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Seed germination and early growth of Jimsonweed as affected by biophysical priming techniques

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Abstract

Seed priming has been reported to enhance growth of plants. To evaluate the effect of some physical seed priming materials (ultrasonic, gamma, beta and laser irradiation, magnetic field and hydro-priming) on seed germination and growth of Jimsonweed a laboratory experiment was conducted at Islamic Azad University of Tabriz branch, using completely randomized design, with three replicates. The results revealed that the highest seed germination percent took place in seeds treated with Mean comparisons for germination percentage also revealed that seeds treated with gamma irradiation resulted in higher germination percentage of (83%). Lowest germination percentages (44%) were observed for exposure of seeds to ultrasonic Higest seedling vigor index was obtained when seeds primed with gamma irradiation for 10 min. (135.4). and lowest from beta irradiation seed treatment (0.31)It may be concluded that Jimsonweed producers could improve seed germination percent by priming the seed with magnetic field for 15 minutes.

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Introduction

Jimsonweed is a weed from the family *Solanaceae*, the potato or nightshade family. Jimsonweed is derived from the Arabic name *Tatorah* or the Hindustani *Dhatura*. *Stramonium* is the old generic name, said to be from *struma* or *stroma, a* swelling (Fernald 1970).

Germination and seedling establishment are critical stages in the plant life cycle (Ganji Arjenaki *Et. al.*. 2011). Pre-sowing hydration treatments (priming) include non-controlled water uptake systems (methods in which water is freely available and not restricted by the environment) and controlled systems (methods that regulate seed moisture content preventing the completion of germination). There are several indications that many physiological mechanisms are involved in seed priming such as the repair of the age related cellular and subcellular damage that can accumulate during seed development (Bray, 1995; Burgass and Powell 1984) and an advancement of metabolic events of imbibition that prepare the radicle protrusion (Dell'aquilla and Beweley 1989). The magnetic stimulation of the wheat seeds resulted in acceleration of the process of germination. Although magnetic fields speed up seed germination and plant growth, the intensity of the applied magnetic fields and the time of seed exposure, however, vary greatly (Pietruszewski and Kania, 2010).

Helium-neon laser irradiation at 632.8 nm of cucumber seed stimulated embryonic root growth, photosynthesis rate and peroxidase activity and reduced leaf plastid pigment content (Shaban *et al.* 1988).

Gamma rays belong to ionizing radiation and are the most energetic form of such electromagnetic radiation. It has an energy level of 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 (Kova´cs and Keresztes 2002).

In other research by Silvia neam and Marariu (2005) magnetic field treatment (120mT) with duration of 5 and 10 min on tomato seed caused meaningful increase in radicle and plumule length, leaf area, and dry weight. In order to obtain the highest crop potential in yield and/or quality, seeds of high quality that produce rapid and uniform seedling emergence are required (Artola *Et. al.*. 2003).The main objective of this study was to evaluate the effects of some biophysical seed treatments on seed germination and early growth of Jimsonweed.

Materials and methods

The experiment was conducted at Islamic Azad University, Tabriz branch, using a completely randomized design with three replications during 2011 growing season.

Experiment Method

Jimsonweed seeds, with 73% viability, were differently treated by ultrasonication for 10 minutes (Yaldagard and Mortazavi 2008), laser irradiation (Mohammadi *Et. al.*. 2012) for 5, 10 and 15 minutes, magnetic field for 5, 10 and 15 minutes (Iqbal *et al.* 2012), gamma irradiation for 10 minutes (Farahvash *Et. al.*. 2007), beta irradiation for 10 minutes (Bradford, 2000), and hydro-priming for 24 hours (Artola *Et. al.*. 2003). Prior to planting, the seeds were surface sterilized with NaOCL 5% [1] for 5 minutes to avoid fungal invasion and then washed immediately with distilled water. Petri dishes and filter papers were also disinfected by NaOCL and UV radiation for 24 hours in a sterile hood before their incubations. For each of 9 physical treatment techniques twenty five treated seeds were placed in 9-cm Petri dishes and then incubated in a germinator with 20 °C temperature for 14 days. Two days after incubation, seeds germinated (having radicle length of at least 5 mm.) were counted daily for 14 days. Traits measured in the laboratory were root length, shoot length, seedling length, germination percentage and seedling vigor index.

[1] Sodium hypo chloride

Statistical Analysis

Analysis of variance of data collected was made by the software MSTAT-C, graphs were drawn with excel software, and means of traits were compared by using LSD test at 5% probability level.

Results and discussion

Root length

Analysis of variance of the traits studied is depicted in Table 1. It shows that seed primings affected root length at 1% level of probability. Comparion of means indicated that highest root length belonged seed treatments by gamma irradiation (0.77 cm) and magnetic field for 15 min. (0.77 cm) respectively. Lowest root length was obtained when seed primed by beta irradiation (0.002 cm). treated by root length when seed magnetic field for 5 min. and 10 min (0.75 cm), laser 5 min (0.64 cm) and control (0.06) (Fig 1). However, root length of the seeds treated by ultrasonic irradiation was 0.004 cm, by laser irradiation for 10 min. was 0.35 cm, by laser for 15 min. was 0.03 cm, hydropriming and control was 0.06 cm (Fig 1). Root length was highly correlated, seedling length, germination percentage and vigor index (Table 2). In other research by Silvia neam and Mararíu (2005) magnetic field treatment (120mT) with duration of 5 and 10 min. on tomato seed caused meaningful increase in radicle and plumule length, leaf area, and dry weight.

Table 1. Variance analysis of traits under study as affected by physical seed priming techniques.

SOV	df	Root length	Shoot length	Seedling length	Germination	Vigor index
Treatment	10	0.37 **	0.45 **	1.66 **	435**	9588.13**
Error	22	0.002	0.003	0.008	44.90	61.68
C.V (%)	-	12.30	12.37	10.91	10.43	12.97

**, means significant at 1% levels of probability.

Table 2. Correlation between traits of study in laboratory in Jimsonweed.

	Root length	Shoot length	Seedling length	Germination	Vigor index
Root length	1				
Shoot length	0.99**	1			
Seedling length	0.99 **	0.99 **	1		
Germination (%)	0.76**	0.76 **	0.76 **	1	
Vigor index (SVI)	0.99 **	0.98 **	0.99 **	0.79 **	1

**, means significant at 1% and 5% probability levels.

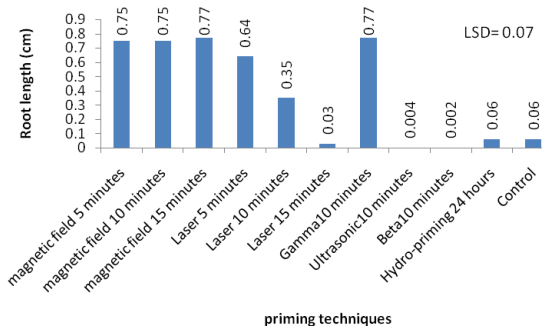

Fig. 1. Root lengths as affected by different priming techniques.

Shoot length

Physical seed treatments also affected shoot length significantly at 1% level of probability (Table 1). Mean comparions indicated that highest shoot length (0.89 cm) was due to seed treatment by magnetic field for 15 min. Lowest shoot length belonged to beta irradiation treaments (0.003 cm.) and ultrasonic irradiation (0.007 cm). Shoot length as to the other treatments 0.83 cm. for magnetic field 10 min., 0.85 cm. for gamma irradiation and hydropriming, 0.13 cm. for magnetic field 5 min. and 0.83 cm. for magnetic field 5 min. and 10 min. Correlations of shoot length with seedling length, germination perceantage, seedling length vigor index were positive and significant at 1% levels of probability (Table 2). Changes in the germination percentage were found to attribute to gamma rays treatments. The stimulating

causes of gamma ray on germination may be certified to the activation of RNA or protein synthesis, which occurred during the early stage of germination after seeds irradiated (Abdel-Hady *Et. al.*. 2008). Although, no certain explanations for the stimulatory effects of low-dose gamma radiation are available until now, in accordance to the results obtained by Wi *Et. al.*. (2007), there is a hypothesis that the low dose irradiation will induce the growth stimulation by changing the hormonal signaling network in plant cells or by increasing the anti oxidative capacity of the cells to easily overcome daily stress factors such as fluctuations of light intensity and temperature in the growth condition (Wi *Et. al.*. 2007). In a study of the gamma radiation effects on chickpea seeds by Toker *Et. al.*. (2005) seedlings irradiated at 200 Gy may have some significant increase in their shoot length, but at 400 Gy an obvious depression in shoot length was observed.

Seedling length

The effect of seed priming methods on the seedling length was significant at 1% level of probability (Table 1). Mean comparisons for seedling length revealed that seeds treated with magnetic field for 5 min. (1.85 cm), increased seedling length as compared to control (0.16 cm) by 91% (Fig 2). Highest seedling length (1.85 cm) was obtained when seeds primed with magnetic field for 5 min. Also, seedling length by laser for 15 min., magnetic field for 10 min., hydropriming were 0.09, 1.59 and 0.19 respectively (Fig 2). Correlation of seedling length with germination percentage and vigor index is significant at 1% level of probability (Table 2). Norfadzrin *Et. al.*. (2007) showed that tomato and okra seeds irradiated by gamma rays, affectedtheir better growth of seedlings. Treating seeds with gamma irradiation may result in a significant increase in seedling length and vigor. Similarly, Florez *Et. al.*. (2007), Vashista and Nagarajan (2010) recorded enhancement in seedling vigor, shoot and root growth of maize, chickpea and sunflower when seeds treated magnetically before sowing. The symptoms frequently observed in the low-or high-dose-irradiated plants are enhancement or inhibition of germination, seedling growth, and other biological responses (Kim *Et. al.*. 2000; Wi *Et. al.*. 2007).

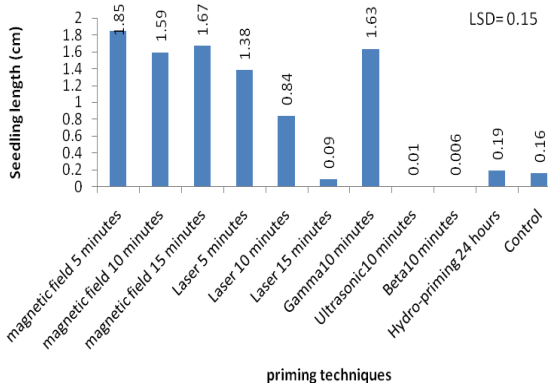

Fig. 2. Seedling length as affected by different priming techniques.

Seed germination percentage

Analysis of variance of the data on seed germination is depicted in Table 1. It shows that seed primings affected this trait at 1% level of probability. Mean comparisons for germination percentage also revealed that seeds treated with gamma irradiation resulted in higher germination percentage of (83%). Lowest germination percentages (44%) were observed for exposure of seeds to ultrasonic (Fig 3). Treating seeds with magnetic field for 5 minutes increased germination percentage by over 75% (Fig 3). Correlation of germination percentage with vigor index was significantly positive at 1% level of probability (Table 2). Soltani *et al.* (2006 a and b) suggested that magnetic field treatment of seed had a positive effect on seed germination and seedling growth of aspargus (*Asparagus officinalis)* and basil (*Ocimum Basilicum)*. Vashisth and Nagarajan (2010) reported that rate and speed of seed germination of sunflower, treated with magnetic fields of 50 and 250 MT for 1 hour, were increased by 5% and 9% respectively. Similar results presented by Fischer *Et. al.*. (2004) on sunflower.

Studies showed that the influence of the stationary magnetic field on the seeds increased the germination of non-standard seeds and improved their quality

(Galland and Pazur, 2005). Ultrasonic waves have also been effective in improving germination (Yaldagard *Et. al.*. 2008). Chaudhuri (2002) reported that in higher radiation dose, germination percentage reduced in addition to root and shoot length, while, in lower dose i.e., 0.1 kGy the germination percentage was not significantly different from control. In another study by Kiong *Et. al.*. (2008), it was found that radiation increases plant sensitivity to gamma rays and this may be caused by the reduced amount of endogenous growth regulators, especially the cytokines, as a result of breakdown, or lack of synthesis, due to radiation.

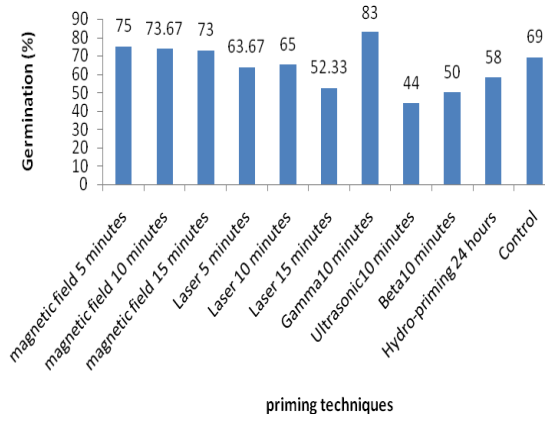

Fig. 3. Germination percentage of Jimsonweed as affected by different priming techniques.

Seedling vigor index (SVI)

Analysis of variance showed that the effects of seed priming agents on vigor index of Jimsonweed was significant that at 1% level of probability (Table 1). Comparison of means (Fig 4) indicated that priming of Jimsonweed seed with gamma irradiation for 10 min. increased seedling vigor index by 91% against control. Higest seedling vigor index was obtained when seeds primed with gamma irradiation for 10 min. (135.4). and lowest from beta irradiation seed treatment (0.31) (Fig 4). Seedling vigor indices of seed priming with laser irradiation 15 min., magnetic field for 5 min., magnetic field for 10 min. and gamma irradiation were 5.18, 118.7, 117.5 and 135.4 respectively.

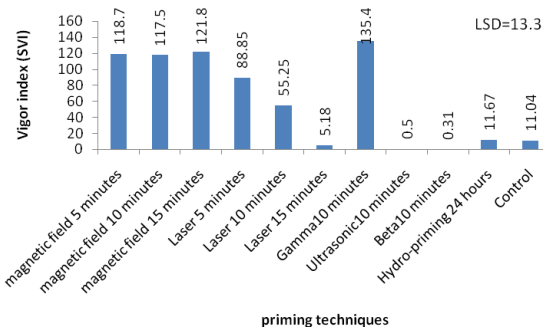

Fig. 4. Vigor index (SVI) in Jimsonweed as affected by different priming techniques.

Conclusion

Based on the results obtained from this study it can be concluded that treating tomato seeds by magnetic field increases its growth and early growth more than other irradiation agents used. Additional investigations are needed to warrant the preferability of magnetic field priming of tomato seed over other seed priming agents.

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