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Original article

Effect of different concentrations of Selenium on germination characteristics and proline content of quinoa (*Chenopodium quinoa* willd) under drought stress

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Extended abstract

Introduction

Drought stress is a major constraint to agricultural productivity all around the world. Drought is the most significant threat to global food security. Food demand becomes a huge issue because water supply is restricted around the planet. Plant seed priming is a simple, low-cost, low-risk, and effective way to boost plant tolerance under stressful situations.In nutrient priming, seeds are pretreated (primed) in solutions containing the limiting nutrients instead of being soaked just in water. Microelements, which are required in very small quantities, play important roles in improving crop productivity and quality. Oxidative stress is caused by the formation of active oxygen species (ROS) in response to water stress. Antioxidant enzymes are regarded to be the "first line of defense" against reactive oxygen species (ROS) produced by a variety of environmental injury species. Selenium's strategies for decreasing the effects of drought are mostly anti-antioxidant defense activation. Quinoa (Chenopodium quinoa Willd) is a stress-tolerant pseudo cereal that has been cultivated for over 7000 years in the Andes, in a variety of environments, with Peru and Bolivia being the main producers. Quinoa is a high-protein food (12-16.5 percent), with protein quality comparable to casein. Furthermore, this "wonder grain" is gluten-free and high in bioactive substances such as antioxidants, polyphenols, flavonoids, vitamins, and minerals that imparts various health benefiting characteristics to this grain. Quinoa plants, including seeds and leaves, can be eaten to provide nutrition to humans and animals. Quinoa is also great for digestion because it has twice the amount of nutritional fibre as other cereals.

Materials and Methods

Thus a factorial experiment in a completely randomised design with three replications was conducted in the Seed Technology Laboratory, Faculty of Agricultural Sciences, Shahed University in 2020 to investigate the effect of sodium selenite pre-treatment on germination indices and prolin content of quinoa plants under drought stress. The variables in the experiment Include four levels of sodium selenite (0.5, 1.5, 3, 4.5, and 6 mg/lit), two levels of hydroprimind and no priming, and three levels of drought stress induced by polyethylene glycol (0.4, 0.8, and 1.2 MP). Germination percentage (GP), mean germination time (MGT), germination speed (GR), and SVI: seedling longitudinal index, seedling

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length, changes in the number of photosynthetic pigments, and proline content, and Catalase enzyme levels were among the traits that were assessed. Statistical analysis of the data included analysis of variance using AS 9.1 software and comparison of the mean of traits evaluated by LSD test at 5% probability level.

Results

The results showed that prime with selenium and drought stress had a significant effect on most germination traits and photosynthetic pigments, proline levels and catalase enzyme. Prime with selenium at its proper concentration led to the early emergence of seedlings in drought-tolerant conditions, but showed an inhibitory effect by increasing the concentration of selenium and increasing the levels of drought stress. Pre-treatment with selenium at 30 mg / L showed the highest percentage of germination (94%) with a 58% increase compared to non-priming and severe stress treatment. Also, seedlings that were primed with selenium had more photosynthetic pigments than non-priming and hydrophilicity under stress. The highest levels of proline and catalase were observed in extreme stress conditions with molar concentrations of 1.5 and 1.5 mg/lit, respectively. As a result, seed priming with selenium can be used to boost quinoa seedling germination and early growth under field circumstances.

***Keywords*:** Catalase enzyme, Chlorophyll, Drought stress, Germination percentage, Selenium priming

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

Traits	Equation	Reference
Germination Percentage	GP = (N×100) / 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
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

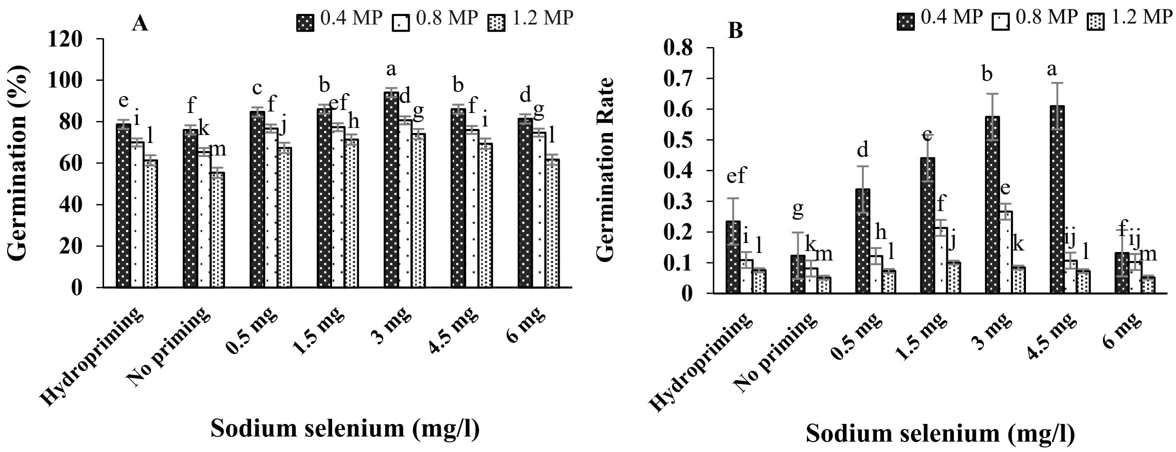


Fig. 1. A- Comparison of the average effect of different selenium concentrations on germination percentage (A), germination rate (B), in drought stress conditions in quinoa plant

Table 1.Variation analysis of the effect of different selenium levels on some studied traits of quinoa under drought stress

S.O.V	df	Germination Percentage	Germination Rate	Mean Germination Time	Mean Delay Germination	Seedling Length	Seedling vigor Longitudinal
Drought stress (D)	2	1112.63**	0.15421**	843.33**	5.676**	25.415**	77543.51**
Se concentration (C)	6	195.95**	0.0620**	28.705**	0.9997**	4.333**	12682.2**
D * C	12	8.338**	0.0647**	34.285**	0.04354**	0.19295**	723.314**
Error		2.4126	0.0000001	0.0000001	0.01230	0.1036	117.02
CV (%)		*2.060*	*0.1486*	*4.454*	*2.0636*	*4.5457*	*4.3263*

Table 1. Continued

S.O.V	df	Content Chlorophyll a	Content Chlorophyll b	Content Total Chlorophyll	Content Carotenoids	Content Prolin	Catalase
Drought stress (D)	2	0.08272**	0.04109**	0.1772**	0.4652**	7.6231**	5.726**
Se concentration (C)	6	0.03789**	0.04932**	0.1373**	0.1131**	0.5274**	0.3897**
D * C	12	0.0215**	0.06077^{ns}	0.1076**	0.06088**	0.32216**	0.5574**
Error		0.0015	0.04718	0.04446	0.00392	0.1055	0.04687
CV (%)		*2.905*	*17.914*	*10.453*	*3.820*	*5.873*	*4.543*

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

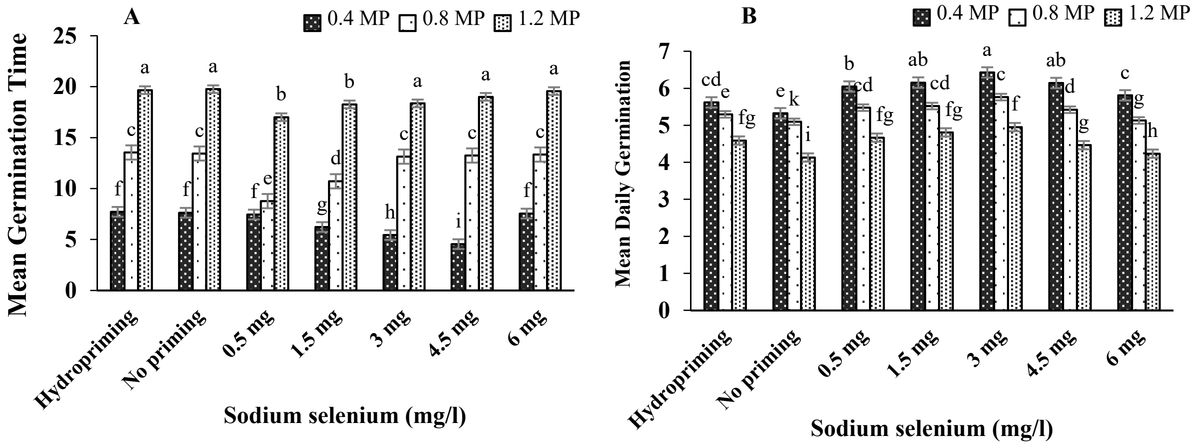


Fig. 2. A- Comparison of the average effect of different selenium concentrations on the average germination duration (A), average daily germination (B) in drought stress conditions in Quinoa plant

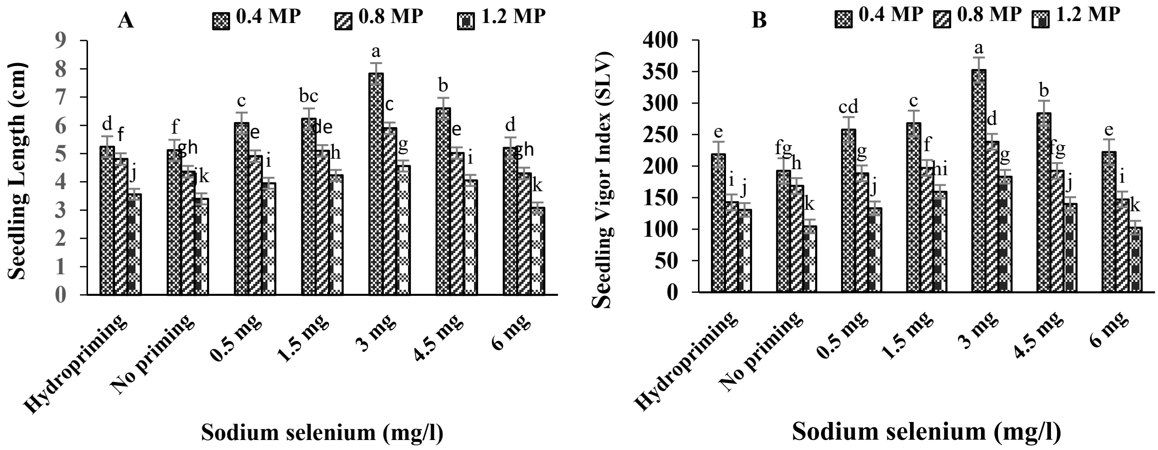
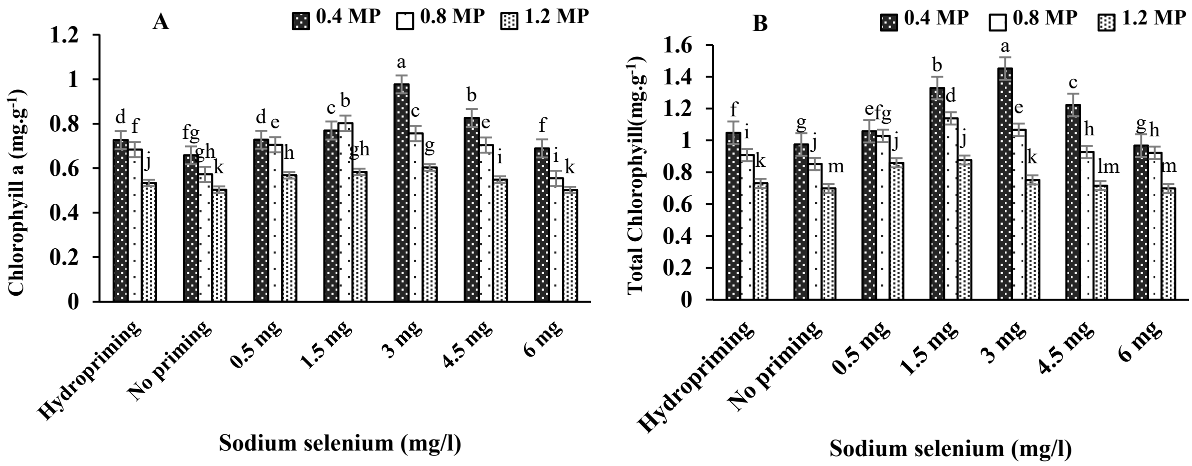


Fig. 3. A- Comparison of the average effect of different selenium concentrations on seedling length (A), longitudinal index of seedling vigor (B) in drought stress conditions in Quinoa



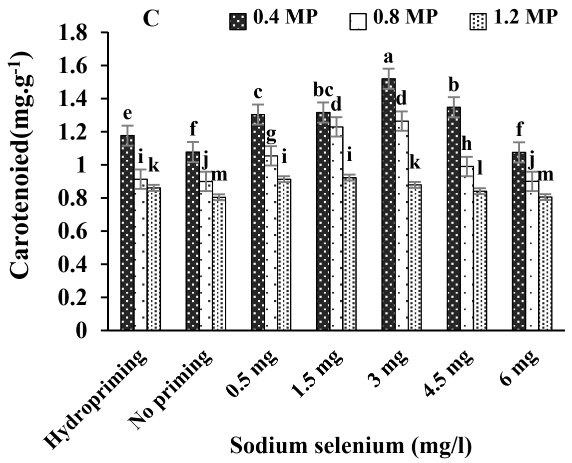


Fig. 4. Comparison of the mean effect of different selenium concentrations on the amount of chlorophyll a (A), total chlorophyll (B), seedling carotenoids (C) in drought stress conditions in Quinoa

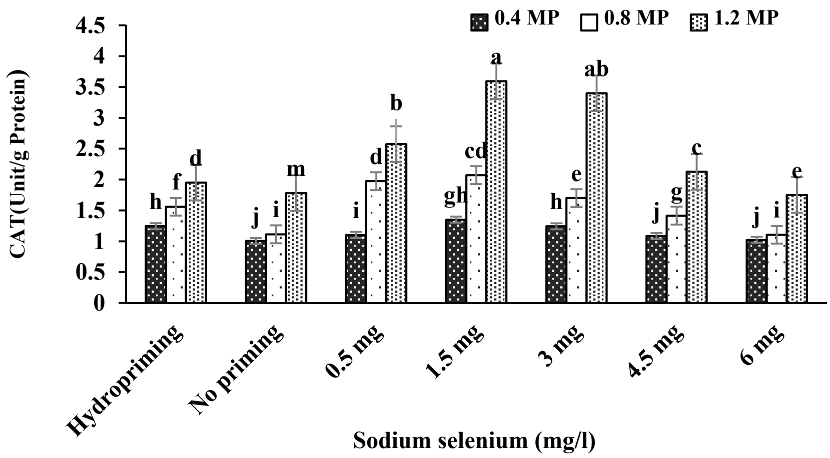


Fig. 5. Comparison of the mean effect of different selenium concentrations on the amount of catalase enzyme in drought stress conditions in quinoa

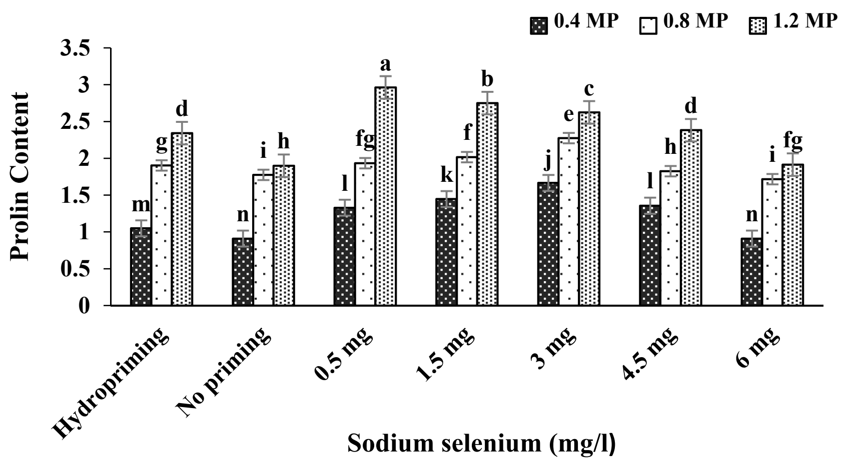


Fig. 6. Comparison of the mean effect of different selenium concentrations on proline content in drought stress conditions in quinoa plant