replications according to the Randomized Plots Design. Çağıl, Çiftçi, Evirgen, Fırat-87, Kafkas, Özbek, Şakar, Şanlıbey and Tigris varieties were used as materials in the study. The effects of different salt concentrations (0 (control), 30 mM, 60 mM, 90 mM and 120 mM) on germination rate, germination speed, average germination time and sensitivity index were investigated. As a result of the study, it was determined that there were decreases in all the traits examined compared to the control application due to the increase in salt concentrations in all varieties. Especially in 90 and 120 mM NaCl applications, it was determined that the salt tolerance of the varieties decreased. Lentil varieties have been differently affected by salt applications, and the presence of genetic variation between varieties has helped us identify salt-resistant varieties. The varieties most sensitive to salinity were determined as Evirgen and Tigris. When all parameters are evaluated together, Özbek, Çağıl and Şanlıbey varieties have been determined as the best performing genotypes in terms of salt resistance.

1. Introduction

Soil salinity, which is among the factors that limit production because of improper use of natural resources or pollution due to various reasons, is increasing with each passing day (Flowers et al. 1997; Sözen and Karadavut 2017). The increase in the requirement for food in proportion to the increase in the world population with each day (Çakır 2018), and the scarcity of freshwater resources necessitate the search for alternative solutions (Acar et al. 2011). It was reported in previous studies that half of the agricultural areas in the world will not be used because of the salinity problem in the middle of the 21st century (Radi et al. 2013). The salinity problem in the soil affects plant production negatively in our country (Bağci et al. 2007; Atak 2014). It is extremely important to identify lentil varieties that can be productive in economic terms with high resistance to salinity in areas that have salinity problems and to recommend and grow these in these areas. The period when the cultivated plants are most sensitive to salinity is the first developmental period. Therefore, it is necessary to know the reactions plants show against salinity during the first developmental periods to determine the salt resistance of plants. This study was conducted to determine the salt resistance of lentil varieties registered in our country at different salt concentrations during germination periods.

2. Materials and Methods

The present study was conducted in University of Selçuk Faculty of Agriculture Department of Field Crops Laboratory in 2020 with Random Plots Trial Design at 4 replications to determine the resistance of lentil varieties registered in our country to different salt concentrations in germination periods. The study was conducted in dark conditions in a fully controlled germination cabin at a constant ambient temperature of 22±1.0°C; and 5 different NaCl doses (0 (control), 30, 60, 90, and 120 mM) were used in germination trials in the study. Specific germination pots that had a size of 20 x 10 cm, on which germination paper was placed, were used for germination. Solutions of NaCl that had concentrations of 0 (control), 30, 60, 90, and 120 mM were used for germination tests. The seeds of each variety were first kept at 1.5% sodium hypochlorite solution for 5 minutes and in distilled water for 5 minutes immediately after this to perform surface sterilization of the seeds of lentil varieties before germination. Also, 100 seeds with surface sterilization were

* Corresponding author email: *eceyhan@selcuk.edu.tr*

placed in each germination pot used in the experiment, and distilled water or 20 ml salt solutions were added to each of them; and 0.5 g l-1 benomyl fungicide with active ingredient was added to the solutions to prevent fungal growth during germination. Çağıl, Çiftçi, Evirsen, Fırat-87, Kafkas, Özbek, Şakar, Şanlıbey and Tigris varieties were used as plant material in the study, and the effects of different salt concentrations on germination rate, germination speed, average germination time, and sensitivity index were investigated.

3. Results and Discussion

According to the results of the present study, the salt doses, variety and salt doses × variety interactions were found to be statistically significant at 1% in terms of germination rate, germination rate, average germination time, and sensitivity index; and the groupings and average values of the treatments are given in Table 1, Table 2, Table 3 and Table 4.

3.1. Germination Rate

When the general life cycle of plants is examined, it is reported that the most critical period in which plants are sensitive to salinity is the germination period (Aldemir and Ceyhan 2015; Uzun Kayıs and Ceyhan 2015).

When Figure 1 is examined, it is seen that the highest germination rate was observed in the control group at 88.14%, and the lowest germination rate was in 120 mM NaCl application with 72.06%. The germination rate of lentil varieties decreased as the salt dose increased from the control group towards the 120 mM NaCl application (Figure 1). The highest germination rate was detected in the Özbek variety (93.75%) as the average of the salt doses applied in the experiment, and the lowest germination rate was in the Evirgen variety (61.70%) (Figure 2). The significance of the Salt dose x Variety interaction in terms of germination rate shows that the germination rate of lentil varieties is affected differently by salt doses. It was reported in studies that tolerance to salt doses may vary in plant species, even in varieties in the same species (Aldemir and Ceyhan 2015; Gençtürk et al. 2015; Uzun Kayıs and Ceyhan 2015). In the light of these data, Özbek, Kafkas, and Şanlıbey varieties, which had high germination rates in high salt dose applications, were the varieties that should be emphasized.

Table 1
Germination rates of lentil varieties under salt stress (%)

Varieties	Salt Doses					Average
	Control	30 mM	60 mM	90 mM	120 mM	
Çağıl	75.25 mn	72.75 no	72.75 no	70.50 op	70.75 op	72.40 e
Çiftçi	93.75 cd	89.25 fg	86.50 ghi	80.00 kl	74.00 no	84.70 c
Evirgen	75.25 mn	67.25 pq	59.50 st	57.00 t	49.50 u	61.70 g
Fırat-87	83.25 h-k	71.25 nop	68.25 pq	64.25 qr	61.75 rs	69.75 f
Kafkas	93.75 cd	90.00 d-g	89.00 fg	86.25 g-j	83.00 ıjk	88.40 b
Özbek	98.00 ab	94.50 bc	94.00 bcd	92.75 c-f	89.50 efg	93.75 a
Şakar	96.50 abc	91.50 def	88.50 g	84.00 h-k	73.25 no	86.75 b
Şanlıbey	99.00 a	93.50 cde	87.25 gh	82.25 jkl	78.75 lm	88.15 b
Tigris	78.50 lm	80.25 kl	75.25 mn	70.00 op	68.00 pq	74.40 d
Average	88.14 a	83.36 b	80.11 c	76.33 d	72.06 e	80.00

CV%: 2,80; LSD (Salt Doses 1 %): 1.380; LSD (Variety 1 %): 1.851; LSD (Salt Doses x Variety 1 %): 4.139

[1]The difference between means shown with the same letter was insignificant.

3.2. Germination Speed

When Figure 3 is examined, it is seen that the highest germination speed was detected in the control group with 12.05 (days), and the lowest germination speed was in 120 mM NaCl application with 7.27 (days) as the average of the varieties. The germination speed of lentil varieties decreased as the salt concentration increased from the control group towards the 120 mM NaCl dose application (Figure 3). It was reported that the salt added to the germination medium increased the osmotic pressure in the water and prevented the uptake by seeds or decreased the germination speed with the toxic effect of ions, such as Na+ and Cl- (Goertz and Coons 1989; Esechie 1994; Kırtok et al. 1994; Özdemir and Engin 1994; Güvenç ve Kantar 1996; Essa 2002; Sadeghian ve Yavari 2004; Sözen and Karadavut 2019). The average of the salt doses applied in the experiment was at the highest germination speed in the Şakar variety (14.93 days), and the lowest germination speed was in the Evirgen variety (5.33 days) (Figure 4).

Şakar, Çağıl, and Şanlıbey varieties were the varieties that should be emphasized with their performance in terms of germination speed.

3.3. Average Germination Time

When Figure 5 is examined, it is seen that the average germination time of the varieties increased as the salt dose increased from the control group to 120 mM salt dose application. The highest mean germination time was obtained in 120 mM salt dose with 10.97 (days), and the lowest mean germination time was obtained in the control group with 8.10 (days) (Figure 5). Taiz and Zeiger (2002), reported that increased osmotic potential would occur depending on increased doses of NaCl in the salt solution, and may cause delayed germination time in the seeds. As the average of the salt doses applied in the experiment, the longest

germination time was detected in the Kafkas variety (12.40 days), and the shortest germination time was detected in the Çağıl variety (6.38 days) (Figure 6). When the average germination times of the varieties were evaluated at different salt doses, the shortest germination time was detected in Çağıl, Şakar, and Şanlıbey varieties, respectively.

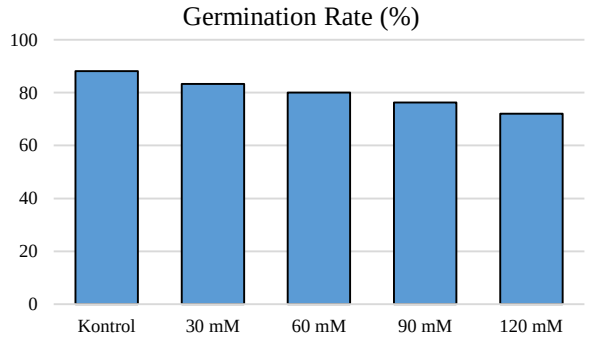

Figure 1
Germination rates of lentil varieties at different salt doses

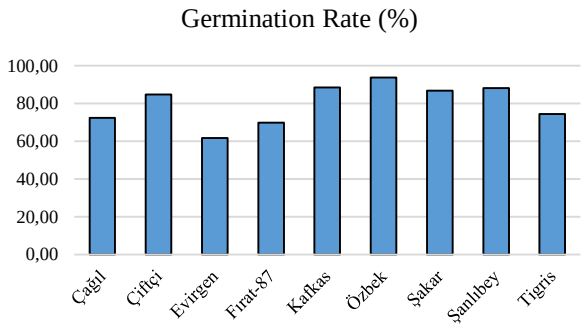

Figure 2
Average germination rates of lentil varieties at different salt doses

Table 2
Germination speeds of lentil varieties under salt stress (day)

Varieties	Salt Doses					Average
	Control	30 mM	60 mM	90 mM	120 mM	
Çağıl	12.47 e	12.66 e	11.86 ef	11.90 ef	11.26 fg	12.03 b
Çiftçi	15.04 c	12.11 ef	10.89 g	8.23 l-o	6.32 rs	10.52 d
Evirgen	7.69 op	6.09 st	4.69 uv	4.38 v	3.81 v	5.33 g
Fırat-87	12.07 ef	9.16 h-k	8.64 k-n	8.09 mno	7.36 opq	9.06 e
Kafkas	9.30 h-k	8.66 j-n	6.66 qrs	6.80 qrs	5.99 st	7.48 f
Özbek	9.54 hıj	9.96 h	9.88 h	8.78 i-m	8.99 i-l	9.43 e
Şakar	19.40 a	18.52 a	16.68 b	12.57 e	7.48 opq	14.93 a
Şanlıbey	13.83 d	12.16 e	10.93 g	9.65 hı	8.93 i-m	11.10 c
Tigris	9.15 h-k	7.83 nop	7.04 pqr	6.27 rs	5.31 tu	7.12 f
Average	12.05 a	10.79 b	9.70 c	8.52 d	7.27 e	9.67

CV%: 4,98; LSD (Salt Doses 1 %): 0.297; LSD (Variety 1 %): 0.398; LSD (Salt Doses x Variety 1%): 0.889

[1]The difference between means shown with the same letter was insignificant.

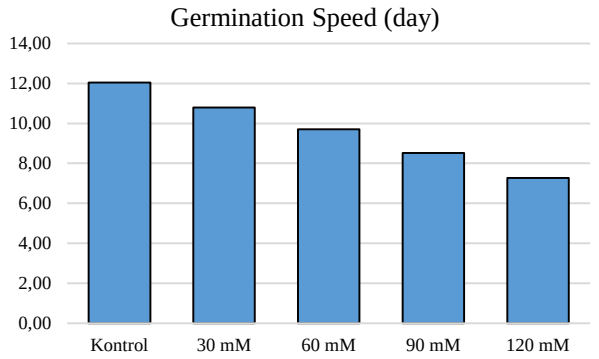

Figure 3
Germination speeds of lentil varieties at different salt doses

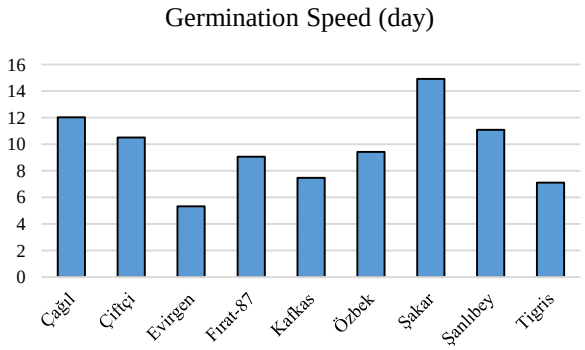

Figure 4
Average germination speeds of lentil varieties at different salt doses

3.4. Sensitivity Index

When Figure 7 is examined, it is seen that the sensitivity index increased as moved from 30 mM salt dose to 120 mM salt dose as the average of the varieties. Increased salt doses also increased the sensitivity index values of the varieties. The highest sensitivity index was detected as 1.40 in 120 mM salt dose, and the lowest sensitivity index was detected as 1.07 in 30 mM salt dose. As the average of the salt doses applied in the trial, the highest sensitivity index was detected in the Çiftçi variety (1.45), and the lowest sensitivity index was detected in Özbek variety (0.97) (Figure 8). In a study conducted by Tan and Akçay (2018), it was reported that as the average of the varieties, the increased salt level also increased the sensitivity index because of

the prolonged germination period with the increase in the salt level. Similar results were also reported in previous studies (Aldemir and Ceyhan 2015; Aydın et al. 2015; Gençtürk et al. 2015; Uzun Kayıs and Ceyhan 2015). When the sensitivity values of the Increased salt doses also increased the sensitivity index values of the varieties were examined from 30 mM salt dose to 120 mM salt dose application, it was found that especially Özbek, Çağıl, and Şanlıbey increased salt doses also increased the sensitivity index values of the varieties were more tolerant to salinity than other increased salt doses also increased the sensitivity index values of the varieties.

Table 3
Average germination time of lentil varieties under salt stress (day)

Varieties	Salt Doses					Average
	Control	30 mM	60 mM	90 mM	120 mM	
Çağıl	6.19 stu	5.91 tuv	6.58 rst	6.28 stu	6.97 qrs	6.38 f
Çiftçi	6.59 rst	7.75 n-q	8.32 l-o	10.23 fgh	11.97 c	8.97 d
Evirgen	10.04 hij	11.42 cde	13.02 b	13.26 b	13.35 ab	12.22 a
Fırat-87	7.49 opq	8.70 klm	8.52 k-n	8.82 kl	9.27 jk	8.56 e
Kafkas	10.53 fgh	10.81 d-h	13.59 ab	12.93 b	14.13 q	12.40 a
Özbek	10.69 e-h	10.01 hij	10.00 hij	10.90 d-g	10.40 fgh	10.40 c
Şakar	5.14 v	5.13 v	5.50 uv	7.28 pqr	10.17 ghi	6.64 f
Şanlıbey	7.39 pqr	7.92 m-p	8.26 l-o	8.87 kl	9.32 ijk	8.35 e
Tigris	8.82 kl	10.53 fgh	11.04 def	11.63 cd	13.17 b	11.04 b
Average	8.10 e	8.68 d	9.43 c	10.02 b	10.97 a	9.44

CV %: 4,89; LSD (Salt Doses 1 %): 0.284; LSD (Variety 1 %): 0.381; LSD (Salt Doses x Variety 1 %): 0.853
[1]The difference between means shown with the same letter was insignificant.

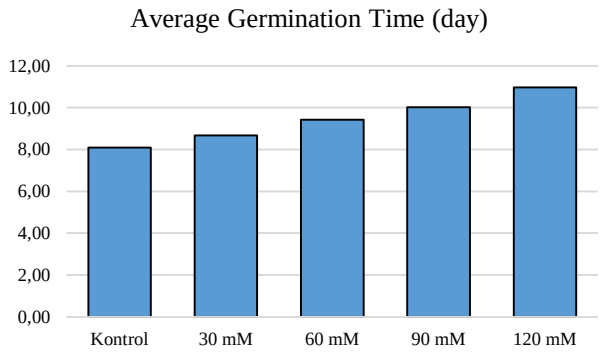

Figure 5
Average germination times of lentil varieties at different salt doses

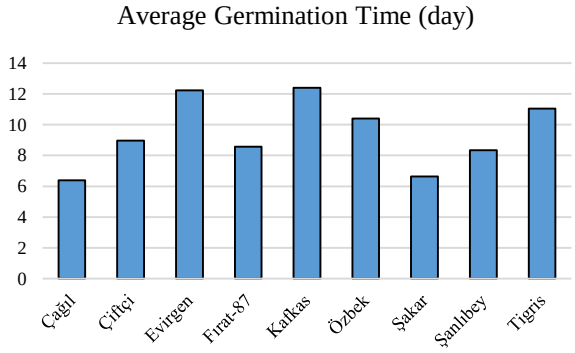

Figure 6
Averages of average germination times of lentil varieties at different salt doses

Table 4
Sensitivity index of lentil varieties under salt stress

Varieties	Salt Doses				Average
	30 mM	60 mM	90 mM	120 mM	
Çağıl	0.95 m	1.06 i-m	1.01 klm	1.13 h-k	1.04 f
Çiftçi	1.18 f-i	1.26 e-h	1.55 c	1.82 b	1.45 a
Evirgen	1.14 h-k	1.30 d-g	1.32 def	1.33 de	1.27 cd
Fırat-87	1.16 g-j	1.14 h-k	1.18 f-i	1.24 e-h	1.18 e
Kafkas	1.03 j-m	1.29 d-g	1.23 e-h	1.34 de	1.22 de
Özbek	0.94 m	0.94 m	1.03 j-m	0.98 lm	0.97 f
Şakar	1.00 klm	1.07 i-m	1.42 cd	1.98 a	1.37 b
Şanlıbey	1.07 i-m	1.12 h-l	1.20 e-i	1.26 e-h	1.16 e
Tigris	1.20 e-i	1.26 e-h	1.33 de	1.50 c	1.32 bc
Average	1.07 d	1.16 c	1.25 b	1.40 a	1.22

CV %: 6,35; LSD (Salt Doses % 1): 0.048; LSD (Ç Variety % 1): 0.072; LSD (Salt Doses x Variety % 1): 0.144
1The difference between means shown with the same letter was insignificant.

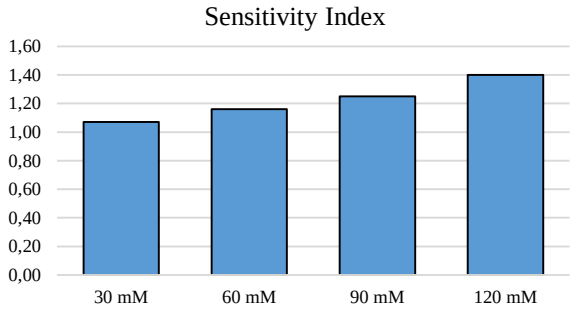

Figure 7
Sensitivity index of lentil varieties at different salt doses

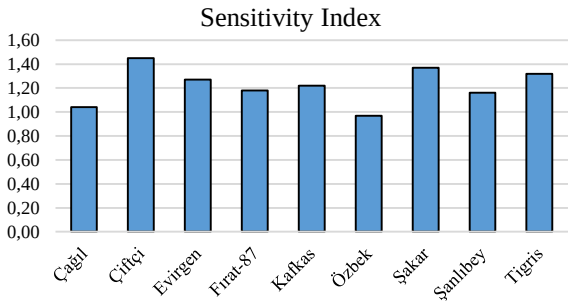

Figure 8
Average sensitivity index of lentil varieties at different salt doses

4. Conclusions

As a result of the study, significant differences were detected in the interaction of the variety, salt dose, and variety x salt dose in terms of germination rate, germination speed, average germination time, and salt sensitivity index values regarding the average of salt applications. The increased salt doses also increased the sensitivity index values of the varieties could not maintain their resistance at low salt doses at increasing salt levels. In terms of salt sensitivity, genetic differences at the germination phase were more evident especially at 90 and 120 mM NaCl levels.

As a result of the findings obtained in the study, it was concluded that salt application decreased the germination rates of the varieties, but on the other hand, it also caused a significant prolongation in average germination time because of slower germination of the seeds. As moved from 30 mM salt dose to 120 mM, the increase in salt dose also increased the sensitivity index; and lentil varieties were affected differently by salt treatments. Also, the genetic variations among varieties helped to identify salt-resistant varieties.

5. References

Acar R, Yorgancılar M, Atalay E, Yaman C (2011). Farklı tuz uygulamalarının bezelyede (*Pisum sativum* L.) bağıl su içeriği, klorofil ve bitki gelişimine etkisi. *Selcuk Journal of Agriculture and Food Sciences* 25 (3): 42-46.

Aldemir Ö, Ceyhan E (2015). Salinity response of some chickpea (*Cicer arietinum* L.) genotypes in germination and seedling growth of periods. *17th International Conference on Agricultural Engineering, Roma, WASET, ICAE 2015*, 17: 668-674.

Atak M (2014). Ekmeklik buğday genotiplerinin çimlenme aşamasında oluşturulan tuz stresine tepkilerinin belirlenmesi. *MKÜ Ziraat Fakültesi Dergisi* 19 (1): 1-10.

Aydın M, Karadas S, Ceyhan E (2015). Salinity Response of Some Cowpea Genotypes in Germination of Periods. *17th International Conference on Agricultural Engineering, WASET*, ICAE 2015, 17: 664-667.

Bağci SA, Ekiz H, Yilmaz A (2007). Salt tolerance of sixteen wheat genotypes during seedling growth. *Turkish Journal of Agriculture and Forestry* 31 (6): 363-372.

Çakır İ (2018). Ekmeklik Buğday Genotiplerinin Orta Anadolu Sulu Ve Kuru Şartlarında Bazı Verim Ve Kalite Özelliklerinin Belirlenmesi. *XII. Tarla Bitkileri Kongresi*, Kahramanmaraş, 56-60.

Esechie H (1994). Interaction of salinity and temperature on the germination of sorghum. *Journal of Agronomy and Crop science* 172(3): 194-199.

Essa T (2002). Effect of salinity stress on growth and nutrient composition of three soybean (*Glycine max* L. Merrill) cultivars. *Journal of Agronomy and Crop Science* 188 (2): 86-93.

Flowers TJ, Garcia A, Koyama M, Yeo AR (1997). Breeding for salt tolerance in crop plants the role of molecular biology. *Acta Physiologiae Plantarum* 19(4): 427-433.

Gençtürk K, Karlı G, Ceyhan E (2015). Bezelye (*Pisum sativum* L.) genotiplerinin çimlenme döneminde tuza toleransı. *Türkiye XI. Tarla Bitkileri Kongresi*, Çanakkale, Cilt I:s. 951-956.

Goertz S, Coons J (1989). Germination response of tepary and navy beans to sodium chloride and temperature. *Hortscience* 24(6): 923-925.

Güvenç İ, Kantar F (1996). Tuza dayanıklı fasulye (*Phaseolus vulgaris* L.) genotiplerinin belirlenmesi. *SDÜ Ziraat Fakültesi Dergisi* 9 (11): 144-153.

Kırtok Y, Veli S, Düzenli S, Tükel S, Kılınç M (1994). Evaluation of salinity stress on germination characteristics and seedling growth of 3 bread wheat's (*Triticum aestivum* L.). *Ege Üniversitesi Ziraat Fakültesi Tarla Bitkileri Bilimi, TÜBİTAK ve Üsigem, Agronomi Bildirileri* (1): 57-61.

Özdemir S, Engin M (1994). Nohut (*Cicer arietinum* L.) bitkisinin çimlenme ve fide büyümesi üzerine NaCl konsantrasyonlarının etkisi. *Turkish Journal of Agriculture and Forestry* 18: 323-328.

Radi AA, Farghaly FA, Hamada AM (2013). Physiological and biochemical responses of salt-tolerant and salt-sensitive wheat and bean cultivars to salinity. *Journal of Biology and Earth Sciences* 3(1): 72-88.

Sadeghian S, Yavari N (2004). Effect of water-deficit stress on germination and early seedling growth in sugar beet. *Journal of Agronomy and Crop Science* 190 (2): 138-144.

Sözen Ö, Karadavut U (2017). Determination of the relationship between yield and yield components of winter red lentil genotypes under the conditions of Amik Plain. *Turkish Journal of Agricultural and Natural Sciences* 4 (4): 468-476.

Sözen Ö, Karadavut U (2017). Determination of direct and indirect relations between some yield characters of red lentil cultivars. *Pakistan Journal of Botany* 49 (6): 2339-2346.

Sözen Ö, Karadavut U (2019). The comparison of domestic lentil genotypes in terms of some quality features. *Mediterranean 1st International Multidisciplinary Studies Co*ngress, 01-03 March 2019, 240-247.

Taiz L, Zeiger E (2002). Plant Physiology. *Sinauer Associates, Sunderland, MA*, 690.

Tan M, Akçay E (2018). Farklı tuz konsantrasyonlarında kinoa (*Chenopodium quinoa* Willd.)'nın çimlenme özelliklerinin belirlenmesi. *Alınteri Zirai Bilimler Dergisi* 33 (1): 85-91.

Uzun Kayıs S, Ceyhan E (2015). Salinity tolerance during germination and seedling growth of some lentil (*Lens culinaris* Medic.) cultivars. *Selcuk Journal of Agriculture and Food Sciences* 29 (1): 15-24.