EFFECTS OF DIFFERENT SALT DOSES ON SEEDLING GROWTH AND RELATIVE WATER CONTENT OF SUNFLOWER (Helianthus annuus L.)

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ABSTRACT

This study was conducted to determine the effects of different salt doses on seedling growth and relative water content of sunflower (*Helianthus annuus* L.) varieties. In the study, three sunflower varieties [Pioneer MM54 (C1), Pegaz (C2), Buleria (C3)] and three different salt doses [0 (control) (S1), 50 mM (S2), 100 mM (S3)] were used. In the study, seedling lenght (SL), root length (RL), seedling fresh weight (SFW), root fresh weight (RFW) and relative water content (RWC) characteristics were examined. As a result of the study, it was determined that there were generally decreases with increasing salt doses in all varieties in terms of the parameters examined. It was determined that the highest salt dose applied in the study (100 mM) had a greater negative effect on seedling, root development and relative water content. In terms of varieties, it was determined that the Pioneer MM54 variety was more tolerant to salt applications than other varieties.

Keywords: abiotic stress**,** relative water content, salt tolerance, sunflower

INTRODUCTION

Sunflower is one of the most widely cultivated oilseed crops globally, known for its high oil content and quality (40-47%), making it a valuable vegetable oil source (Saleem et al., 2003; Monazzah et al., 2017). Its high oil content, along with the presence of a high proportion of unsaturated fatty acids and a low content of saturated fatty acids, makes it a valuable source of plant-based oil (Gürsoy, 2019, 2022; Rehman et al., 2019). Consequently, it holds significant importance in human nutrition (Tan, 2014). Given the challenges in achieving adequate and balanced nutrition and the difficulties in accessing reliable food sources, the production of plants like sunflower has become increasingly crucial (Tan, 2014). Moreover, due to its high adaptability, sunflower can be grown for oil production in nearly every region of our country (Kaya, 2016).

Salinity has emerged as one of the prominent stress factors increasing globally in recent years (Kireçci and Yürekli, 2019). Salt stress is an abiotic stress factor significantly affecting the development, yield, and quality of plants (Gürsoy, 2023a). In environments where various abiotic stress factors such as salinity and drought prevail, seeds of plants grown experience reduced vitality, suppressed germination, and weak seedling development (Demirbaş and Balkan, 2018). Consequently, plant yields decrease due to these effects (Ulukan et al., 2012). In high salinity conditions where plants are cultivated, several adverse conditions such as water stress, ion toxicity, membrane disorders, inhibited cell division, and growth retardation occur (Zhu, 2007; Gürsoy, 2023a). There are differences among plant species in response to salt stress (Ertekin et al., 2017). Therefore, it is crucial to identify these differences before cultivation.

The aim of this study was to determine the effects of different salt doses applied to various sunflower varieties on seedling development and relative water content.

MATERIAL AND METHOD

This research was conducted at Aksaray University Scientific and Technological Research Laboratory (ASÜBTAM). Three different sunflower varieties [Pioneer MM54 (C1), Pegaz (C2), Buleria (C3)] and three different salt doses [0 (control) (S1), 50 mM (S2), 100 mM (S3)] were used in the experiment, arranged in a completely randomized design with three replications. Before the experiment, the seeds were soaked in 5% sodium hypochlorite solution for 10 minutes for surface sterilization. After soaking, the seeds were rinsed several times with distilled water and dried until they reached their initial weights. Ten seeds for each salt dose were placed on filter papers in Petri dishes, and 10 mL of solutions with appropriate concentrations of salt was added. Petri dishes designated as control received only distilled water. To prevent evaporation, the Petri dishes were sealed with parafilm and left for germination at room temperature. Filter papers were replaced every 2 days, and 10 mL of solutions with different concentrations of salt were added according to the applied doses. Seeds with a 2 mm radicle length were considered germinated (ISTA, 2003). Seedling height (cm), root length (cm), seedling fresh weight (g), root fresh weight (g), and relative water content (%) were measured in this study.

Measurements:

Seedling Height (cm): The seedlings' heights were measured by separating the shoots from the roots and weighing them on a sensitive scale.

Root Length (cm): The roots of the separated seedlings were weighed on a sensitive scale to determine their length.

Seedling and Root Fresh Weight (g): The fresh weights of the seedlings and roots of plants subjected to both control and salt treatments were determined using a sensitive scale.

Relative Water Content (%): Leaf samples collected from plants subjected to both control and salt treatments were weighed to determine their fresh weights. They were then placed in glass tubes containing 5 mL of distilled water and left in light for 24 hours. After this period, the leaf samples were weighed again to determine their turgor weights. These leaf samples were then dried in an oven at 80°C for 48 hours to determine their dry weights. Finally, the relative water contents were calculated using the following formula (Ritchie et al., 1990):

RWC (%) = (FW - DW) / (TW - DW) × 100

FW: fresh weight, TW: turgor weight, DW: dry weight

The results obtained from the experiment were analyzed using TARIST and MSTAT-C (MSTAT, 1989) statistical programs. Differences between means were determined using the LSD test ($p<0.05$).

RESULTS AND DISCUSSION

Examination of the results of the analysis of variance showed significant differences at the 5% level for the traits of seedling height and root length concerning both varieties and doses. For the traits of seedling fresh weight and root fresh weight, significant differences were found only among the doses. As for relative water content, significant differences were observed among varieties, doses, and the interaction of varieties and doses (Table 1).

When the Table 1 was examined in terms of seedling height, it is observed that as the applied salt doses increase, the seedling height decreases in all varieties. The tallest seedling height was determined in variety C1, measuring 8.27 cm under control conditions. The shortest seedling height was 3.20 cm in variety C3 at the highest salt dose. In all applications, the longest seedling height was found in variety C1. In a study conducted by Çiçek et al. (2018) to determine the effects of salt doses on germination and seedling development of durum wheat genotypes, they reported that increasing salt concentrations resulted in reduced seedling height. Culpan and Gürsoy (2023) conducted a study with *Nigella* species and reported reductions in both species with increasing salt doses, with germination and consequently seedling development not occurring at the highest salt dose.

Table 1. Average values for the effect of salt doses applied to sunflower varieties on seedling characteristics and relative water content

Characters	Cultivars	Doses			Means
		Control (0)	50 mM	100 mM	
Seedling Lenght (cm)	C1	8,27	6,87	5,43	6,85 a
	C2	8,00	6,17	4,43	6,20 ab
	C3	7,10	6,10	3,20	5,47 b
	Means	7,79 a	6,38 b	4,35 c	
	$LSD_{0,05}$:	Cultivar: 0,877	Dose: 0,861		
Root Lenght (cm)	C1	2,90	2,33	1,97	2,40 a
	C2	2,37	1,53	1,27	1,72 b
	C3	2,13	1,73	1,07	1,64 b
	Means	2,47 a	1,87 b	1,43 c	
	$LSD_{0,05}$:	Cultivar: 0,353	Dose: 0,374		
Seedling Fresh weight (g)	C1	0,27	0,20	0,10	0,19
	C2	0,23	0,20	0,13	0,19
	C3	0,23	0,23	0,10	0,19
	Means	0,24a	0,21a	0,11 b	
	$LSD_{0,05}$:	Dose: 0,068			
Root Freshweight(g)	C1	0,05	0,03	0,02	0,03
	C2	0,04	0,01	0,01	0,02
	C3	0,05	0,03	0,01	0,03
	Means	0,05a	0,02 b	0,01c	
	$LSD_{0,05}$:	Dose: 0,010			
Relative Water Content (%)	C1	78,53 a	72,17 b	68,50 c	73,07 a
	C2	66,13 c	50,87 d	44,43 e	53,81 b
	C3	43,63 e	41,53 ef	38,87 e	41,34 c*
	Means	62,77 a	54,85 b	50,60 c	
	$LSD_{0,05}$:	Cultivar: 2,810	Dose: 3,318	Cultivar x Dose: 3,147	

*Different letters indicate different groups

In terms of root length (Table 1), it is determined that the root length decreases with increasing salt doses in all varieties, similar to seedling height. Variety C1 exhibited the longest root length at 2.90 cm, while variety C3 had the shortest root length at 1.07 cm. Doğan and Çarpıcı (2016) applied five different NaCl doses (0, 50, 100, 150, and 200 mM) to investigate the effects of different salt concentrations on germination of triticale lines. The study revealed that an increase in salt concentrations negatively affected radicle length, with the shortest radicle obtained from 200 mM salt concentration. Gürsoy (2023b) reported a decrease in root length with increasing salt doses in a study where priming applications were made to reduce the effects of salt stress in pea varieties.

Regarding seedling fresh weight, no statistical difference was found between 50 mM and 100 mM salt doses, and they were grouped together. However, the highest seedling fresh weight was 0.27 g in variety C1 under control conditions. The lowest seedling fresh weight was determined in varieties C1 and C3 at the 100 mM salt dose. According to these results, it is determined that seedling fresh weight is also affected by salt doses. Ertekin et al. (2017) investigated the effects of salt stress on germination parameters, root, and shoot length of some pea varieties in a study. They reported decreases in germination parameters and root and shoot length for all varieties as salt concentration increased. Kurtuluş and Boydak (2022) reported the lowest seedling fresh weight at the highest salt

dose (300 mM) in their study aimed at determining the effects of salt doses on the germination of pea varieties.

In terms of root fresh weight (Table 1), it is determined that the highest root fresh weight was under control conditions and the lowest was at the 50 mM and 100 mM salt doses. In terms of varieties, it was determined that the most tolerant varieties were C1 and C3, while the most sensitive one was C2. Türk and Alagöz (2020) reported significant decreases in root weight with salt stress in their study conducted with *Festuca arundinacea* seeds. Culpan and Gürsoy (2023) investigated the effects of salt doses on germination of Nigella species and reported that the highest value was under control conditions, and the lowest was at the 100 mM dose.

When examined in terms of relative water content (Table 1), it is determined that water content decreases as salt doses increase. The highest relative water content was under control conditions, while the lowest was at the 100 mM salt dose. The highest relative water content was determined as 78.53% in variety C1 under control conditions. The lowest was 38.87% in variety C3 at the 100 mM salt dose. Yakıt and Tuna (2006) investigated the effects of salt stress on maize plants and reported that relative water content decreased with salt doses, with the highest value observed under control conditions. Culpan and Gürsoy (2023) studied the effects of salt doses on germination of Nigella species and reported that the highest relative water content was under control conditions, and the lowest was at the 100 mM dose.

CONCLUSIONS

In this study, the effects of salt applications on the seedling development and relative water content of sunflower varieties were investigated. The results showed that increasing salt doses had a negative impact on the examined characteristics of sunflower varieties. Significant reductions were observed, especially at the 100 mM dose. According to the results obtained from the study, it can be said that Pioneer MM54 variety is somewhat more tolerant to salinity compared to other varieties.

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