Effects of seed priming and supplementary irrigation on yield and yield component of Lallemantia iberica

Mahdieh Ayyari, Saeid Zehtab-Salmasi, Kazem Ghassemi-Golezani

Abstract
This research was carried out in 2012 and 2013 to investigate the effects of seed priming and supplementary irrigation on yield and yield component of Lallemantia iberica. Two experiments were arranged as factorial based on randomized complete block design (RCBD) with three replications. Seed priming methods were control, hydro-priming, salt-priming and irradiation with two doses of gamma rays (200 and 400 Gy) and irrigation treatments were rain-fed (I1), irrigation at flowering stage (I2) and irrigation at both flowering and grain filling stages (I3). Plant establishment, grain number per plant, hundred grain weight, biological yield, grain yield and harvest index were evaluated. Results showed that hydro-priming increased plant establishment, but the differences between control, hydro-priming and KNO3 priming was not significant. Moreover, differences in harvest index among control, hydro-priming and KNO3 priming were not significant. Plant establishment and harvest index were decreased by gamma irradiation of seeds. Plants from hydro-primed seeds produced the highest number of grains per plant. Hundred grain weight was enhanced by hydro-priming and gamma irradiation (200 Gy) under I2 and I3 and gamma irradiation (400 Gy) under all irrigation treatments, compared with non-priming. Biological yield was improved by hydro-priming under I2 and I3 and gamma irradiation (200 Gy) under I3. The highest grain yield per unit area was recorded for plants from hydro-primed seeds under I2 and I3 followed by plants from unprimed seeds under I1. Since hydro-priming of Lallemantia iberica seeds due to mucilage content is difficult, cultivation of non-primed seeds with a supplementary irrigation at flowering stage could produce satisfactory yield.

Keywords: Gamma irradiation, Lallemantia iberica, seed priming, supplementary irrigation, yield.

1. Introduction
Water is one of the most important ecological factors determining crop growth and development (Jaleel et al., 2007) [8]. An efficient use of limited water resources and better growth under limited water supply are desirable traits for crops in drought environments (Deng et al., 2007) [9]. Performing of supplemental irrigation in areas that face drought stress is helpful. But over-irrigation on the other hand causes low water use efficiency and low plant resistance to water shortage. Thus, determining the appropriate time for irrigation is of crucial importance in agricultural applications (Afzal et al., 2010) [1]. In recent years, many studies have shown that proper supplemental irrigation can increase crop yield by significantly improving soil water conditions and their water use efficiency (Deng et al., 2007) [9]. Water stress after anthesis causes premature aging and reduces transfer of food reserves from vegetative parts to grain (Mainard and Jeuffroy, 2001). Irrigation at the appropriate stage increases vegetative growth and photosynthesis to continue for a longer time that will produce optimum yield (Ghobadi et al., 2012) [17]. In the semi-arid regions, crops often fail to establish quickly and uniformity, leading to decreased yields because of low plant populations (Ghassemi-Golezani et al., 2010) [9]. The priming of seeds has been reported to result in better seedling growth and increase yield under water deficit stress conditions (Kaur et al., 2002; Rengel and Graham, 1995) [8, 13]. The general purpose of seed priming is the beginning of germination processes before radicle emergence. Treated seeds are usually re-dried to primary moisture, but they would exhibit rapid germination when imbibed under normal or stress conditions (Ashraf and Foolad 2005) [4]. There are several usages of nuclear techniques in agriculture. In plant improvement, the irradiation of seeds may cause genetic variability that enable plant breeders to select new genotypes with improved characteristics such as precocity, salinity tolerance, grain yield and quality (Ashraf et al., 2003) [3]. Gamma irradiation was found to increase plant productivity. In this connection, Jaywardena and Peiris (1988) stated that gamma rays represent one of the important physical agents used to improve the characters and productivity of many crops such
as rice, maize, bean, cowpea and potato. Therefore, this research was carried out to investigate the effects of different priming techniques and gamma irradiation on yield and yield component of *Lallemantia iberica* under rain-fed and supplementary irrigation conditions.

### 2. Materials and Methods

Two experiments were conducted in 2012 and 2013 at the Research Farm of the Faculty of Agriculture, University of Tabriz, Tabriz, Iran (Latitude 38° 05’ N, Longitude 46° 17’ E, Altitude 1360 m above sea level). Mean precipitation of 2012 and 2013 was recorded as 239.95 mm. Table 1 shows the information of monthly precipitation for these two years. The experiments were arranged as factorial based on randomized complete block design (RCBD) with three replications. Factors were seed priming techniques and supplementary irrigations.

### 3. Results and Discussion

Analyses of variance of the data indicated that number of plants per m² was significantly affected by seed priming ($p \leq 0.01$), but not by water supply ($p > 0.05$). Effects of seed priming ($p \leq 0.05$) and year × priming ($p \leq 0.01$) on grains per plant were also significant. Hundred grams weight significantly affected by seed priming ($p \leq 0.01$), irrigation ($p \leq 0.01$), and priming × irrigation ($p \leq 0.05$). Biological yield was significantly affected by seed priming, year × irrigation ($p \leq 0.05$) and priming × irrigation ($p \leq 0.05$). The effects of priming and priming × irrigation ($p \leq 0.01$), year × priming and year × irrigation ($p \leq 0.05$) on grain yield were significant. Seed priming had also significant on harvest index ($p \leq 0.01$). Hydro-primed seeds produced the highest number of plants per unit area, which was not statistically different from non-primed and KNO₃ primed seeds. However, gamma irradiation decreased plant number, particularly at high doses. Irrigation had no effect on plant number, because supplementary irrigations were applied after plant establishment at reproductive stages (Table 2).

#### Table 1: Information of monthly precipitation during 2012 and 2013.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>25.1</td>
<td>6.4</td>
<td>20</td>
<td>35.6</td>
<td>22.2</td>
<td>15.8</td>
<td>14.9</td>
<td>5.1</td>
<td>9.2</td>
<td>20.2</td>
<td>42.8</td>
<td>18</td>
<td>262.6</td>
</tr>
<tr>
<td>2013</td>
<td>36.7</td>
<td>43.8</td>
<td>9.6</td>
<td>47.3</td>
<td>39.5</td>
<td>7.8</td>
<td>4.5</td>
<td>0.4</td>
<td>7.6</td>
<td>47.4</td>
<td>18</td>
<td>18</td>
<td>262.6</td>
</tr>
</tbody>
</table>

#### Table 2: Means of number of plant per m², grain number per plant and HI (%) for *Lallemantia iberica* affected by seed priming in 2012 and 2013.

<table>
<thead>
<tr>
<th>Priming methods</th>
<th>Number of plant per m²</th>
<th>Grain number per plant</th>
<th>HI (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-priming</td>
<td>275.4 ab</td>
<td>62.57 b</td>
<td>32.73 a</td>
</tr>
<tr>
<td>Hydro-priming</td>
<td>299.6 a</td>
<td>78.98 a</td>
<td>32.97 a</td>
</tr>
<tr>
<td>KNO₃ priming</td>
<td>275.7 ab</td>
<td>69.33 ab</td>
<td>31.90 a</td>
</tr>
<tr>
<td>Gamma irradiation (200 Gy)</td>
<td>245.2 bc</td>
<td>67.08 ab</td>
<td>27.60 b</td>
</tr>
<tr>
<td>Gamma irradiation (400 Gy)</td>
<td>219.4 a</td>
<td>60.26 b</td>
<td>27.50 b</td>
</tr>
</tbody>
</table>

Means with different letters indicate significant difference at $p \leq 0.05$ (LSD test).

#### Table 3: Means of grain number per plant, hundred grain weight, biological yield, grain yield of *Lallemantia iberica* affected by seed priming and supplementary irrigations in 2012-2013.

<table>
<thead>
<tr>
<th>treatments</th>
<th>Grain number per plant</th>
<th>Hundred grain weight (g)</th>
<th>Biological yield (g/m²)</th>
<th>Grain yield (g/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>priming</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-priming</td>
<td>I₁ 63.74 a</td>
<td>0.43 f</td>
<td>208.9 de</td>
<td>74.89 de</td>
</tr>
<tr>
<td>I₂ 70.73 a</td>
<td>0.47 bcde</td>
<td>335.9 ab</td>
<td>105.0 ab</td>
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</tr>
<tr>
<td>I₃ 53.25 a</td>
<td>0.46 cde</td>
<td>181.0 c</td>
<td>60.15 b</td>
<td></td>
</tr>
<tr>
<td>Hydro-priming</td>
<td>I₁ 67.03 a</td>
<td>0.45 def</td>
<td>229.4 abc</td>
<td>96.32 abc</td>
</tr>
<tr>
<td>I₂ 75.23 a</td>
<td>0.47 bcde</td>
<td>353.1 ab</td>
<td>112.9 a</td>
<td></td>
</tr>
<tr>
<td>I₃ 94.69 a</td>
<td>0.48 abcd</td>
<td>334.4 ab</td>
<td>111.6 bc</td>
<td></td>
</tr>
<tr>
<td>KNO₃ priming</td>
<td>I₁ 75.80 a</td>
<td>0.44 df</td>
<td>300.0 abcd</td>
<td>97.01 abc</td>
</tr>
<tr>
<td>I₂ 58.12 a</td>
<td>0.45 def</td>
<td>205.8 bc</td>
<td>88.93 bcd</td>
<td></td>
</tr>
<tr>
<td>I₃ 74.07 a</td>
<td>0.47 bcde</td>
<td>295.8 abcd</td>
<td>98.03 abc</td>
<td></td>
</tr>
<tr>
<td>Gamma irr. (200 Gy)</td>
<td>I₁ 61.02 a</td>
<td>0.48 bcde</td>
<td>268.6 bcde</td>
<td>76.94 bcde</td>
</tr>
<tr>
<td>I₂ 62.73 a</td>
<td>0.47 bcde</td>
<td>223.8 cde</td>
<td>67.74 bc</td>
<td></td>
</tr>
<tr>
<td>I₃ 77.50 a</td>
<td>0.52 a</td>
<td>382.4 a</td>
<td>93.44 abcde</td>
<td></td>
</tr>
<tr>
<td>Gamma irr. (400 Gy)</td>
<td>I₁ 58.36 a</td>
<td>0.50 ab</td>
<td>213.8 cde</td>
<td>60.32 d</td>
</tr>
<tr>
<td>I₂ 64.66 a</td>
<td>0.52 a</td>
<td>314.8 abc</td>
<td>73.18 dfg</td>
<td></td>
</tr>
<tr>
<td>I₃ 57.77 a</td>
<td>0.49 abc</td>
<td>208.6 bc</td>
<td>56.65 g</td>
<td></td>
</tr>
</tbody>
</table>

Means with different letters indicate significant difference at $p \leq 0.05$ (LSD test).

Rain-fed (I₁), irrigation at flowering (I₂) and irrigation at both flowering and grain filling (I₃).
Hydro-priming caused the highest grain number per plant. Plants from non-primed and gamma irradiated (400 Gy) seeds had the lowest grain number per plant. Other investigators revealed that high doses of gamma rays could decrease seed production (Nouri and Tavassoli, 2012) [12].

As shown in table 3, plants from hydro-primed seeds under I1, gamma irradiated (200 Gy) seeds under I1, gamma irradiated (400 Gy) seeds under I1, I2 and I3 increased hundred grain weight as compared with control. The highest hundred grain weight was recorded for gamma irradiated treatments under I3 (200 Gy) and I2 (400 Gy). Plants of non-primed seeds under I1 resulted in the lowest hundred grain weight. Decrease of assimilate supply during grain filling stage may cause the limitation of seed storage capacity and decrease grain weight (Araus et al., 1986) [2]. Millado et al. (1972) [11] studied the effect of various doses of gamma irradiation on grain weight in wheat and concluded that in general 10 KR and 15 KR increases grain weight.

Plants from 200 Gy treated seeds under twice supplementary irrigation (I3) had the highest biological yield, which was not statistically different from plants of non-primed seeds under I2, hydro-primed seeds under I1, I2 and I3, KNO3 primed seeds under I1 and I2 and gamma irradiated (400 Gy) seeds under I2 (Table 3). Rasaie et al. (2012) also showed that supplementary irrigation at the flowering stage causes high biological yield in peas (Pisum sativum L.).

The highest and lowest grain yield per unit area were recorded for plants from hydro-primed seeds under I2 and gamma irradiated (400 Gy) under I3, respectively. In this study, grain number per plant had more effect on grain yield, compared with 100 grain weight. Gamma rays increased grain weight and decreased grain number per plant. So, high grain yield of plants from gamma irradiated (200 Gy) seeds under I3 was the result of high grain weight (Table 3). Therefore, hydro priming can enhance grain yield of Lallemantia iberica, but priming of this plant seeds by water, due to their mucilage content is difficult, it seems to be better to use unprimed seeds with a supplementary irrigation at flowering stage.

Plants from hydro-primed seeds had the highest harvest index, which was not statistically different from plants of non-primed and KNO3 primed seeds. Harvest index was decreased by gamma irradiation of seeds and high doses caused to decrease it more. This could be the result of higher biological yield of plants from 200 Gy irradiated seeds and lower grain yield of plants from 400 Gy irradiated seeds, compared with control (Table 2).

4. References