University of Birjand

تنشهای محیطی در علوم زراعی
Environmental Stresses In Crop Sciences
Env. Stresses Crop Sci.
Vol. 15, No. 3, pp. 741-750 (Fall 2022)

http://dx.doi.org/10.22077/escs.2021.4024.1954

Original article

Investigation of some physiological and antioxidant responses of caper (*Capparis spinosa* L.) plant to salt stress

R. Baladi[1], M. Nabipour[2*], M. Farzaneh[3]

1. Ph.D Student in Agronomy, Department of Production Engineering and Plant Genetics, Campus of Agriculture, Shahid Chamran University of Ahvaz, Ahvaz, Iran
2. Professor in Department of Production Engineering and Plant Genetics, Campus of Agriculture, Shahid Chamran University of Ahvaz, Ahvaz, Iran
3. Assistant Professor in Department of Production Engineering and Plant Genetics, Campus of Agriculture, Shahid Chamran University of Ahvaz, Ahvaz, Iran

Received 29 December 2020; Accepted 26 March 2021

Extended abstract

Introduction

Caper (*Capparis spinosa*) is used as multipurpose and adaptable plant which provides a valuable opportunity to enhance greenery and prevent soil erosion in harsh climatic areas. This plant is tolerant of salinity and blooms along the coast. Due to the recent severe drought in Iran and most of the arid and semi-arid regions of the world, farmers have tried to grow drought and salinity tolerant plants (such as capper) instead of plants with high water requirements. Salinity is one of the most common non-Biotic stresses in arid and semi-arid regions, which causes a significant reduction in photosynthesis, which depends on photosynthetic tissue and photosynthetic pigments, so that the general growth traits in Plants are reduced. The present experiment was performed to determine changes in physiological and biochemical properties as well as the ratio of sodium ions to potassium under salinity stress to evaluate salinity resistance and determine the best planting date for capper plant. Also, by obtaining the results of this research, capability, position of development and promotion of this plant in erodible and saline lands that have become the center of fine dust to be determined.

Materials and methods

In order to a experiment was arranged as split plot based on randomized design complete block with three replicatione in the research farm of the Faculty of Agriculture, Shahid Chamran University of Ahvaz in 1397-98 crop year. Treatments include six planting dates as the main factor (7 October, 6 November, 6 December, 5 January, 4February and 6 March) and the sub-factor including four salinity levels (control (urban water), 15, 30 and 45 dS m^{-1}). In this study, was used mechanical scraping method using sandpaper and then placing the seeds in gibberellic acid solution at a concentration of 1500 mg / l to remove the dormancy of the seeds. In the 8-leaf stage, salinity test was started. Sodium chloride salt was used to prepare salinity treatments. To prevent sudden shock to the plants, salinity treatments were applied gradually. Measurements for this experiment began ten days after the highest salinity stress level was applied.

Results and discussion

Based on the results of this study, the planting dates of 7 October and 6 November were selected as the two best planting dates and the planting dates of 4 February and 6 March were Deleted due to low

[*]Correspondent author: Majid Nabipour; E-Mail: m.nabipour@scu.ac.ir.

germination percentage and insufficient number of plant samples from the experiment. The results indicated that salinity had a significantly negative effect on chlorophyll content of caper seedlings while carotenoid content in caper seedlings was significantly increased. The amount of reduction in chlorophyll a content is greater than that of chlorophyll b. protein content decreased and malon dealdehyde increased under salinity stress. Salinity had a significant effect on net photosynthesis. Comparison of the mean effect of salinity on net photosynthesis showed that with increasing salinity level, the amount of net photosynthesis decreased. The highest rate of net photosynthesis was related to the control treatment and the lowest rate of net photosynthesis was related to salinity levels of 30 and 45 dS m^{-1}, which did not show a significant difference with each other. Antioxidant enzyme activity; superoxide dismutase (SOD), catalase (CAT), peroxidase (POD) and ascorbate peroxidase (APX) also increased in response of salinity. The highest amount of reaction to salinity is related to superoxide dismutase enzyme and the other three enzymes showed less reaction to salinity so that for 30 and 45 dS m^{-1}levels there was no significant difference with each other but their highest amount of activity is related to this Levels are 30 and 45 dS m^{-1} and the lowest level of activity is related to the control treatment. Our observations of ionic content in the aerial organ showed that the sodium content (Na^+) increased with increasing salinity, and Athe potassium content (K^+) decreased, but in each level of salinity the amount of sodium was lower than potassium. The results of physiological characteristics and Na^+/K^+ ratio showed that the caper plant is an almost salinity tolerant species (up to 15 dS m^{-1}) which can be a suitable option for successful propagation in arid, semi-arid and saline environments and prevent soil erosion in these areas. Therefore, the use of this plant due to its flexibility to salinity and drought can be a valuable opportunity to increase the green area and prevent provide soil erosion and reduce the negative effects of the dust phenomenon, especially in the south and southwest regions.

***Keywords*:** Antyoxidan, Catalase, Peroxidase, Planting date, Superoxide dismutase

Table1. Analaysis of variance (Mean square) for measured traits

S.O.V	df	Photosynthesis	Chlorophyll a	Chlorophyll b	Carotenoid	Total chlorophyll	Protein
Block	2	0.50^{ns}	0.015^{ns}	0.012^{ns}	0.009^{ns}	0.017^{ns}	0.09^{ns}
Planting date	3	34.23^{**}	0.013^{ns}	0.002^{ns}	0.001^{ns}	0.018^{ns}	1.08^{ns}
Error a	6	1.03	0.065	0.009	0.010	0.113	1.60
Salinity	3	92.75^{**}	0.985^{**}	0.085^{**}	0.112^{**}	1.647^{**}	27.70^{**}
PD*S	9	3.25^{*}	0.066^{*}	0.008^{*}	0.006^{ns}	0.118^{*}	0.60^{ns}
Error	24	0.92	0.015	0.002	0.004	0.026	0.48
C.V(%)		*12.83*	*22.35*	*15.96*	*23.43*	*18.25*	*9.57*

Table1.Continued

S.O.V	df	MDA	Sodium content	Potassium content	Ascorbate peroxidase	Superoxide dismutase	Catalase	peroxidase
Block	2	0.45^{ns}	11.52^{ns}	17.31^{ns}	3.75^{ns}	360.30^{ns}	1.97^{ns}	86.71^{ns}
Planting date	3	2.64^{ns}	16.26^{*}	37.93^{*}	15.59^{ns}	4.45^{ns}	19.89^{ns}	303.62^{**}
Error a	6	1.73	2.91	3.04	8.36	144.98	9.40	24.22
Salinity	3	35.04^{**}	122.97^{**}	487.66^{**}	668.99^{**}	2447.78^{**}	224.15^{**}	1187.77^{**}
PD*S	9	1.19^{ns}	3.01^{ns}	22.85^{ns}	10.88^{ns}	83.42^{ns}	3.84^{ns}	54.55^{ns}
Error	24	0.34	1.57	10.09	1.93	38.76	5.78	20.89
C.V(%)		*19.15*	*10.45*	*12.13*	*8.43*	*15.33*	*28.97*	*19.30*

*, **,ns respectively at a probability level of 5,1% and not meaningful.

Table2. mean comparisons of photosynthesis and pigment content of caper plant at Planting date× salinity treatment

Planting date	Salinity levels	Photosynthesis	Chlorophyll a	Chlorophyll b	Total Chlorophyll
	$ds.m^{-1}$	$\mu mol.m^{-2}.s^{-1}$	----------$mg.g^{-1}fw$----------		
7 October	Control	12.37^{ab}	0.88^{b}	0.41^{b}	1.29^{b}
	15	10.72^{c}	0.75^{bcd}	0.34^{bcd}	1.10^{bcd}
	30	7.01^{edf}	0.54^{efg}	0.33^{bcde}	0.87^{de}
	45	5.77^{fg}	0.20^{ij}	0.22^{g}	0.42^{g}
6 November	Control	13.65^{a}	1.18^{a}	0.53^{a}	1.72^{a}
	15	8.16^{d}	0.67^{cdef}	0.39^{bc}	1.06^{bcd}
	30	7.17^{def}	0.31^{hij}	0.24^{fg}	0.55^{fg}
	45	6.25^{ef}	0.16^{j}	0.20^{g}	0.36^{g}
6 December	Control	11.24^{bc}	0.73^{bcde}	0.37^{bc}	1.10^{bcd}
	15	7.05^{def}	0.64^{def}	0.37^{bc}	1.01^{cd}
	30	4.30^{gh}	0.39^{ghi}	0.32^{cdef}	0.71^{ef}
	45	4.42^{gh}	0.31^{hij}	0.24^{fg}	0.56^{fg}
5 January	Control	7.78^{de}	0.87^{bc}	0.39^{bc}	1.26^{bc}
	15	5.71^{fg}	0.60^{def}	0.32^{bcdef}	0.93^{de}
	30	4.39^{gh}	0.31^{hij}	0.25^{efg}	0.56^{fg}
	45	3.99^{h}	0.46^{fgh}	0.26^{defg}	0.72^{ef}

Table3. mean comparisons of effects of planting date on some measured traits

Planting date	Sodium content	Potassium content	Peroxidase
	----------$mg.g^{-1}fw$----------		u/mg protein
7 October	12.12^{ab}	26.13^{b}	21.21^{cb}
6 November	13.56^{a}	28.67^{a}	18.11^{c}
6 December	10.89^{b}	25.25^{b}	25.89^{ab}
5 January	11.38^{b}	24.63^{b}	29.50^{a}

Means with similar letters in each column are not significantly different at the 5% level based on the duncan test

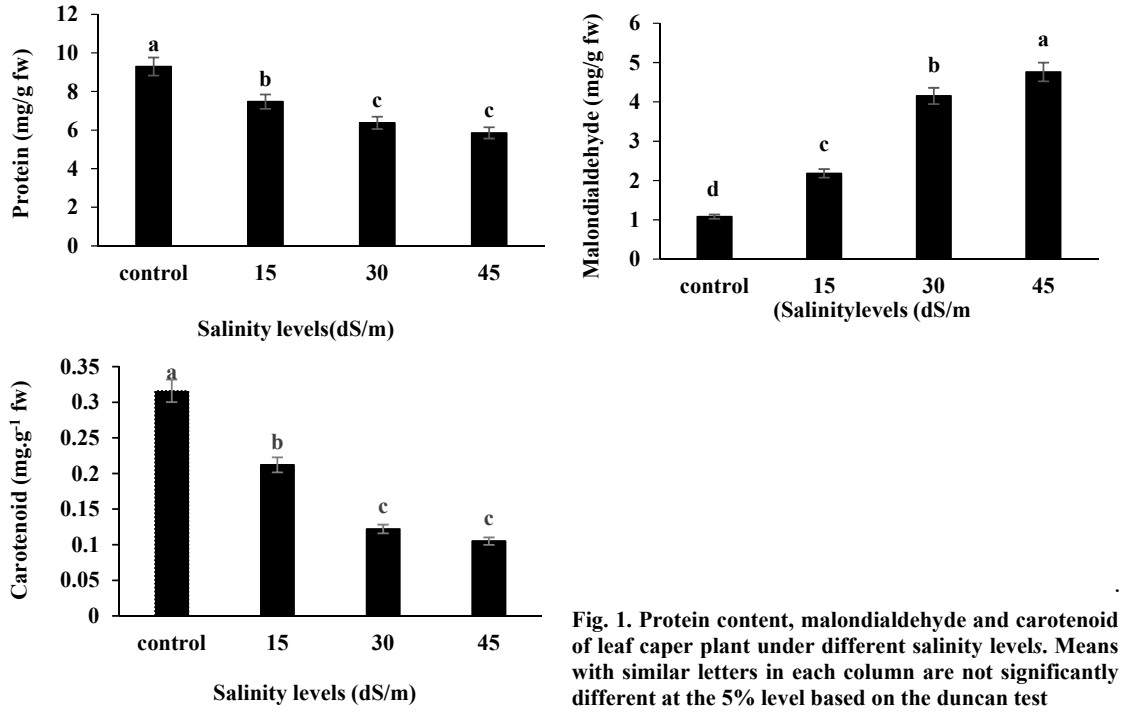

Fig. 1. Protein content, malondialdehyde and carotenoid of leaf caper plant under different salinity levels. Means with similar letters in each column are not significantly different at the 5% level based on the duncan test

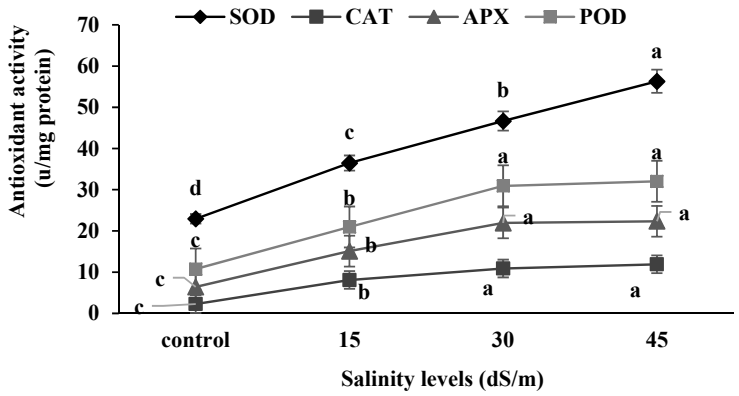

Fig. 2. Antioxidant enzymes' activity under different salinity levels. Means with similar letters in each line are not significantly different at the 5% level based on the duncan test. SOD: Superoxide dismutase, CAT: catalase, POD: peroxidase, and APX: ascorbate peroxidase.

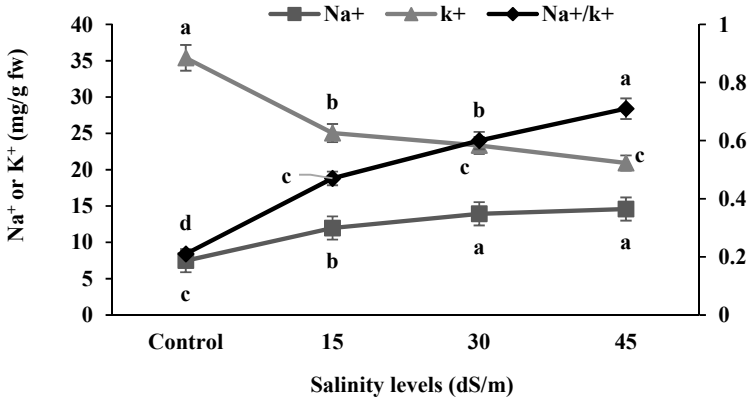

Fig. 3. Sodium and potassium content in additon to their ration (Na+ /K+) under different salinity levels. Means with similar letters in each line are not significantly different at the 5% level based on the duncan test.