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Effects of Salinity Stress on Germination and Early Growth of Sweet William (*Dianthus barbatus*)

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Abstract: The Sweet William (*Dianthus barbatus*) is a plant from Caryophyllaceae family. The germination and growth of plant is an important phonological stages, that plant survival is depends to it, especially in the saline conditions. Salinity tolerance in the arid and semiarid regions is one of the most important factors that effect on the agricultural production. This study was performed in the completely randomized design with three replicates in order to investigation of the role of salts of NaCl, $NaHCO_3$, $NaCO_3$, $CaCl_2$ with different osmotic potentials including of 0, 2, 4, 6 and 8 ds/m on the germination and early growth of *Dianthus barbatus.* In the present study, indices such as percent germination, germination rate, Reduction of germination percentage (RGP), radicle and plumule length, average of fresh and dry weight seedling were measured. Statistical results revealed that the effects of salinity on germination, radicle and plumule length were significant (p<5%), so that both the heighest and lowest percent germination and germination rate were obtained in the control and treatment with concentration 8 ds/m of $NaHCO_3$, respectively. The radicle length, plumule length, average fresh and dry weight seedling were reduced with increasing salinity.

Key words: *Dianthus barbatus*, germination, salinity stress

INTRODUCTION

The *Dianthus barbatus* is a plant from Caryophyllaceae family. The genus *Dianthus* L. comprises about 300 species with a worldwide distribution but centered in the Mediterranean region; some species are cultivated as ornamentals (Jurgenus *et al*., 2003). Environmental stresses are among the most limiting factors to crop plant productivity. Salinity is one of the most detrimental ones (Flowers *et al*., 1997; Boyer, 1982). Different plants of their show have different abilities in the salty environment. Shannon based definition of salinity consist of the presence of excessive soluble salts and mineral elements in soil and water solution, which leads to accumulation of salt in the area radicle and roots plant of the problem changes to absorb enough water from the soil solution. Nearly half of the irrigated land and 20% of the world's cultivated land are currently affected by salinity (Zhu, 2001). High salinity in the root zone affects the growth of many plant species. Saline soils contain multiple types of soluble salt components, each of which has a different effect on the initial growth of plants (Younis and Hatata, 1971; Redmann, 1974; Hardegree and Emmerich, 1990; Tobe *et al*., 2002, 2003), and the compositions of soluble salts in saline soils differ greatly among locations (Tobe *et al*., 2002). Among these salt components, Ca^{2+} is noteworthy because it significantly affects the salinity responses of plants in both initial growth (Bliss *et al*., 1986; Marcar, 1986; Hamada, 1994; Tobe *et al*., 2002, 2003) and later developmental stages (LaHaye and Epstein, 1969; Cramer *et al*., 1986; Kurth *et al*., 1986; Colmer *et al*., 1996). When salinity results from an excess of NaCl, homeostasis of not only Na^+ and Cl^- but also K^+ and Ca^{2+} is disturbed (Serrano *et al*., 1999; Hasegawa *et al*., 2000; Rodriguez-Navarro, 2000).Salinity greatly affects seed germination (Misra and Dwivedi, 2004), and consequently induces a reduction in germination rate and a delay in the initiation of the germination and seedling establishment (Almansouri *et al*., 2001). thus, it is worthwhile to study the physiological mechanisms of poor seed germination caused by salt stress and to develop suitable measures to alleviate the negative effects of salinity on seed germination thereby crop establishment on saline soils (Zheng *et al*., 2009). It has been estimated that more than 20% of all cultivated lands around the world containing levels of salts high enough to cause salt stress on crop plants (Boyer, 1982; Yeo and Flowers, 1982). Salt stress affects many physiological aspects of plant growth (Maghsoudi and Maghsoudi, 2008). Shoot growth was reduced by salinity due to inhibitory effect of salt on cell division and enlargement in growing point (Mccue and Hanson, 1990). Toxic effects of salts may change enzymatic activity and hormonal balance of plants (Maghsoudi and Maghsoudi, 2008). Plant growth is ultimately reduced by salinity stress but plant species differ in their salinity tolerance (Munns and Termaat, 1986).The major inhibitory effect of salinity on plant

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Table1: Influence of concentration of solution salts on the germination and growth parameters in Sweet William.

Treatment	Concentrations (ds/m)	Germination (%)	Germination rate	Reduction germination%	Pulumle length (cm)	Radicle length (cm)	Average fresh weight seedling(gr)	Average dry weight seedling (gr)
Control	0	100^{a}	4.77^{a}	0^{i}	17.13^{a}	17.167^{a}	0.044^{a}	0.0123^{a}
	2	68.333^{bc}	2.93^{cd}	31.66^{gh}	6.83^{de}	6.25^{cd}	0.0088^{de}	$0.0018cd^{e}$
$NaHCO_3$	4	55^{de}	2.11^{e}	45^{ef}	2.5^{fg}	2.46^{def}	0.0011^{f}	0.0004^{e}
	6	28.33^{h}	1.054^{g}	71.66^{b}	1^{gf}	1^{ef}	0.0001^{f}	0.00009^{e}
	8	0^{i}	0^{h}	100^{a}	0^{g}	0^{f}	0^{f}	0^{e}
	2	70^{bc}	3.02^{cd}	30^{gh}	10.01^{bcd}	8.06^{bc}	0.0085^{de}	0.0026^{bcde}
$NaCO_3$	4	55^{de}	2.18^{e}	45^{ef}	1.66^{gf}	1.66^{def}	0.0015^{f}	0.0003^{e}
	6	33.33^{gh}	1.44^{fg}	66.66^{bc}	2.46^{gf}	2.45^{def}	0.0027^{ef}	0.0008^{de}
	8	25^{h}	1.05^{g}	75^{b}	0.667^{g}	0.667^{f}	0.0006^{f}	0.0001^{e}
	2	73.33^{b}	3.36^{bc}	26.66^{h}	11.98^{bc}	11.86^{b}	0.026^{b}	0.0055^{b}
NaCl	4	61.66^{cd}	2.68^{e}	38.33^{gf}	7.75^{de}	8.3^{bc}	0.019^{c}	0.0034^{bcde}
	6	51.66^{de}	2.26^{e}	48.33^{ef}	8.15^{cde}	8.98^{bc}	0.018^{def}	0.0027^{bcd}
	8	45^{f}	1.96^{e}	55^{de}	5.13^{ef}	6.01^{cde}	0.0064^{def}	0.0022^{bc}
	2	75^{b}	3.54^{b}	25^{h}	12.73^{b}	10.41^{bc}	0.0094^{de}	0.0028^{bcde}
$CaCl_2$	4	66.66^{bc}	3.01^{cd}	33.33^{gh}	9.78^{bcd}	9.16^{bc}	0.0091^{d}	0.0051^{b}
	6	46.66^{f}	1.98^{e}	53.33^{de}	7.23^{de}	6.86^{bcd}	0.0052^{def}	0.0011^{de}
	8	40^{fg}	1.54^{f}	60^{cd}	7.13^{de}	7.7^{bc}	0.0042^{def}	0.0026^{bcde}

Description of Tables: Comparison of averages has been done by use of Duncan multiple range test ($p<0.05$) has been done. Letters which are relevant to the comparison of averages are comparable within their treatments

growth and development has been attributed to osmotic inhibition of water availability as well as the toxic effect of salt ions responsible for salinization (Hakim *et al*., 2009). Nutritional imbalance caused by such ions leads to reduction in photosynthetic efficiency and other physiological disorders (Yeo and Flowers, 1983; Yeo *et al*., 1990). Reduced germination rate and plant growth conditions effect the depend the composition of salt, salt type, salt concentration and stage of plant growth. The aim of the present study was to evaluate the effect solutions NaCl, $NaHCO_3$, $NaCO_3$, $CaCl_2$ salinity at germination and early seedling growth stage.

MATERIALS AND METHODS

Experimental design: In this experiment was conducted in shahid Chamran University Faculty of Agriculture at 2009-2010. Seed cultivar used in this experiment was native mass in southwest Iran (Ahvaz state: The latitude and longitude of Ahvaz is: 31º 19′45″ N/48º 41′28″ E, also the city has an average elevation of 20 m above sea level). Seeds of Sweet William were surface sterilized with 2.5% sodium hypochlorite for 10 min and washed seven times with sterile distilled water. In this experiment 20 seeds were placed per Petri dish. And salts sodium chloride salts (NaCl), calcium chloride ($CaCl_2$), sodium carbonate ($NaCO_3$) and sodium hydrogen carbonate ($NaHCO_3$) with four concentrations of 0, 2, 4, 6, 8 ds/m prepared. Below and top seeds filter paper was placed. In each Petri dishe were added 5 ml of salts. To the control treatment to Petri dishe was added distilled water. After the treatments were, Petri dishes were placed in germinator with temperature 25ºC. Counting germinated seeds every day. After 7 days, germination percentage and germination rate was determined by counting the number of germinated seeds and expressed as percentage. Reduction of Germination Percentage (RGP), Radicle and plumule lengths and average fresh weight seedling were determined after completing germination. Radicle and plumule were isolated and dried in oven at 105ºC for 2 h, and then maintained at 80ºC for 3 days to determine their dry weights.

Determination of germination percent, germination rate and reduction of germination percentage (RGP): For calculating the germination percent, germination rate and Reduction of Germination Percentage (RGP) was used following formula:

Germination percent = $S/T \times 100$
Germination rate = $N1/D1+N2/D2+ \ldots +Ni/Di$
This formula S is the number of germinated seeds, T is the total number of seeds and Ni number of germinated seeds, per day (Di).
RGP = 1-The number of germinated seeds conditions salinity/the number of germinated seeds conditions control×100

Preparation of salts solution: Salinity levels using pure salts were prepared with the following equation:

EC = TDS/640 (Meot-Duros and Magne, 2008)
EC = Electrical conductivity
TDS = Concentration of soluble salts in mg/L

Statistical analysis: The experiment was a completely randomized design. All data were subjected to one-way ANOVA using the SAS soft-ware package. Difference at $p<0.05$ was considered significant between treatments.

RESULTS AND DISCUSSION

The results showed that salinity had a significant effect on germination percentage and rate, plumule and radicle length, plumule and radicle dry weight ($p<0.05$). The values for germination percentage and rate, plumule and radicle length, plumule and radicle dry weight decreased with increasing (Table 1).

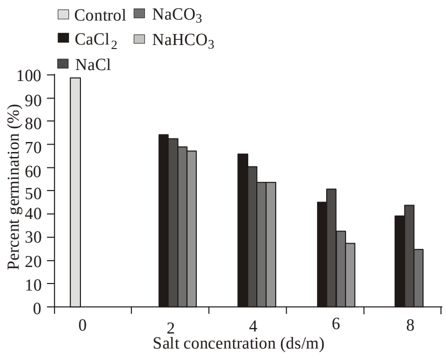

Fig.1: Effects of the concentrations of salts on germination percentage

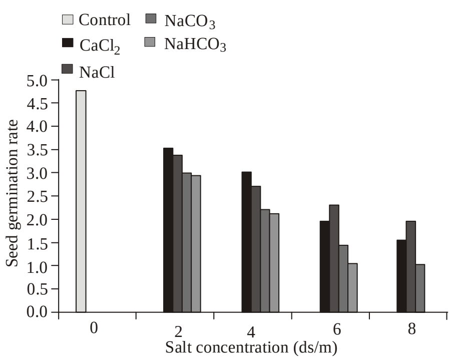

Fig. 2: Effects of the concentrations of salts on seed germination rate

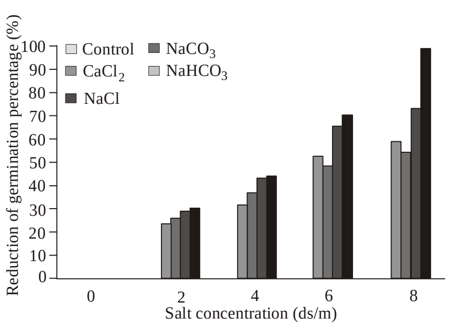

Fig. 3: Effects of the concentrations of salts on reduction of germination percentage

Effect of salts stress on germination percentage: The results of seed germination are shown in Fig. 1. Seed germination showed with increasing concentrations of each salt $CaCl_2$, NaCl, $NaCO_3$, $NaHCO_3$ the process of over a significant decrease ($p \leq 0.05$). It was observed that the germination of seeds treated with $NaHCO_3$ is stronger inhibited than that treated with other salts. So that the seeds not germination in concentration of 8 ds/m this salt. Also were observed after the control treatment salt NaCl highest percentage germination compared with other salts.

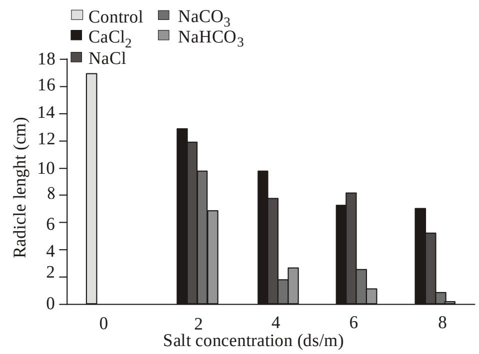

Fig. 4: Effects of the concentrations of salts on plumule length

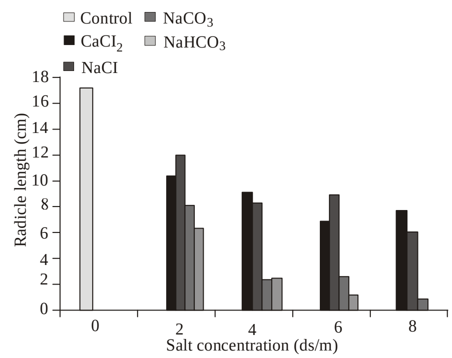

Fig. 5: Effects of the concentrations of salts on radicle length

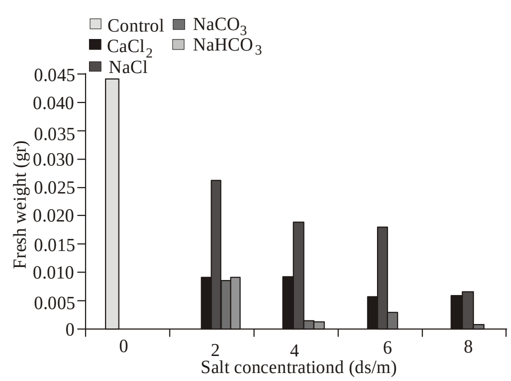

Fig. 6: Effects of the concentrations of salts on average of fresh weight seedling

Effect of salts stress on seed germination rate: Also Germination rate reduced with increasing salt concentration. Highest germination rate is related to the control treatment and the lowest rate is about NaHCO3 salt in the concentration 8 ds/m the seeds not able to germination (Fig. 2).Reason germination loss can be attributed to present over of cations and anions is the dissolution in water reduced water potential so that

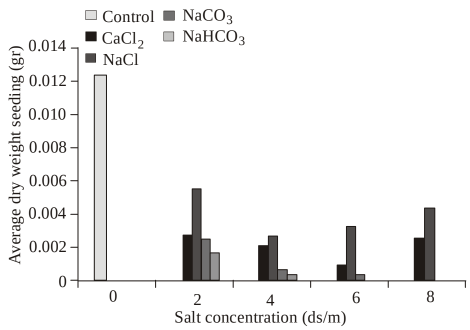

Fig. 7: Effects of the concentrations of salts on average of dry weight seeding

despite the presence of water in the environment, seed could not absorbed facing typical are Water deficiency (Jamil *at el*., 2006).

Effect of salts stress on reduction of germination percentage (RGP): Average comparisons reduction of germination percentage in different salt showed the greatest reduction in salt $NaHCO_3$ with 8 ds/m occurred (Fig. 3).

Effect of salts stress on Plumule and radicle length: Plumule length and radicle length of the seed Dianthus barbatus declined in all the salt treatments relative to the control and with increase in salinity (Fig. 4, 5). Highest Plumule and radicle length were observed in control treatment and lowest Plumule and radicle length of salt $NaCO_3$ and $NaHCO_3$ in the concentrations 8 ds/m. Other research has also been reported with increasing salinity, root and shoot length reduced. Reduction of seedling height is a common phenomenon of many crop plants grown under saline conditions (Javed and Khan, 1975; Karim *et al*., 1992; Amin *et al*., 1996).

Effect of salts stress on average of fresh weight seedling: Study results in Duncan test showed that the control treatment has the highest fresh weight on plumule and radicle (Fig. 6). $NaHCo_3$ salt concentration in 8 ds/m not seed germination due to the lowest weight, but fresh weight treatment with concentration $NaCO_3$ salt 8 ds/m with the 30% germinated seeds was not significantly different were with $NaHCO_3$ treated. Seedling fresh weight loss can be due to low amount of water is tissue Seedling with the results of Sharma *et al.* (2004) conforms to on seedling fresh weight reduction under the influence of salinity stress.

Effect of salts stress on average of dry weight seedling: Average of dry weight seedling was inversely related to salt concentration (Fig. 7). Highest of the dry weight was observed in control treatment and the lowest dry weight in $NaHCO_3$ and $NaCO_3$ whit concentration in 8 ds/m.

CONCLUSION

It was concluded that germination and early seedling growth of different salts were inhibited by increasing salt concentration. It seems that, salinity stress effects on seed germination via limitation of water absorption by seeds (Dodd and Donovan, 1999), excessive use of nutrient pool (Bouaziz and Hicks, 1990) and creation of disorders in protein synthesis. It's reported that, salinity stress effects on alpha and beta amylase duration seed germination (Derek and Black, 1994). No seed was germinated at 8 ds/m in $NaHCO_3$ salt. Generally the results observed devastating effects on $NaHCo_3$ more than other salts were measured indexes (Table 1). The seeds so that in concentration of 8 ds/m $NaHCO_3$ destroyed. According to elements germination can be concluded that seed germination Sweet William is sensitive to salinity, therefore recommended that the soil test to determine the type and concentration of salt is done before the planting flowers Sweet William.

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