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Effect of Water Stress on Germination Indices in Safflower Cultivars (Carthamus Tinctorius L.)

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ABSTRACT

Environmental stress, especially drought stress, can play an important role in the reduction of the plant growth stage, specifically germination stage in arid and semi arid regions in Iran. More than 90 percent of Iranian domestic need for oil is imported. Safflower, one of the native and valuable oil seeds in Iran, is tolerant to drought and salinity. Its seeds contain 35% high-quality oil and 15% protein. In order to study the effects of drought stress on germination indices in safflower cultivars, an experiment was conducted in factorial form, using a completely randomized design of four replications. In this experiment, seven safflower cultivars (CH353,CH65,Asteria,CH697,Rinconada,Iranian variety zarghan and Gol-sefid Isfahan) were evaluated in six levels of drought treatment(distilled water,-3,-6,-9,-12,-15 bar).Results indicated significant differences among cultivars, and drought stress levels. In all traits, a significant decrease was observed with increase in stress level. It seems that the length of stem among the other traits has more sensitivity to drought stress. Drought stress effects on the radical length more than -3 bars caused the reduction in radical length. CH65 variety has the longest length of root with 20.273 mm. CH353, and Rinconada had the longest length of plumule. The highest germination percentage belonged to Asteria (76.168%) and -6 bars with (98%). The least germination percentage belonged to CH697 with (35.668%).The percentage of germination and velocity of germination lessened when drought stress exceeded more than -9 bars. Rinconada had the highest velocity of germination. The highest coefficient of velocity of germination belonged to Asteria. Traits in tolerant cultivars did not show a significant decline up to -3 bars. The most tolerant cultivar was Rinconada. Considering all germination indices, CH697 was the susceptible cultivar.

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INTRODUCTION

Current estimates indicate that 25% of the worlds agricultural lands is now affected by the water stress . Environmental stress, especially drought stress, can play an important role in reduction of the plant growth stage typically germination stage in arid and semi arid regions in Iran. More than 90 percent of Iranian domestic need for oil is imported. Safflower, one of the native and valuable oil seeds in Iran, is tolerant to drought and salinity. Its seeds contain 35% high-quality oil and 15% protein. Iran has about 240 mm raining there for it is a dry region in the world. One of the commonest experiments in germination of the seeds is using PEG . Many experiments have been done and the results have showed that plumule has higher tendency to water stress among other traits. Germination is a critical stage of the plant life and resistance against drought during the germination makes a plant stable. Iran, with an annual 240 mm of rainfall, is classified as a dry region in the world. One of the commonest experiments in germination of the seeds is the application of PEG. Many experiments have been done and the results have showed that plumule is more likely to be affected by water stress than other traits. Maliwal and Paliwal(1982) showed that under water stress, in grain legumes; mung been , black gramand cluster been both germination and height of seedlings were significantly reduced. Seeds of 10 cultivars of bean were exposed to six levels of water stress (0 , -0.2 , -0.4 , -0.6 , -0.8 and -1.0 MPa) induced by polyethylene glycol (de Queiroz et .al., 1997). Germination percentage decreased with increasing water stress. Cultivar Jalo Precoce and Onix were the most tolerant to water stress. Alfalfa (*Medicago sativa L.*) germplasm for seedling tolerance were screened in the field as was as in the laboratory tests (Rambaugh and Johnson, 1981). The accessions that can emerge at -6.5 bars of soil water potential in the laboratory (concentration of

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polyethylene glycol , PEG – 6000 was adjusted to provide -6.5 bars of soil water potential) have better field emergence and survival under drought stress than accessions that cannot emerge in the laboratory.

MATERIALS AND METHOD

In order to study the effects of water stress on germination indices in safflower cultivars, an experiment was conducted in factorial form, using a completely randomized design with four replications. In this experiment, seven safflower cultivars (A factor: CH353 ,CH65 ,Asteria ,CH697 ,Rinconada ,iranian variety Zarghan and Isfahan)were evaluated in six levels of drought treatment (B factor: distilled water,-3,-6,-9,-12,-15 bar) of PEG 6000.

PEG (gr/lit)	Stress level (bar)
138	-3
189	-6
222	-9
251	-12
270	-15

PEG were prepared by dissolving the required amount of PEG in distilled water (at 25°). The seed were surface sterilized with 0.01% $Hgcl_2$ solution for one minute. After the treatment the seeds were washed several times with distilled water. 25 seeds were put in each petridish on filter paper moistened with repective treatment in four replications. The petridishes were covered to prevent the loss of moisture by evaporation. Germination percentage was recordet every day interval for 1 day after soaking. Seeds were considered germinated the emergent radical reached 2 mm length rate of germination and cofficent of velocity of germination were calculated as follow

Rate of germination = dg/dt

Coefficient of velocity of germination = $100 \times \frac{A_1 + A_2 + ...A_x}{A_1T_1 + A_2T_2 + ...A_xT_x}$ (Pollock and Ross 1972)

Mean of day germination = $\sum(Nt / \sum N)$

RESULTS AND DISCUSSION

Increased salinity levels has deleterious effect on germination and radical length and plumule length. The recorded values are presented in(Table 2).

A) Radical Length:

According analysis (Table 1) there wrer significant different among varieties and water levels. The highest radical belonged to CH65 with 20.73 mm and the least radical belong to CH697 with 10.896 mm . C.V in this experiment was 23.46%.(Table 3). Safflower allocated more food to root in order to resistance against stress situation (Table2). Consequently, under these conditions, a considerable amount of root energy is used to actively absorb the required nutritious elements; so the energy allocated to root growth decreases Interaction between variety and salinity levels was not significant and the lest radical belong to -15 bar. With the increase of drought stress levels radical length decreased.

B) Length of Pulmus:

The highest pulmus belonged to *CH65* , *CH353* , Rinconada. Rinconada variety with 70.066 mm , had the highest pulmus. There is significant between A and B factor. The highest a pulmus belong to Isfahan and distilled water with 37.42 Ch697 , Asteria variety Zarghan in -9 , -12 , -15 had without length pulmus. In higher levels of stress, plumule length decreased and this was less than what was observed in radicle length.

Among all traits , germination percentage trait was affected by salinity stress less than the other traits. Isfahan variety is the most resistant and most CH697 is the sensitive.

Table 1: Variance analysis of characters.

							Mean square
Average velocity of germination	Index Average velocity of germination	Mean of Day germination	Germination Percentage	Pulmus length (mm)	Radical length (mm)	df	S. O.V
11.137**	53.71**	3.25**	346.890**	62.930**	289.67**	6	(A)Variety
49.198**	96.14**	6.22**	1314.163**	4506.64**	1035.2**	5	(B)Stress
0.930**	33.70**	0.83**	76.48n.s	14.38**	30.97n.s	30	Intraction

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							(AB)
0.324	1.1193	0.058	70.26	3.94	15.9	126	Error
16.89	7.39	4.43	48.57	29.07	23.46		C.V

Table 2: Mean comparison of different levels of salinity.

Average velocity of germination	Index Average velocity of germination	Mean of Day germination	Germination Percentage	Pulmus length (mm)	Radical length (mm)	Stress Level (Bar)
4.36ab	15.32a	5.14ed	81.57ab	32.2 a	23.76a	Dinstilled water
4.57a	15.35a	5.10e	87.42ab	3.26b	22.74a	-3
4.08b	15.12ab	5.26cd	89.00a	1.19c	19.79b	-6
3.64c	14.61b	5.29c	73.57b	0.83c	16.10c	-9
2.38d	14.09ab	5.67b	49.42c	0.48c	11.78d	-12
1.18c	10.57c	6.34a	24.14d	0.37c	8.61e	-15

Statistically, there is no significant difference among the means with the same letter in each column in Duncan's test (p = 5%)

C) Germination Percentage:

The highest germination percentage take place in distilled water with 98% in -6 level and the least belong to -15 bar with 24.144%. The least Germination belong to CH697 ,and there is no different among varieties (Table 3). The significant decrease resistance the varieties occurred at -9 bars. In a study on germination percentage of rapeseed in salinity stress conditions, it has been revealed that in the highest level of salinity stress(15 dSm^{-1}), a great number of varieties has exhibited a dramatic decrease in their final germination percentage. However, a number of these varieties germinated even better than the control group in these conditions(Jajarmi, V . (2007). Among between varieties the highest belong to Rinconad with 98%.

Table 3: Mean comparison of varieties safflower.

Average velocity of germination	Index Average velocity of germination	Mean of Day germination	Germination Percentage	Pulmus length (mm)	Radical length (mm)	Variety
3.7ab	15.22a	5.22c	77.16a	7.066a	18.462a	CH 353
3.6ab	15.03a	5.34c	67.50a	6.98a	20.273a	CH 65
3.8a	15.14a	5.32c	77.16a	7.067a	18.519a	Rinconada
3.4bc	12.76b	5.69b	71.33a	6.23ab	13.638b	Isfahan
1.9d	11.59c	6.22a	35.66a	5.414b	10.896c	CH 697
3.8ab	15.25a	5.21c	76.16a	5.413b	19.344a	Asteria
3.2c	15.16a	5.28c	78.16a	6.55ab	18.828a	Zarghan

Statistically, there is no significant difference among the means with the same letter in each column in Duncan's test (p = 5%)

D) Mean of day Germination and Average Velocity of Germination:

The highest mean of day germination belongs to CH697 with 6.22 day. It showed that average velocity of germination in this variety is very slow, Although Asteria variety had the least with 5.21 day. Increased drought concentration reduced root length, plumule length, and, mean germination time whose results can be related to osmotic effects, water potential reduction and ionic imbalance. The highest (AVG) belong to Rinconada and the least belong to CH697, Zarghan

Conclusions:

In the studying the tolerance of varieties to water stress, germination percentage cannot be a good index in screening varieties (Germination percentage trait was affected by water stress less than the other traits). To find the best one tolerant variety to such condition, taking all traits, into account in this study, we found that Rinconada variety is the most resistant and CH697 is the most sensitive. Given the fact that lower levels of drought concentration in the environment (-3 bars)resulted in increasing most of the traits especially radicle and plumule length. Pumule length and germination velocity have not changed a great deal up to levels of -6 bars, however, germination percentage has shown great changes. It seems that final germination percentage and germination velocity were respectively the most resistant and sensitive components to salinity stress.

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