The 2nd International Seed Science and Technology Conference of Iran
"Seed 2024"
(Medicinal Plant, Crop, Horticulture, Pasture & Forest)
seed2024.razi.ac.ir

Physiological responses of three populations of *Artemisia sieberi* Besser to drought stress during early growth stage

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Introduction

Artemisia sieberi and *Artemisia aucheri* are the most abundant Artemisia species in Iran. Unfortunately, in recent years, the drying up of *Artemisia spp.* has been observed in many parts of the country, mainly due to overgrazing and successive droughts. These habitats are very sensitive and fragile due to the harsh habitat conditions. Climate change, overgrazing, and land-use change are very important in determining the fate of these habitats. *Artemisia sieberi*, a species of paramount genetic value to Iran, is predominantly propagated through seeds. Its high nutritional value for livestock and exceptional tolerance to the rigors of desert and semi-desert environments make it a highly prized species. *Artemisia sieberi* is extensively found in the desert plains of the country, either as a monoculture or as a dominant species within rangeland communities. As a shrub well-adapted to harsh desert conditions, it serves not only as forage in winter pastures but also demonstrates remarkable resistance to heat, drought, and erosion (Kamali et al., 2021b). Furthermore, drought conditions negatively impacted seed germination, with few seeds germinating at a water potential of -1.4 MPa. Based on the findings, mid-May was determined to be the most suitable time for seeding from a climatic perspective. Additionally, the results indicated that light was a limiting factor for germination, while temperature had a positive correlation with seed germination. This study aimed to investigate the germination behavior of different populations of Artemisia sieberi under drought stress. As a drought-tolerant species, Artemisia sieberi holds significant potential for the restoration of arid and semi-arid regions. Given the critical role of seed germination in species survival and vegetation development, a thorough understanding of the germination process of Artemisia sieberi can contribute to improving restoration techniques and sustainable management of these areas.

Materials and methods

To investigate the effects of drought stress on germination characteristics and early seedling growth of *A. sieberi*, seeds were collected from three populations in the rangelands of Gosheh, Aradan, and Garmsar. To break seed dormancy, seeds collected from four populations of *A. sieberi* were pre-chilled at 0-5°C for 9 days, as this species requires cold stratification for germination. All equipment used in the experiment, including the incubator, forceps, and culture vessels, was thoroughly sterilized with a 70% ethanol solution to prevent microbial contamination. To inhibit fungal growth on the seeds and ensure healthy germination, the seeds were treated with Vitavax 2 fungicide. The experiment was conducted in a completely randomized factorial design with four replications. Each replication consisted of 25 seeds in a Petri dish. The Petri dishes were placed in an incubator maintained at a constant temperature of 19-23°C with a 12-hour light cycle. Seeds were placed on Whatman No. 40 filter paper to ensure uniform moisture distribution. To induce various levels of drought stress, polyethylene glycol 6000 solution was used. Four drought stress levels were applied: 0, -2, -4, and -6 MPa, with 0 MPa serving as the controL. To prevent water evaporation, Petri dishes were sealed in plastic bags, and the solution in the Petri dishes was replaced daily to maintain a constant polyethylene glycol concentration. The number of germinated seeds was counted and recorded daily. Germination percentage was calculated as the number of germinated seeds divided by the total number of seeds and multiplied by 100. A seed was considered germinated when the radicle reached a length of 2 mm. Germination rate was calculated using the standard formula. Additionally, radicle and hypocotyl lengths were measured. Data were analyzed using SPSS software. Prior to any statistical analysis, the normality of data was tested using the Kolmogorov-Smirnov test. Homogeneity of variances was also tested using Levene's test.

Results and Discussion

results indicated that there were no significant differences among the populations of *Artemisia sieberi* under control conditions. However, increasing drought stress significantly reduced germination percentages and rates in all three populations. Maximum drought stress resulted in an 83% reduction in germination in the Garmsar population and an 80% reduction in germination rate in the Gosheh population (figure 1&2). Drought stress resulted in a decrease in seedling length in the studied populations, Drought stress reduced seedling growth in all three populations, with complete inhibition of growth at high stress levels (figure 3). Among the studied populations, Gosheh exhibited lower resilience to stress compared to the other two populations. In most cases, seeds collected from Garmsar and Aradan showed similar performance under stress. These findings are consistent with numerous previous studies, including that of Willenborg et al. (2005). This study also demonstrated that as drought stress intensity increased, particularly at -4 MPa, both germination percentage and rate decreased significantly. Additionally, the results indicated that seedlings were more sensitive to severe drought stress (-6 MPa and above), exhibiting a significant reduction in root length.

Conclusion

Studying the ecology and propagation of this plant and understanding its germination and establishment behaviors is of particular importance. n recent decades, the ecological importance of the species Artemisia in desert areas has been somewhat identified, and the country's executive apparatus (natural resources) has initiated the seeding of winter pastures with this plant. Implementing seeding, planting, and intercropping programs in rangelands can significantly help in the restoration of the vegetation cover of Artemisia habitats. The survival of the Artemisia species in dry and semi-dry rangelands is not only related to the plant's adaptation to abiotic factors but is also significantly influenced by biotic factors, especially humans and herbivores. By following up on field studies over many years and utilizing the results of this research, valuable information can be provided for the conservation and introduction of this species. Additionally, in extensive studies, the best and most resistant seed populations should be selected and used in rangeland restoration operations.

Keywords: *Artemisia sieberi* Besser, population, germination percentage, radicle

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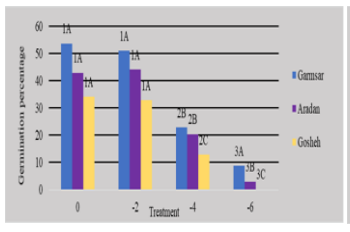
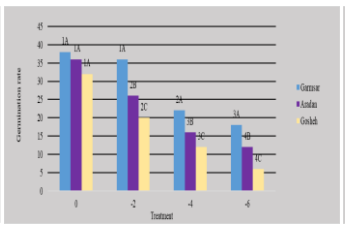
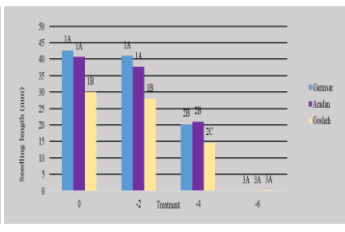
Table and Figure



Interaction effects of drought stress and population on germination percentage of *Artemisia sieberi*



Interaction effects of drought stress and population on germination rate of *Artemisia sieberi*



Interaction effects of drought stress and population on seedling length of *Artemisia sieberi*

numbers represent drought stress levels, and letters represent differences among populations