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Evaluate the effect of drought stress on germination and seedling growth of wild safflower (Carthamus oxyacantha) by using the PEG solution

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ABSTRACT: In order to study the effect of drought stress by using a solution PEG on germination and seedling growth of Wild Safflower (Carthamus oxyacantha) a completely randomized design experiment with four replications was done in the Department of Agronomy and plant breeding laboratories in 2015_2016 .. All Wild Safflower seeds were collected from farms near Ardebil. For each experiment, 25 seeds were placed in previously sterilized petri dishes. At the end of the experiment the number of normal germination, germination percentage, germination rate, the percentage of none germinated seeds, Coefficient of germination rate, mean germination time, average of germination rate, uniformity of germination and germination index were recorded. To create drought stress was used of the solution of polyethylene glycol (PEG) 6000 (see, -2, -4, -6 and -8 MPa) in a petri dish. The results showed that the majority of traits in different treatments were significant. Increasing levels of drought, reducing the number of normal germination and germination percentage, Coefficient of germination rate, average of germination rate, germination index, uniformity of germination and germination rate and increase the percentage of none germinated seeds and average of germination time. In -8 MPa dry treatment no seed was germinated and germination was zero.

Keywords: Normal Bud, Weed, Germination, Wild Safflower

INTRODUCTION

For a real, principled, and scientific fight against weeds, accurate identification of weeds in all aspects, including their biology, is necessary. Without knowledge of the biology of a weed, predicting its behavior, power, timing, and competition is impossible, and any method of control and prevention employed carries high risks and even the possibility of obtaining opposite results. Wild safflower, known scientifically as Carthamus oxyacantha, is a plant from the Asteraceae family, also known as wild safflower or Jeweled Distaff Thistle. It is an annual C3 plant, stationary, with two broad leaves and summer prickly leaves that sometimes reach more than one meter in height. It is one of the important weeds in wheat fields, cotton, legumes, sugar cane, garlic, onions, orchards, and pastures. Among all the stresses that plants face, drought stress is one of the most important limiting factors for agricultural production in most parts of the world. According to research conducted among living stresses (diseases, pests, and weeds) and non-living stresses (drought, flooding, salinity, heat, and cold), drought stress alone has been responsible for 45% of the reduction in agricultural crop yields (Imam and Zavareh, 2005). Although studies have been conducted on evaluating drought tolerance and genetic diversity within the safflower crop species (Mojidi et al., 2011; Sabzalian et al., 2008), Johnson et al. (1997) observed significant diversity among genotypes in evaluating seed germination of safflower cultivars obtained from three moisture regimes. Froozan (1997) found greater fundamental differences between genotypes for germination parameters in determining safflower tolerance to drought stress during seedling germination and establishment, such as final germination percentage, length of aerial organs, and root length. Drought stress during safflower germination reduces the percentage and rate of germination (Rostami et al., 2003). However, it was found through various sources and references that fewer studies have been conducted on the effect of drought stress on wild safflower plants. The aim of this study is to investigate the effect of drought stress on the germination of wild safflower weed.

Materials and Methods:

To investigate the effect of drought stress using PEG solution on germination and seedling growth of wild safflower (Carthamus oxycantha), an experiment was conducted in a completely randomized design with four replications at the Agricultural Faculty laboratory in Ardabil in 1394-1395. All seeds were collected from the natural environment of Ardabil region. In each experiment, 25 seeds were placed in each petri dish for testing. Healthy seeds with high viability were used for the experiment. Disinfection was carried out using 90% alcohol for one minute, followed by rinsing with distilled water. The petri dishes used, along with filter paper, were sterilized in an autoclave to prevent any fungal contamination. Petri dishes were transferred to a germinator at a temperature of 1±15 degrees Celsius, which had been determined as the optimal temperature for wild safflower seed germination in previous experiments. Daily observations were made until complete cessation of seed germination, and germinated seeds (root emergence up to 2 mm) were counted. At the end of the experiment, the number of normal germinations (seedlings with short, thick hypocotyls and coiled roots) and abnormal germinations (ungerminated seeds) were determined, along with percentage of germination, germination rate, percentage of ungerminated seeds, germination velocity coefficient, average germination time, mean germination rate, germination index, and uniformity of germination.

Results and Discussion

Number of normal seedlings and percentage of germination

The results of the analysis of variance (Table 1) for the number of normal seedlings and percentage of germination in the drought treatment showed that the effect of drought levels was statistically significant for both traits at a one percent level of significance. The comparison of means for these two traits (Table 2) showed that increasing drought levels resulted in a decrease in the number of normal seedlings and the percentage of germination. The control treatment had the highest number of seedlings with an average of 15.75 and 63% germination rate. Increasing drought beyond a certain level caused germination to continue but eventually stop, as observed in the dryness treatment 8-, where no germination occurred and the number and percentage of germination were zero.

Percentage of ungerminated seeds and germination speed coefficient

The results of the analysis of variance (Table 1) for the percentage of ungerminated seeds and the germination speed coefficient in the drought treatment showed that the effect of drought levels was statistically significant for both traits at a one percent level of significance. The comparison of means for these two traits (Table 2) showed that increasing drought levels resulted in an increase in the percentage of ungerminated seeds and a decrease in the germination speed coefficient. As the drought levels increased, the percentage of ungerminated seeds also increased. Therefore, the control treatment had the lowest percentage of ungerminated seeds, while the drought treatment 8- had the highest percentage of ungerminated seeds with 100%. For the germination speed coefficient, the control treatment had the highest coefficient of 16.22%, which was statistically similar to the level 2- treatment. However, with increasing drought levels, this trait decreased, reaching its lowest value of 0% in the 6- treatment, which was significantly different from the control treatment. Further drought stress caused no germination to occur in the 8- treatment, and the germination speed coefficient was also zero.

Average germination time and mean germination rate

The results of the analysis of variance (Table 1) for average germination time and mean germination rate in the drought treatment showed that the effect of drought levels was statistically significant for both traits at a one percent level of significance. The comparison of means for these two traits (Table 2) showed that increasing drought levels resulted in an increase in the average germination time and a decrease in the mean germination rate. The control treatment had the shortest average germination time of 6.19 days and the highest mean germination rate of 162 seeds per day. This mean germination rate was statistically similar to the level 2- treatment. However, with increasing drought levels, the average germination time increased, and the mean germination rate decreased. At the 6- treatment level, the mean germination rate reached its lowest value of 109 seeds per day, which was significantly different from the control treatment. Further drought stress caused no germination to occur in the 8- treatment, and the mean germination rate was also zero.

Germination index and uniformity of germination

The results of the analysis of variance (Table 1) for the germination index and uniformity of germination in the drought treatment showed that the effect of drought levels was statistically significant for both traits at a one percent level of significance. The comparison of means for these two traits (Table 2) showed that increasing drought levels resulted in a decrease in both traits. The control treatment had the highest germination index with an average of 51.71%, which was statistically similar to the level 2- treatment. However, with increasing drought levels, this trait decreased, reaching its lowest value of 32.0% in the 6- treatment. The uniformity of germination also decreased with increasing drought levels, as the number of normal seedlings, percentage of germination, germination index, and germination speed coefficient all decreased. Therefore, the highest uniformity of germination was observed in the control treatment, which was statistically similar to the level 2- treatment, while the lowest uniformity was observed in the 6- treatment. No germination occurred in the 8- treatment.

Germination speed

The results of the analysis of variance (Table 1) for germination speed in the drought treatment showed that the effect of drought levels was statistically significant at a one percent level of significance. The comparison of means (Table 2) showed that increasing drought levels resulted in a decrease in germination speed. The control treatment had the highest germination speed with an average of 2.82 seeds per day, which was statistically different from other treatments. However, with increasing drought levels, this trait decreased, reaching its lowest value of 0.29 seeds per day in the 4- treatment. The 6- treatment had similar values to the control treatment, while further drought stress caused no germination to occur in the 8- treatment, and the germination speed was also zero.

Table 1- Analysis of variance for the effect of drought treatment on germination of wild marigold seeds

mean squares										
germination rate	germination uniformity	germination index	mean germination rate	average germination time	germination rate coefficient	percentage of not germinated	germination percentage	number of normal sprouts	Degree free	Source of variatin
0.828**	0.350**	0.365**	0.0067**	3.549**	7.11**	2794.00**	33.63**	7.17**	4	Treatment
0.019	0.034	0.011	0.00031	0.275	0.384	105.066	1.014	0.211	15	Error
21.16	-25.06	10.18	2.28	22.50	21.16	13.85	23.09	19.78	-	Coefficient of variation

Table 2- Comparison of means for the effect of drought treatment on wild poppy seed germination Means with common letters are not significantly different.

Germination speed (number per day)	germination uniformity	germination index	mean germination rate	average germination time	germination rate coefficient	percentage of not germinated	germination percentage	number of normal sprouts	Treatments
2.82a	-10.85a	1.57a	0.162a	6.19a	16.22a	37.00c	63.00a	15.75a	Control group treatment
1.50b	-18.36ab	1.10b	0.134ab	7.42a	13.21ab	56.00b	44.00b	11.00b	2 megapascals
0.29c	-48.56bc	0.25c	0.085c	6.56a	8.5c	90.00a	10.00c	2.50c	4 megapascals
0.36c	-77.56c	0.32c	0.109bc	9.13a	10.95bc	87.00a	13.00c	3.25c	6 megapascals
0.00c	0.00a	0.00c	0.00d	0.00b	0.00d	100.00a	0.00c	0.00c	8 megapascals
Means with common letters have no significant difference									

General conclusion

The results of the analysis of variance for the studied traits under drought treatment showed that the effect of drought levels was statistically significant for all of these traits. The comparison of means for these two traits showed that increasing drought levels led to a decrease in normal seedling count, germination percentage, germination speed coefficient, mean germination speed, germination index, uniformity of germination, and germination speed percentage, along with an increase in the percentage of ungerminated seeds and average germination time. Excessive drought stress resulted in the continuation of germination up to a certain point, followed by its complete cessation, as seen in the 8- treatment where no germination occurred and the germination speed was zero. Drought stress affects various aspects of plant growth, leading to delayed and reduced germination, inhibited aerial organ growth, and decreased dry matter production. Specific signs of water stress include reduced osmotic and total water potentials, stomatal closure, and reduced growth. Therefore, laboratory studies, in addition to field research, are important to investigate plant response to drought stress, particularly weeds, using materials such as polyethylene glycol. Given the widespread dry and semi-dry regions in Iran, this research can provide valuable insights.

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