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ORIGINAL ARTICLE

Effects of Seed Priming and Gamma Irradiation on some Physiological traits of *Lallemantia iberica* in rain-fed and Supplementary irrigation condition

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ABSTRACT
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 (I_1), irrigation at flowering stage (I_2), irrigation at both flowering and grain filling stages (I_3).Physiological parameters such as LWC, CCI and some of the fluorescence parameters were evaluated. Results showed that irradiated seeds with 200 Gy under I_3resulted in the highest biological yield, which was statistically similar to those of non-priming × I_2, hydro-priming × I_1, hydro-priming × I_2, hydro-priming × I_3, KNO_3 priming × I_1 and KNO_3 priming × I_3.Since,hydro and KNO_3 priming of this plant seeds due to their mucilage content are difficult, it seems to be better to use unprimed seeds with a supplementary irrigation at flowering stage.
***Keywords**: Chlorophyll content, fluorescence, gamma irradiation, rain-fed, seed priming*

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INTRODUCTION

Water is one of the indispensable parts of a plant's growth needs. Water deficiency brings about low quality and quantity of the yield [24].Performing of supplemental irrigation in areas that face to drought stress is helpful. But over-irrigation on the other hand causes low water use efficiency and low plant resistance to water shortage, increasing the damages by some pests and diseases, and as well as the reduction of soil aeration. Thus, calculating or measuring the appropriate time for irrigation is of crucial importance in agricultural applications [1]. There are many physiological and biochemical changes in crops for responses to drought stress such as changes in pigment content, osmotic adjustment and water use efficiency [6,9,28].

Photosynthetic pigments such as chlorophyll have an important role in harvesting of light. The chlorophyll content could depend on seasonal and environmental changes [29]. Some researchers have reported damage to leaf pigments as a result of water deficit [26]. Chlorophyll fluorescence is the red and far-red light emitted by photosynthetic tissue when it is excited by a light source [31]. Chlorophyll measurement is a non-invasive method for imaging photosynthetic fluxes, because fluorescence depends directly on photosynthetic activity and it can be inferred through this [11,10]. There are many applications in the measurement of fluorescence, most notably the detection of plant stress factors, with the objective of improving comfort conditions for the plant and providing higher production rates [7,8].

In the semi-arid regions, crops often fail to establish quickly, leading to decreased yields because of low plant populations [12]. The priming of seeds has been reported to result in better seedling growth and increase yield under water deficit stress conditions [16, 27]. Seed priming also reduces leakage of metabolites, repairs deteriorated seed parts, improve RNA and protein synthesis [21]. The beneficial effects of priming are associated with the repair and building up of nucleic acid, increased synthesis of protein as well as the repair of both mitochondria and membranes [20, 21]. Moreover, priming restores antioxidant mechanism in treated seeds [30]. The general purpose of seed priming is to activate germination processes, but not to complete germination. Treated seeds are usually re-dried to primary moisture before use, but they would exhibit rapid germination when re-imbibed under normal or stress conditions [4]. Methods of seed priming include osmo-priming, salt-priming, hydro-priming, matrix-priming and thermo-priming [17,21].

Gamma rays belong to ionizing radiation and are the most energetic form of such electromagnetic radiation, having the energy level from around 10 kilo electron volts (keV) to several hundred keV. Therefore, they are more penetrating than other types of radiation such as alpha and beta rays [18]. 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 [3]. Gamma irradiation was found to increase plant productivity. Jaywardena and Peiris [15] stated that gamma rays represent one of the important physical agents used to improve the characters and productivity of many plants (e.g. rice, maize, bean, cowpea and potato).

Lallemantia iberica belongs to the tribe Stachyoideae-Nepeteae, family Lamiaceae and this family has 46 genera and 410 species and subspecies in Iran [23]. *Lallemant iaiberica* originated from Caucasian region that has been found in Asia (Syria, Iran and Iraq), but it is now appeared in central and Southern Europe. People use leaves, oil, seed [13] and it has traditional uses as reconstituent, stimulant, diuretic and expectorant [5,23]. Thus, this research was carried out to investigate the effect of seed priming and gamma irradiation on leaf water content, chlorophyll content index and fluorescence of *Lallemantia iberica* in rain-fed and supplementary irrigation conditions.

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 38º 05´ N, Longitude 46º 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.

Seeds of a local variety of *Lallemantia iberica* were divided into five parts: control, hydro-primed, salt-primed and irradiated with two doses of gamma ray. Hydro-primed seeds were socked in distilled water for 8 hours, and then they were dried to the primary moisture. Salt-primed seeds were socked in 1% KNO_3solution for two hours and then re-dried. Irrigated seeds were subjected to gamma rays from 60 Co source using 200 and 400 Gy doses.

Seeds were sown in May and irrigated once a week till four leaves stage. Then plants were divided into three parts: rain-fed, irrigation at flowering stage, and irrigation at both flowering and grain filling stages.

In both years, three leaves (upper, middle and lower) from three plants were cut at flowering stage before supplementary irrigation, and then within icy plastic bags they were transferred to the laboratory. Wet weight of the leaves was determined and thereafter leaves were dried in an oven at 72ºC for 48 hours. After that, dry weight of the leaves was recorded. Leaf water content (%) was estimated [22] as:

$$(\%)\ \text{leaf water content} = \left(\frac{\text{wet weight - dry weight}}{\text{wet weight}}\right) \times 100$$

Chlorophyll content index was measured in both years by a chlorophyll meter (CCM-200)at grain filling stage. Afluorometer (OPTI-SCIENCES-OS-30) was used to estimate fluorescence parameters at flowering stage in the first year. At maturity, plants in an area of 0.75 m^2 from each plot were harvested and biological yield per unit area was determined. The data were subjected to analyses of variance, using MSTATC and SPSS software.

RESULTS AND DISCUSSION

Analyses of variance of chlorophyll fluorescence parameters revealed that seed priming and irrigation had no significant effects on F_0, F_m,F_v andF_v/F_m($p > 0.05$). Leaf water content was not significantly ($p > 0.05$) affected by seed priming. Biological yield significantly affected by year, priming and interactions of irrigation × year ($p \leq 0.05$) and irrigation × priming ($p \leq 0.01$). Chlorophyll content index was not significantly affected by any of the factors ($p > 0.05$).

Stress condition could increase F_0,F_m and F_v; and decrease F_v/F_m(32). Increasing F_0 and F_m could be the result of an increase in light inhibition of photosystem II [19]. This could also damage PSII. F_v/F_m value is an indicative of PSII capacity to transfer electron, which has a high correlation to quantum efficiency of net photosynthesis [25]. Insignificantly changes in chlorophyll fluorescence parameters, especially

quantum yield (F_v/F_m), as this research, shows that PSII has high photochemical efficiency under different conditions. However, the same range of F_v/F_m dose not reveal that photosynthesis system was not affected by, but it means that PSII efficiency was the same, not electron transfer to PSII.
According to the Table 2, irradiated seeds with 200Gy resulted in the highest biological yield of *Lallemanti aiberica* under I_3, which was not statistically different from the treatments of non-priming × I_2, hydro-priming × I_1, hydro-priming × I_2, hydro-priming × I_3, KNO_3 priming × I_1, KNO_3 priming × $I_3$and gamma irradiation (400 Gy) × I_2.Similarly, Hegazi and Hamideldin [14] found that gamma irradiation with 400 Gy increased yield. Rasaei et al. (26) also showed that supplementary irrigation at the flowering stage cause high biological yield in peas (*Pisum sativum*L.).Therefore, hydro and KNO_3 priming can enhance biological yield of *Lallemantia iberica*; since these priming methods of this plant seeds due to their mucilage content are difficult, it seems to be better to use unprimed seeds with a supplementary irrigation at flowering stage.

Table 1: Information of monthly precipitation during 2012 and 2013

Year/month	Jan.	Feb.	Mars.	April.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
2012	25.1	6.4	20	35.6	22.2	15.8	14.9	0	5.1	9.2	20.2	42.8	217.3
2013	36.7	43.8	9.6	47.3	39.5	7.8	4.5	0	0.4	7.6	47.4	18	262.6

Table 2:Means of biological yield of *Lallemantia iberica* affected by seed priming and supplemental irrigations during 2012-2013

treatments		Biological yield
priming	irrigation	(g.m^{-2})
Non-priming	I_1	208.9 ^{de}
	I_2	335.9^{ab}
	I_3	181.0 ^{e}
Hydro-priming	I_1	229.4^{abcd}
	I_2	353.1^{ab}
	I_3	334.4^{ab}
KNO_3 priming	I_1	300.0^{abcd}
	I_2	205.8 ^{de}
	I_3	295.8^{abcd}
Gamma irr. (200 Gy)	I_1	268.6^{bcde}
	I_2	223.8^{cde}
	I_3	382.3 ^{a}
Gamma irr. (400 Gy)	I_1	213.8^{cde}
	I_2	314.8^{abc}
	I_3	208.6 ^{de}

Different letters indicate significant difference at $p \leq 0.05$
I_1, I_2 and I_3: Rain-fed, irrigation at flowering and irrigation at both flowering and grain filling, respectively

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