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Original article

The effect of salicylic acid on germination of tow genotypes of quinoa (*Chenopodium quinoa* Willd L.) under drought stress

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Extended abstract

Introduction

Drought is one of the most common environmental stresses that contributes to the growth and development of plants and is a major factor in reducing the production of products. Priming is a simple technique that improves seedling establishment and plant efficiency in farms. Seed priming has proved beneficial in improving the germination metabolism and early stand establishment of crops under normal and stress conditions .Salicylic acid (SA) plays an important role in abiotic stress tolerance, and more interests have been focused on SA due to its ability to induce a protective effect on plants under adverse environmental conditions. Salicylic acid (SA), an endogenous plant growth regulator has been found to generate a wide range of metabolic and physiological responses in plants thereby affecting their growth and development. Quinoa is a grain-like plant with high nutritional value and tolerance to abiotic stresses such as heat, cold and drought stress. Food quinoa importance due to the perfect combination of amino acids, calcium, phosphorus, iron and sodium low.

Materials and Methods

Thus in order to investigate the effect of Salicylic acid pre-treatment on germination indices of quinoa plant under drought stress, a factorial experiment was conducted in a completely randomized design with three replications in Seed Technology Laboratory, Faculty of Agricultural Sciences, Shahed University in 1397.The experimental factors Includes salicylic acid at four levels (0, 50, 100 and 150 mM) and drought stress caused by polyethylene glycol at four levels (0, -4-, 8-, -12 bar) and the quinoa plant varieties (cultivars and varieties Giza1, Titicaca). The measured traits including germination percentage (GP), mean germination time (MGT), germination speed (GR), and germination coefficient (GC), SVI: seedling longitudinal index, SVI: weight index of seedling bud, root length, stem length, stem fresh weight, stem fresh root and seedling dry weight, and changes in the amount of photosynthetic pigments. Statistical analysis of the data included analysis of variance using AS 9.1 software and comparison of mean of traits evaluated by LSD test at 5% probability level.

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Results and discussion
Analysis of variance showed that salicylic acid pre-treatment, drought stress and their interaction had a significant effect on germination indices and photosynthetic pigmentation and medicinal plant varieties quinoa. With increasing drought stress, the germination characteristics of quinoa plants decreased and the use of salicylic acid improved the seed germination properties of quinoa seeds and salicylic acid application improved germination characteristics of quinoa seeds. The highest germination percentage (98 percent) and its effective traits were obtained from seed soaking with salicylic acid with maximum concentration (1.5 mM) and low levels of drought stress. Longitudinal index and weight of seedling vigor was decreased at high concentrations of salicylic acid and high levels of drought stress. On the other hand, consumption of 1 and 1.5 mM of salicylic acid increased the amount of chlorophyll and carotenoids and increased tolerance of this plant to drought stress. The highest amounts of chlorophyll a, chlorophyll b and total chlorophyll were observed under drought stress conditions and 1.5 mol / mol of salicylic acid and Titicaca cultivar.

***Keywords*:** Drought stress, Germination percentage, Photosynthetic pigments, Salicylic acid

Table 1. Analysis of variance of the effect of different levels of salicylic acid and different varieties of Quinoa on some studied traits under drought stress

S.O.V	df	Germination percentage	germination Rate	Germination rate coefficient	Mean Time Germination	Root Length
Variety (V)	1	204.166**	0.517**	63.704*	0.183**	2.300**
Salicylic acid (S)	3	.32.291**	1.248**	56.138**	0.077**	9.244**
Drought stress (D)	3	2408.68**	34.030**	256.758**	0.287**	4.089**
V × S	3	406.250**	2.178**	296.53**	0.427**	4.448**
V × D	3	17.361**	2.3178**	131.768**	0.203**	8.634**
S × D	9	32.532**	0.6477**	66.090**	0.111**	2.297**
V × S × D	9	25.925**	1.043**	132.692**	0.181**	8.644**
Error	64	7.03	0.057	11.274	0.015	0.007
CV(%)		*3.193*	*3.188*	*6.438*	*6.378*	*2.136*

Table 1. Continued

S.O.V	df	Shoot Length	Root fresh weight	Stem fresh weight	Seedling dry weight	Seedling vigor Longitudinal
Variety (V)	1	12.767**	0.0002**	0.003**	0.000**	3504.890**
Salicylic acid (S)	3	0.686**	0.0001**	0.005**	0.000**	4181.450**
Drought stress (D)	3	6.585**	0.0003**	0.002**	0.000**	17932.41**
V × S	3	0.525**	0.0033**	0.000**	0.000**	415.401**
V × D	3	0.4930**	0.0001**	0.000**	0.000**	3100.475**
S × D	9	0.6727**	0.0003**	0.000**	0.000**	853.315**
V × S × D	9	1.289**	0.0002**	0.000**	0.000**	3877.361**
Error	64	0.012	0.00005	0.00008	0.00001	22.326
CV(%)		*4.262*	*2.340*	*2.111*	*3.803*	*4.164*

Table 1. Continued

S.O.V	df	Seedling vigor Weight	Content Chlorophyll a	Content Chlorophyll b	Content Total Chlorophyll	Content Carotenoids
Variety (V)	1	0.200**	0.541**	4.612**	155.360**	255.990**
Salicylic acid (S)	3	0.442**	0.063**	0.588*	16.090**	14.286**
Drought stress (D)	3	0.285**	0.933**	1.066**	44.979**	197.825**
V × S	3	0.501**	0.150*	0.040**	2.007**	40.143**
V × D	3	0.707**	0.215*	1.170**	38.738**	62.144**
S × D	9	0.111**	0.839**	1.758**	67.245**	181.276**
V × S × D	9	0.196*	0.490**	0.773**	29.876**	64.970**
Error	64	0.00156	0.00059	0.0083	0.240	0.022
CV(%)		*5.152*	*1.939*	*6.180*	*5.167*	*0.821*

**,* and ns denote significant differences at 0.05 and 0.01% levels, and not significant respectively.

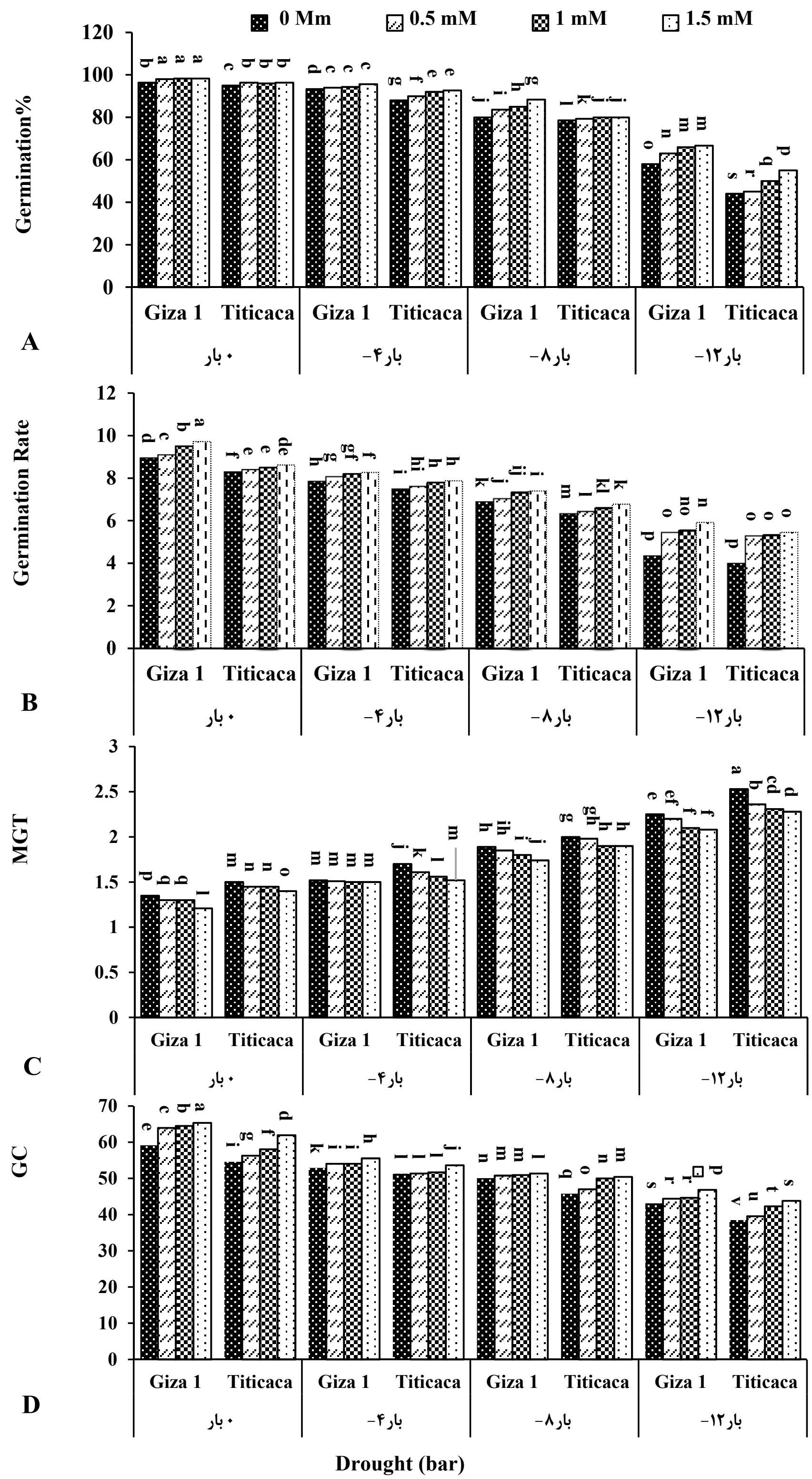

Fig. 1. Comparison of the average interactions of cultivar × Prime with salicylic acid × drought stress on germination percentage(A), germination rate(B), average germination time (MGT)(C), germination rate coefficient (D) Tow genotypes quinoa

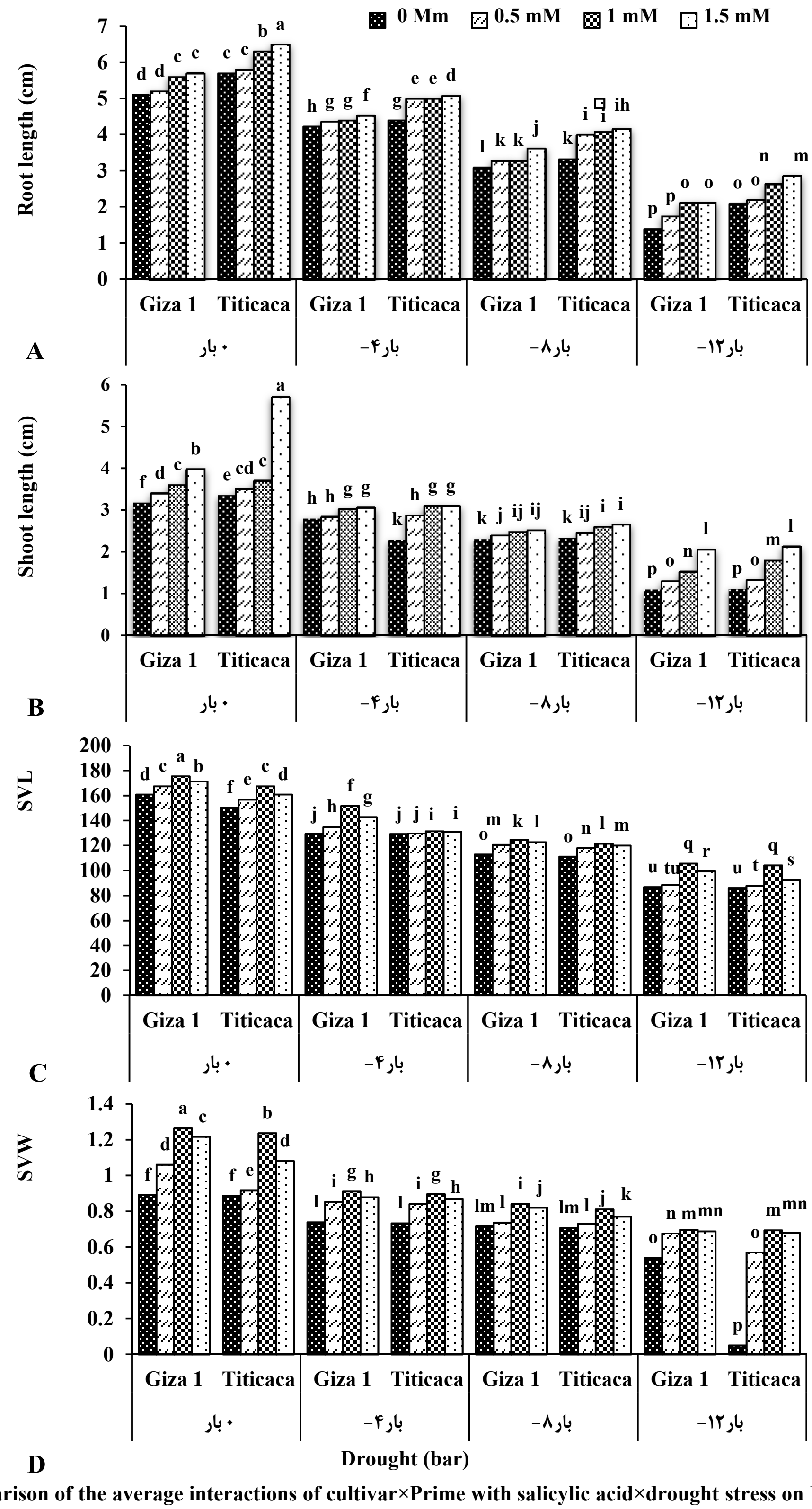

Fig. 2. Comparison of the average interactions of cultivar×Prime with salicylic acid×drought stress on Root length(A), shoot length(B), Seedling vigor Longitudinal index(C), Seedling vigor Weighted index(D)Tow genotypes quinoa

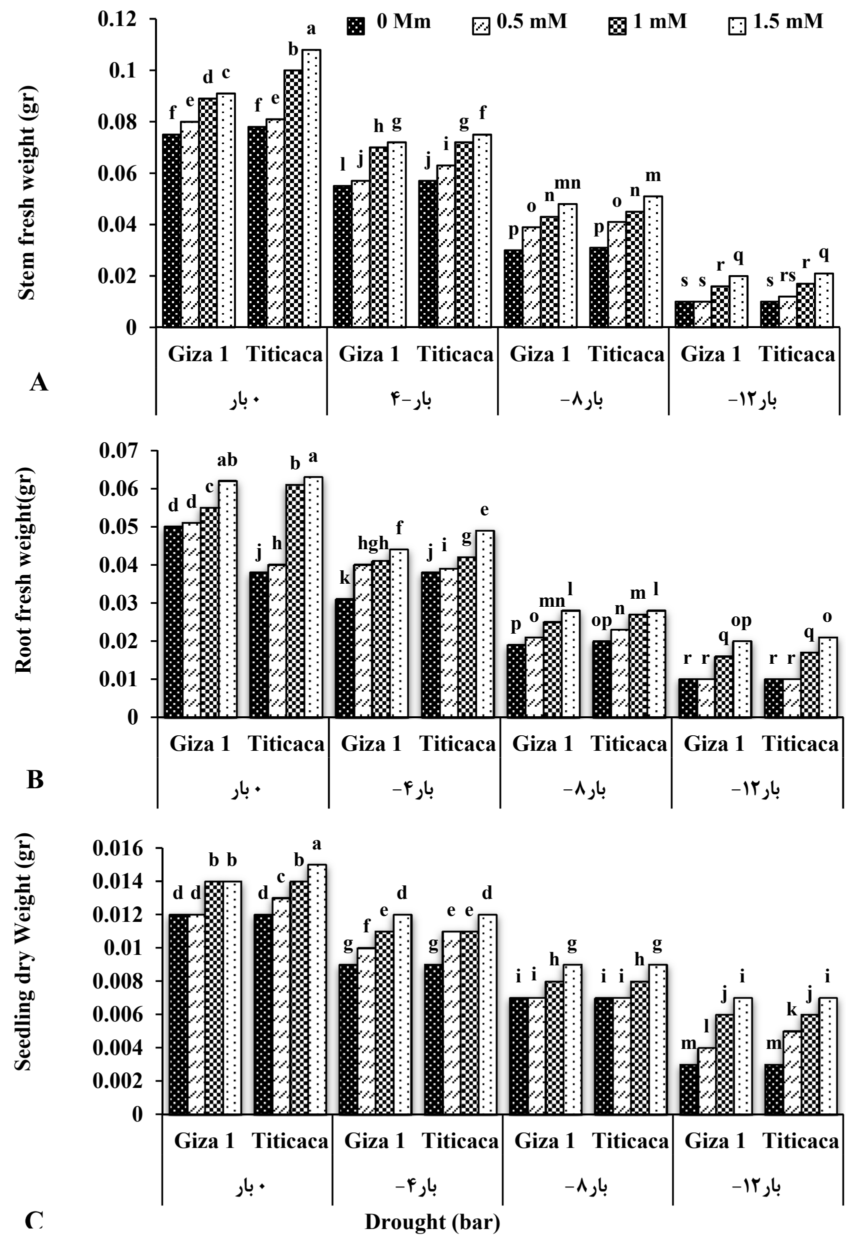

Fig. 3. Comparison of the average interactions of cultivar × Prime with salicylic acid × drought stress on Stem fresh weight (A), Root fresh weight (B), Seedling dry weight (C) Tow genotypes quinoa

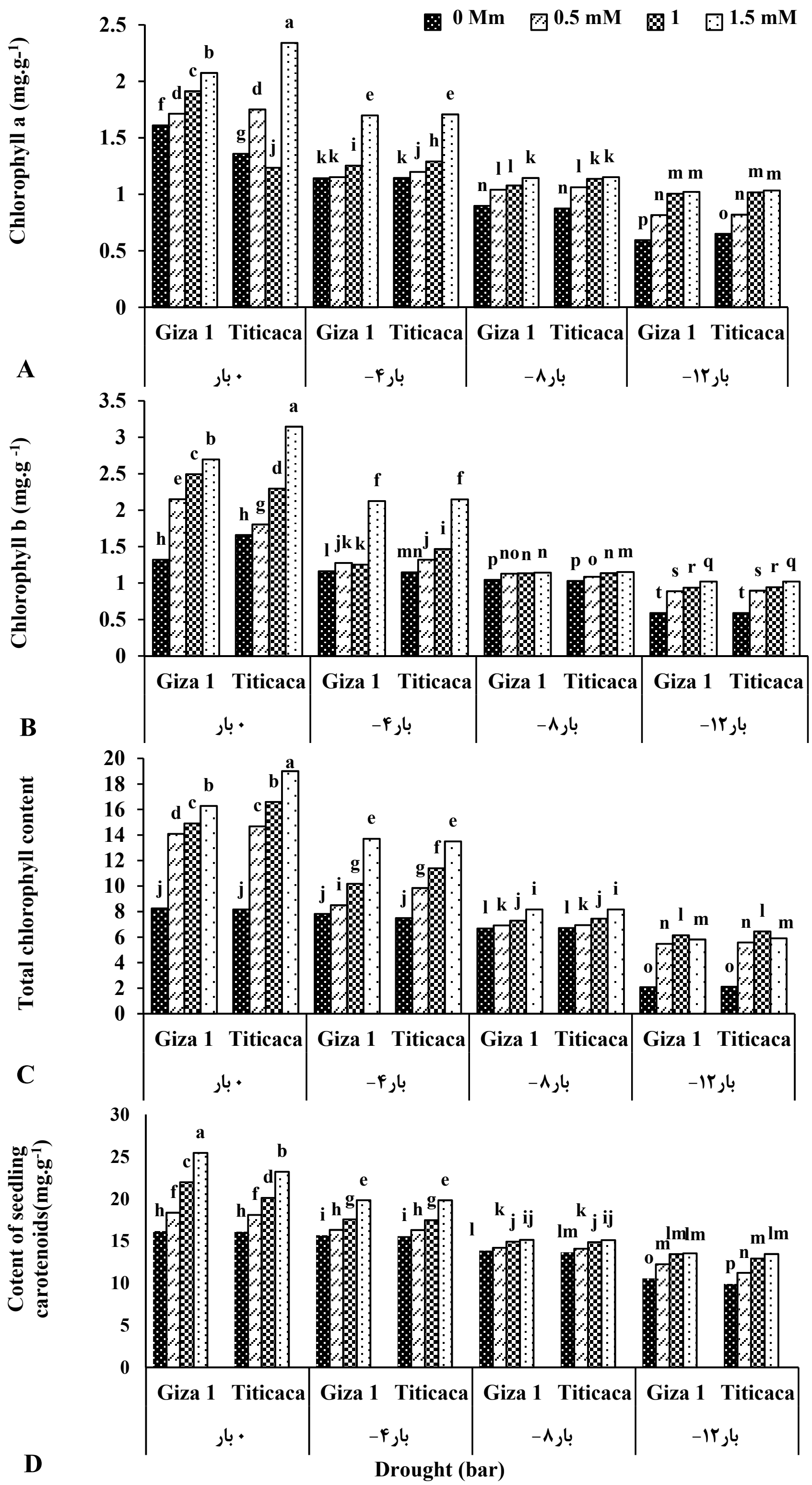

Fig. 4. Comparison of the average interactions of cultivar × Prime with salicylic acid × drought stress on amount of chlorophyll a (A), chlorophyll b (B), Total chlorophyll content(C), Cotent of seedling carotenoids(D) Tow genotypes quinoa