



RESEARCH PAPER

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Effects of physical treatments on germination and stand establishment of sunflower (*Helianthus annuus* L. var. *Hyson*) under laboratory condition

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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 sunflower 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 “magnetic field” for 10 min. and lowest in those treated by ultrasonic irradiation and hydro-priming. Mean comparisons indicated that the highest seedling length belonged to seeds treated by hydro-priming and beta irradiation and lowest from seeds primed by magnetic field for 5 min., magnetic field for 15 min. Highest seedling vigor index was obtained when seeds primed by magnetic field for 10 min. It may be concluded that tomato producers could improve seed germination percent by priming the seed with magnetic field for 15 min.

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Introduction

Sunflower (*Helianthus annuus* L.) is a rich source of edible oil (Friedman *et al.*, 2007). The most important roles play genetic and environmental factors in the normal process of germination and plant growth. A key role is also played by proper preparation before sowing, which applies to chemicals (seed dressing, growth regulators), scarification, seed stratification and physical factors: fixed and variable magnetic and electrical fields, microwave, ionizing and laser radiation), which usually positively affects germination and plant growth and the height of the yields obtained (Muszyński and G³adyszewska, 2008; Chen *et al.*, 2005).

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) and an advancement of metabolic events of imbibition that prepare the radicle protrusion (Dell'aquila and Beweley, 1989).

In faba bean, (Artk and Peksen, 2006) found a reduction in seed yield and harvest index in some varieties and also stated that, 25 and 50 Gy gamma radiation varied from the control treatment in many of the studied variables. Laser light is used as bio-stimulator in agriculture. As these biophysical methods of stimulation do not change the course of physiological process controlled by genetic systems, the optimal doses for seed don't provoke genetics effects (Vasilevski, 2003). Different laser light types in the UV and visible region have been used successfully in seed enhancements (Ouf and Abdel-Hady, 1999).

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). The success of biostimulation caused by monochromatic and low intensity laser light is dependent on wavelength (λ , nm), irradiation time (t, s) and irradiation dose (D, J/cm²) (Hernandez *et al.*, 2001). High seed quality is absolutely necessary in the context of modern crop production systems, and it is a specific requirement because it affects crop establishment, growth and yield; therefore it has a profound influence on economic production (Hampton, 2002). 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 sunflower.

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

Sunflower seeds, with 85% 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% 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 seedling length, seedling dry weight, germination rate, and germination percentage and seedling vigor index.

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

Seed germination percentage (SGP)

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 magnetic field for 10 min. resulted in higher germination percentage of (98.33). Lowest germination percentages (11.67% and

20%) were observed for exposure of seeds to ultrasonic irradiation and hydro-priming respectively (Table 2). Treating seeds with magnetic field for 10 minutes increased germination percentage by over 15% (Table 2). Correlation of germination percentage with Vigor index (SVI) was significantly positive at 1% level of probability (Table 3). This is in conformity with Moon and Sook (2000) where they concluded that seed priming of tomato seed by electrical and magnetic field increased seed germination percentage. Moon and Chung (2000) also reported similar results from seeds treated with AC electric and magnetic field on germination percentage and better seedling establishment seedling as compared with untreated tomato seeds Yinan *et al.*, (2005). Also reported increased plant growth under magnetic field seed treatment. Chaudhuri (2002) reported that gamma radiation of seed by higher doses induced, germination percentage, shoot length, while, by lower doses, (0.1 kGy) did not affect germination percentage.

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

s.o.v	df	Seedling length	Germination (%)	Seedling dry weight	germination rate	Vigor index (SVI)
Treatment	10	166.91 **	1396.36 **	12.14**	10.55**	182762.69**
Error	22	11.40	85.60	0.26	0.04	2516.31
C.V (%)	-	10.73	12.39	7.54	3.55	9.54

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

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 hydro-priming (45.30 cm), increased seedling length as compared to control (27.33 cm) by 65% (Table 2). Highest seedling length (45.30 cm) was obtained when seeds primed with hydro-priming. Also, seedling length by laser for 15 min., magnetic field for 10 min., hydropriming were 24, 29.33 and 45.30 respectively (Table 2). Correlation of seedling length with germination percentage and vigor index is significant at 1% level of probability (Table 3). Soltani *et al.*, (2006 a, b) reported a positive effect of magnetic field on

Asparagus officinalis and *Ocimum basilicum* seed germination and seedling growth. Podleony *et al.*, (2004) stated that effect of magnetic treatment on the germination and emergence of two broad bean cultivars was positive and significant. Similar effects were also observed on cucumber seedlings by Yinan *et al.*, (2005).

Seedling dry weight

Analysis of variance of the traits studied is depicted in Table 1. It shows that seed primings affected seedling dry weight at 1% level of probability. Comparison of means indicated that highest seedling dry weight belonged seed treatments by laser irradiation 10 min. (8.8 cm) and laser irradiation 15 min. (8.3 cm)

respectively. Lowest seedling dry weight was obtained when seed primed by beta irradiation (2.4 cm). treated by seedling dry weight when seed magnetic field for 5 min. (7.6 cm), laser 5 min (8.1 cm) and control (4.2) (Table 2). However, seedling dry weight of the seeds treated by gamma irradiation was 6.3 cm, by magnetic field for 10 min. was 8.1 cm, by laser for

15 min. was 8.3 cm, hydropriming was 5.7 cm (Table 2). Seedling dry weight was highly correlated, germination rate and vigor index (Table 3). Effect of magnetic field of 120 mT and 5 and 10 minutes on tomato seeds showed a significant increase in both the time of root length, shoot length, leaf area and dry weight, it was (Silvianeam and Marariu, 2005).

Table 2. Comparison of means effects of physical seed priming on some traits in sunflower in laboratory.

Priming Agents and Duration of Exposure	Seedling length (cm)	Germination (%)	Seedling dry weight (mg)	germination rate	Vigor index (SVI) (mg)
magnetic field 5 minutes	19.63	91.67	7.63	6.50	699.3
magnetic field 10 minutes	29.33	98.33	8.10	7.80	797
magnetic field 15 minutes	24	96.67	8.12	7.15	785.6
Laser 5 minutes	34.73	83.33	8.15	8.27	679.5
Laser 10 minutes	26.93	80	8.82	7.54	692.8
Laser 15 minutes	37	90	8.34	4.46	746.3
Ultrasonic 10 minutes	27.33	43.33	7.63	5.53	330
Gamma 10 minutes	38	46.67	6.33	8.53	295.3
Beta 10 minutes	36.57	63.33	2.40	3.80	150
Hydro-priming 24 hours	45.30	43.33	5.76	4.30	249
Control	27.33	85	4.20	3.50	356.7
LSD 5%	7.77	21.29	1.19	0.49	115.5

Germination rate (GR)

Physical seed treatments also affected germination rate significantly at 1% level of probability (Table 1). Mean comparisons indicated that highest germination rate (8.5) was due to seed treatment by gamma irradiation (Table 2). Lowest germination rate belonged to beta irradiation treatments (3.8 cm.) and control (3.5 cm). Germination rate as to the other treatments 7.8 cm. for magnetic field 10 min., 8.5 cm. for gamma irradiation., 4.3 cm. for hydropriming, 6.5 cm. for magnetic field 5 min. and 7.1 cm. for magnetic field 15 min. (Table 2). It has reported that the effect of the laser light on plant productivity is far more than other waves, such that crop yields can be

increased from 10 to 50 percent (Vasilevski, 2003). Farahvash *et al.*, (2007) reported that gamma radiation of wheat seeds positively affected its productivity. Effect of gamma radiation on some physiological traits of wheat were studied and showed that the plant at doses of 900 (Rad) for 8-day period, highly increased crop yields. Yinan *et al.*, (2005) Increased rate of germination, seedling growth, lipid oxidation of ascorbic acid in cucumber seeds pretreated with magnetic field is observed. Florez *et al.*, (2007) and Racuciu *et al.*, (2008) also increases the rate of germination, and seedling fresh weight, shoot and whole-plant corn yield was observed magnetic field.

Table 3. Correlation between traits of study in laboratory in sunflower.

	Seedling length	Germination (%)	Seedling dry weight	Vigor index (SVI)	germination rate
Seedling length	1				
Germination (%)	-0.51**	1			
Seedling dry weight	-0.32	0.29	1		
Vigor index (SVI)	-0.48**	0.81**	0.78**	1	
germination rate	-0.20	0.17	0.62**	0.49**	1

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

Seedling vigor index (SVI)

Analysis of variance showed that the effects of seed priming agents on vigor index of sunflower was significant that at 1% level of probability (Table 1). Comparison of means (Table 2) indicated that priming of sunflower seed with laser irradiation for 10 min. increased seedling vigor index by 123% against control. Highest seedling vigor index was obtained when seeds primed with magnetic field for 10 min. (797). and lowest from beta irradiation seed treatment (356.7). 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 746.3, 699.3, 797 and 295.3 respectively. Ahmadi *et al.*, (2007) showed that water absorption by seeds in wheat hydropriming for 12 h increased the speed of emergence, vigor index and seedling dry weight is.

Conclusion

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

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