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Effect of Physical and Chemical Treatments on Seed Germination and Dormancy Breaking of Prosopis Farcta

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Abstract

Syrian Mesquite is the predominant plant and vegetation community in the arid and semi arid regions in Iran. Germination of Syrian Mesquite seeds in the laboratory or nursery has been difficult and problematic, yet little is known about the Syrian Mesquite seed germination process. This research was carried out to investigate the effects of different factor on seed germination of *P. farcta*. Physical agents such as mechanical stratification (cutting with knife) and chemical pre-treatments such as H_2SO_4, HCl, $CaSO_4$, HNO_3, NaCl, K_2SO_4, NaOH and $CaCl_2$ were used. The results showed that the dormancy is mostly dependent on physical structure of seed coat, because more than 80% of the seeds were germinated exactly two days after cutting the seed coats. Cutting treatment resulted in highest seed germination (89.33%) in comparison with chemical treatments. Pre-treatments of the seeds with different acids (definitely H_2SO_4) indicated that rupture of seed coat can easily accelerate the germination process. In chemical treatments, the maximum germination percent was observed after pre-treatment the seeds with H_2SO_4 for 10 min by 57.33%.

Keywords: *Prosopis farcta*, Seed germination, Seed dormancy-breaking, Physical and chemical pre-treatments.

INTRODUCTION

Prosopis farcta (Banks & Sol), belongs to the Fabaceae family and mimosoideae sub family. It is one of the most economically and ecologically important shrub species in arid and semi-arid zones of the world (Pasiecznik et al. [15]).

The genus *Prosopis* with about 44 species is widespread in arid and semiarid regions of Asia, America, Africa and Middle East and also in south rejoins of Iran. This plant can tolerate high temperatures in completely salty lands because of its deep-going roots and special stem physiology. This is almost cultivated in arid lands to combat desertification. It is used as a wind breaks instead of chemical compounds and for shelter belts. It has a special seed structure with which can produce a seed bank on the deserts (Zhu [26]; Schmidt [19]; Jarrell and Virginia [10]).

It is one of the most economically and ecologically important shrub species in arid and semi-arid zones of the world. The main use purpose of presence of *Prosopis* is as a main source of energy (fuel and charcoal). Its Pods are a valuable source of carbohydrate and protein for farm animals, human and the lumber still has a minor use in construction and furniture production (Pasiecznik et al. [15]; Arce and Balboa [2]). Their capability to grow on the poorest soils where few species can survive makes them dominant species among other desert living plants. Also, this genus has especial composition of chemical compounds which are called flavonoids (Mahgoub et al. [13]). Previous studies on Physical stratification, chemical and salts solutions effects on *Prosopis* seed germination indicated that *Prosopis* seed coat resulted in low rate in germination (Bazzaz [3]; Cony and Trione [6]).

Khosh-Khui and Bassiri [11] found that hard seed coat was the principal cause for poor seed germination of myrtle's seed, and scarification with cold acid for 60 min at 20 ºC was the best treatment for removing dormancy. Mechanical scarification and concentrated Sulfuric acid treatment have been widely used to improve seed germination of several hard seeded coat species (Tigabu and Oden [21]). The germination responses of *Medicago orbicularis* L. Bartal and *Astragalus hamosus* L. to mechanical, physical and chemical scarification, applied for removing seed dormancy, has been demonstrated that dormancy exclusively imposed by seed coat (Patane and Gresta [16]).

Since no report is available on the germination characteristics, or the effect of mechanical and chemical conditions on *Prosopis* seeds germination, The min purpose of this study improve the seed germination of Syrian Mesquite (*Prosopis farcta*), which is an important shrub in the arid and semi arid regions in Iran. Seeds were subjected to physical (cutting) and chemical (Sulfuric acid, hydrochloric acid, calcium sulfate, nitric acid, sodium chloride, potassium sulphate, sodium hydroxide and calcium chloride) treatments. This is the first report on seed germination and dormancy-breaking of this unique plant in Iran.

MATERIALS and METHODS

Seeds of *Prosopis farcta* (Banks & Sol.) were collected during September 2008 from semi arid zone in the south of Tehran province, Iran. This area is geographically located at 35º 33' 30 N latitude and 51º 26' 19 E longitude. Seeds were separated from the pods using sharp knives and were dry-stored in paper bags at room temperature until germination. Seeds were selected visually for uniform size and healthy aspect and preserve under natural light and room temperature conditions. After washing of the seeds by liquid soap and distilled water, they were pre-treated in two periods of 5 and 10 minutes with chemical factors such as NaOH (76%), H_2SO_4 (96%), HNO_3 (65%), HCl (37 %) and different salts solutions ($CaCl_2$, $CaSO_4$, $K2SO_4$, NaCl; -1.6 MPa osmotic pressure). Before sowing, seeds were rinsed three times in distilled water. The germination was conducted in 9-cm petri-dishes containing one disk of Whatman No. 1 filter paper, with 5ml of test solution. Three replicates of 50 seeds each were used for each treatment. Seeds were considered to be germinated with the emergence of the radicles. Germinated seedlings were counted and removed every alternate day, for 35 days following seed sowing.

The experiment was arranged as a completely randomized design (CRD) with three replications for each treatment. Each treatment included 50 seeds. All analyses were performed with a statistical software package (SPSS version 13) and the means were compared by Tukey test at 5% level of probability.

RESULTS and DISCUSSION

The results of acidic treatments on seed germination of Mesquite plant are shown in figure 1. Generally, in all treatments the highest germination percent was observed in physical treatment (cutting) by 89.33% and had significant differences in comparison with chemical treatments at 5% level. This result showed that seed dormancy of Mesquite is controlled by physical dormancy.

The results indicated that different acids had a positive effect on seed germination and dormancy braking of *Prosopis* species. In chemical treatments, the maximum seed germination percent was observed after pre-treatment the seeds with H_2SO_4 for 10 min (57.33%) and followed by H_2SO_4 for 5 min (39.66%) and had significant differences in comparison with other acidic treatments at 5% level of probability. On the other hand, lowest germination was obtained in HCl for 5 min by 7.33%.

Salt solutions in compare to acid treatments had lower effects on seed germination percent of *Prosopis farcta* (Figure 2). The highest seed germination in salt solution treatment was obtained in NaOH for 10 min by 19.66% and not significant difference with NaOH for 5 min (18.66%). These two treatments had significant difference compared to other salt solutions at 5%. $CaCL_2$ for 5 and 10 min had not effects on seed dormancy breaking of *P. farcta* and seed germination was not occurred.

Heidari et al. [9] and Abu-Qaoud [1] stated that mechanical scarification is best treatment for increase in seed germination of *Prunus* and *Pistacia* species, respectively. Pelaez et al. [18] and Peinetti et al. [17]

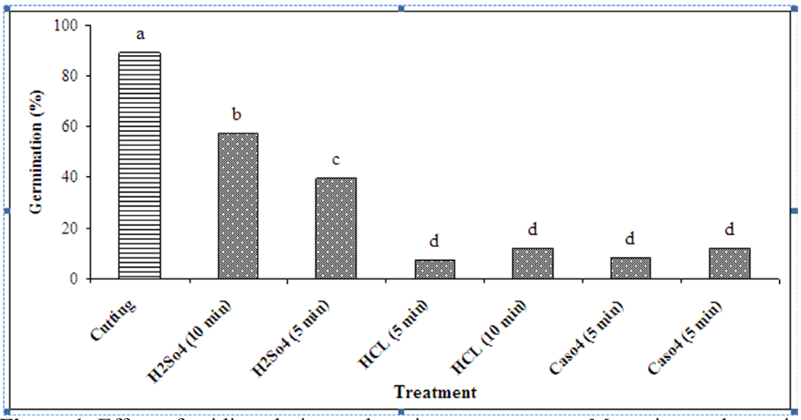

Figure 1. Effect of acidic solution and cutting treatments on Mesquite seed germination. Means followed by the same letter are not significantly different, as indicated by Tukey test at P > 0.05.

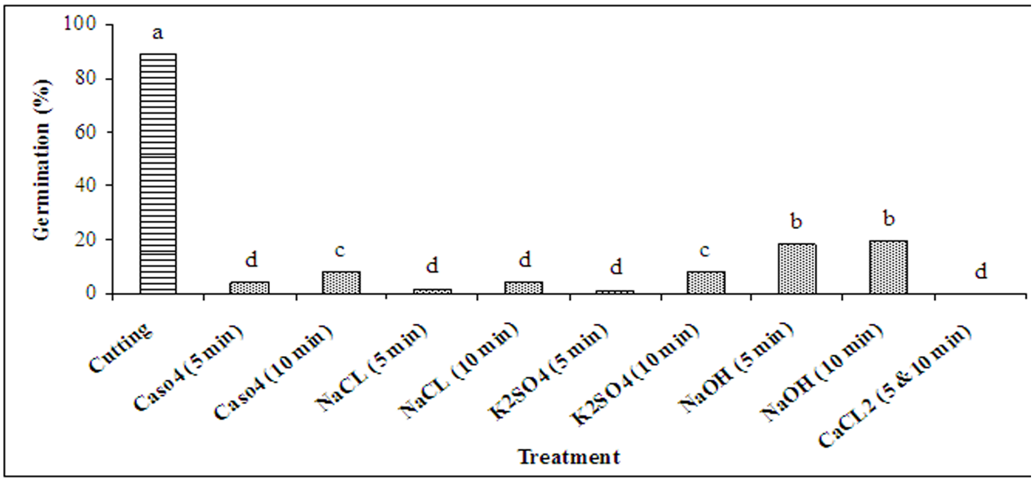

Figure 2. Effect of salty solution and cutting treatments on Mesquite seed germination. Means followed by the same letter are not significantly different, as indicated by Tukey test at P > 0.05.

reported very high germination percentages (95% or more) for acid and mechanical scarified *Prosopis caldenia* seeds, respectively. The results obtained from this study confirm the conclusions of Bralewski et al. [4] and Usberti et al. [22], concerning *Daucus carota* L. and *Brachiaria brizantha*, *B. decombuns* and *Panicum antidotale*. Also, Muhammad and Amusa [14] and Youssef [25] was reported seed germination were increased with increasing Sulfuric acid concentration and treatment time of *Tamarindus indica* and *Retama raetam*, *Ononis serrata* and *Mesembryanthemum crystallinum* ,respectively. Research results of Villagra [23] show that increasing salinity (NaCl) caused a decrease in both rate of germination and final percentages in *Prosopis alpataco* and *P. argentina* species.

Seed dormancy is one of the most important viability mechanisms in plants. Usually seed dormancy is seen so little in plants which are domesticated from ancient times compared to wild species and recent native ones. Seed germination algorithm is affected by compounds and permeability of seed coat. Water absorption, enzymatic activity, embryo growth, seed coat rupture and plant grow are important steps of germination (Schmidt [19]).

Water, gases and mechanical resistance are the factors which are discussed in relation with dormancy. The seed which are resistant to water penetration are called “hard seeds”. This impenetrability may be caused by existence of cuticole layer or/and an extended layer of epidermic cells. The entrance water is always controlled with a little whole in seed coat which is called strophior near the hilum, the integrity and nature of seed coat. Seed coat like a semi-permeable one is penetrable for water and ions but restrictive for other chemical compounds. This difference in permeability may happen because of polarization of acidic and basic groups of membrane lipids (Weatherby [24]). Such membranes repel ions of similar charge while attracting those of opposite charges. Thus, un- ionized molecules of liquids or bases do not permeate as readily as ionized molecules (brown and Gibson [5]).

Scarification is important factor influencing seed germination of different species under different habitats. Each desert plant species has its own set of mechanisms that enable it to establish under a wide range of conditions. Acid scarification is known to be highly effective in improving germination of species with hard seed coats (Shaltout and EL-Shorbagy [20]). In the present study, germination of the studied species found to be accelerated on treatment with 96% Sulfuric acid under the different periods. Treatment of 96% Sulfuric acid was fully effective in breaking dormancy of *P. farcta* at 5 and 10 min. the similar results have been reported by Grouzis and Danthu [8] and Kulkarni et al. [12]. For species of hard seeds (such as seed of *P. farcta*), the resistance of the seed integument to the penetration of water may be lifted by Sulfuric acid treatment, manual or mechanical scarification or scalding, which reduce the resistance and the impermeability of the integument (Elberse and Breman [7]).

We have shown that treatment of seed with Sulfuric acid is factor that can significantly influence germination of *P. farcta*. Therefore, each treatment that break the seed coat and induce entrance of water in to the seed can increase the germination percentage of *Prosopis farcta*. The results obtained will be useful in carrying out tree improvement and plantings of Syrian Mesquite trees for fuel wood and food production. Rapid seedling growth is also essential for anti-desertification. This information could ultimately help in the sustainable development of the arid zones. Therefore, for increasing seed germination application of H_2SO_4 for 10 min can be suggested as pre-treatment.

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