Research Article

Effects of Different Treatments on Seed Germination Improvement of Calotropis persica

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The purpose of this study was to investigate the effects of different treatments on seed germination in the desert plant species Calotropis persica (Gand.). This species is known to have long time for seed germination considering arid region condition and short time of access moist. An experiment was performed with 13 treatments and 4 replications in a completely randomized design. Treatments included KNO₃ with concentrations of 0.1, 0.2, and 0.3 percent, immersion in hot water for five min, acetylsalicylic acid 100, 200, and 300 mg L⁻¹, ethereal sulfuric acid (60%) for 5 and 10 min, thiourea with concentrations of 0.1% and 0.3%, and prechilling for 10 days. Tap water was used as the control. Our findings indicate that KNO₃ 0.1% and 100 mg L⁻¹ acetylsalicylic acid were the most effective treatments for improvement of seed germination properties in this species. In a comparison of the two mentioned treatment, KNO₃ 0.1% treatment is the best.

1. Introduction

Germination is a critical stage in the life cycle of weeds and crop plants and often controls population dynamics, with major practical implications. Seed germination is the critical stage for species survival [1, 2]. In recent 20 years, desertification has been recognized as a major environmental problem and is a major focus of United Nations Environment Programme [3]. Vegetation is a protector of the soil against water and wind erosion as well as a casualty of soil erosion [4, 5]. Each desert-inhabiting plant has its own complex of strategies that enables it to persist in desert habitats [6]. Strategies for improving the growth and development of arid region plant species have been investigated for many years. Treated seeds with chemical compound usually would exhibit rapid germination when absorbing water under field conditions [7].

Calotropis is a genus of flowering plants in the dogbane family, Apocynaceae. They are commonly known as milkweeds because of the latex they produce. Calotropis species are considered common weeds in some parts of the world. The flowers are fragrant and are often used in making floral tassels in some mainland Southeast Asian cultures. Calotropis persica is growing in tropical region only. Iran is a country in the mid-latitude belt of arid and semiarid regions of the Earth. Approximately 60% of Iran is classified as arid and semiarid [8]. Based on results, the seed of full ripening fruits with scarification had the highest germination percent. [9] investigated the effects of salt stress and prime on germination improvement and seedling growth of Calotropis procera L. seeds and the results showed that priming improved the seedling characteristics in all samples, especially in −0.05 MPa, but a decrease with decrease in osmotic potential. The work in [10] studied the effect of temperature, light, pretreatment, and storage on seed germination of Rhodomyrtus tomentosa and their result showed that light significantly improved germination of fresh seeds but storage decreased the light-sensitivity of germination. Soaking for 24 hours in 250–600 mg L⁻¹ gibberellic acid, 5–20% potassium nitrate, or 10% hydrogen peroxide solution increased seed germination. Calotropis sp. is an important economic plant used for drug and other purposes. The purpose of this study was to develop methods to increase germination percentage, shorten germination time, provide
more rate germination, and result in more efficient seed propagation techniques for *C. persica* seeds.

## 2. Material and Methods

Seeds of *C. persica* were collected from Jiroft arid regions in southern Iran in 2013. A preliminary germination test was performed and low germination percentage was obtained. To solve this problem, we implemented an experiment with a randomized complete design. Before the start of the experiment, seeds were surface sterilized in 1% sodium hypochlorite solution for 5 min, then rinsed with sterilized water, and air-dried for 28 h before putting in petri dishes. Treatments included pretreatment with KNO₃ (0.1 and 0.3 percent) for 48 hours, acetylsalicylic acid to the moisture in the petri dish (100, 200 and 100 mg L⁻¹), prechilling (4 degrees centigrade for 10 days), hot water (70°C) for 5 min, ethereal sulfuric acid (60%) for 5 and 10 min, thiourea with concentrations of 0.1% and 0.3%, and control treatment (irrigation with distilled water). The seeds were placed on top of Whatman paper number 1 within 10 cm petri dishes containing 10 mL distilled water. Counting number of germinating seeds began from the first day and was done till the end of the experiment (19 days). Germination percentage was recorded daily during the study period. Rate of germination was estimated using modified Timpson's index of germination velocity [11]. Mean germination time (MGT) was calculated to assess the rate of germination [12]:

\[
MGT = \frac{\sum D \cdot N}{n},
\]

where \( N \) is the number of seeds which in \( D \) day grow, \( n \) the total number of seeds grown, and \( D \) the number of days from the date of germination and the germination rate index was obtained by reversing MGT at the end of this period; final germination percentage was recorded. There are no outliers; normality of data was checked and nonnormal data transformed by arc sin to verification of this hypothesis arc sin transformation was used for germination percentage before analysis [13]. Experimental data was analyzed by SPSS 17.0 to analyze the data and Duncan's test at 5% level was used to compare the means.

## 3. Results

The results of ANOVA (Table 1) showed that there are significant differences (at 1% level) between effective treatments on germination characteristics and the different treatments resulted in significant differences among germination properties (Table 1).

| Germination properties | Source of variation | Degree of freedom | Sum of squares | Mean of squares | \( F \) (Fisher test) |
|------------------------|---------------------|-------------------|---------------|----------------|------------------|
| Germination percentage | Between groups      | 12                | 26678.793     | 2223.233       | 35.758**         |
|                        | Within groups       | 39                | 2424.805      | 62.174         |                  |
| Mean germination time   | Between groups      | 12                | 97.666        | 8.139          | 4.194**          |
|                        | Within groups       | 39                | 75.675        | 1.940          |                  |
| Germination rate        | Between groups      | 12                | 0.051         | 0.004          | 3.550**          |
|                        | Within groups       | 39                | 0.047         | 0.001          |                  |

** Significant difference at 1%.

The results of this research showed that germination percentage of *C. persica* increases due to application of KNO₃ in different concentrations and acetylsalicylic acid 100 and 200 mg L⁻¹ and decreased germination percentage due to application of hot water for 5 min, prechilling for 10 days, sulfuric acid 5 and 10 min, and thiourea 0.3%. Acetylsalicylic acid 300 mg L⁻¹ and thiourea 0.1% have the same effect on germination percentage in comparison to control treatment. The increased germination percentage by KNO₃ 0.1, 0.2, and 0.3% and acetylsalicylic acid 100 mg L⁻¹ was significant (Figure 1).

The seed germination rates of *C. persica* increased significantly when KNO₃ 0.1% was used. Acetylsalicylic acid 200 and 300 mg L⁻¹ and thiourea 0.3% increased seed germination rate, but this increase was not significant. However, the germination rate was decreased when hot water for 5 min, prechilling for 10 days, sulfuric acid for 5 and 10 min, KNO₃ 0.2 and 0.3%, acetylsalicylic acid 100 mg L⁻¹, and thiourea 0.3% were used (Figure 2).

Mean germination time of *C. persica* decreased by using KNO₃ 0.1% but this difference was not significant. In seeds of *C. persica*, all treatments, except for KNO₃ 0.1%, caused increase in mean germination time (Figure 3).

## 4. Discussion and Conclusion

According to the obtained results, KNO₃ 0.1% and acetylsalicylic acid 100 mg L⁻¹ were the most effective treatments for improvement of seed germination properties in *C. persica* plant species. In a comparison of the two mentioned treatments, KNO₃ 0.1% treatment is the best. This technique has become a common seed treatment that can increase rate, percentage, and uniformity of germination or seedling emergence, mainly under unfavorable environmental conditions. Rapid seed germination and stand establishment are critical factors for crop production under stress conditions. Hot water for 5 min and prechilling for 10 days did not show positive effect on germination improvement. The study result of scarification of seeds of *Acacia angustissima* showed that seeds soaking in hot water cause seed germination induction but increasing duration of seed contact with hot water leads to decline of seed germination percentage [14]. In a research it is shown that prechilling for 10 days had
a positive effect on germination rate and mean germination time of both medicinal species of *Foeniculum vulgare* and *Cuscuta epithymum* but germination percentage decreased due to application of prechilling [15]. Sulfuric acid for 5 and 10 min did not have positive effect on seed germination of *C. persica*; as a result, seed treatment with sulfuric acid cannot improve seed germination. This result demonstrated that above mentioned treatment had the destructive effect on embryo. It is notified that increasing in doses of sulfuric acid caused germination improvement and suggested chemical scarification in concentrated H$_2$SO$_4$ for 2 hours [16]. In this research thiourea did not have a positive effect on germination improvement of *C. persica*. Acetylsalicylic acid 100 mg L$^{-1}$ improved mean germination time and germination percentage in comparison with amount of 200 and 300 mg L$^{-1}$.

In this research, KNO$_3$ 0.1% is recognized as the best treatment for improvement seed germination properties of *C. persica*. Similar results were reported in previous studies for the species of *Citrullus colocynthis* [17], *Foeniculum vulgare* and *Cuscuta epithymum* [15], *Hypericum aviculariifolium* [18], and *Avena fatua* [19]. According these results, KNO$_3$ 0.1% treatment is suggested for improvement of *C. persica* germination and this treatment is proper for propagation of studied species. Positive effect of KNO$_3$ could be due to its role in balancing hormonal portion within seed which
in turn results in germination inhibitors ratio like ABA (abscisic acid). Virtually all of the cellular and metabolic events that are known to occur before the completion of germination of nondormant seeds also occur in imbibed dormant seeds; indeed, the metabolic activities of the latter are frequently only subtly different from those of the former [20]. The seeds of most Mediterranean and desert species have dormancy characteristics or structural properties that prevent immediate germination of at least a proportion of the seeds [21–24]. The results obtained will be useful in carrying out tree improvement and plantings of *C. persica* trees for fuel wood, local medicine, and industrial production. Rapid seedling growth is also essential for reclamation of desert. This information could ultimately help in the sustainable development of the arid zones.

### Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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