



## Effect of water stress on germination indices in seven 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 during germination in arid and semi arid regions in Iran. More than 90% of the 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 reduces the radical length at more than -3 bars. CH65 variety has the longest length of root with 20.3 mm. CH353, and Rinconada had the longest length of plumule. The highest germination percentage belonged to Asteria (76%) and -6 bars with (98%). The lowest germination percentage belonged to CH697 with (36%). The percentage of germination and the 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.

**Key words:** Safflower - water stress - germination indices

### Introduction

Current estimates indicate that 25% of the world's agricultural lands is now affected by water stress. It can be said that it is one of the most devastating environmental stresses. The high yield of a plant in sufficiently irrigated conditions is not necessarily related to high yield under drought stress and vice versa. Depending on which stage of growth a plant experiences drought stress, it reacts quite differently to the stress (Gales, 1983).

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 of 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. M. M. Heikal (1981) investigated the effect of different osmotic stresses (from 0 to  $-8 \times 10^5$  Pa) obtained with NaCl or polyethylene glycol 6000 solutions on the germination of flax, sesame and onion seeds. The rate of seed germination and the final germination percentages as well as the amount of water absorbed by the seeds were considerably lowered with the rise of osmotic stress levels whatever the stress agent used, more considerable reduction was obtained under polyethylene glycol 6000 than under NaCl.

Effects of drought stresses induced by polyethylene glycol (PEG) on germination of Mongolian pine (*Pinus sylvestris* var. *mongolica*) indicated that the seeds from both provenances did not germinate when PEG concentration was more than 25%. The germination capacity and germination rate of natural seeds were significantly higher than those of plantation seeds for all



treatment levels ( $P < 0.05$ ). The mean growth rates of radical and hypocotyl from natural seeds were significantly higher than those from plantation seeds at all treatment levels below 20% PEG treatment ( $P < 0.05$ ) (Zhu JiaoJun 2006).

## 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 6000 was prepared by dissolving the required amount of PEG in distilled water (at 25°). The seeds were surface sterilized with 0.01% HgCl<sub>2</sub> 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 respective treatment in 4 replications. The petridishes were covered to prevent the loss of moisture by evaporation. The petridishes were put into an incubator for 8 days at 20 degrees centigrade. Every 24 hours after soaking, germination percentage and other traits were recorded daily. Seeds were considered germinated when the emergent radical reached 2 mm length. Rate of germination and coefficient of velocity of germination were calculated using the following formulas:

Rate of germination =  $dq/dt$

Coefficient of velocity of germination =  $100 \times \frac{A_1 + A_2 + \dots + A_x}{A_1 T_1 + A_2 T_2 + \dots + A_x T_x}$  (Pollock and Ross 1972)

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

## Results

Increasing drought levels had deleterious effect on germination and radical length and plumule length. The recorded values are presented in table 1.

### A) Radical length

There are significant differences among varieties and drought levels. CH353, CH65, and Rinconada, which have the longest radical length, are in the same statistical level, though among these three, the tallest radical belonged to CH65 with 20.73 mm and the shortest radical belonged to CH697 with 10.9 mm. The results showed that with the increasing of drought stress level, radical length decreased.

### B) Length of Plumule

The highest plumules belonged to Rinconada, CH353, and CH65 (table 1). The highest plumule (37.4 mm) belonged to Isfahan in the presence of distilled water. CH697, Asteria and Zarghan in -9, -12, -15 had no plumule. In general, plumule length is strongly affected by droughts stress levels, especially levels upper than -3. Jajarmi in his studies of salinity effects on safflower has come to similar results (2007).

### C) Germination percentage



The highest germination percentage was observed in -6 level with 98%, indicating its high tolerance to drought stress, and the least belonged to -15 bar with 24%. CH697 has the lowest germination percentage (Table 1). Among varieties the highest percentage belonged to Rinconad with 98%.

#### D) Mean of day Germination:

The highest mean of day germination belonged to CH697 with 6.2 days. It showed that average velocity of germination in this variety is very slow, Although Asteria variety had the least with 5.2 days, indicating its high germination velocity. The shortest mean day germination was observed under – 3 level, belonging to CH353 and Rinconada. These varieties had both the highest germination percentage and velocity of germination, resulted from their high genetic potentials.

#### E) Average Velocity of Germination

The highest (AVG) belonged to Rinconada and the least belonged to CH697, Zarghan.

Table 1. Mean comparison of varieties safflower

Variety	Average velocity of germination	Index Average velocity of germination	Mean of Day germination	Germination Percentage	Pulmus length (mm)	Radical length (mm)
CH 353	3.7ab	15.2a	5.2c	77a	7.1a	18.5a
CH 65	3.6ab	15.0a	5.3c	67a	7.0a	20.3a
Rinconada	3.9a	15.1a	5.3c	77a	7.1a	18.5a
Isfahan	3.4bc	12.8b	5.7b	71a	6.2ab	13.6b
CH 697	1.9d	11.6c	6.2a	36a	5.4b	10.9c
Asteria	3.8ab	15.3a	5.2c	76a	5.4b	19.3a
Zarghan	3.2c	15.2a	5.3c	78.a	6.6ab	18.8a

#### Discussion

In the studying the tolerance of varieties to drought stress, germination percentage cannot be a good index in screening varieties, This is because the germination percentage trait was affected by salinity stress less than the other traits as well it is strongly influenced by the environment in which the seed developed, seed age and storage conditions. To find the best tolerant variety to such conditions, taking all traits into account in this study, we found that Isfahan variety is the most resistant and CH697 is the most sensitive varieties.

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