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ORIGINAL ARTICLE

Effects of Different Salinity Levels on Germination and Seedling Growth of Turnip (*Brassica rapa* L.)

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ABSTRACT
Salinity is one of the major abiotic stresses, and high concentrations of salts in irrigation water are a common environmental problem affecting plant growth and yield. In this study, we aimed to determine the effects of salinity levels (0.60, 120, 180 and 240 mM) on germination and seedling growth of 16 turnip varieties. The results showed that increased NaCl significantly affected mean germination and seedling growth. It was concluded that the delay in germination was mainly due to higher NaCl accumulation in the seeds. However, it appeared that NaCl adversely influenced turnip seedling characters.
Key Words: Turnip (Brassica rapa L.), Germination, Salinity, Seedling growth

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INTRODUCTION

Seed germination is usually the most critical stage in seedling establishment, determining successful crop production [1]. Factors adversely affecting seed germination may include sensitivity to drought and salt tolerance [2]. Salinity is a complex environmental constraint that presents 2 main components: an osmotic component due to the decrease in the external osmotic potential of the soil solution, and an ionic component linked to the accumulation of ions that become toxic at high concentrations (mainly Na, Cl, SO_4, CO_3, and HCO_3), and a stress-induced decrease in the content of essential elements, such as K and Ca. The source of the sensitivity to salinity is not fully understood. Some researchers have indicated that the main reason for germination failure was the inhibition of seed water uptake due to a high salt concentration, whereas others have suggested that germination was affected by salt toxicity [3,4]. Salinity results in growth retardation and reduction in fruit size, and decreases the number and size of seeds, and consequently yield [5]. As a consequence of these primary effects, secondary stresses, such as oxidative damage, often occur [6]. This study was conducted to evaluate germination and some growth parameters of turnip (*Brassica rapa* L.) in response to salt stress.

MATERIALS AND METHODS

An experiment was conducted in the growth room of the Department of Horticulture Science, Science and Research Branch, Islamic Azad University, Tehran, Iran. For this purpose, 16 varieties of turnip was used in the experiment. Their names and sources of origin are mentioned in Table 1. Seeds of each cultivar were surface sterilized in 5% Sodium hypochlorite solution for 5 min and then carefully rinsed with distilled water to remove the sterilizing agent. Five different levels of NaCl (0, 60, 120, 180 and 240 mM) were used. Fifty seeds of each cultivar were allowed to germinate in each Petri plate double lined with a sterilized filter paper moistened with 10 mL of Hoagland's nutrient solution with or without appropriate levels of NaCl. The treatment solution in each Petri plate was changed every day so as to ensure the desired salt level. Germination started after two days of sowing and a seed was considered germinated when the radicle emerged up to 5 mm in length. The data for germination was recorded daily up to day 15 of the start of the experiment after which time the experiment was terminated. After 15 days of the start of the experiment, plant seedlings were removed carefully from the Petri plates and separated into shoots and roots. After recording fresh weights, the plant samples were oven-dried at 65°C for five days and their dry weights measured. A completely randomized design (CRD) with four replicates was used for data analysis using the SAS For comparing the means, the Least Significance Difference (LSD) test was used.

RESULTS AND DISCUSSION

The results revealed that NaCl significantly affected the germination and early seedling growth in turnip (Table 2) ($p \leq 0.05$). NaCl caused a considerably greater decrease in germination as compared with control treatment (Table 2). NaCl treatments (240 mM) caused a significant reduction mean time germination (MTG) and mean daily germination (MDG) as compared to control (Table 2). Lowest seedling vigor index (SVI) was achieved in seeds treated with 240 mM NaCl (Table 2). The results revealed that 240 mM application significantly decreased roots and shoot length (Table 2). Shoot and root dry weights were reduced under NaCl stress, the main effects of salinity on shoot and root dry weights were statistically significant as compared with control (Table 2).

Table 1. Sources of origin of Turnip used in the experimentation.

Crop Name	No	Cultivar	Source
Turnip	1	*Brassica rapa L.*	Mashhad
	2	*Brassica rapa L.*	Sabzevar
	3	*Brassica rapa L.*	Khash
	4	*Brassica rapa L.*	Sirjan
	5	*Brassica rapa L.*	Marvast Yazd
	6	*Brassica rapa L.*	Dezful
	7	*Brassica rapa L.*	Nehbandan
	8	*Brassica rapa L.*	Mehriz
	9	*Brassica rapa L.*	Ali Yazd
	10	*Brassica rapa L.*	Isfahan
	11	*Brassica rapa L.*	Qom
	12	*Brassica rapa L.*	Birjand
	13	*Brassica rapa L.*	Shiraz
	14	*Brassica rapa L.*	Kermanshah
	15	*Brassica rapa L.*	Ardakan
	16	Brassica rapa L.Top Milan	England

Table 2. Effect of NaCl on germination and seedling growth of Turnip (*Brassica rapa* L.)

Treatment	Mean germination time	Mean daily germination	Seedling vigor index	Shoot length	Root length	Dry weight
0	2.4 C	11.93 A	58.81 A	17.8 A	43.79 A	17.23 A
NaCl (60 mM)	2.61 BC	11.35 A	23.99 B	11.15 B	14.59 B	11.35 A
NaCl (120 mM)	2.98 A	9.68 B	14.94 C	8.70 C	10.43 C	9.68 B
NaCl (180 mM)	2.82 AB	3.75 C	3.04 D	4.59 D	2.89 D	3.75 C
NaCl (240 mM)	2.05 D	1.63 D	1.08 D	2.09 E	1.44 D	1.63 D

This study provides important information about the impacts of salinity on different turnip growth stages. In agreement with the present work, Shannon and Grieve [7] concluded that turnip tops are significantly more salt tolerant than roots. Francois [8] reported that for each unit of increase in salinity (above the salinity threshold) root and shoot biomass productions reduced 8.9% and 4.8% respectively. The control treatment showed there existed clear variation between the varieties in terms of emergence percentage, root dry weight and shoot dry weight. Basically, dry weights decreased as shoot and root length declined after salinity levels increased. However, our findings showed that NaCl had greater inhibitory effects on seedling growth than on germination because significant decrease in germination in the cultivars was observed. Our findings agree with those of Leopold and Willing [9], Hampson and Simpson [10] and Perez-Alfocea et al. [11], who determined that germination and seedling growth were reduced in soils with varying responses for cultivars while NaCl affected the germination of seeds by creating an external osmotic potential preventing water uptake. These results are in agreement with those of Papadopoulos et al. [12], Csizinsky [13], Coons and Pratt [14], Pessarakli and Tucker [15] and Katerji et al. [16] who found significant differences in salt tolerance of different bean cultivars and several other crop. Van Hoorn [17] reported similar inhibition of seedling growth of many crops by salt stress. Alislail and Bartels [18] also reported that salinity reduced dry weights of tepary bean seedlings. In conclusion, in the emergence and seedling growth stages there were differences between the varieties for salt tolerance.

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