Effect Of Different Seed Priming On Germination Rate And Seedling Growth Of Ziziphus Spina-Christi

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ABSTRACT

This study was conducted to evaluate the effect of different types and concentrations of priming solution on seed germination and seedling performance of spina-christi. The seeds were primed in solutions of sodium chloride of 0, 4, 8, 12 and 16 dS/m, zinc sulfate of 0, 4, 8, 12 and 16 dS/m (osmopriming), distilled water (D.W.) and distilled water at 40°C (D.W. 40°C) (hydro-priming). The seeds were soaked in above solutions for 12 hr and a lot of seeds were used as control (without priming). All priming treatments showed a germination rate higher than control (P < 0.05). The highest germination rate (18.11%), stem length, stem fresh and dry weight and root fresh weight occurred in ZnSO₄ solution with electrical conductivity (EC) of 8dS/m. Also, the results showed that seedlings originated from the seeds primed at different solutions of ZnSO₄ had better performance and produced more leaves and spines than those originated from the seeds primed with different solutions of NaCl. The maximum leaves and spines produced in 12 dS/m of ZnSO₄.

Key words: Sodium Chloride, NaCl, Zinc Sulfate, ZnSO₄, Hydropriming, Osmopriming

Introduction

The genus Ziziphus belong to the Rhamnaceae family consists of 100 species of evergreen or deciduous trees or shrubs distributed in tropical and subtropical regions of the world. Spina-christi is one of the wild species of Ziziphus that grows in the form of shrub or little bushes, that strongly resists heat and drought. It develops very deep taproot and has an extraordinary regenerative power. It has edible fruit and in addition different parts of plant such as leaf, bark and root have been used in folk medicine [18].

Ziziphus is commonly propagated by seeds, therefore it exhibits a wide genetic heterogeneity [21] and the fruits show variability in size and quality. At present, the seedling are used as a rootstock for cultivars with high fruit quality.

The seeds of Z. spina-christi possess hard woody seed-coat which hamper germination. Moreover, slow growth of the seedlings in the first year of sowing is one of the problems that put a limit on the growing of this species [2,19]. Different techniques have been used to improve seed germination and seedling growth [18]. Having seedling with enhanced and identical growth is the main step in producing grafted sapling in nursery.

One seed treatment method that has been proved to be successful in improving seed germination and emergence is priming. Seed priming is a controlled hydration treatment at low water potential that allows pre-germinative metabolism to proceed, but prevents radicle emergence [4]. This metabolic advancement at low water potential is expressed as a more rapid radicle emergence rates when seeds are transferred to higher water potential. Different substances are used as osmotica which lower the water potential such as PEG, NaCl, KNO₃, ZnSO₄ and CaCl₂, etc. Seed priming has been successfully demonstrated to improve germination and emergence in seeds of many vegetable and field crops under normal as well as stress condition [3,6,7,8,11,18,20]. It has been showed that the types of substances with same osmotic potential had different effect on seedling vigor. For example, in rice, osmopriming with CaCl₂ was the more effective than KCl and hydropriming [9]. In tomato, the primed seeds with KNO₃ were produced the seedling with better growth than the seeds primed with NaCl [9]. In another research the seeds of hot pepper were treated with distilled water, sodium chloride, salicylic acid, ascorbic acid and PEG-8000 as priming agents, the best priming treatment was KNO₃ which reduced the germination time by 50%, and also improved the stem and root length and fresh weight of seedling [1]. Although with increasing moisture stress progressively by PEG solutions, seed germination of Ziziphus lotus was inhibited, but seeds germinated well in distilled water, after PEG treatments [15]. Farooq et al., [9] reported that seeds subjected to NaCl priming...
resulted in improving germination and seedling vigor by dormancy breakdown as compared to untreated seeds. Z. spina-christi is widely found in many parts of Iran, particularly in the south, where different orchards have been established for fruit production.

The aim of this research was to investigate the type and concentration of priming solution to ameliorate germination% and seedlings growth of spina-christi.

Materials and Methods

The fruits of spina-christi locally known as ‘konar’ were procured from Báqu Plantation in Bandar Abbâs and they were transferred to the laboratory. Fruits exocarp, mesocarp and hard endocarp were separated. The seeds viability was tested randomly on some seeds by mean of tetrazolium. The rest of seeds were used in this experiment. The seeds were surface sterilized by dipping in Mancozeb solution (a fungicide 1000 mg/l) for 10 minute. After that, the seeds were primed in solutions of sodium chloride of 0, 4, 8, 12 and 16 dS/m, Zinc sulfate of 0, 4, 8, 12 and 16 dS/m (osmopriming), distilled water (D.W.) and distilled water at 40°C (D.W. 40°C) (hydro-priming). The seeds were soaked in above solutions for 12 hr and a lot of seeds were used as control (without priming). So the treatments were:

- Control= seeds without treatment; and
- T1= distilled water (D.W.); T2=D.W. at 40°C; T3= NaCl 4dS/m; T4= NaCl 8dS/m; T5= NaCl 12dS/m; T6= NaCl 16dS/m; T7=ZnSO4 4dS/m; T8= ZnSO4 8dS/m; T9= ZnSO4 12ds/m and T10= ZnSO4 16dS/m

Afterward, the seeds were removed from solutions and they were dried in room temperature so that their humidity was reduced to 6-7%. For germination test, the primed and non-primed seeds (25 seeds/petri dishe) were placed on filter paper (Whatman No.2) in petri dishes and irrigated with distilled water. After 15 days the germination percentage was recorded. Seeds with both a normal plumule and radicle were considered germinated [13]. The germinated seeds of each group were separately sown into plastic containers containing perlite. The containers were placed in a light and dark period of 12 hr at 20°C and 60-70% relative humidity and they were irrigated with distilled water. After 45 days, 5 seedlings randomly were selected from every container and growth characteristics such as stem (shoot) and root length, the fresh and dry weight of stem as well as the fresh and dry weight of the root and also the number of leaves and spines were measured.

The experiment was conducted in completely random design with 4 replications and 25 seeds in each replication. Data were subjected to analysis of variance using SPSS statistical software (SPSS Inc. Chicago.USA, version 15). The means were compared using Tukey’s test at 5% of probability.

Results and Discussion

The results showed that, all treatments of priming, hydro-priming (D.W. and D.W. at 40°C) and osmopriming (different concentrations of NaCl and ZnSO4) showed a germination rate (P < 0.05) higher than control (seeds without treatment) (Fig1). In fact, the seeds in control did not show any germination. It seems that the spina-christi seeds have two type of dormancy; physical and physiological. For breaking physical dormancy, hard seed coat has been removed. Since with seed priming germination has been improved, it can be concluded that hydro and osmopriming can affect on physiological dormancy breaking. Farooq et al.,[9] also concluded that priming seeds with NaCl improved seed germination rate and seedling vigor by dormancy breakdown. The highest germination rate (18.11%) occurred in ZnSO4 solution with electrical conductivity (EC) of 8dS/m (T8) which was higher than that in NaCl solutions with EC 16dS/m (T10) (P < 0.05). It means that high concentration of ZnSO4 had adverse effect on the germination rate. It has been reported that, although priming improve the rate of germination, synchronous seedling emergence and growth, the effectiveness of different priming agents varies with different concentration of priming solution and crop species[12]. Faster emergence rate after priming may be due to increased rate of cell division in the root tips of seedlings from primed seeds as reported in wheat [5] and tomato [9].

Upon sowing, primed seeds can rapidly imbibe and revive the seed metabolism, resulting in rapid and higher germination rate. It has been reported that seed priming resulted antioxidant increment as glutathione and ascorbate in seed. These enzyme make more germination speed via reduction of lipid peroxidation activity [19].

The produced seedlings from the seeds primed in ZnSO4 solution with EC 8dS/m (T8) provided significantly higher shoot length than those in NaCl solutions with EC of 8 (T4) and 12 dS/m (T5) (Fig2). These results are in agreement with the results obtained by Nematollahi et al (2009) on cumin and also Amjad et al., [1] that indicated, halopriming and osmopriming resulted in an increase in the stem length of hot pepper seedling.

The highest root length produced in seeds treated for 12 h in D.W. which was not significantly different from those in 8 dS/m ZnSO4 and they were higher than the root length in different levels of NaCl and ZnSO4 solutions (Fig2). It has been also showed by Nematollahi et al., [17] that the root length increased in the seedling produced from the cumin seeds primed with water, sodium chloride and zinc sulfate.
Columns with the same letters are not different at 5% probability using Tusky test.

**Fig. 1:** Effect of different priming on germination %. cont.= control; T1= distilled water (D.W.); T2=D.W. at 40°C; T3=NaCl 4dS/m; T4=NaCl 8dS/m; T5=NaCl 12dS/m; T6=NaCl 16dS/m; T7=ZnSO₄ 4dS/m; T8=ZnSO₄ 8dS/m; T9=ZnSO₄ 12dS/m and T10=ZnSO₄ 16dS/m

Concerning fresh and dry weight, the results showed that the highest amount of shoot F.W. achieved in ZnSO₄ 8dS/m (T8) which was significantly higher than those produced in NaCl solutions with EC of 4 and 8 dS/m. Amjad et al., [1] also showed that shoot F.W. increased with priming the seeds of hot pepper using ZnSO₄. All primed seeds showed a higher shoot dry weight than unprimed seeds but, there was not significant differences between them (Fig3). However,
Mohammadi et al., [16] and Khan et al., [14] indicated that the seeds priming with sodium chloride in canola and hot pepper respectively bring about a rise in the dry weight of the seedling.

Root fresh and dry weight have been affected by types and concentration of priming (Fig 4). The greatest root fresh weight (64 mg/g) occurred in D.W. at 40°C which was significantly higher than control, T3, T4 and T9. But, there was no significant difference between diverse treatments of ZnSO₄ except T9 which was significantly lower than T1. Osmopriming with NaCl and ZnSO₄ proved superiority over control in enhancing the seed performance under normal condition. Significant improvement in root and shoot length may be attributed to earlier germination induced by primed over unprimed seeds [9], which resulted in vigorous seedlings with more root and shoot length than the seedlings from unprimed seeds.

The results showed that seedlings originated from the seeds primed with different solutions of ZnSO₄ had better performance and produced more leaf and spin than those originated from the seeds primed with different solutions of NaCl. The maximum leaf and spin produced in 12 dS/m of ZnSO₄ (Table 1). The reason may be due to this fact that, in higher plants zinc is either required for, or at least modulates, the activity of a large number of various types of enzymes, including dehydrogenases, aldolases, isomerases and transphosphorylases. Many zinc-dependent enzymes are involved in carbohydrate metabolism in general and of leaves in particular. Besides its function in the carbonic anhydrase reaction, zinc is required, for example, for the activity of two other key enzymes, fructose 1,6-bisphosphatase and the aldolase.

Farooq et al., [10] reported that all the seed priming techniques significantly improved the α-amylase activity, soluble sugars and dehydrogenase activity compared with untreated control. Activity of dehydrogenase, an index of tissue respiration and metabolism, and that of α-amylase as starch hydrolyzing enzyme.
Fig. 4: Effect of different seed priming on root fresh weight and dry weight of seedling. Mg/g

Table 1: The Effect of different seed priming on the numbers of leaf and spin

<table>
<thead>
<tr>
<th>Organ</th>
<th>Cont.</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
<th>T6</th>
<th>T7</th>
<th>T8</th>
<th>T9</th>
<th>T10</th>
</tr>
</thead>
<tbody>
<tr>
<td>leaf</td>
<td></td>
<td>3.04ab</td>
<td>4.19a</td>
<td>2.09ab</td>
<td>3.61ab</td>
<td>2.42ab</td>
<td>2.23ab</td>
<td>1.99ab</td>
<td>0.99b</td>
<td>0.42b</td>
<td>3.22ab</td>
</tr>
<tr>
<td>Spin</td>
<td></td>
<td>3.14ab</td>
<td>4.76a</td>
<td>2.61ab</td>
<td>3.60ab</td>
<td>2.48ab</td>
<td>2.48ab</td>
<td>1.48ab</td>
<td>0.6b</td>
<td>0.51b</td>
<td>3.08ab</td>
</tr>
</tbody>
</table>

In each row the means with the same letters are not significantly different at 5% of probability using Tukey’s test.

Conclusion:

In conclusion, seed germination was affected by all treatments of priming. Seeds without priming did not show any germination. ZnSO₄ especially in 8 dS/m was the most effective, because in addition to increasing germination rate, the seedling were more vigorous than the other treatments.

References


