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SEED PRIMING TECHNIQUES MAY IMPROVE GRAIN AND OIL YIELDS OF SUNFLOWER (*HELIANTHUS ANNUUS* L.)

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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, laser, magnetic field, irradiations and hydro-priming) on yield and yield components of sunflower, field experiments were conducted at Islamic Azad University, Tabriz branch, Iran during 2011-2012 in a randomized complete block design, with three replications. The results revealed that crop LAI, following pre-sowing treatments, increased by magnetic fields, laser for 5 and 15 min. and ultrasonic up to 3.36, 3.41, 3.91 and 3.53, respectively. Beta and gamma rays, hydropriming and non-priming of seeds reduced it at 70 DAE. Highest mean yield produced from seeds treated with laser (419.7g.m^{-2}) and magnetic field (379.8g.m^{-2}) for 5 min. However, it decreased by increasing laser duration from 5 to 10 min. Biomass produced ranged from 947.4 g.m^{-2} in seeds primed under laser for 5 minutes. and 406.7 g.m^{-2} in non-priming ones. It was also found that sunflower seeds irradiated with laser for 5 and 10 minutes and magnetic fields resulted in highest harvest index (49.1%), as compared with other treatments. It may be concluded that sunflower growers could improve crop yield by priming the seeds with magnetic field and laser irradiation before sowing.

Key words: Magnetic field, Oil percentage, Physical priming.

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is a rich source of edible oil (Friedman *et al*., 2007). Sunflower (*Helianthus annuus* L.) is an important oilseed crop suited to agro-climatic conditions and prevailing cropping systems of Pakistan (Kaleem *et al.*, 2011; Hassan and Kaleem, 2014). It is suggested that seed priming generally causes faster germination and field emergence, which have practical agronomic importance in crop production, especially under adverse environmental conditions (Mc Donald, 2000). Farooq *et al*. (2008) conducted a study to explore the possibility of yield improving in late sown wheat crop by seed priming. Germination rate as well as growth of crop plants can be improved by physical irradiations (Marks and Szecówka, 2010; Podleoeny *et al*., 2004). Dubey *et al*. (2007) showed an increase in plant height and branches per plant when okra (*Abelmoschus esculentus* L. Monch.) seeds were irradiated with different doses of gamma rays. Ultrasonic irradiation of carrot (*Daucus carota* L.) seeds led to the early ripening by 5–10 days (Aladjadjiyan., 2002). Dubey et al. (2007) and Aladjadjiyan (2002) reports suggested that the use of ultrasound waves may enhance stimulation and germination of some plant seeds. Similarly, Vashisth and Nagarajan (2008, 2010) emphasized the positive effects of seeds exposed to static magnetic field for improvement of maize, chickpea and sunflower growth. Florez *et al*. (2007) and Racuciu *et al*. (2008) also noticed increased germination rate, seedling length and plant fresh weight of corn by using magnetic fields treatment. Marks and Szecówka (2010) found that pre-sowing magnetic treatment stimulated growth of above ground parts of potato. Toker *et al*., (2005), studying the effects of 200 Gy gamma radiation on chickpea seeds reported that seedling lengths increased significantly, while at 400 Gy it was appreciably reduced. Melki and Marouani (2009) also reported an improvement of 32% in root length of hard wheat at the 20 Gy dose gamma ray. Positive effects of seeds exposed to physical priming methods on rapid seed emergence and yield improvement of field crops has been previously reported.

Gamma rays belong to ionizing radiation and are the most energetic form of suchelectromagnetic 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 (Kova´cs & Keresztes, 2002).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, 2003). Ionizing radiations are also used to sterilize some agricultural products in order to increase their conservation time or to reduce pathogen propagation when trading these products within the same country or from country to country (Melki & Salami, 2008). The main objective of this study was to evaluate the effects of some biophysical seed treatments on yield and yield components of sunflower.

MATERIALS AND METHODS

Two field experiments were conducted at the Research Station of the Islamic Azad University, Tabriz Branch, Iran, in a randomized complete block design with three replications, to evaluate some yield related traits of sunflower (*Helianthus annuus* cv. Hysun 33), during growing seasons of 2011 and 2012. The cultivar under study was a medium-repining hybrid with growth period of 115-125 days. Tabriz is located at the north-west of Iran and the climate is semiarid and cold. The soil was a sandy-loam with EC of 0.74 $ds.m^{-1}$ and pH of 7.9. Weather data during crop growth cycle is given in table1.

Table 1. Some weather conditions of experimental site during growing seasons of 2011-2012.

Year	Month	Temperature (°C)	Precipitation (mm)	Relative humidity (%)
2011	April	12.9	37.1	49.0
	May	20.3	28.5	62.0
	June	23.9	21.0	46.3
	July	28.9	3.5	32.7
	August	31.1	3.0	30.7
	Total	-	93.1	-
2012	April	15.0	36.4	44.4
	May	18.8	32.9	60.4
	June	25.5	22.8	50.0
	July	30.0	5.0	35.2
	August	30.9	2.2	30.6
	Total	-	99.3	-

The experimental areas was ploughed in the fall and manured with 12 $t.ha^{-1}$. Fields were cultivated, disked, furrowed and then plotted in the early spring before sowing the seeds. Based on soil analysis fields were fertilized with 110 $kg.ha^{-1}$ urea, (1/2 at sowing time and the rest at 4-5 leaf stages), 50 $kg.ha^{-1}$ P_2O_5 and 25 $kg.ha^{-1}$ K_2O during 2011 and some rates of N and P fertilizers plus 35 $kg.ha^{-1}$ K_2O during 2012. The seeds, with 85% viability, were differently treated by ultrasonication[1] for 10 min., laser[2] irradiation for 5, 10 and 15 min., magnetic field[3] for 5, 10 and 15 min., gamma and beta[4] irradiations both for 10 min., distilled water for 24 hours (hydro-primed)and without treatment as control. Seeds were sown on 1st May and 29th April during 2011 and 2012, respectively at 4-5 cm depth in rows 60 cm. apart and 30 cm on the rows. Irrigation adjusted based on 80 mm evaporation from pan class A, and totally seven times during crop growth period. Weeds were hand removed during growing seasons, any pesticide used to control insects etc. Above ground parts of the crop harvested between 2-5 Sep. of both years. At 75 days after emergence leaf area index was determined using the following equation (Kashef, 1996):

$$S=0.655113\ (L\times W) - 0.00011\ (L\times W)^2$$

Where; means S, L and W stand for leaf area per plant, leaf length and width, respectively.

Seed oil was also extracted by Soxhlet Method. Analysis of variance of data collected was made by the software MSTAT-C, and means of traits were compared by using LSD test at 5% probability level.

RESULTS AND DISCUSSION

The weather conditions during the growing season in the years 2011 and 2012 were quite same (Table 1). Therefore the averaged data from two years of experiment were compared.

There was no significant difference between data from the two years of experiment. With consideration of similar temperature and precipitation rates during growing seasons of sunflower in the present study, this result was not un-expected.

Leaf area index: The effect of seed priming methods on the leaf area index (LAI) of sunflower was highly significant and its LAI due to pre-sowing treatments of seeds with magnetic fields, laser for 5 and 15 min. and ultrasonic increased up to 3.36, 3.41, 3.91 and 3.53, respectively, which were 141%, 145%, 181% and 153% larger than control (Table 3). Beta and gamma rays, hydro-priming and non-priming methods, on the other hand, reduced it at 70 DAE. The result is in good agreement with those of Melki and Marouani (2009) on hard wheat (*Triticum asetivum*). They emphasized the negative effects of beta and gamma radiations on chlorophyle biosynthesis and related plant leaf structures.

Number of seeds per anthodium: Number of seeds per anthodium was significantly affected by priming techniques (Table 2). Plants developed under beta and gamma irradiations produced anthodiums with lower number of seeds. A positive and significant correlation between LAI and number of seeds per anthodium in sunflower has been previously reported (Vashisth and Nagarajan, 2010).

Hundred seeds weight: Effects of priming agents on hundred seeds weight (HSW) was significant at 1% level of probability (Table 2). Seeds treated with laser (5 and

1- 50-60 Hz, 1.5 v.
2- He-Ne, IR 2000, 6328 A°, 220 V, 50 Hz
3- 40 mT,3 A, 2.7 V
4- Co_{60} and Sr_{90} 2 micro-coryle

10 min.) and magnetic field (5, 10 and 15 min.) produced larger seeds with HSW of 8.5 g, 8.6 g, 9.0 g, 9.0 g and 8.7 g, respectively (Table 3). When seeds were primed with beta and gamma irradiations, mean HSW of sunflower due to lower seeds number per anthodium increased (8.6 g). In this experiment lower HSW obtained from laser (15 min.), which had no significant difference with hydro-priming and control treatments (Table 3). Increasing duration of laser irradiation from 10 to 15 minutes significantly reduced HSW. Similar result was reported by Podleoeny (2002) in faba bean (*Vicia faba*). In the present study crop plants grown from laser treated seeds due to the increased effect some of yield component produced higher 1000 seeds mass, and higher time doses of laser (more than 22 min.) caused decrease in thousand seeds weight of bean. Fischer *et al*. (2004) by stimulating sunflower seeds with magnetic field induction of 20 μT and 16 Hz. frequency, obtained an increased seeds weight and plant height.

Grain yield: Seed priming increased grain yield of sunflower significantly (Fig. 1). Data obtained from this study indicated that highest mean yield produced from seeds treated with laser (419.7 g.m^{-2}) and magnetic field (379.8 g.m^{-2}) for 5 min., but with increasing duration of laser seed treatment from 5 to 10 min. it was reduced (fig. 1). Grain yields produced by beta and gamma seed radiations were almost similar to that of the laser treatment for 15 min., (Fig. 1). This result is in conformity with those of Alajadjiyan and Ylieva (2003), Atak *et al*. (2003) and Vasilevski (2003) who emphasized that seed priming would affect speed and percent of seed germination, and finally seed yield, in several crop plants. They also concluded that better results may depend upon the combined effect of appropriate magnetic field strength and exposure time. Harichand *et al.* (2002) observed that the treatment of seeds with magnetic field at 10 mT for 40 hours increased plant height, spike mass and crop yield. Similar results have been reported by Hernandez et al. (2006), when maize seeds were treated with laser radiation. Increasing effects of magnetic field priming of tomato seeds on fruit weight per plant, and whole plant dry weight were also reported by Desouza et al. (2006).

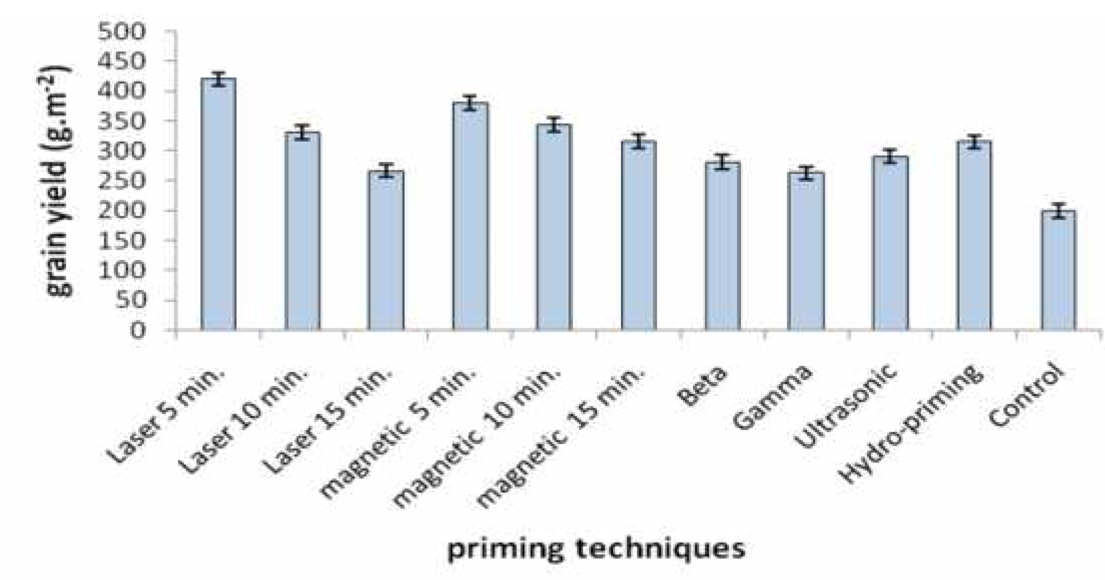

Fig 1. Grain yield of sunflower as affected by different priming techniques.

Biomass: Effect of seed priming by physical agents on the above ground biomass of sunflower was significant at 1% level of probability (Table 2). Biomass values among treatments ranged from 947.4 g.m^{-2} in seeds primed under laser for 5 min. to 406.7 g.m^{-2} in non-priming one. Exposure time of magnetic field treatment did not influence sunflower biomass production (Fig. 2). Plants developed from laser for 15 min, gamma and ultrasonic treatments produced 92.6%, 84.5% and 92.1% higher biomass than control, but these treatments had lower grain yield, as indicated in fig.1. Higher LAI in sunflower at laser radiation for 5 min did have a positive effect on grain yield. This is in confimity the results obtained by Vasileviski (2003). Variable magnetic fields through their effects on changes in hormone concentrations, enzyme functions, membrane ion transport and DNA synthesis and transmission may affect the biological activities of organisms (Strasak *et al*. 2002).

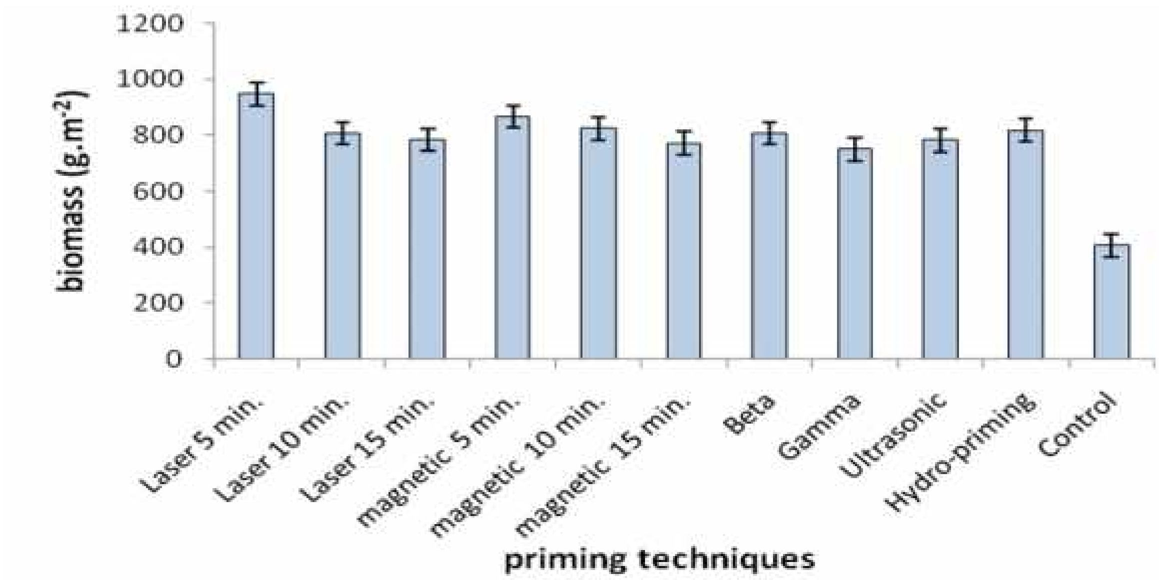

Fig 2. Biomass of sunflower as affected by different priming techniques.

Harvest index: Seed priming techniques influenced harvest index (HI) of sunflower significantly (Table 2). Sunflower seeds irradiated with laser for 5 and 10 minutes and magnetic fields resulted in higher HI (49.1%) as compared to other treatments, which is in conformity with those of Alajadjiyan and Ylieva (2002) in tobacco (*Nicotiana tabaccum*) and Atak *et al*. (2003) in soybean (*Glycine max*).

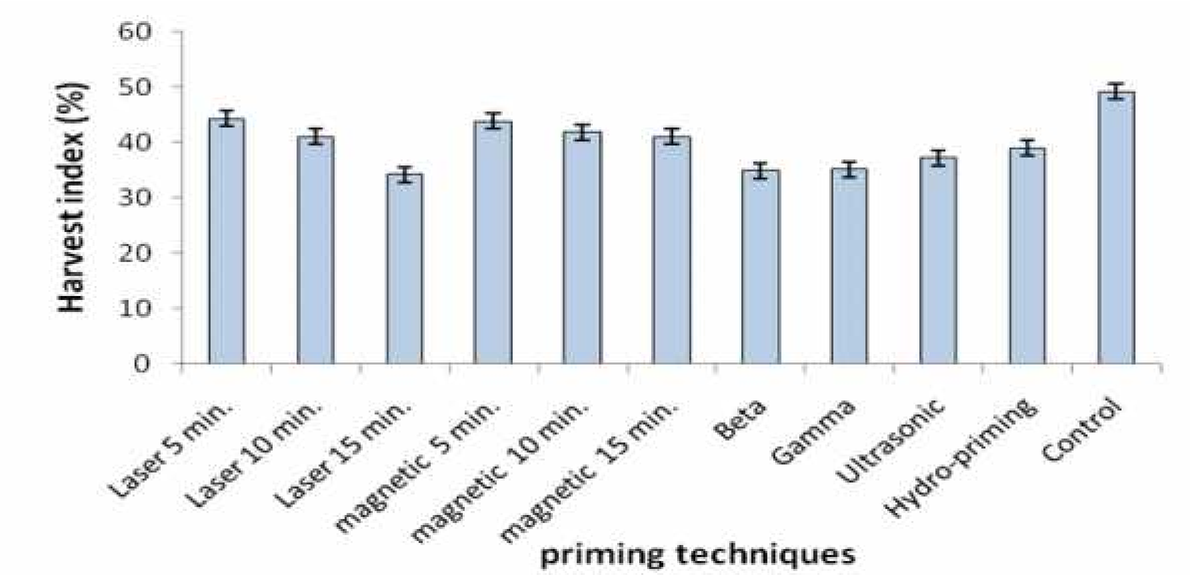

Fig 3. Harvest index of sunflower as affected by different priming techniques.

Oil yield: Percentage of oil extracted from sunflower seeds was not affected by seed treatments, significantly (Table 2). In our experiment all of the seeds produced from studied treatments had almost similar oil content (39.5%), but, only a slight and non-significant increase (nearly 1.3%) observed, when the seeds were sown without priming. The results indicated that physical priming techniques had positive effect on oil yield of the sunflower (Fig. 4). Means comparison revealed that the oil yield extracted from the grains under laser treatments for 5 and 10 min. and magnetic field for 5 and 10 min. may increase up to nearly 1.9, 1.5, 1.7 and 1.5 time, respectively, compared to the un-primed one. With increasing exposure time of laser and magnetic treatments oil yield of sunflower reduced, but the yield values were significantly greater than control. Crop plants improved from hydroprimed seeds produced oil yield same as to laser radiation for 10 min and magnetic field for 15 min.

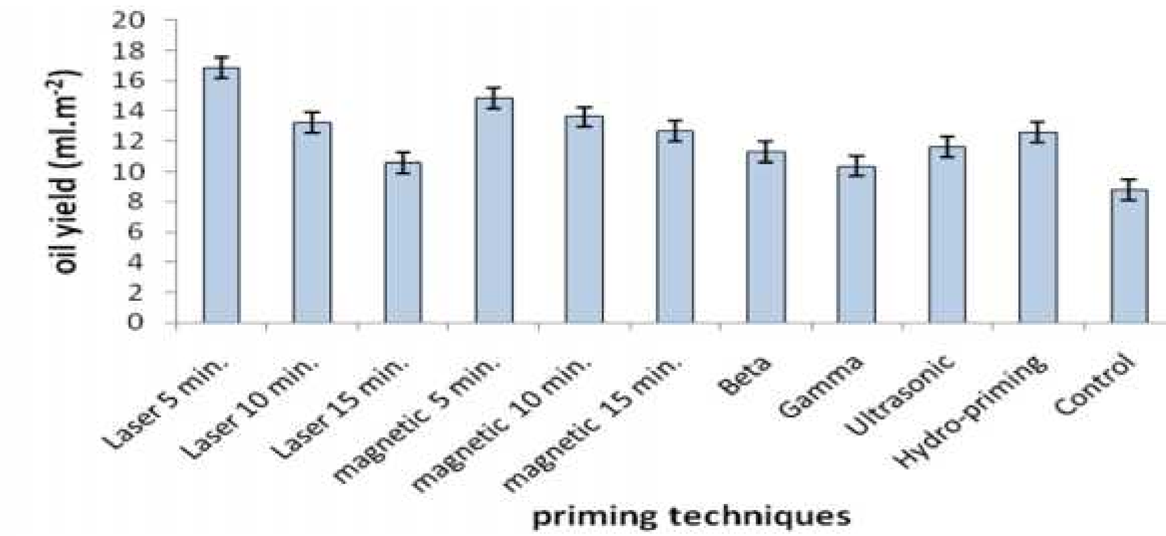

Fig 4. Oil yield of sunflower as affected by different priming agents.

Table 2. Variance analysis of effects of physical priming techniques on sunflower traits.

SV	df	LAI	Number of seeds per anthodium	HSW	Grain yield	Biomass	Harvest index	Oil percentage	Oil yield
Replication	2	0.07 ^{ns}	9733.30 ^{ns}	8.71**	24.77 ^{ns}	6.64 ^{ns}	29.52 ^{ns}	3956.56 ^{ns}	2.22 ^{ns}
Treatment	10	4.27**	66234.28**	14.33**	930.80 *	1769.17**	628.98**	538.55 ^{ns}	20.05*
Error	20	0.10	17168.30	0.78	181.01	199.19	97.53	903.82	6.16
CV (%)	__	11.71	18.79	11.02	24.40	10.78	22.91	22.50	10.81

ns and *,** represent non-significant and significant at 5%, 1% probability levels, respectively.

Table 3. Comparison of mean effects of seed priming on some traits of sunflower.

Priming agents and duration of exposure	LAI	Seeds No. per anthodium	HSW
Laser 5 minutes	3.36	887.7	8.50
Laser 10 minutes	2.76	691.3	8.60
Laser 15 minutes	3.12	785	6.12
magnetic field 5 minutes	3.41	757.3	9.02
magnetic field 10 minutes	3.35	688.3	8.99
magnetic field 15 minutes	3.91	652	8.72
Beta	1.60	580	8.73
Gamma	1.90	547.7	8.65
Ultrasonic	3.53	721	7.25
Hydro-priming 24 minutes	1.44	819.7	6.90
Control	1.39	540.1	6.6
LSD 5%	0.53	223.2	0.86

Conclusion: Based on the results obtained from this study it can be concluded that treating sunflower seeds with laser and magnetic field treatments increase grain yields of sunflower.

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