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Original article

The effect of salicylic acid and potassium nitrate on germination characteristics, photosynthetic pigments and seedling proline seedlings of two safflower cultivars under salinity stress

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Extended abstract

Introduction

Soil salinity causes major losses in crop production, especially in arid and semi-arid regions where 110 million out of 270 million ha of irrigated lands are located. Salinity is becoming more extensive as a result of land clearing and unsustainable irrigation and salinity management practices, as well as increasingly by bringing marginal lands into production. Priming is one of the effective methods to improve seed germination and seedling establishment in stressful environmental conditions such as salinity. Safflower (*Carthamus tinctorius* L.) is the most important oil seed crop from Asteraceae family. These plants are usually preferred in arid and semi-arid regions under rain-fed conditions, where low rainfall and high evapotranspiration during vegetation periods restricts the growth of crop plants. Under these conditions, drought and salinity are the major abiotic stresses that severely inhibit germination, seedling establishment and plant growth; consequently, seed yield decreases. The purpose of this experiment was to investigate the effect of salicylic acid and potassium nitrate pretreatments on germination components, growth characteristics, photosynthetic pigments and proline of two safflower cultivars under salinity stress.

Materials and methods

In order to investigate the effect of salicylic acid and potassium nitrate on germination and photosynthetic indices of two safflower cultivars under salinity stress, a factorial experiment was conducted in a completely randomized design with three replications in the Seed Technology Laboratory of Shahed University of Agricultural Sciences in 2018. Experimental factors include safflower cultivars of Sofeh Isfahan and Goldasht cultivars, priming at three levels of control (distilled water), salicylic acid 0.5 mM and potassium nitrate 0.3% and salinity stress caused by Qom Lake salt at four levels of 0, 5, 10 and 15 dS m^{-1}, respectively.

Results and discussion

The results showed that increasing the salinity of salt (sodium chloride) decreased the seed germination characteristics, relative water content and photosynthetic pigments and increased

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proline content. In Sefeh cultivar, the highest amount of germination components such as germination percentage (90%), germination rate (9.16 seeds per day), root length (25 mm), stem length (49.5 mm) Seedling fresh weight (1.25 g) and seedling dry weight (0.14 g) were obtained in the absence of salinity stress and application of salicylic acid. Also, under stress conditions of 15 dS m^{-1} and salicylic acid treatment, Sefeh cultivar had significant germination and growth. Salicylic acid pretreatment under salinity stress reduces the negative effects of salinity stress, thus increasing the germination percentage and seedling growth indices. Pretreatment of potassium nitrate increased photosynthetic pigments in Sefeh cultivar of Isfahan under salinity stress. Using cost-effective seed priming can improve seed germination components for growth in salinity conditions.

Conclusions

The results showed that salinity stress reduced the percentage and rate of germination, root and shoot length, fresh and dry weight of seedlings in both safflower cultivars. Negative effects of salinity stress on physiological parameters included reduction of photosynthetic pigments. Also, salinity stress affected the amount of proline in the contract and increased the amount of this trait. Sefeh cultivar under salinity stress with salicylic acid application had better tolerance than Goldasht cultivar. It is suggested that the quantitative and qualitative traits of safflower cultivars be evaluated under field conditions under salinity and priming to yield stages and yield components. To be able to more confidently recommend suitable cultivars in areas with saline soils.

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Keywords: Chlorophyll, Germination, Pretreatment, Safflower, Salinity

Table 1. Analysis of variance (mean square) the different characteristics of safflower two Cultivars under priming and senility conditions

S.O.V	df	Germination percentage	Germination rate	Root Length	Shoot length	Seedling fresh weight	Seedling dry weight
Cultivar (C)	1	98.81**	0.005^{ns}	0.48**	0.63**	1.15*	0.04*
Priming (P)	2	493.56**	2.94**	1.85**	6.38**	0.05**	0.02**
Salinity (S)	3	10030.01**	87.54**	4.54**	25.47**	1.45**	0.01**
C * P	2	164.56**	3.66**	0.25**	1.43**	0.09**	0.05**
C * S	3	33.59**	0.78**	0.11**	0.54**	0.39**	0.007**
P *S	6	63.12**	0.75**	0.06**	0.83**	0.14**	0.01**
C * P * S	6	67.95**	1.01**	0.27**	0.95**	0.17**	0.01**
Error	48	0.248	0.065	0.0005	0.00098	0.000043	0.00001
CV (%)		*0.92*	*4.08*	*1.90*	*1.46*	*0.99*	*4.01*

Table 1. Continued

S.O.V	df	Chlorophyll a	Chlorophyll b	Total Chlorophyll	Carotenoid	Prolin
Cultivar (C)	1	4.82**	0.77 ns	0.66 ns	267.01**	0.41**
Priming (P)	2	2.21**	7.68**	6.08**	22.50**	0.15**
Salinity (S)	3	12.71**	14.62**	11.67**	192.63**	0.87**
C * P	2	11.32**	14.97**	12.03**	237.74**	0.04**
C * S	3	3.12**	1.53**	1.25**	18.17**	0.04**
P *S	6	12.22**	13.42**	10.78**	167.12**	0.21**
C * P * S	6	3.39**	7.56**	5.94**	157.60**	0.02**
Error	48	0.12	0.36	0.28	21.33	0.001
CV (%)		*16.06*	*23.61*	*23.33*	*26.55*	*4.60*

ns, *and**respectively non-significant and significant at 5% and 1%.

Table 2. Mean comparison of traits under interaction levels variety ×priming× salinity.

Cultivar	Priming	Salinity	Germination percentage	Germination rate	Root Length	Shoot length	Seedling fresh weight	Seedling dry weight
		ds/m	(%)	seed/ day	---------mm---------		----------g----------	
		0	73.33e	8.01e	14f	34e	1e	0.12c
	Control	**5**	56.66i	5.81j	12h	16n	0.76j	0.08g
		10	40.66n	3.25s	10j	10q	0.49n	0.06h
		15	26.66t	2.83w	4o	7t	0.21t	0.02l
		0	90a	9.16a	25a	49.5a	1.25a	0.14a
Safeh Esfehan	**0.5 mM SA**	**5**	73.33e	5.56k	14f	34.6d	1.12c	0.12c
		10	46.66k	4.4o	12h	20.6j	0.83g	0.09f
		15	30q	3.16t	10j	17m	0.4p	0.05i
		0	84.78b	8.18d	18d	39.4c	1.24b	0.13b
	0.3% KNO_3	**5**	66.66g	5.9i	12h	20k	1.1d	0.11d
		10	42m	4.58n	8l	12o	0.53m	0.06h
		15	28s	3.1u	5n	8s	0.31q	0.03k
		0	70.66f	6.8g	15e	26g	0.78i	0.08g
	Control	**5**	53.33j	5.4l	13g	16n	0.67l	0.05i
		10	33.33p	3.56r	9k	11p	0.31q	0.04j
		15	23.33u	2.66x	0.9p	5u	0.1u	0.01m
		0	83.33c	8.57b	20.3b	46.5b	0.9f	0.1e
Goldasht	**0.5 mM SA**	**5**	73.33e	6.96f	19c	24h	0.83g	0.09f
		10	43.33l	5m	14f	20k	0.42o	0.06h
		15	36.66o	4.08p	12h	18.1l	0.27r	0.02l
		0	80d	8.25c	11i	33f	0.82h	0.09f
	0.3% KNO_3	**5**	63.33h	6.08h	9k	21i	0.72k	0.08g
		10	33.33p	3.83q	7m	16n	0.4p	0.05i
		15	29r	3v	7m	9r	0.26s	0.02l

Means with the same letters in each column are no differences according to LSD test

Table 2. Continued

Cultivar	Priming	Salinity	Chlorophyll a	Chlorophyll b	Total Chlorophyll	Carotenoid	Prolin
		ds/m	----------mg/g FW----------				
Safeh Esfehan	Control	0	3.7d	3.28i	3.43f	20.82g	0.44u
		5	1.81l	1.59p	1.28s	19.56i	0.55r
		10	0.71s	1.3t	0.97v	14.86p	0.63o
		15	0.22u	0.5v	0.2w	6.05x	0.64n
	0.5 mM SA	0	5.11a	4.71d	4.23d	25.75d	0.48t
		5	1.73m	4.13e	3.67e	22.18f	0.56q
		10	1.31o	3.28i	2.95j	20.5h	0.85g
		15	0.52t	1.32s	1.43q	15.8n	1.34c
	0.3% KNO3	0	4.86b	6.44a	5.76a	30.74a	0.55r
		5	3.32e	3.71f	3.33g	23.03e	0.61p
		10	3.14g	3.39h	3.04i	19.37j	0.64n
		15	2.63h	2.39k	2.15l	10.08s	0.75i
Goldasht	Control	0	2.5i	3.7g	4.37c	18.07k	0.35v
		5	1.82k	3.1j	2.77k	12.74r	0.54s
		10	0.79r	1.23u	1.1u	9.73u	0.84h
		15	0.06v	0.11w	0.1x	7.24w	0.95e
	0.5 mM SA	0	4.66c	5.92b	5.3b	29.27b	0.65m
		5	4.66c	1.8n	1.6o	16.55m	0.73j
		10	0.82q	1.67o	1.49p	15.53o	1.39b
		15	0.52t	1.48q	1.37r	13.4q	1.61a
	0.3% KNO3	0	3.24f	4.88c	3.29h	26.31c	0.68l
		5	1.92j	2.02l	1.82m	17.09l	0.7k
		10	1.42n	2.01m	1.81n	10.04t	0.88f
		15	1.05p	1.36r	1.21t	9.57v	1.06d

Means with the same letters in each column are no differences according to LSD test