Int. Agrophys., 2010, 24, 321-324

INTERNATIONAL
Agrophysics
www.international-agrophysics.org

Note

Influence of stationary magnetic field on lentil seeds

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Received February 16, 2010; accepted April 7, 2010

A b s t r a c t. The paper describes the investigation of magnetic field treatment on the development of lentil seeds. Stationary magnetic field has been used. The germination energy and germination, length of stems and roots, measured on the 7th and 14th day, as well as the total mass have been used in order to evaluate the effect of magnetic field treatment. The germination energy and germination of seeds have not shown significant differences between variants. The length of stems and roots, measured on the 7th and 14th day, as well as the total mass have shown dependence from the dose of treatment, better expressed for the parameters measured on the 14th day.

K e y w o r d s: magnetic field, stimulation, lentil seeds

INTRODUCTION

Recently the use of physical methods for plant growth stimulation is getting more popular due to the less harmful influence on the environment. The influence of magnetic field on plant development is studied rather intensively but still not enough deeply. The understanding of the stimulating effect requires availability of rich experimental material. This is the motivation of our study of the effect of stationary magnetic field on seeds of lentil.

Numerous authors have established the positive influence of the stationary magnetic field on the plant seeds. The treatment fastens plants development (Florez *et al*., 2007; Gouda and Amer, 2009), improves germination and seedling growth (Carbonell *et al*., 2008, Martínez *et al.*, 2009a), activates protein formation and enzymes activity (Atak *et al*., 2007; Racuciu *et al*., 2007; Çelik *et al*., 2009). The investigations have shown that the treatment of the seeds with magnetic field increases the germination of non-standard seeds and improves their quality (Pietruszewski *et al*., 2007). Experiments have been made with large range of plants: grain (Torres *et al*., 2008, Vashisth and Nagarajan, 2008; 2010), leguminous (De Souza *et al*., 2006; Martínez *et al*., 2009b; Podleśny *et al*., 2004, 2005), and perennials (Çelik *et al*., 2008; Dardeniz *et al*., 2006; Dhawi and Al-Khayari, 2009). There are significant differences in the induction B of investigated magnetic fields – from $B = 62$ µT (Odhiambo *et al*., 2009) to 250 mT (Vashisth and Nagarajan, 2010). Exposure times also vary largely.

One of the possible hypotheses for explanation of observed positive effect of magnetic treatment could be found in paramagnetic properties of some atoms in plant cells and pigments *ie* chloroplasts. In outer magnetic field magnetic moments of these atoms turn align the field. Magnetic properties of molecules determine their ability to absorb and then transform the energy of magnetic field in other kind of energy and to transfer this energy later to other structures in plant cells, thus activating them.

Many farmers recently demonstrate rising interest to the use of physical methods for plant stimulation because its convenience for biological farming. The aim of this investigation was to show the possibilities for using stationary magnet with enough space between poles for pre-sowing seed treatment.

MATERIALS AND METHODS

Seeds of lentil (*Lens Culinaris*, Med.,) have been used for investigating the influence of static magnetic field on the development of plants. The induction of magnetic field has been B =150 mT, measured with a digital Teslameter Systron - Donner. Magnetic-field-induction value has been chosen according to the opinion that weaker magnetic field has stronger effect on plant productivity. Seeds have been distributed in five variants and 5 replicate each one containing 10 seeds each. Seeds in each variant have been exposed to magnetic field treatment for different time: 0 min (control), 3, 6, 9, and 12 min.

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The experiments have been performed in February – March 2009 under laboratory conditions. Seeds have been preliminarily soaked in distilled water for 1 h, presuming that the intra-cell water, due to its magnetic properties, plays role in the absorption of the energy of magnetic field. After the treatment the lentil seeds were cultured in small plastic pots (∅ =7.5 cm and h = 8.8 cm) on wet cotton. The natural light cycle was 9 h – light/15 h – darkness with daily temperature 21±2°C and night temperature 15±2°C.

In order to estimate the influence of the magnetic field on lentil seeds next some criteria have been used:

– the germination energy (GE) of seeds (%), determined on the 4th day after the start of the experiment – as a ratio of the number of germinated to the total number of seeds for the corresponding variant;
– germination (G) of seeds (%), determined on 7th (8th) day as a ratio of the number of germinated to the total number of seeds;
– length of stems (SL) and main roots (RL) (mm) determined on the 7th and 14th day;
– total mass (TM) (mg) determined on the 14-th day.

Each variant has been performed in five repetitions with ten seeds in each. Data were statistically processed using the Fisher's dispersion analysis.

RESULTS AND DISCUSSION

The germination energy (GE) and the germination (G) are shown in Table 1 and Fig. 1. Both parameters show the highest values for non-treated samples. The values for all variants are enough high – not less than 80%. Differences between variances and control are not statistically significant.

The result is similar for the length of stem and root measured on the 7th day – values of treated samples are lower than the control (Fig. 2a). Differences between SL and RL for treated and non-treated samples for some exposure times are not statistically significant either.

The results for the measurements on the 14th day show more expressive differences. The stem lengths shown on Fig. 2b and the total mass on Fig. 3 have well expressed increase for the samples treated with magnetic field for 6 and 9 min.

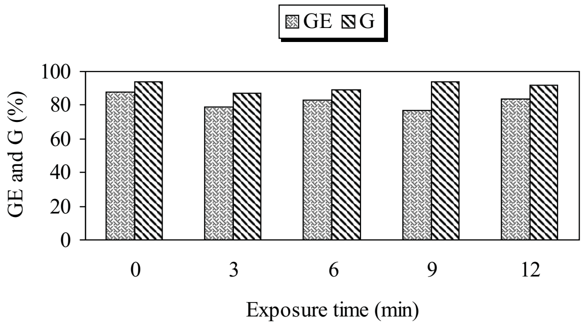


Fig. 1. Germination energy (GE) and germination (G) of lentil seeds exposed for different time to static magnetic field.

From the data in Table 1 one can notice that SL and RL on the 14th day for all the treated samples are longer than the control. Observed increase for SL, RL and TM in the case of 3 min exposure is respectively 40, 30% and no increase for TM; in the case of 6 min exposure, respectively 104, 98, and 11%; in the case of 9 min exposure, respectively 120, 102, and 12%; and in the case of 12 min exposure, respectively 12, 17 %, and no increase for TM. It have to be pointed out that only the length of the main root has been measured without taking into account the lateral roots.

Because of large variety of investigated seeds, used magnetic fields and chosen times of exposure in the literature, it was difficult to compare results obtained in this work with previously published ones. The closest to our experimental setting is that one of Martinez *et al*. (2009a). In their investigation lentil seeds have been treated with magnetic field with an induction of 125 mT, compared to 150 mT in this investigation. Some of exposure times described in their paper – 1 and 10 min, were the same range as in this experiment – 3, 6, 9, and 12 min. Given these coincidences we compared the results of this experiment only with the results in the mentioned paper of Martinez *et al*. (2009a).

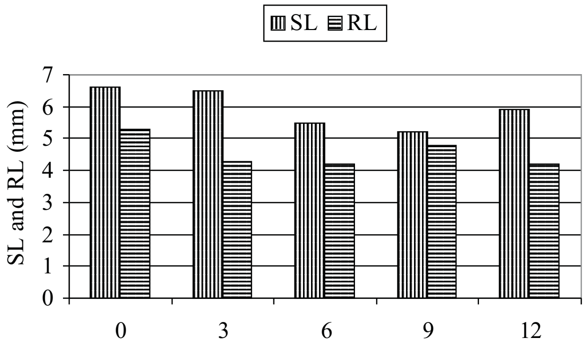
The results of their experiments reveal that on the 7th day the mean values of stem and total length of lentil plants exposed to dose D2 (10 min) and B = 125 mT were significantly greater than the control. In our experimental setting

T a b l e 1. Growth parameters of lentil seeds, exposed to magnetic field with intensity 150 mT (average value ± standard error)

Exposure time (min)	GE (%)	G (%)	7th day		14th day		
			SL (mm)	RL (mm)	SL (mm)	RL (mm)	TM (mg)
0	88±5.4	94±4.4	6.6±1.2	5.3±1.6	72.2±9.5	7.3±0.2	256±27
3	79±7	87±7.2	6.5±0.9	4.3±2.2	101±7 b	10.1±0.8b	255±27
6	82±6	89±6.6	5.5±0.9	4.2±1.6	147±10 a	16.5±0.8a	285±24
9	77±12	94±7.6	5.2±1.2	4.8±1.6	143±13 a	14.8±1.2a	286±24
12	84±5.7	92±5.4	5.9±0.9	4.2±1.2	81.5±8	8.6±0.8	244±29

a – $p < 0.001$, b – $p < 0.01$, c – $p < 0.05$.

a



b

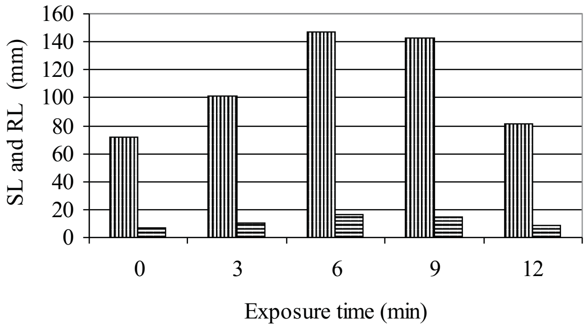


Fig. 2. Stem (SL) and root length (RL) of lentil seedlings exposed for different time to static magnetic field measured at the: a – 7th, and b – 14th days.

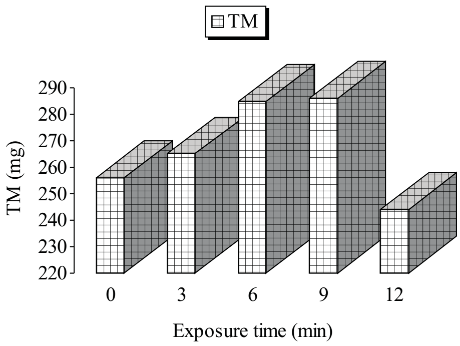


Fig. 3. Total mass (TM) of lentil seedlings exposed for different time to static magnetic field measured at the 14-th day.

similar result has been achieved on 14th day for seeds treated with dose 9 min at B = 150 mT (Figs 2b and 3 of Martinez *et al*. (2009a)).

Both in this experiment and in that of Martinez *et al.* (2009a), the smaller doses of magnetic treatment (1 min in theirs and 3 min in this) do not show stimulation effect compared with the control. In this experiments treatment with bigger dose – 12 min, generally shows worse results than the treatment for 6 and 9 min.

The selective effect of different doses of magnetic field treatment may be explained with ions properties. Ions in the cell have the ability to absorb magnetic energy corresponding to specific parameters related to their vibration and rotation energy sublevels. This phenomenon represents a kind of resonance absorption and could explain the stronger effect of applying definite values of magnetic field induction, observed by Aladjadjiyan (2002) and Martinez *et al*. (2009) as well as in the presented investigation.

CONCLUSIONS

1. Results obtained for lentil seeds allow to conclude that magnetic treatment improves the growth of plants. It can be recommended to farmers for improving plant performance and the yield.

2. The best treatment in this experimental setting with magnetic-field induction 150 mT has been achieved at exposure time 6 min and 9 min for the parameters measured on the 14th day.

3. The influence of stationary magnetic field is not well defined. Different plants could be sensitive to different combination of B and exposure time, thus further investigations of the nature of magnetic field stimulation are needed.

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