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Effects of Drought Stress on *Artemisia sieberi* Besser Germination Behavior

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ABSTRACT

The *Artemisia sieberi* Besser plant belongs to the Asteraceae family which disperses in dry lands. This species is resistance to drought and plays an important role on preserving the soil in dry regions. The aim of this study was to investigate the effect of drought stress on the *Artemisia sieberi* Besser germination behavior. To evaluate the drought treatment effect on the *Artemisia sieberi* Besser plant germination, the seeds were pre-chilled for 9 days at zero to 5 °C for its dormancy duration to remove its dormancy. Moisture stress test was carried out with 0, -0.2, -0.4 and -0.6 MPa treatments using PEG solutions in petri dishes under a random plot. The results of this experiments showed that the water potential has a very significant different on the rate and percentage of germination, plumule length and allometry ratios, and is significant on one percent level, in a way that rate and percentage of germination is decreased through the water potential decrease, But radicle length is significantly less sensitive on drought stress in comparison with other features. As through stress increasing, the radicle length would be increased till -0.6 MPa and then in would be decreased.

Keywords*: Artemisia sieberi*, Drought stress, Germination, Allometry ratios

INTRODUCTION

Arid and semi arid regions covering majority part of Iran which has a warm and dry weather with mild and cold winters and little annually rainfall causes poor plant coverage. Preservation and development of plant cover of rangelands as natural ecosystems are biological methods to prevent desertification. The most suitable species for growth in this rangeland are the endemic species which are compatible with an environment condition, high provender worth, effective on soil stabilization, and preserve the biological environment (Azarnivand, 2003). Unfortunately, these species are being eradicated because of inappropriate use of rangeland resources and reclamation of them is essential. Drought is one of the most important problems of these regions, which cause delay of germination, reduces shoots growth and also decreases the production of a dry matter (Hoekstra *et al.*, 2001).

As a result plant growth and settlement will be confronted with problems in these regions. For desert restoration and land reclamation land, using the endemic species has higher priority than foreign species in different aspects, such as; temperature fluctuation, dryness soil and water saltiness, pests and disease, competition with other species in the area (Moghimi, 2005).

One of the endemic species of Iran rangelands is the *Artemisia sieberi* Besser or *Artemisia spp*. *Artemisia* with 34 different species in Iran is one of the most important plant species after *Astragallus* genus in the aspect of coverage, density and plant expansion. Sagebrush is genetically important species in Iran which propagate by seeds and resistant to heat, drought, and pests. *Artemisia sieberi* is one of the most precious species that is one of the tolerant plants in desert lands and semi desert lands in Iran. It covers large areas of desert lands alone or in combination with other rangeland types. Sagebrush is one of the very compatible plants in hard conditions of the desert such as hot weather, dryness and erosion. It also using as forage in winter pastures and cattle fee (Mozafarian, 1999).

Artemisia sphaerocephala species is using for reclamation deserts but it has low percentage of germination through air seeding and dry condition (Zheng *et al.*, 2005). The most suitable climate condition for seeding is in the middle of May. Light confined germination and temperature and germination has direct relation. The results of the drought stress experiment with polyethylene glycol (PEG 6000) solution on two species of *Agropyron afghanicum* and *A. cristatum* showed that the drought stress had negative effects on the percentage of germination and these plants had low resistance to drought (Shahryari and Javadi, 2005). Villalobos and Pelaez (2001) studied the effect of drought stress on germination and establishment of the *Prosopis caldenia* species, the highest germination rate was on the evidence treatment and lowest germination rate was in the -1 Mpa treatment with a temperature regime in the variety of about 20° to 35° ^{o}C on the probable level of less than 51 present had a considerable reduction. Kappen *et al.* (1972) examined the moisture stress and photosynthetic activities of *Artemisia herba alba* species during a dry season in desert. They stated that Sagebrush plant has a very little water in it's natural living place during dry season, and this the implication of negative hydrostatic pressure of about -163 MPa in xylem and a osmotic potential of the leaves of about -92 MPa. They demonstrated that daily water stress decreases strongly during the night and under this condition Sagebrush has photosynthetic activity for the whole duration of the duration of dryness in the year, for a few hours. seeds can tolerate dryness to threshold level and after that, dryness rising will decrease germination linearly and because of this evaluating the climax sum helps us to plan the seed in the region in which dryness would not raise more than the evaluated climax to obtain desired germination.

As plant life will begin from seed germination, success in this important stage has critical role on life succession and preservation of the species till now. A complete study about Sagebrush germination for improving the plant coverage in arid regions and for preserving this plant's growth place, has not been accomplished.

Considering the dry climate and harsh condition of the country's desert especially in resent droughts. Knowing about the germination behavior and determining the species resistance against dryness, is on essential matter and germination behavior of Sagebrush species under the stress condition was investigated

MATERIALS AND METHODS

Experiments were conducted with frequency of for times with 4 repeats in a random completely design. Germination percentage was measured in the experiment (Hartmann *et al.*, 1983). Germinated seed were those with (at least) 2 millimeters radicle length. The germination rate was calculated through this formula:

$$V = \frac{\sum D.N}{\sum N}$$

Which D is time (determining the day of germination) and N is the number of germinated seeds on the D Day (Sarmadnia, 1997). The length of the plumule and radicle after the emergence of the first two new leaflets were recorded (Khavazeh, 1998). The important index of allometry was determined by calculating the length ratio of the plumule to the radicle. As the Sagebrush seeds needs chilling for germination, the selected seeds were pre-chilled at the temperature of zero to 5 ^{o}C in about 9 days (Khavazeh, 1998 ; Modares Hashemi, 2003). All devices of experiment were disinfected with alcohol and the seeds were disinfected by Vita Wax 2/1000 fungicide. Seeds were appropriately spaced on Watman 40 mm filter paper in each petri dish. The treatments were randomly allocated to petri dishes.

Petri dishes were placed in the incubators with temperature of 25 ^{o}C. Daily watering by distilled water was done in a way that the seeds were not immersed in the water. The number of the germinated seeds was recorded daily. Different water potentials were applied on petri dishes using PEG (polyethylene glycol 6000) to study the effect of water stress. Experiment was carried out with four replicates of 25 seeds in incubator with 25^{0}C and 12-hour alternate light and dark. A series of drought stresses, i.e., water potentials of 0.0(control group), −0.2, −0.4, and −0.6 MPa were produced by different concentrations of polyethylene glycol 6000 (PEG 6000) solutions (Michel and Kaufmann, 1973). A total of 16 petri dishes for 4 replicates of 25 seeds and 4 moisture stress levels were employed. To prevent evaporation of water, the petri dishes were placed in plastic bags. The solutions inside the petri dishes were watered every few days to prevent the increased concentration of PEG. All seeds were kept under the same conditions for 4 weeks.

Seeds were considered to have germinated when the radicles emerged (1–2 mm in length out of the tegument) (Ren and Tao, 2004). Before data analyzing, first the data were examined (for being normal) with Kolomogorove – semirnov test and (for homogeneity test) Levene test. Finally, the data were analyzed through ANOVA and the mean comparison was done using LSD test (the last amount of significant difference) on the level of 1%. To drawing the diagrams the Excel Software had been used.

RESULTS

Experiment result of drought stress treatment has effect on the germination. In this experiment the effect of PEG solutions with 0.0(control group), −0.20, −0.40, and −0.6 MPa intensities on the germination features were examined. Analysis of variance shows the drought stress experiment in all drought treatment in measured variables such as percentage and rate germination has significant difference in 1% and plumule length on the level of 5%.

The mean comparison for effect of different levels of drought treatment

Table 1. ANOVA for drought resistance experiment

		Square means of traits under study				
Sources of variation	df	Germination %	Germination rate	Radicle length (cm)	Plumule length (cm)	Allometry ratios
treatment	3	1168.52**	573.89**	2.5*	0.27**	0.01**
error	12	57.07	6.39	0.5	0.01	0.0004
CV	-	12.29	11.31	14.71	14.31	17.56
R^2	-	0.83	0.96	0.56	0.92	0.91

*P<0.05, **P<0.01; ns: Non – significant

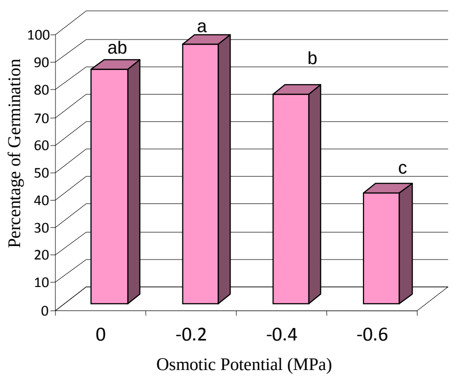

Figure. 1. Mean effects of drought treatments on the percentage of germination

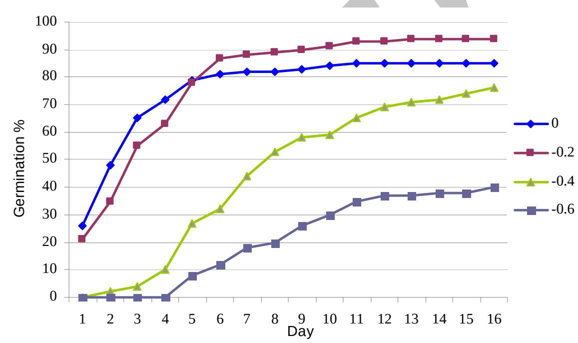

Figure 3. Mean of daily germination percentage on the treatment 0, -0.2, -0.4 and -0.6 MPa

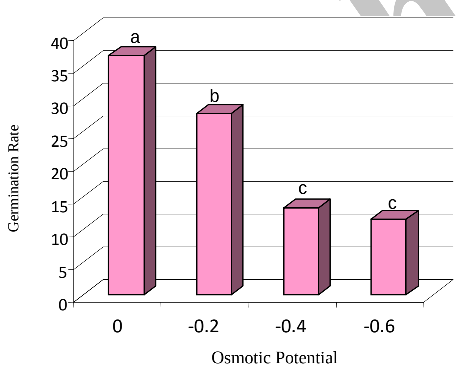

Figure. 2. Mean effects of drought treatment s on the rate of germination

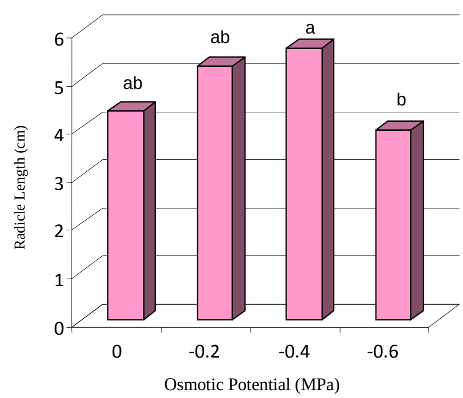

Figure. 4. Mean effects of drought treatments on the radicle length

(Figure 1). The mean comparison by LSD method shows that the most germination percentage is in the -0.2 MPa treatment with 94%. Through increasing the intensity of drought soluble, the germination rate will be decreased. In the present study the highest amount of germination was in the evidence treatment (with 36.64) and the lowest amount was in -0.6 MPa treatment (with 11.67)

Fig (3) shows the mean value of germination percentage in different treatments on the test day which has increased clearly in the -0.2 MPa treatment of germination percentage in comparison with other treatments. Also, the first germination day will be increased through the drought stress enhancement and the less first days of germination is seen on the -0.2 MPa treatment.

Fig.4 shows, -0.2, -0.4 and -0.2, -0.6 MPa treatments are not significantly different in the aspect of radicle length. But -0.4, -0.6 MPa treatments are significantly different. The radicle length has been decreased in -0.6 MPa intensity comparison with other treatments. radicle length will be increased from -0.2 to 0 MPa through drought enhancement. Drought enhancement decreases the plumule length and allometry ratios. According to figure 5 and 6 the mean comparison through LSD method indicates that the highest pulumel length and allometry ratios are for the evidence treatment and the lowest is for the -0.6 MPa treatment.

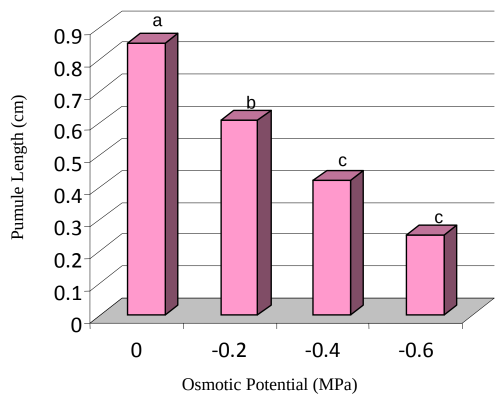

Figure. 5. Mean effects of drought treatments on the plumule length

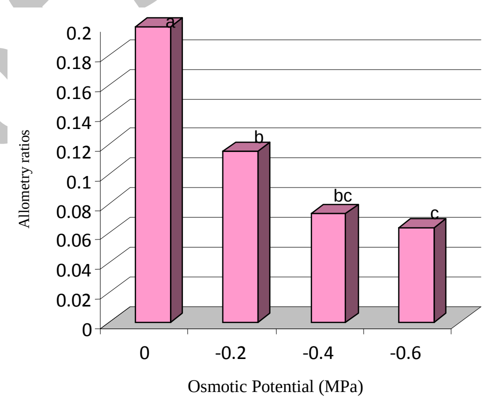

Figure. 6. Mean effects of drought treatments on the allometry ratios

DISCUSSION

The germination rate and percentage will be decreased by increasing the drought soluble intensity that Zheng *et al.* (2005) found same results for the *Artemisia sphaerocephala* species. They state that under the drought stress condition the rate and percentage of germination will be decreased, and few seeds would be germinated on -1.4 MPa and this is more obvious in very high or low temperature. Villalaboos and Pelaez (2001) and Horak and Sweat (1994) studied about *Cucurbita foetidissima* species. Villalaboos and Plelaez (2001) studied the drought stress effects on the germination and establishment of *Prosopic caldenia* species. They showed that the highest rate of germination was in the evidence treatment on the 30^{0}C and the lowest germination rate was in -1 MPa treatment on 35^0C. Their results indicated that germination rate on -1 MPa treatment with variable temperature regime decreased which is the same as the results of this research. Wilenberg *et al.* (2005) stated that enhancement of the drought level from 0 to -4 MPa leads to significant decrease and germination rate.

In -0.6 MPa intensity, radicle length in comparison with three other treatments was decreased which indicate that is sensitive to -0.6 MPa drought through drought enhancement from 0 to -0.4 MPa. It can be stated that this plant would enhance its radicle growth in drought condition to -0.4 MPa, this plant needs drought for improving the radicle growth. Balestri and Cinelli (2004) showed that on *Pancratium maritimum* plant, drought is obstacle for germination, and the germination process has been improved on an intensity which is less that -0.6 MPa,. Huang *et al.* (2000) and Pande and Singh (1981) stated that one of the important factors of drought stress tolerance is the root system, which can increase the drought tolerance through root development , increasing the root volume and surviving and root enhancement to shoot.

Drought enhancement decreases the plumule length and the plant would increases its radicle length in comparison with plumule length in drought condition to obtain more water. These results are same as Seong and Park(1990) study on a *Astragallus* species, and the study results of Finch *et al.* (2001) on *Dacuscarota* species and Shahryari and Javadi (2005) on *Agropyron* species. They state that drought stress enhancement, decreases the plumule length. Tork *et al.* (2004) declare that plumule growth has more sensitivity about stress than radicle growth. Generally, germination experiment results showed that through increasing the PEG soluble intensity decreases the germination rate and germination percentage, plumule length and allometry ratios, and decrease of air bodies of alive mass is noticed for adaptation with dry and water-lack condition. It is suggested that to attaining more comprehensive information from germination and Sagebrushes vigor researches on different temperature (to determining the best temperature for germination) should be done, in different times and in different climates.

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