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Effect of Different NaCl Concentrations on Germinations Period of Oil Sunflower Seeds (*Helianthus annuus* L.) Grown in the Black Sea Region

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Abstract

This study was carried out to determine the effects of different NaCl doses (0, 50, 100, 150 and 200 mM) on the seeds which obtained from the 6 regions in the Central Black Sea, where cultivated sunflower (Bafra, Vezirköprü, Havza, Merzifon, Çorum and Turhal) in 2016. In the experiment, germination rate, germination time, rootlet and tiller length of the seeds were measured. It was found that the seed samples showed different responses to NaCl doses and correspondingly germination rates were 36.3-86.0%, germination times were 4.68-6.05 day, rootlet lengths were 2.36-8.35 cm, tiller lengths were 3.06-9.13 cm. Increasing NaCl doses had a negative effect on the seed samples in the way of the parameters examined except that some seeds. Especially, 100 mM, 150 and 200 mM NaCl doses reduced germination and seedling in sunflower plants.

Keywords: NaCl, germination rate, sunflower, shoot length

1. Introduction

Plants are exposed to several adverse physical and chemical conditions, depending on the enviroment they are in. When these conditions begin to seriously affect the growth and development of the plant, it gets stressed. Stress can cause the plants vital activities (to stay alive and yield) to slow down, and even to stop completely if duration is too long (Shao et al., 2008). Mineral stress, which is an abiotic factor that included in stress factors, significantly affects agricultural areas with the rate of 20% (Blum, 1986). Salinity is one of the most serious factors limiting the productivity of agricultural crops, with adverse effects on germination, plant vigour and crop yield (Munns & Tester, 2008). The most sensitive period in the developmental stages of plants is the germination period. A good germination period affects the developmental and the yield of the plant significantly. Especially negative conditions (salt stress etc.) in this period will prevent healty germination and plant emergence thus reducing the resistance against weeds, diseases and pests, resulting in a serious decrease in productivity. The response of the seed against the salt during the germination and seedling periods, which is the most sensitive periods of each plant, varies (Demir et al., 2003). Sunflower, which has the first order in vegetable oil production in our country, is also in the middle level with respect to salt tolerance (Katerji et al., 2000; Almansouri et al., 2001). Sunflower plants, grown for oil, in arid and semi-arid regions is exposed to salt stress due to salt accumulating on the soil surface along with irregular irrigation. It has been proven by many scientific studies that yield has decreased significantly in this way (Kaya et al., 2006; Day et al., 2008). Because of such factors, the oil requirement for our country can not be met due to the lack of sufficent and productive production. Sunflower is cultivated in many regions by the virtue of its good adaptability, high yield and good quality oil. Especially in arid and semi-arid areas where the salinity is high, the resistance against salt stress was determined during the germination periods of these varieties due to the fact that new cultivars were planted and new varieties were continuously applied to the market, new resource informations about the subject was tried to be obtained.

2. Materials and Methods

This study was prepared in 2016, Sinop University Science and Literature Faculty Biology Department Plant Physiology laboratories according to Coincidental Parcels Trial Design by 4 repetitions. The oil sunflower seeds, which were heavily cultivated and origin unknown in Central Black Sea Region, obtained from grain markets of

Samsun (Bafra, Vezirköprü, Havza), Amasya (Merzifon), Çorum (Merkez), and Tokat (Turhal) regions. They were used as samples in the experiment and seeds were applied 0, 50, 100, 150 and 200 mM NaCl doses. Before starting the experiment, the seeds were determined to be 25 pieces each, and surface sterilization was performed in a 5% sodium hypochlorite solution for 10 minutes. After sterilization, 25 seeds were placed homogenously between two drying papers in 11 × 11 cm sized petri dishes, and NaCl solutions were added to each petri dish for each predetermined 4 repetitions and placed in plastic mouth bags to prevent evaporation. The prepared experiments were allowed to germinate for 10 days at 25 + 1 ^{o}C in a completely dark germination cabinet. During this period, the seeds in the cups were checked everyday and recorded as germinated with a root length of 2 mm. The germination percentage (%) was determined by counting the total germinated seeds at the end of the 10th day. The germination period was determined according to formula developed by Ellis and Roberts (1980). Root and shoot length were determined by measuring root and shoot height of 10 germinated seeds randomly selected from each repetition on the 10th day of experiment.

The data obtained from the research were statically analyzed using SPSS computer program and the differences between the averages were checked by Duncan Multiple Comparison Test according to their significance levels.

Figure 1. Overview of seed application and germination tests

3. Results and Discussion

It has been observed that the varietal analysis results on the germination rate, germination period, root length and shoot length values of oil seeded sunflower seeds obtained from the grain markets in the Central Black Sea Region are statistically significant at $P < 0.01$ level (Table 1). The mean values obtained from the variance analysis results on the parameters and Duncan groups are shown in Table 2.

Table 1. Variance analysis results for yield obtained from different NaCl doses on the varieties

Analysis of Variance	df	Parameters			
		GP (%)	MG (day)	RL (cm)	SL (cm)
Seed (T)	5	279.5**	34.3**	55.2**	10.53**
Salinity (S)	4	70.69**	46.35**	54.02**	306.05**
S×T	20	65.91**	24.78**	46.45**	31.77**

Note. ** Significant at 0.01 levels; ns, nonsignificant; GP: Germination percentage; MG: Mean germination; RL: Root length; SL: Shoot length.

Table 2. Effects of different dosages of NaCl on germination and seedling characteristics of oil seed sunflower seeds. Different letters denote significant difference at $P < 0.05$. All parameters were determined randomly selected from each repetition on the 10th day of experiment. Data expressed as means ± standart deviations (n = 4)

Treatments/NaCl Doses (mM)	Germination Rates (%)					
	0	50	100	150	200	Ort.
Merzifon	68.7c	58.3ef	79.7b	86.0a	54.0gh	**69.3b**
Turhal	69.0c	79.7b	76.7b	79.7b	80.0b	**77.0a**
Çorum	51.7hı	54.0gh	43.0j	48.7ı	38.0k	**47.1e**
Havza	80.3b	78.0b	68.0c	58.0ef	57.0efg	**68.3b**
Vezirköprü	56.7efg	60.0de	56.0fg	67.3c	63.3d	**60.7c**
Bafra	84.7a	60.0de	68.0c	36.3k	42.0j	**58.2d**
Mean	**68.5a**	**65.0b**	**65.3a**	**62.6c**	**55.7d**	
LSD						
	Germination Duration (day)					
Merzifon	5.18hıj	5.20m	5.21ghıj	5.24ghıj	5.49def	**5.26c**
Turhal	5.15ıj	5.30fghı	5.22ghıj	5.68bcd	5.68bcd	**5.41b**
Çorum	4.68m	5.36efgh	5.38edfg	5.80b	5.15m	**5.27c**
Havza	5.35efghı	5.34efghı	5.52cde	5.38efgh	5.71bc	**5.46b**
Vezirköprü	5.34efghı	5.38efgh	5.04jk	6.01a	6.03a	**5.56a**
Bafra	4.76lm	5.07jk	4.99kl	5.50m	6.05a	**5.27c**
Mean	**5.08d**	**5.28c**	**5.23c**	**5.60b**	**5.69a**	
LSD						
	Root Length (cm)					
Merzifon	8.35a	5.86cde	5.26fg	5.19fgh	3.71k	**5.67a**
Turhal	4.91ghı	4.73hıj	5.62ef	4.36j	4.52hıj	**4.83c**
Çorum	7.37b	6.21c	5.28fg	5.53ef	4.87ghı	**5.85a**
Havza	3.19lm	4.91ghı	5.91cde	4.86ghı	2.97m	**4.37d**
Vezirköprü	3.59kl	5.11b	4.66ıj	3.26def	2.36fg	**3.80b**
Bafra	4.43ıj	6.14cd	5.62ef	3.53b	2.92ghı	**4.53a**
Mean	**5.31b**	**5.49a**	**5.39b**	**4.46b**	**3.56c**	
LSD						
	Shoot Length (cm)					
Merzifon	6.92def	6.43fgh	7.29d	5.55jkl	4.11rs	**6.06ab**
Turhal	4.74nopq	8.58b	6.32gh	4.63opq	3.06mno	**5.47bc**
Çorum	6.13hı	8.01c	5.79ıjk	5.96hıj	3.44t	**5.87bc**
Havza	7.38d	7.05de	6.41gh	4.93mnop	4.36klm	**6.03a**
Vezirköprü	5.11lmno	9.13a	6.55pqr	5.73ıjk	4.28qrs	**6.16c**
Bafra	6.44fgh	6.68efg	5.41klm	5.14lmn	3.92st	**5.51d**
Mean	**6.12b**	**7.65a**	**6.30b**	**5.32c**	**3.86d**	
LSD						

3.1 Germination Rates

It was a significant effect on germination rates when NaCl was applied at different doses to specimens of oil sunflower seeds cultivated in the Black Sea Region and obtained after harvest. The highest germinatin rates was obtained at 150 and 0 mM NaCl doses in Merzifon (86.0%), and Bafra (84.7%) seed samples while the lowest germination rates were obtained from seed samples of Bafra (36.3%) and Çorum (38.0%) at doses of 150 and 200 mM NaCl. It was observed that with the exception Turhal and Vezirköprü specimens, the germination rates of the seed samples had decreased depending on the salt concentration. It was determined that samples of Merzifon and Turhal hadn't affected by salt stress but increased at a certain rate while Çorum and Bafra samples had been very sensitive to salt stress and seriously decreased. Many researches specify that plants exposed to salt stress vary in response to stress depending on the amount of salt, and the duration of expose, increase in salt

level inhibits K^+ intake of plants and it accumulates in the plant cell at an excessive level thus causes a toxic effect inhibiting the growth and development of the plant causing osmotic and ionic stress (Hasegawa et al., 2000; Munns, 2002; Wang et al., 2003; Parida & Das, 2005; Dajic, 2006).

3.2 Germination Duration

When germination durations of seed specimens obtained from different regions are examined, it is seen that the increase of NaCl concentrations significally affect the germination period of seed specimens. The shortest germination duration was obtained as 4.68 days at 0 mM NaCl concentration in Çorum sample while the longest germination duration was 6.05 days at 200 mM NaCl concentration in Bafra sample. All in all, as the salt concentration applied to the seed samples increases, the germination duration at the seed samples become longer. Since salt causes osmotic and ionic stress in the developmental and growth of plants, it slows growth and reduction in water intake consequently inhibit cell growth (Parida & Das, 2005; Tuteja, 2007). The results obtained from germination and evaluation results are similar to those of Anuradha et al. (2014) and Yari et al. (2015).

3.3 Root Length and Shoot Length

Seed samples were adversely affected by the doses of NaCl given at different doses in terms of root length values decreased as dose increased. The highest root length was determined as 8.35 and 7.37 at 0 mM NaCl doses from Merzifon and Çorum respectively while the shortest root length was determined as 2.36 and 2.92 at 200 mM NaCl doses of Vezirköprü and Bafra seed samples respectively (Table 2). Similar results were obtained in shoot length and the changes in different NaCl ranged from 3.06-9.13 cm. The longest shoot length (9.13 cm) was obtained from the Vezirköprü seed sample at 50 mM NaCl, while the lowest soot length (3.06 cm) was obtained from the Turhal seed sample at 200 mM NaCl dose. Salt stress causes significant decreases in root/shoot extension in plants as it affects cell activity, division and prolongation in plants (Burssens et al., 2000; Wang et al., 2009). The results of different NaCl doses on root and shoot length effects in samples of oil sunflower seeds are similar to the results obtained by researchers such as Day et al. (2008), Anuradha et al. (2014) and Yari et al. (2015).

It has been observed that oilseed sunflower seeds, cultivated in the Black Sea Region and supplied from different regions have a significant negative reaction to salt stress. In some sunflower seed for oil samples, low NaCl doses were found to have a positive effect on germination rate, root length and shoot length, whereas as the amount of NaCl increased, the physiological development of seed samples slowed down in all parameters. Many researchers have suggested that similar to this, they have noted that increased salinity slows down water uptake by plants, thereby diminishing the activity of some enzymes and preventing germination and root growth of seeds. They argued that it is very important to evaluate the resistance of seeds to salt, especially in arid and semi-arid regions, so that the seeds exposed to salt stress can be germinated in the best way (Werner & Finkelstein, 1995; Mohammadizad et al., 2014). As a result of the current study made under laboratory conditions, the increased NaCl level can adversely affect the germination of oil-seeded sunflower seeds, resulting in the plant's ability to reduce or completely stop seedling formation.

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