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Magnetic field Induction Stimulates Marigold Growth Characteristics Responsible for its Productivity under Greenhouse induction

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ABSTRACT: Physical treatment methods may be used as bio-stimulators in agricultural medicinal plants production such as marigold. The experiment was laid out in a completely randomized design in greenhouse with three replicates. Marigold seeds were differently treated by ultra-sonication, gamma irradiation and beta irradiation for exposure time of 10 min., laser irradiation and magnetic field for exposure times of 5, 10 and 15 min. Seeds without any irradiation served as control. Treating seeds with magnetic field for exposure time of 5 min. increased marigold leaf area. Seed priming materials affected plant length of marigold. Highest number of leaves per plant was developed due to seed treatment by laser irradiation for exposure time of 10 min. Based on the results obtained from this study it can be concluded that treating marigold seeds by magnetic field may increases its primary growth more than other irradiation agents used.

Keywords: Bio-stimulators, Crop production, Greenhouse, Seed priming materials.

INTRODUCTION

Marigolds (*Calendula officinalis* L.) are very important medicinal plants cultivated outdoors as winter annual plants. It belongs to Asteraceae family and is used for landscaping, as a source of color in the gardens and as cut flowers. It is considered to be one of the valuable medicinal plants which contains oleanolic acid and other compounds, which have considerable interest for potential health benefits, including protective effects against development of cancer, inhibition of existing tumor cells, protection against chemotherapy and radiation therapy adverse effects, anti-inflammatory activity, antioxidant activity, cardiovascular protective effects and antiviral effects (Dharmananda 2009).

Germination and seedling establishment are critical stages in the plant life cycle (Ganji Arjenaki *et al.* 2011). 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, 2003; Burgass and Powell, 2005) and an advancement of metabolic events of imbibition that prepare the radicle protrusion (Dell'aquilla and Beweley, 1989).

Gamma rays belong to ionizing radiation and are the most energetic form of such electro-magnetic 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 2012). In another research conducted by Silvia Neam and Marariu (2005), magnetic field treatment (120mT) of tomato seeds under exposure times of 5 min and 10 min caused meaningful increase in radicle and plumule length, leaf area, and dry weight of crop plants. 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 magnetic stimulation of 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). It seems that, physical treatment methods may be used as bio-stimulators in agricultural medicinal plants production such as pot marigold.

MATERIALS AND METHODS

The experiment was conducted at Islamic Azad University, Tabriz Branch, using a completely randomized design in green house with three replications during 2014. The seeds of marigold (*Calemdula officinalis*) used for this study were obtained from Seed Improvement Institute, Karaj, Iran.

A. Experiment Method

The moisture content of the seed was 10 %. Pot marigold seeds, with 73% viability, were differently treated by ultra-sonication for exposure time of 10 min. (Yaldagard and Mortazavi 2008), laser irradiation (Mohammadi et al. 2012) for exposure times of 5, 10 and 15 min., magnetic field exposure times of 5, 10 and 15 min. (Iqbal *et al.* 2012), gamma irradiation for exposure time of 10 min. (Farahvash *et al.* 2007) and beta irradiation for exposure times of 10 minutes (Bradford, 2000).

Prior to sowing, the seeds were surface sterilized with NaOCL 5% for 5 min. to avoid fungal invasion and then washed immediately with distilled water and 5 min. Seeds without any irradiation served as control. Twenty-five primed seeds for each treatment were placed in pots (19 × 21 cm) containing farm soil under greenhouse conditions (25±1 °C).

B. Statistical Analysis

Agronomic traits were examined following standard procedures. 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

A. Leaf area per plant

Analysis of variance of the data on leaf area is depicted in Table 1. It shows that seed priming affected leaf area per plant at 1% level of probability. Mean comparisons for leaf area also revealed that seeds treated with laser irradiation for exposure time of 10 min. resulted in higher leaf area, and the lowest from exposure of seeds to ultrasonic wave. Treating seeds with magnetic field for exposure time of 5 min. increased leaf area. In a research study conducted by Silvia Neam and Marariu (2005) magnetic field treatment with 120 MT intensity with duration of 5-10 min. on tomato seeds caused meaningful increase in radicle and plumule length, leaf area, and seedling dry weight.

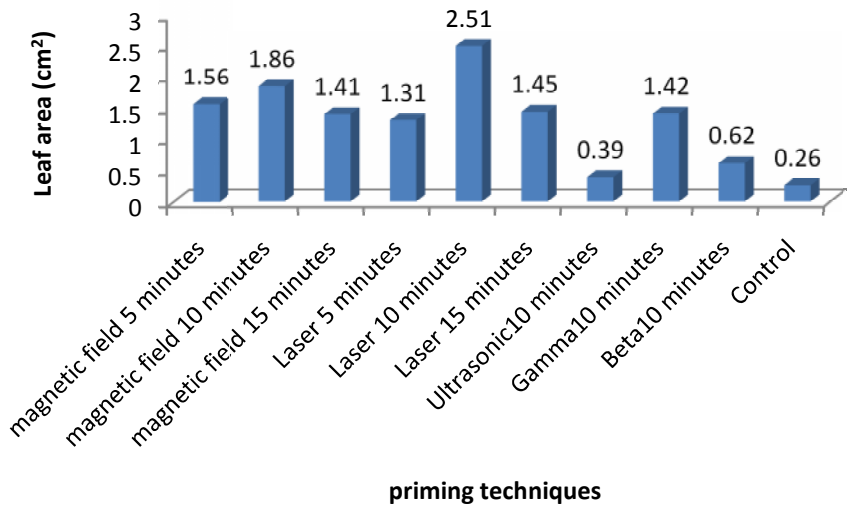

Fig. 1. Marigold seed Leaf area as affected by different priming techniques.

C. Plant length

Based on data shown in Table 1, seed priming materials affected plant length of marigold at 1% probability level. Comparison of means indicated that highest plant length (21.3 cm) belonged to seed treatments by magnetic field for exposure time of 15 min., and the lowest (5.3 cm) from seed primed by ultrasonic irradiation at exposure time of 10 min. In another study conducted on 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.

D. Number of leaves per plant

Physical seed treatments also affected number of leaves significantly at 1% level of probability (Table 1). Mean comparisons indicated that highest number of leaves was developed per plant due to seed treatment by laser irradiation for exposure time of 10 min. Ultra-sonicated seeds as well as those seeds without any irradiation experienced lower leaves development per plant under greenhouse condition.

E. Root length

Effects of seed priming agents on root length of pot marigold was significant (Table 1). Comparison of means (Table 2) indicated that priming of pot marigold seeds with laser irradiation for exposure time of 10 min. increased root length by 8 cm against non-primed control. In our experiment root length of primed seeds with laser irradiation for 15 min., magnetic field for 5 min. and 10 min. were 26.3, 35.7, 29.3 cm respectively. Norfadzrin *et al.* (2007) showed that tomato and okra seeds irradiated by gamma rays, lead to their better growth of seedlings. Treating seeds with gamma irradiation may result in a significant increase in seedling length and vigor. Chaudhuri (2010) reported that in higher radiation dose of mamma ray, germination percentage of lentil crop reduced in addition to root and shoot length, while, in lower dose of gamma irradiation (i.e., 0.1 kGy), the measured traits were not significantly different against control.

Table 1: ANOVA for effects of physical treatments on primary growth attributes of marigold.

SOV	df	Leaf area	Number of leaves	Root length	Plant length	Root bulk	Dry weight of leaves
Treatment	9	1.27**	138.33**	189**	60.43**	355.89**	9.83**
Error	20	0.1	16.97	18.97	11.39	5.48	0.06
CV (%)	-	15.64	9.69	15.19	11.88	14.31	13.15

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

Table 2: Mean comparison of effects of physical seed priming agents exposure times on primary growth marigold.

Priming agents and duration of exposure	Number of leaves	Root length (cm)	Plant length (cm)	Dry weight of leaves (g)
magnetic field 5 minutes	23.0	35.7	19.5	2.87
magnetic field 10 minutes	23.3	29.3	18.3	0.60
magnetic field 15 minutes	13.3	24.0	21.3	5.50
Laser 5 minutes	20.0	29.7	15.8	4.66
Laser 10 minutes	35.7	41.7	16.8	3.04
Laser 15 minutes	20.7	26.3	11.0	0.53
Ultrasonic10 minutes	12.0	12.0	5.3	0.19
Gamma10 minutes	23.7	34.3	18.3	1.41
Beta10 minutes	19.3	25.7	16.0	0.69
Control	13.3	34.0	12.5	0.40
LSD 5%	6.93	7.37	5.71	0.42

F. Root bulk

Analysis of variance of the data on root volume is depicted in Table 1. It seems that seed priming agents may affect root bulk of marigold. Mean comparisons for root bulk also revealed that seeds treated with magnetic field for exposure times of 10-15 min. resulted in higher value for this trait, and the lowest from beta irradiation and ultrasonic wave both in exposure time of 10 min. Based on Kordas (2009) assay, physical treatments of spring wheat may lead to length and bulk of root as well as plant growth improvement.

G. Dry weight of leaves

Studied factors also significantly influenced dry weight of leaves of marigold (Table 1). Comparison of means (Table 2) indicated that priming of pot marigold seeds with magnetic field for exposure time of 15 min. increased leaf dry weight against check plots. Highest weight dry leaf was obtained when seeds primed with magnetic field under higher exposure time. Our results are in good agreement with those reports of (*Silvia* Neam and Marariu. 2012) on tomato. Also report results of Aladjadjiyan (2007) revealed that in seedlings from seed samples of corn and soybean under magnetic field treatments above-ground biomass of crop plants at 60 days after emergence increased significantly in comparison with control.

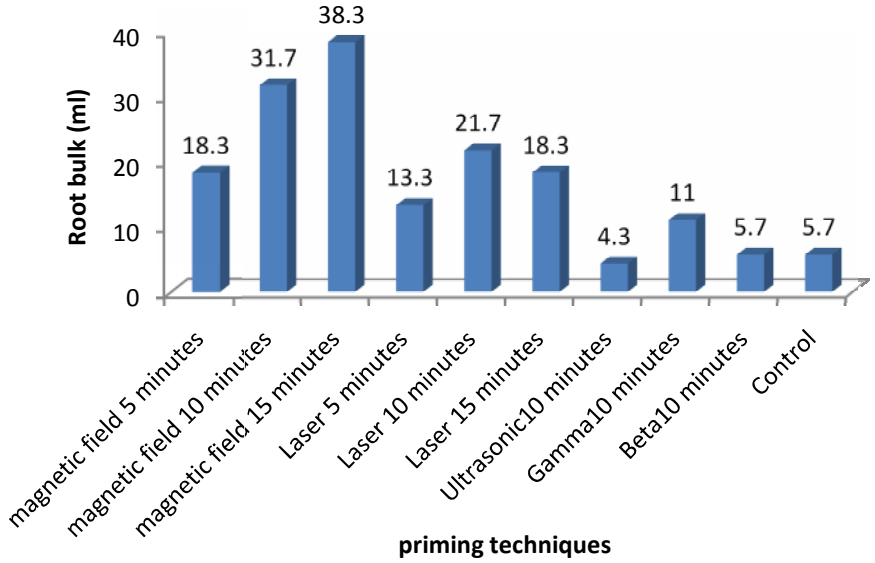

Fig. 2. Marigold seed root bulk as affected by different priming techniques.

CONCLUSION

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

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