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The response of some calendula cultivars (*Calendula officinalis* L.) to salt during the germination period

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Abstract

Calendula officinalis L. is one of the important medicinal plants known as "Pot marigold" in the world and has become widespread in recent years due to its medicinal and economic importance.

Salt stress is one of the important abiotic stress factors that limits crop productivity by affecting the growth of plants, especially in arid and semi-arid regions. These negative effects of salt stress, which affects growth and development by causing osmotic and ion stress in plants; It varies depending on the type of salt, the level and duration of the stress, the genotype of the plant exposed to the stress and the developmental stage.

This research was carried out to determine the effects on some physiological parameters of calendula (*Calendula officinalis*) plant grown under different salt (NaCl) dose applications (control, 50, 100 and 150 mM). Parameters such as germination time, germination rate, root and stem length, root and stem length of calendula plant were investigated. As a result of the research; The effect of salt stress on the investigated parameters was found to be statistically significant. It was determined that increasing salt concentrations decreased germination rate, germination time, stem and root length.

Keywords: *Calendula officinalis*; NaCl; Germination; Salinity

1. Introduction

Salinity, along with drought, is one of the main abiotic stress factors that directly affect crop production and productivity today and in the near future (Parida and Das, 2005). It is common in arid and semi-arid regions, especially in irrigated areas, due to reasons such as inadequate irrigation and drainage, low precipitation, high evaporation and irrigation with poor quality irrigation water (Munns and Tester, 2008; Erkoyuncu and Yorgancılar 2020). Salinity is one of the important problems that reduce plant diversity and agricultural productivity in our country as well as in the world. It has been reported that there is a problem of salinity and alkalinity (barrenness) in an area of 1,518,722 ha in Turkey, and this area constitutes 2% of our country's surface area and 5.48% of the total cultivated lands (Temel and Simsek, 2011; Tiryaki 2018).

Due to the increase in osmotic pressure in saline environment, it prevents water intake and accordingly, metabolic events related to germination cannot be initiated (Srivastava 2002). The most negative effect of salt is during the germination period (Taiz and Zeiger 2002). Salinity delays germination in plants, shortens plant height, decreases leaf area and number of siblings, and ultimately affects plant yield negatively (Gupta and Srivastava. 1989; Pessarkli et al..

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1991; Van Hoorn 1991). According to some researchers, it has been revealed that while the total leaf area decreases in plants growing in salty environments, on the other hand, the rate of photosynthesis slows down with the closure of stomata (Levitt 1972; Caro et al., 1991; Cuartero et al. 1999). There are significant differences in physiological and metabolic changes between plant species and varieties, and even between various parts of the plant in terms of response to salt (Awank et al. 1993).

Although salt has multiple (pleiotropic) effects in plants, salt-tolerant plants can exhibit many differences at the anatomical, biochemical and molecular level (Pastori and Foyer, 2002; Bartels and Sunkar, 2005; Tiryaki 2018).

Asteraceae (Compositae) is a family known for being the largest family of flowering plants, constituting approximately 10% of Angiosperms. Members of this family are represented by approximately 1,700 genera and 25,000 species worldwide, excluding Antarctica (Barroso, 1986). It has been stated that there are 1,209 species belonging to the Asteraceae family in the Flora of Turkey. The genus Calendula, which is represented by about 55 species in the world, in Turkey, *Calendula arvensis* L. (Orange daffodil), *Calendula suffruticosa* Vahl. (Öküzgözü) and *Calendula officinalis* L. (Calendar) There are 3 species (Guner et al., 2012).

Calendula officinalis, which is popularly known as calendula or medicinal narcissus, is one of the most frequently used medicinal plants since ancient times. The smell of this species is weak and aromatic, and the taste is bitter (Kalasa 2019). Calendula plant in folk medicine; It is used in the treatment of skin inflammations, in the healing of burns, bruises and cuts on the skin, in the treatment of herpes, in the treatment of liver and biliary tract diseases (Grieve 1931; Kirtikar and Basu, 1993; Khare, 2004; Baydar, 2006).

In this study, it was aimed to determine the effect of NaCl solution containing different concentrations of salt on the germination of *Calendula officinalis* seed.

2. Material and methods

This research was carried out in the laboratory conditions of Balıkesir University Altınoluk Vocational School Department of Medicinal and Aromatic Plants in 2022. Two different kinds of Calendula seeds were used as material in the study.

Calendula seeds were germinated in NaCl solution containing salt at different concentrations (0, 50, 100 and 150 mM) at ordinary room temperature (average 14 °C in four replications and subjected to a classification in terms of physiological properties. Germination experiments were carried out in 9x9 cm transparent and capped petri dishes. 20 seeds were placed between blotting papers in each petri dish and 10 ml of solution was applied to each petri dish. At each stage of the experiment, all the containers were kept at the initial humidity, and when necessary, irrigation was carried out with distilled water (5 ml) adjusted with the NaCl solution contained in the applied solution. Germination rate, germination time, root and stem lengths were determined for 7 days from the establishment of the experiment.

The data obtained from the experiment were analyzed with the TARIST statistical program according to the randomized blocks experimental design. LSD test was used to compare the means.

3. Results and discussion

In the study, the effects of four different NaCl concentrations on the characters of calendula cultivars were investigated and the effects on germination rate, germination time, root length and stem length were found to be significant.

3.1. Germination Rate (%)

Germination rate values of calendula cultivars obtained in media containing different concentrations of NaCl are given in Table 1.

The difference between NaCl doses and cultivar x NaCl interactions in terms of germination rate in NaCl solution with different concentrations of calendula cultivars included in the experiment showed that it should be examined at the 5% significance level (Table 1).

Table 1 Germination rate (%) values of Calendula cultivars at different NaCl concentrations*

	0	**50**	**100**	**150**	**Means**
Population I	87.00 b	89.00 b	94.00 a	75.00 d	86.25
Population II	88.00 b	88.00 b	92.00 ab	79.00 c	86.75
Means	87.50 b	88.50 b	93.00 a	77.00 c	

LSD (0.05):6.486; LSD salinity: 3.918; LSD salinity x cultivars: 2.475; *There is no statistical ($p < 0.05$) differences between values with the same letters in the same columns.

Among the NaCl doses, the highest germination rate was obtained with 93.00% and 100 mM NaCl, the lowest germination rate was obtained at the control (87.50%) and 50 mM NaCl (88.50%) doses.

The most successful effect for germination rate was determined as 94.00% at 100 mM NaCl dose in Population I variety. The lowest effect in this regard was determined as 75.00% at 150 mM NaCl dose in Population I variety.

3.2. Germination Time (days)

Germination time values of calendula cultivars obtained in media containing different concentrations of NaCl are given in Table 2.

Table 2 Germination time (days) values of Calendula cultivars at different NaCl concentrations*

	0	**50**	**100**	**150**	**Means**
Population I	5.14 cd	4.59 f	4.82 e	6.02 b	5.14 b
Population II	5.29 c	4.68 ef	5.02 d	6.52 a	5.38 a
Means	5.22 b	4.64 d	4.92 bc	6.27 a	

LSD (0.05):5.276; LSD cultivars: 0.176; LSD salinity: 0.384; LSD salinity x cultivars: 0.148; *There is no statistical ($p < 0.05$) differences between values with the same letters in the same columns.

In the study, it was shown that the difference between NaCl doses, variety and variety x NaCl interactions in terms of germination time of calendula cultivars in NaCl solution with different concentrations should be examined at the 5% significance level (Table 2).

Among the NaCl doses, the earliest germination time was 4.64 days, 50 mM NaCl, and the latest germination days were 6.27 days at 150 mM NaCl dose.

Among the cultivars, the earliest germination days were found in Population I (5.14 days), and the latest germination days in Population II (5.38 days).

In terms of germination time, the earliest germination was determined as 4.59 days at 50 mM NaCl dose in Population I variety, and the latest germination day was determined as 6.52 days at 150 mM NaCl dose in Population II variety.

3.3. Root Length (cm)

Root length values of calendula cultivars obtained in media containing different concentrations of NaCl are given in Table 3.

In the study, it has been shown that the difference between NaCl doses and variety x NaCl interactions in terms of root length in NaCl solution with different concentrations of calendula cultivars should be examined at the 5% significance level (Table 3).

Among the NaCl doses, the highest root length was determined as 2.05 cm with 100 mM NaCl, and the lowest root length was 1.78 cm in the control dose.

In terms of root length, the longest root was determined as 2.08 cm at a dose of 100 mM NaCl in Population II cultivar. In this regard, the lowest root length was found to be 1.73 cm at a dose of 150 mM NaCl in Population II variety.

Table 3 Root length (cm) values of Calendula cultivars at different NaCl concentrations*

	0	**50**	**100**	**150**	**Means**
Population I	1.74 cd	1.94 bc	2.02 ab	1.79 c	1.87
Population II	1.81 c	2.00 b	2.08 a	1.73 d	1.90
Means	1.78 c	1.97 b	2.05 a	1.76 c	

LSD (0.05):7.124; LSD salinity: 0.067; LSD salinity x cultivars: 0.0593; *There is no statistical ($p < 0.05$) differences between values with the same letters in the same columns.

3.4. Stem Length (cm)

Stem length values of calendula cultivars obtained in media containing different concentrations of NaCl are given in Table 4.

Table 4 Stem length (cm) values of Calendula varieties at different NaCl concentrations*

	0	**50**	**100**	**150**	**Means**
Population I	1.64 e	1.78 c	1.86 b	1.73 cd	1.75
Population II	1.69 d	1.76 c	1.96 a	1.64 e	1.76
Means	1.67 c	1.77 b	1.91 a	1.69 c	

LSD (0.05):8.371; LSD salinity: 0.023; LSD salinity x cultivars: 0.044; *There is no statistical ($p < 0.05$) differences between values with the same letters in the same columns.

In the experiment, the difference between NaCl doses and cultivar x NaCl interactions in NaCl solution with different concentrations of calendula cultivars in terms of stem length showed that it should be examined at the 5% significance level (Table 4).

Among the NaCl doses, the highest stem length was 1.96 cm at 100 mM NaCl, and the longest stem length was obtained at the control (1.67 cm) and 150 mM NaCl (1.69 cm) doses.

In terms of stem length, the longest stem was 1.96 cm at a dose of 100 mM NaCl in Population II cultivar. In this regard, the lowest root length was determined as 1.64 cm in 150 mM NaCl dose in Population II variety and 1.64 cm in Population I variety in control dose.

Our findings on germination time, germination rate, root length and stem length; who stated that excess salt concentration in soil water causes an increase in osmotic pressure and thus affects plant growth negatively by limiting the uptake of water from the soil by plants (Ekmekci et al. 2005); Salim (1991), who reported that root and seedling dry weights decreased with the increase in salt concentrations in wheat; reported that salinity generally reduces or delays the germination rate in plants, shortens plant height, reduces leaf area and number of siblings (Gupta and Srivastava 1989; Pessarkli et al. 1991; Van Hoorn 1991); stating that germination rates are used as a criterion in determining salt tolerant genotypes (Begum et al, 1992); Stating that the limit of being affected by salinity according to plant varieties also changes according to the development periods (Shannon, 1985); In the study, the effects of salt applications on seeds at 24 hours, germination power, reduction in germination rate, radicle, coleoptile length and reduction rates, radicle, coleoptile dry weight and reduction rates, salt tolerance index were investigated in some wheat cultivars. indicating that it has a negative effect on the salinity and that there are significant differences in the response to salinity between the genotypes examined (Koseoglu and Dogru 2021); In his research on the examination of 23 bread wheat varieties in terms of germination and some characteristics in the first development period; germination rate of varieties in the first development period, seedling height. This is in line with the results of Senay et al. (2005), who reported that root length and dry matter ratios were different from each other and that with increasing salt concentrations, germination rate, root length and seedling length decreased, but the dry matter ratio increased.

4. Conclusion

Salt stress; It is a complex abiotic stress that limits the usable water content with its osmotic effect and causes the ion content to reach toxic levels with its ionic effect. Therefore, in order to understand the effects of salt stress on plants and the salt tolerance mechanisms of plants, the effects of both osmotic and ion stress on the whole plant, tissue and cellular level should be examined at the level of morphological, physiological, biochemical and molecular mechanisms.

According to the results of the research, the highest root length is 100 mM (2.08 cm) and 50 mM (2.00 cm), the highest stem length is 100 mM (1.96 cm), the highest germination rate is between 93.00% and 100 mM NaCl, among varieties, the highest The number of early germination days was determined in Population I variety (5.14 days), and the latest germination days in Population II variety (5.38 days). With increasing NaCl concentrations (150 mM), reductions were detected in all of the criteria discussed.

Compliance with ethical standards

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References

[1] Awank YB, Atherton JG, Taylor AJ, 1993.Salinity effects on strawberry plants grown rock wool, growth and leaf relations. Journal of Horticultural Science, 68. 783-790.

[2] Bartels D, Sunkar R 2005. Drought and Salt Tolerance in Plants. Critical Reviews in Plant Sciences, 24: 23-58.

[3] Baydar NB, 2006. Modern Medicine Hand-in-Hand with Alternative Medicine-The Encyclopedia of Medicinal Herbs. Volume 1. Ankara: Palme Publishing.

[4] Begum. F., Karmoker, J.L., Fattah, Q.A. and Maniruzzaman, A.F.M. 1992. The effect of salinity and Its correlation with K+ , Na+ , Claccumulation in germinating seeds of Triticum aestivum L. cv. Akbar. Plant Cell Phsysiol 33 (7):1009-1114.

[5] Caro M, Cruz V, Cuartero J,Estan MT, Bolarin MC, 1991. Salinity tolerance of normal-fruited and cherry tomato cultivars. Palnt and Soil 136, 249-255.

[6] Cuartero J, Fernandez-Munoz R, 1999. Tomato and salinity. Sci. Hortic., 78: 83-125.

[7] Ekmekci E, Apan M, Kara T, 2005. Effect of Salinity on Plant Growth. OMU Agr. Fac. Journal, 2005,20(3):118-125.

[8] Erkoyuncu MT, Yorgancılar M, 2020. The Effect of Priming Applications (Salicylic Acid and Ascorbic Acid) on Germination of Canola (*Brassica napus* L.) Exposed to Salt Stress, Iğdır University Journal of Science Institute, 10(4): 3109-3121, 2020.

[9] Kalas M, 2019. Pharmaceutical Botanical and Phytochemical Studies on Some Calendula L. Species Growing Around Eskişehir. Master Thesis, Eskişehir Anadolu University Institute of Health Sciences, May 2019.

[10] Khare CP, 2004. Encyclopedia of Indian Medicinal Plants, Germany, SpringerVerlag Publisher, pp. 116-117.

[11] Kirtikar KR, Basu BD, 1993. Indian Medicinal Plants. Vol. I. Dehradun, India, pp. 296.

[12] Koseoglu ST, Dogru A, 2021. Effects of Different NaCl Concentrations on Germination Period of Some Bread Wheat (*Triticum aestivum* L.) Genotypes. ETOXEC, 1, pages 33-42.

[13] Levitt J, 1972. Salt and ion stresses. In: Levitt, J. (ed.), Responses of Plants to Environmental Stresses, pp: 489–532. Academic Press, New York.

[14] Grieve M, 1931. A Modern Herbal: The medicinal, culinary, cosmetic and economic properties, cultivation and folklore of herbs, grasses, fungi, shrubs and trees with all their modern scientific uses, Jonathan Cape Ltd, London, pp 456.

[15] Gupta SC, Srivastava J P, 1989. Effect of salt stres on Morpho-Physıological parameters ın wheat. Indian J. Plant Physiol. Vol. 32. no.2. pp 169-171.

[16] Guner A, Aslan S, Ekim T, Vural M, Babaç MT, 2012. List of Plants of Turkey (Veinous Plants). Istanbul: Nezahat Gokyigit Botanical Garden and Flora Research Association Publication.

[17] Munns R, Tester M, 2008. Mechanisms of Salinity Tolerance. Annual Review of Plant Biology, 59: 651-681.

[18] Parida AK, Das AB 2005. Salt tolerance and salinity effects on plants: a review. Ecotoxicol and Environ Safety, 60: 324-49.

[19] Pastori GM, Foyer CH 2002. Common components, networks, and pathways of cross-tolerance to stress. The central role of "redox" and abscisic acid-mediated controls. Plant Physiology, 129: 460-468.

[20] Pessarakli M, Tucker TC, Nakabayashi K, 1991. Growth response of barley and wheat to salt stres. Journal of Plant Nutrition. 14(4), 331-340.

[21] Salim M, 1991. Comparative growth responses and ionic relations of four cereals during salt stress. Journal of Agronomy & Crop Science. 166. 204-209.

[22] Shannon MC, 1985. Principles and strategies in breeding for higher salt tolerance. Plant and Soil. 89: 227-241.

[23] Srivastava SK, Singh HK and Srivastava AK, 2002. Effect of spacing and pinching on growth and flowering of Pusa Narangi Gainda, marigold (*Tagetes erecta* L.). Indian J. Ag. Sci., 72(10): 611-612.

[24] Senay A, Kaya MD, Atak M, Ciftci CY, 2005. Effects of Different Salt Concentrations on Germination and Seedling Growth of Some Bread Wheat Varieties. Journal of Field Crops Central Research Institute, 14, 50-55.

[25] Taiz L, Zeiger E, 2002. Plant Physiology (Third Edition). Sinauer Associates, Inc., Publishers, Sunderland, 67-86.

[26] Temel S, Simsek U 2011. Desertification Process of Soils in Igdır Plain and Solution Proposals. Alinteri, 21(B): 53-59.

[27] Tiryaki I, 2018. Adaptation Mechanisms of Some Field Crops to Salt Stress, KSU Journal of Agriculture and Nature 21(5):800-808, 2018.

[28] Van Hoorn JW, 1991. Development of soil salinity during germination and early seedling growth and its effect on several crops. Agricultural Water Management. 20:17-28.