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Original article

The effect of different concentrations of salicylic acid on germination characteristics of two genotypes of quinoa (*Chenopodium quinoa* willd.) under salinity stress

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Extended abstract

Introduction

Due to the development of saline lands and reduction of favorable agricultural land for cultivation identification of salinity-resistant medicinal plants, or factors that can reduce the effect of salinity are of high importance. Salinity is one of the major environmental limiting factors on plant growth and productivity. Seed priming is used to improve seedling establishment and increase plant efficiency. Priming is a simple technique that improves seedling establishment and improves the efficiency plant in the field. In fact, the main effect of seed priming is on the rapid growth of seedlings and early germination. Salicylic acid plays an important role against abiotic stresses such as salinity due to the high protective power of the plant. Find plants that are tolerant as a suitable way for the efficiency of salt water and limited water resources in the country. Selection of Quinoa as a like Grain is one of the best ways to prevent crop yield loss under stress conditions. Quinoa is a grain-like plant with high nutritional value and tolerance to abiotic stresses such as heat, cold and drought stress. Quinoa is resistant to drought and salinity due to its phenological flexibility and resistance to climate constraints. Food quinoa importance due to the perfect combination of amino acids, calcium, phosphorus, iron and sodium low. The flour from this plant lacks gluten and is a good food for people with small intestine autoimmunity. It also prevents cancer, cardiovascular disease and osteoporosis with high phytoestrogens.

Materials and Methods

Thus, in order to investigate the effect of Salicylic acid pre-treatment on germination indices of quinoa seedling under salinity stress, a factorial experiment was conducted based on completely randomized design with three replications in Seed Technology Laboratory, Faculty of Agricultural Sciences, Shahed University in 2019..The experimental factors included; salicylic acid at four levels (0, 0/5, 1 and 1/5 Mm) and salinity stress caused by NaCl at four levels (0, 50, 100, 150 mM NaCl) and the quinoa cultivars were Giza1 and Titicaca. Measured traits included germination percentage (GP), mean germination time (MGT), germination rate (GR) and germination coefficient (GC), SVI: seedling longitudinal index, SVI: seedling weight index and pigment content Are photosynthetic. Statistical

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analysis of data including analysis of variance was performed using SAS 9.1 software and mean comparison of traits evaluated by LSD test at 5% level of probability.

Results

The results showed that increasing the salinity stress decreased the content of photosynthetic pigments and seed germination characteristics.under salinity stress, with increasing stress, the germination percentage decreased so that the lowest germination percentage was observed at salinity stress of 15 dS/m. Application of salicylic acid under salinity stress had a positive trend in germination percentage, so that at different salinity levels, application of 1 mM salicylic acid showed the greatest effect on germination percentage. and at concentrations below 1 mM this trend was reduced. The Longitudinal index of seedling vigor and weight indices of seedling vigor were observed at 1 mM salicylic acid concentration and no salinity stress. with the concentration of salicylic acid increased, the content of photosynthetic pigments showed an increasing trend. Based on these results, proper plant management can guarantee plant establishment under salinity stress. Based on these results, by applying seed priming with salicylic acid, plant establishment can be improved in salinity stress conditions.

***Keywords*:** Germination percentage, Photosynthetic pigments, Seed priming, Seedling vigor index

Table 1. The computing relation of the parameters studied in the experiment

Traits	Equation	Reference
Germination Percentage	GP = $(N\times100) / M$	Liopa-Tsakalidi *et al*., 2012
Germination Rate	GR=$\Sigma Ni/Ti$	Pagter *et al*., 2009
Mean germination time	(MGT) = $\sum(Ni\ Di)/ \sum N$	Ranal and Santana, 2006
Cofficient of velocity of germination	CVG=$G1+G2+\ldots..G_n/(1\times G_1)+ (2\times G_2) + \ldots+ (n\times G_n)$	Scoote *et al*., 1984
Mean daily germination	(MDG) = GP/T	Hunter, Glasbey and Naylor, 1984
Seed length vigor index (SLV)	(SLV) = GP ×Seedling length (SL)	Abdul-Baki and Anderson, 1973
Seed weight vigor index (SWV)	(SWV) = GP × Seedling dry weight (SDW)	Abdul-Baki and Anderson, 1973

N= sum of germinated seeds at the end of the experiment, M= total planted seeds, T= period of germination, Ti= number of days after germination, n= number of germinated seeds in Ti, Mcgr= maximum cumulative germination percentage, Ni= Total seeds sown, SL= Seedling Length, Di: The time from the start of the experiment to the ithobservation.

Table 2. Analysis of variance of the effect of different levels of salicylic acid and different varieties of Quinoa on some studied traits under Salt stress

S.O.V	df	Germination percentage	Germination Rate	Germination rate coefficient	Mean Time Germination	Relative water content	Seedling vigor Longitudinal
Variety (V)	1	140.17 **	3.825**	751.363**	0.3651 **	33.083**	400.1**
Salicylic acid (S)	3	917.05**	16.031**	1723.251**	0.8884**	40.479 **	113.2**
Salt stress (St)	3	1104.17**	46.172**	497.702**	0.2376**	93.958**	516.7**
V * S	3	3.2777 ns	7.293**	83.251ns	0.0652 **	0.7810*	2.138 ns
V * St	3	25.94**	1.9939**	19.306 ns	0.0036ns	0.5099ns	33.36**
S * St	9	57.3518**	2.625**	88.794*	0.0518**	0.6902*	8.930**
V * S * St	9	13.50**	1.9271**	83.001*	0.0527**	0.0933ns	6.666 ns
Error	64	4.167	0.4264	34.117	0.0134	0.28013	1.312
CV (%)		*2.438*	*4.721*	*7.957*	*7.932*	*1.107*	*0.9185*

Table 2. Continued

S.O.V	df	Seedling vigor Weight	Content Chlorophyll a	Content Chlorophyll b	Content Total Chlorophyll	Content Carotenoied
Variety (V)	1	0.044893 **	0.01856**	0.00628**	0.03045**	0.00039**
Salicylic acid (S)	3	0.009234**	0.059195**	0.01252**	0.0721**	0.2511**
Salt stress (St)	3	0.38633**	0.001036**	0.0015**	0.00361**	0.26833**
V * S	3	0.100295**	0.01442**	0.00420**	0.01929**	0.0576**
V * St	3	0.13106**	0.002876**	0.00039**	0.0026**	0.0740**
S * St	9	0.16172**	0.008312**	0.00222**	0.01059**	0.49278**
V * S * St	9	0.17311**	0.010343**	0.00263**	0.01324**	0.2194**
Error	64	0.000734	0.000009	0.0000001	0.000007	0.00035
CV (%)		*4.643*	*1.081*	*0.312*	*0.328*	*1.047*

ns,*, ** respectively not significant and denote significant differences at 5% and 1%

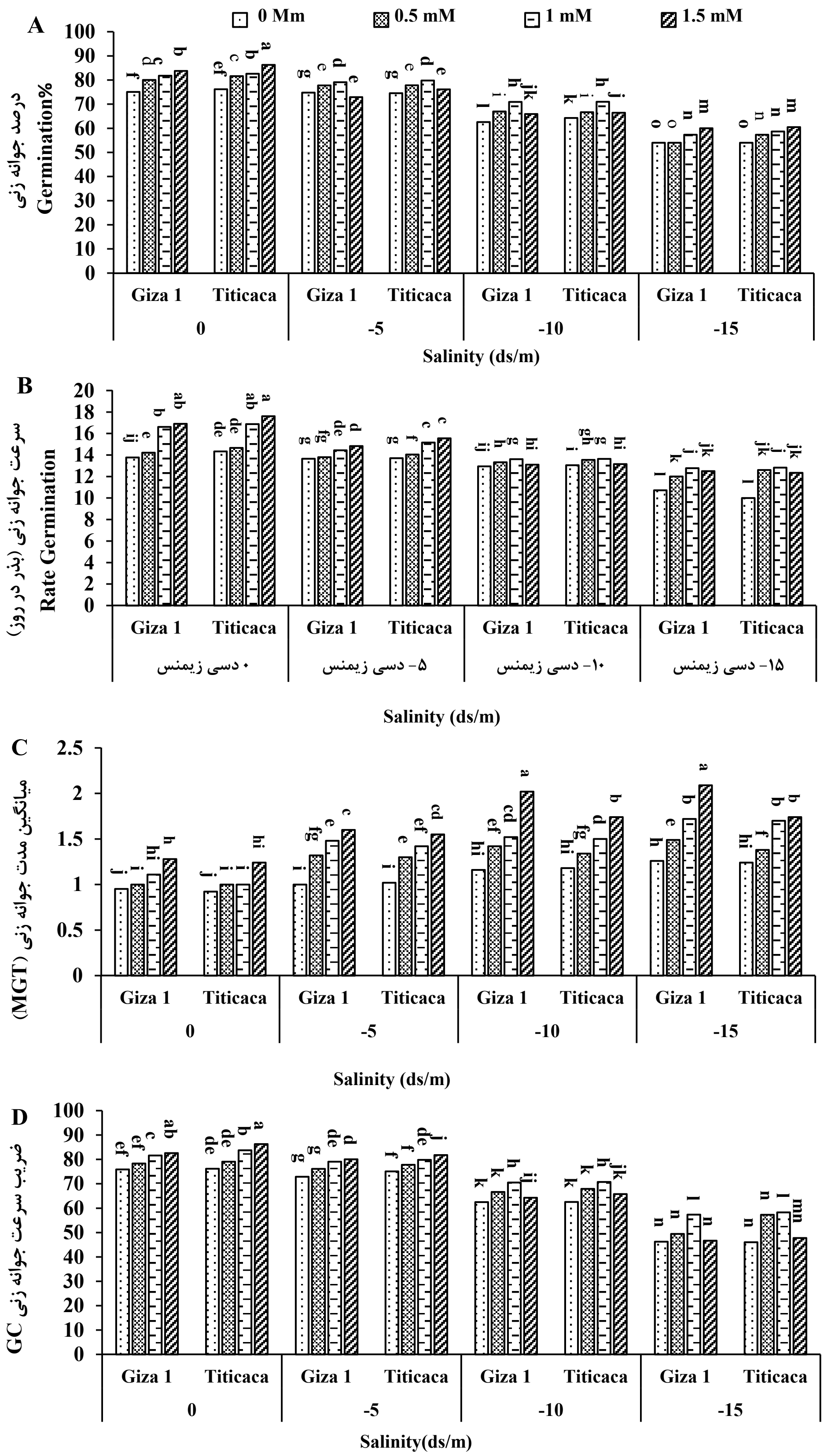

Fig. 1. Comparison of the average interactions of cultivar × Prime with salicylic acid × Salinity stress on (A) germination percentage, (B) germination rate, (C) average germination time (MGT) and (D) germination rate coefficient of two quinoa genotypes

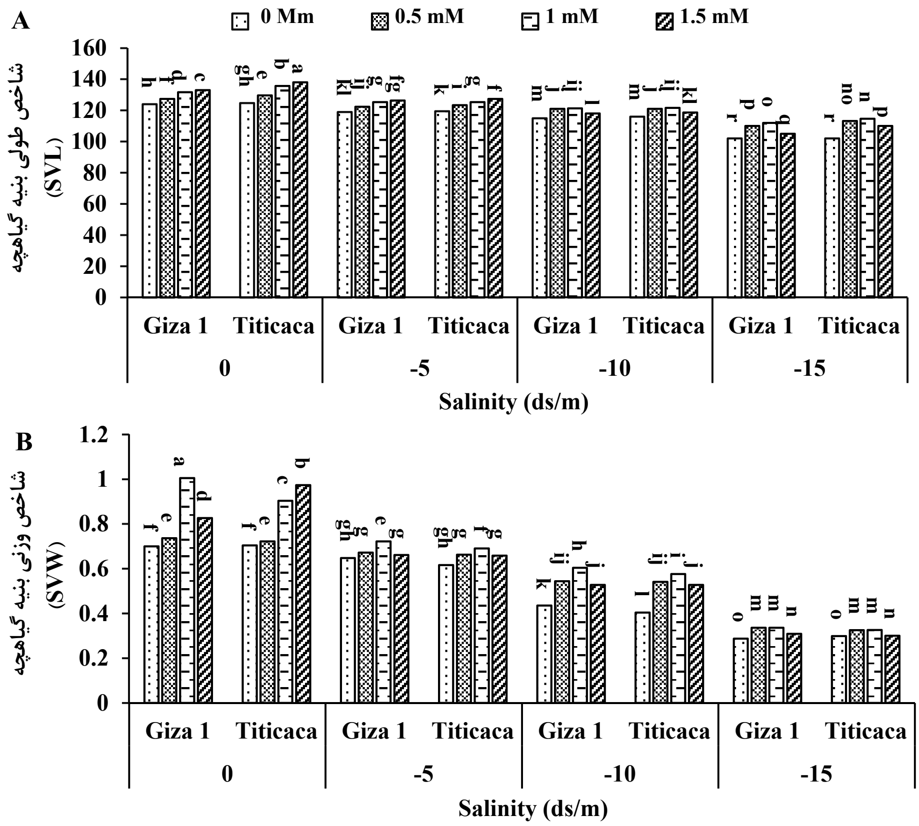

Fig. 2. Comparison of the average interactions of cultivar × Prime with salicylic acid × Salinity stress on (A) Seedling vigor longitudinal index and (B) seedling vigor weighted index of two quinoa genotype

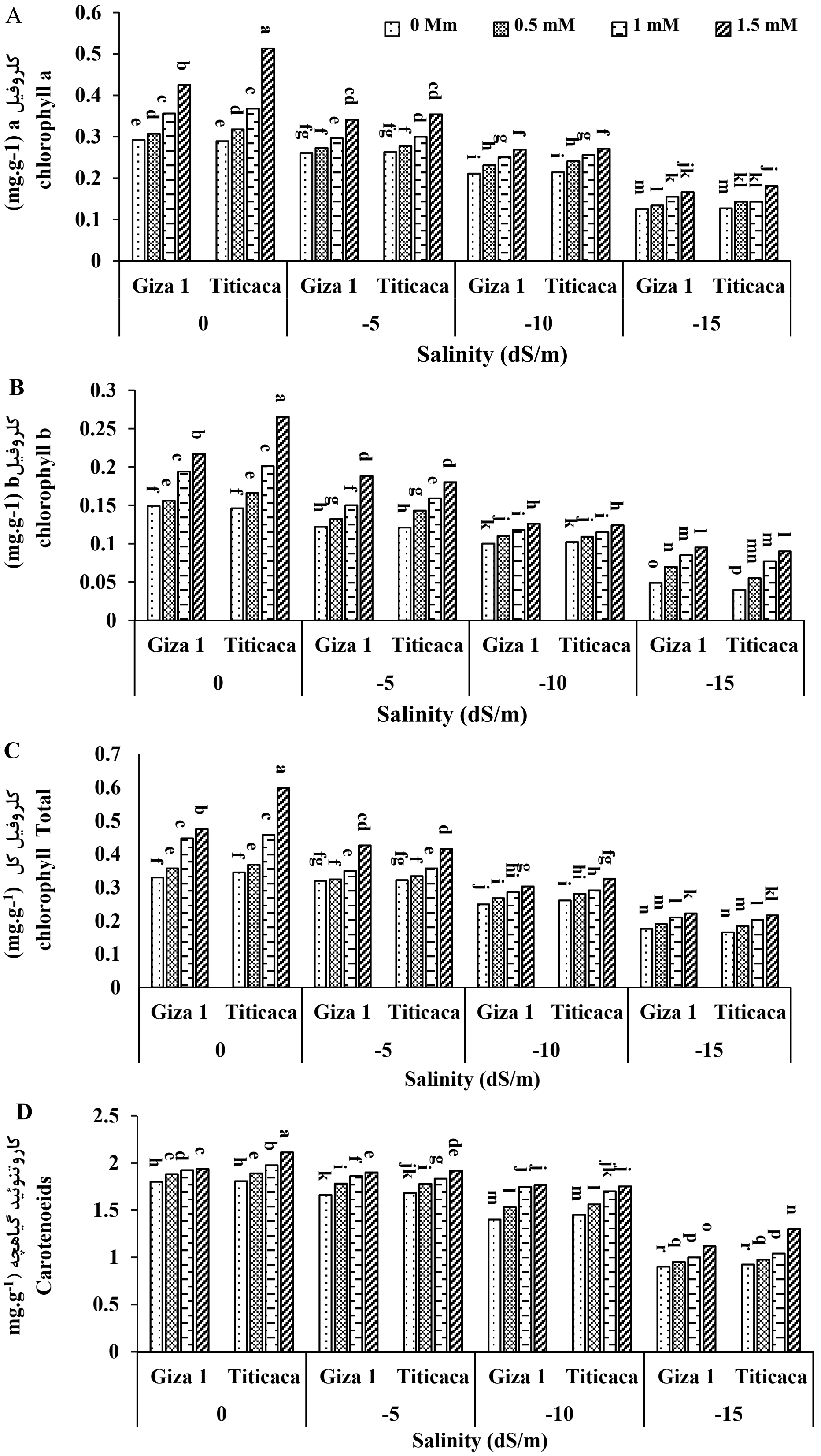

Fig. 3. Comparison of the average interactions of cultivar × prime with salicylic acid × salinityt stress on amount of (A) chlorophyll a, (B) chlorophyll b, (C) Total chlorophyll content and (D) Cotent of seedling carotenoids of two quinoa genotypes.