www.sospublication.co.in

Journal of Advanced Laboratory Research in Biology

We- together to save yourself society

e-ISSN 0976-7614

**Volume 3, Issue 1, January 2012**

**Research Article**

# Study the Response of Cucumber Plant to Different Magnetic Fields

A. Rezaiiasl[1], A. Ghasemnezhad[2*], S. Shahabi[1]

[1]*Institute of Agriculture Machinery, University of Agricultural Sciences and Natural Resources, Gorgan, Iran.*
[2*]*Institute of Horticultural Sciences, University of Agricultural Sciences and Natural Resources, Gorgan, Iran.*

**Abstract:** Magnetic fields (MF) are widely distributed in the environment and their effects are increasing due to various instruments that are used in industry and medicine. In the present experiment, the growth and productivity of cucumber plants of seeds in which affected by different magnetic fields was investigated. The soaked seed samples of cucumber were exposed to a 20μT AC magnetic field for 30 minutes. Similar seed samples also were treated with DC magnetic fields of 5μT for 30 min. To compare the effect of different magnetic fields, control samples with three replications were placed in gape out of magnetic field for 30 min. Results of study showed that the germination of seeds was significantly influenced by different magnetic fields depending on the days after treatment application. The first germinated seeds were observed two days after beginning of test in DC magnetic field (0.7 seed) treatment. In the last days of experiments (day ninth), no difference was observed among treatments. The growth behavior of seedling of cucumber affected by different magnetic field in comparison with control plants in greenhouse showed that seeds in which treated with AC magnetic field have better growth rate. The results of evaluation of plants in the field showed that parameters like fruit length (FL), the diameter of fruit (FMD), Fruit weight (FW), number of side stem (NSS), flower number (NF) and the number of flower per main stem were not significantly different at different times of experiment. Contrary to that, parameters such as the number of fruits per plant (NF) and the length of main stem (LMS) were significantly increased by time. Based on the obtained results of the germination, greenhouse and field trials it can be concluded that direct magnetic field stimulates seed germination and increases the growth rate and vigor of seedling especially at the beginning of germination. Generally, it can be indicated that the initial effect of magnetic field on the germination rate and the growth of seedling is very positive since it induces an improved capacity for nutrient and water uptake, providing greater physical support to the developing shoot.

**Keywords:** Magnetic field, Cucumber, Direct magnetic current, Alternative magnetic current.

## 1. Introduction

Magnetic fields (MF) are widely distributed in the environment and their effects are increasing due to various instruments that are used in industry and medicine. Results of the numerous experimental, epidemiological and theoretical studies are rather controversial and in all areas so far, no unanimous conclusions have been reached (Repacholi and Greenebaum, 1999). A potential link between MF and its effects on living organisms is the fact that MF causes an oxidative stress, that is, increase in the activity, concentration and lifetime of free radicals (Zhang *et al.*, 2003). The exact mechanism of the effect of magnetic field on living organisms is still unclear, but there are researches reporting that the adverse bio-effects of MF are usually mediated by production of free radicals or increase of their longevity in biological systems. Extensive research has revealed that the effects of magnetic treatments depend not only on the magnetic field strength and exposure period (Wittekind *et al.*, 1990) but also on the physiological condition of the organism involved and on the reigning environmental conditions (Weaver, 1993; Gutzeit, 2001). Magnetic

*Corresponding author:
E-mail: aghasemnajad@hotmail.com.

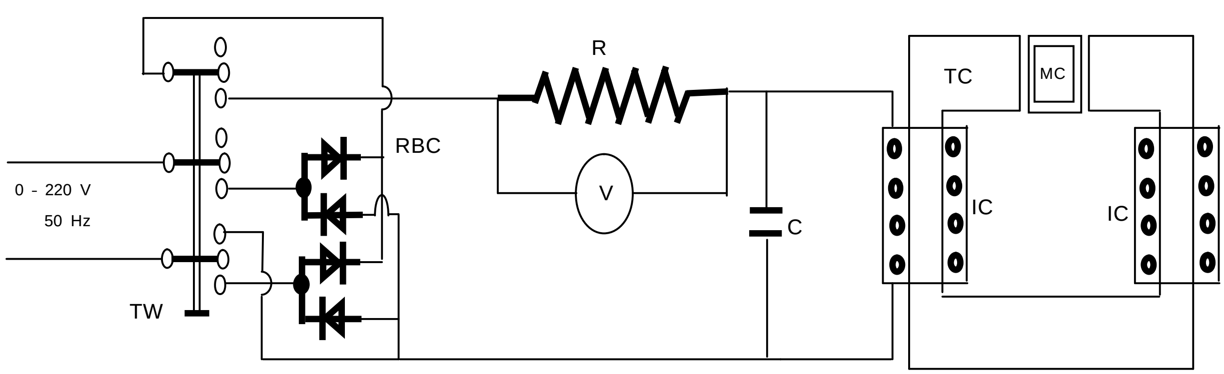
fields have been reported to exert a positive effect on the germination of seeds (Alexander and Doijode, 1995; Carbonell *et al*., 2000), on plant growth and development (De Souza *et al*., 1999; Martínez *et al*., 2000), on tree growth (Ruzic *et al*., 1998), on the ripening of fruits and vegetables and on crop yield (Pietruszewski, 1993). The increase in germination of seeds were magnetically treated was reported (Amaya *et al*., 1996, Aksyonov *et al*., 2001). A stimulatory effect on the first stages of growth of barley plants exposed to 125mT stationary magnetic field has been found by Martínez *et al*., (2000). Increases in rate of germination and growth were also obtained for maize seeds. Treated plants grew higher and heavier than the control, the greatest increased were obtained for plants exposed for 24 h and continuously exposed (Flórez *et al*., 2007). The goal of the present research was to study the response of cucumber plants in which their seed affected by magnetic fields as pre-germination treatments.

## 2. Material and Methods

Fig. 1 illustrates the experimental setup of the magnetic field for seed treatment. The magnetic field treating system consists of a rectangular-type iron core and coils (800 turns, 2mm$^2$) for various magnetic field inductions. An adjustable air gap spacing of 70mm was set in the center of the upper part of the core, where the Petri dishes were inserted. The magnetic flux density (B*)*, in the cell, was varied $B = 20\mu T$ for alternative current (AC) magnetic field and $B = 5\mu T$ for direct current (DC) magnetic field.

The inductance and the resistance of the magnetic field induction coil set were measured by an LCR meter (Ando Electric, AG-4311B) to be 850mH and 4Ω), respectively. One capacitor(c) of 60μF connected in parallel with the induction coil of the core was used for power factor compensation. The magnetic flux density in the gap spacing of the treatment cell was measured by a digital Tesla meter (3D EMF TESTER, EMF 828). The seed samples were exposed to the AC and DC magnetic fields with correspondingly equal rest periods following each field treatment time. AC or DC magnetic fields were selected using a three-phase Two-way switch. DC voltage in coil obtained using a Rectifier Bridge Construction (RBC). The dependent voltages from 0 to 220 V/50H produced by a variable transformer located before Two-way switch. The soaked seed samples of cucumber were exposed to a 20μT AC magnetic field for 30 minutes. Similar seed samples also were treated with DC magnetic fields of 5μT for 30 minutes. To compare the effect of different magnetic fields, control samples with three replications were placed in gape without magnetic field for 30 minutes. Germination test of the seed samples carried out immediately after treatments. Per each treatment, three replications containing seven seeds were placed and put in laboratory conditions for germination. In a period of 10 days, the germinated seeds were recorded and the obtained data analyzed using SPSS 17 software. The germinated seeds were transferred to cup pots to evaluate the growth behavior of plantlets. One week after growing of plantlets in a greenhouse the transplant planted in the field based on a randomized complete block design. In the field and during the growth of plants the yield and yield parameters of cucumber including fruit length (FL), the diameter of fruit (FMD), Fruit weight (FW), number of side stem (NSS), flower number (NF), the number of flowers per main stem, the number of fruits per plant (NF) and the length of the main stem (LMS) were recorded. Obtained data of all experiments were analyzed using SPSS 17 software.

**Fig. 1. Schematic diagram of experimental setup.**




R: resistor; C: capacitor; RBC: Rectifier Bridge Construction
IC: induction coil; MC: magnetic cell; TW: Two-Way switch three-phase; TC: transformer core; V: voltmeter

## 3. Result and Discussion

### 3.1 Seed germination

From the Table 1, it can be seen that the germination of seeds was significantly influenced by different magnetic fields depending on the day after treatment application. The first germinated seeds were observed two days after beginning of the test from the seeds in which treated with DC magnetic field (0.7 seed). Three days after beginning the test, the number of germinated seeds of the control samples and the samples in which treated whit AC magnetic field were equal and lower than that of seeds in which treated with DC magnetic field. The significant difference in the number of germinated seeds of different treatments was observed four days after beginning of an experiment, in which the number of germinated seeds of samples in which treated with AC, was significantly lower than that DC sample. However, statistically, no difference was observed between DC and controlled samples (Table 1). In fourth and fifth days, the same tendency was observed. Nine days after experiment beginning no significant difference was observed among treatments.

A stimulatory effect on the first stages of growth of barley plants exposed to 125mT stationary magnetic fields has been found by Martinez *et al*., (2000). Flórez *et al*., (2004) observed a higher germination rate of treated seeds according to a higher length and weight of rice plants exposed to 125 or 250μT stationary magnetic field for different periods of time varying from 10 min. to chronic exposure. The mechanism how magnetic field influences seed germination is not clear. The increase in germination when seeds were magnetically treated could be explained by better availability and absorption of nutrients. Results of other researchers also showed that Magnetic field treatment of seeds leads to accelerating of plant growth, protein biosynthesis and root development (Phirke and Umbarkar, 1998; RÃCUCIU *et al*., 2006).

**Table 1. Germination of cucumber seeds affected by different magnetic fields.**

| | 1 Day | 2 Day | 3 Day | 4 Day | 5 Day | 6 Day | 7 Day | 8 Day | 9 Day |
|---|---|---|---|---|---|---|---|---|---|
| **Control** | 0 | 0.0a | 1.0a | 2.7a | 3.3ab | 4.0ab | 5.0a | 5.7b | 6.7a |
| **AC** | 0 | 0.0a | 1.0a | 1.7b | 2.7b | 3.3b | 4.3b | 5.0b | 6.3a |
| **DC** | 0 | 0.7a | 1.7a | 3.0a | 4.0a | 5.0a | 5.7a | 7.0a | 7.0a |
| **p-value** | 0 | .079 | .079 | .031 | .037 | .003 | .037 | .001 | .296 |

**Table 2. The growth of seedlings of cucumber (mm) affected by different magnetic flows.**

| | Day one | Day two | Day three | Day four | Day five | Day six | Day seven |
|---|---|---|---|---|---|---|---|
| **Control** | 0.00 | 2.78 | 8.01 | 14.32 | 20.68 | 25.73 | 31.08 |
| **AC** | 0.00 | 7.60 | 13.81 | 20.44 | 26.39 | 31.58 | 36.12 |
| **DC** | 0.00 | 5.15 | 11.24 | 16.78 | 21.64 | 26.49 | 27.50 |
| **p-value** | | 0.54 | 0.116 | 0.175 | 0.095 | 0.025 | 0.001 |

**Table 3. Effect of different magnetic flow on yield and yield components of cucumber in two different harvest times.**

| Time | T | FL | FMD | FW | NSS | NF | LMS | FMS |
|---|---|---|---|---|---|---|---|---|
| | Control | 16.17 | 39.89 | 168.06 | 3.67 | 15.33 | 70.67 | 1.00 |
| **T1** | AC | 16.79 | 38.41 | 157.45 | 3.33 | 13.00 | 84.00 | 3.00 |
| | DC | 12.65 | 24.07 | 54.55 | 1.33 | 10.50 | 93.33 | 2.33 |
| | Control | 15.54 | 40.78 | 159.97 | 1.17 | 6.67 | 55.00 | 1.17 |
| **T2** | AC | 11.63 | 25.50 | 111.28 | 1.17 | 10.17 | 75.83 | 1.50 |
| | DC | 14.13 | 24.25 | 59.51 | 0.50 | 6.67 | 57.67 | 1.83 |
| | Control | 15.87 | 37.88 | 156.55 | 1.67 | 11.33 | 55.50 | 1.17 |
| **T3** | AC | 16.76 | 38.95 | 149.84 | 1.67 | 8.83 | 79.83 | 1.33 |
| | DC | 8.71 | 18.25 | 48.36 | 0.75 | 6.83 | 70.42 | 1.67 |
| **T1** | | 15.86 | 39.52 | 161.53 | 2.17 | 11.11 | 60.39 | 1.11 |
| **T2** | | 15.06 | 34.29 | 139.52 | 2.06 | 10.67 | 79.89 | 1.94 |
| **T3** | | 11.83 | 22.19 | 54.14 | 0.86 | 8.00 | 73.81 | 1.94 |
| | Control | 15.20 | 34.12 | 126.69 | 2.78 | 12.94 | 82.67 | 2.11 |
| | AC | 13.77 | 30.18 | 110.25 | 0.94 | 7.83 | 62.83 | 1.50 |
| | DC | 13.78 | 31.69 | 118.25 | 1.36 | 9.00 | 68.58 | 1.39 |
| | Time | 0.18 | 0.15 | 0.49 | 0.11 | 0.00 | 0.00 | 0.18 |
| **p-value** | T | 0.32 | 0.14 | 0.18 | 0.03 | 0.84 | 0.70 | 0.76 |
| | Time*T | 0.60 | 0.81 | 0.89 | 0.84 | 0.93 | 0.47 | 0.43 |

FL= Fruit length; FMD = the diameter of fruit; FW = Fruit weight; NSS = number of side stem; NF = flower number; LMS = length of main stem; FMS = flower per main stem.

### 3.2 Seedling growth

The growth behavior of seedling of cucumber affected by different magnetic field in comparison with control plants in greenhouse showed that seeds in which treated with AC magnetic field have better growth rate.

As it can be seen from Table 2, although no significant difference was observed among the growing rates of seedlings of different magnetic fields and control till five days of germination, the seedling of the AC field tended to grow better. Results showed that the growth of seedlings of cucumber in which was treated with AC magnetic field was significantly higher than those of AC field and controls.

### 3.3 Yield and yield components of cucumber

Results of analysis of data showed that most of parameters related to yield were not significantly different under different magnetic fields. As demonstrated in Table 3, parameters like fruit length (FL), the diameter of fruit (FMD), Fruit weight (FW), number of side stem (NSS), flower number (NF) and the number flower per main stem were not significantly different at different times of the experiment. Contrary to that, parameters such as the number of fruits per plant (NF) and the length of main stem (LMS) were significantly increased by time. Plants, which were treated with different magnetic field in most cases except the number of side stem per plant (NSS), were not significantly influenced. No interaction was observed between treatments at different times.

Although in most cases no significant difference between different magnetic fields on plant growth in field conditions was observed, the effect of magnetic field on seed germination and the growth of plantlet in greenhouse confirm the found of other researchers. The initial positive effects of magnetic field on seedling growth are very positive since they appear to induce an improved capacity for nutrient and water uptake, providing greater physical support to the developing shoot and finely formed flower and fruits. Increasing the number of side stem per plant in field conditions of cucumber plant affected by magnetic field can enhance the number of leaves and leaf area in which directly related to the photosynthetic rates. Due to the greater interception of light and the greater amount of assimilates available for vegetative growth, a higher photosynthetic rate increase vegetation growth and subsequent reproduction in which resulted to the higher cucumber yield (De Souza *et al*., 2005). A positive effect of magnetic treatment on the leaf thickness of tomatoes in which leading to a noticeable increase in the thickness of the spongy tissue, and in the length and width of chlorophyll-containing cells, and the upper and lower epidermal cells, has been reported by Socorro *et al*., (1999). Generally, it can be indicated that the initial effect of magnetic field on the germination rate and the growth of seedling is very positive since it induces an improved capacity for nutrient and water uptake, providing greater physical support to the developing shoot. On the other hand, the better root growth and development in young seedlings affected by magnetic field might lead to better root systems throughout the lifetime of a plant. The enhancement in leaf area and leaf dry weight in the plants derived from the treated seeds must have increased photosynthetic rates due to the greater interception of light and the greater amount of assimilates available for vegetative growth.

## References

[1]. Alexander, M.P., Doijode, S.D. (1995). Electromagnetic field, a novel tool to increase germination and seedling vigour of conserved onion (*Allium cepa* L.) and rice (*Oryza sativa* L.) seeds with low viability. *Plant Genetic Resources Newsletter*, 104: 1-5.

[2]. Aksyonov, S.I., Bulychev, A.A. and Grunina T.Y. Goryachev, S.N., Turovetsky, V.B. (2001). Effects of ELF-EMF treatment on wheat seeds at different stages of germination and possible mechanism of their origin. *Electro- Magnetobiol.*, 20: 231-253.

[3]. Amaya, J.M., Carbonell, M.V., Martínez, E. and Raya, A. (1996). Effect of stationary magnetic field on growth and germination of seeds (in Spanish). *Agricultura*, 773: 1049-1064.

[4]. Carbonell, M.V., Martínez, E., Amaya, J.M. (2000). Stimulation of germination in rice (*Oryza sativa* L.) by a static magnetic field. *Electro-Magnetobiol.*, 19(1): 121-128.

[5]. De Souza, A., Casate, R., Porras, E. (1999). Effect of magnetic treatment of tomato seeds (*Lycopersicon esculentum* Mill) on germination and seedling growth [in Spanish]. *Invest. Agr. Prod. Prot. Veg.*, 14(3): 437-444.

[6]. Flórez, M., Carbonell, M.V. and Martínez, E. (2007). Exposure of maize seeds to stationary magnetic field: effects on germination and early growth. *Environ. Exp. Botany*, 59: 68-75.

[7]. Ghanati, F., Abdolmaleki, P., Vaezzadeh, M., Rajabbeigi, E., Yazdani, M. (2007). Application of magnetic field and iron in order to change medicinal products of *Ocimum basilicum*. The *Environmentalist*, 27:429–434.

[8]. Gutzeit, H.O. (2001). Biological effects of ELF-EMF enhanced stress response: new insights and new questions. *Electro- Magnetobiol.*, 20(1): 15-26.

[9]. Martinez, E., Carbonell, M.V. and Amaya, J.M. (2000). A static magnetic field of 125mT stimulates the initial growth stages of barley (*Hordeum vulgare* L.). *Electro- and Magnetobiology*, 19(3):271-277.

[10]. Repacholi, M.H., Greenebaum, B. (1999). Interaction of static and extremely low frequency electric and magnetic fields with living systems:

Health effects and research needs. *Bioelectromagnetics*, 20:133–160.

[11]. Rãcuciu, M., Creangã, D., Horga, I. (2006). Plant growth under static magnetic field influence. National Conference on Applied Physics, June 9–10, 2006, Galati, Romania.

[12]. Pietruszewski, S.T. (1993). Effect of magnetic seed treatment on yields of wheat. *Seed Sci. Technol.*, 21: 621-626.

[13]. Phirke, P.S., Umbarkar, S.P. (1998). Influence of magnetic treatment of oilseed on yield and dry matter. *PKV Research Journal*, 22(1): 130–132.

[14]. Socorro, A., Gil, M., Labrada, A., Díaz, C., Lago, E. (1999). Cell model of seed tissue treated with magnetic field. II International Symposium on Applied Nuclear and Related Techniques in Agricultura, Industry and Environment, La Habana, Cuba, 26-29 October.

[15]. Weaver, J.C. (1993). Combined environmental exposures to chemicals and transient magnetic fields: a hypothesis for possible human health hazards, BEMS Sixteenth Annual Meeting, Copenhagen June 12-16, 1993. *Abstract book*. The Bioelectromagnetics Society, Copenhagen, Denmark, pp. 36.

[16]. Wittekindt, E., Broers, D., Kraepelin, G., Lamprecht, I. (1990). Influence of non-thermic AC magnetic fields on spore germination in a dimorphic fungus. *Radiat. Environ. Biophys.*, 29: 143-152.

[17]. Zhang, Q.M., Tokiwa, M., Doi, T., Nakahara, T., Chang, P.W., Nakamura, N., Hori, M., Miyakoshi, J., Yonei, S. (2003). Strong static magnetic field and the induction of mutations through elevated production of reactive oxygen species in *Escherichia coli* soxR. *Int. J. Radiat. Biol.*, 79:281–286.