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Research Article

The Influences of Extremely Low Frequency AC Magnetic Fields At 60Hz on Mung Beans Growth

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ABSTRACT: There are many reports about the biological effects of extremely low frequency magnetic fields (ELF MFs),but few of them investigate how different intensity MFs act upon the growth of living organisms. This study aims to assess the influences of the different intensity of ELF MFs on the early growth of living organisms using mung beans as test materials. We used 60Hz 110Vrms AC electric power as the source and made a toroidal magnetic coil by self for this experiment. The ELF MF is induced using a magnetic circuit with a toroidal magnetic coil and a 60W lamp in series, which is driven by 60Hz 110V AC electric power, the maximum intensity of ELF MF is 950mG. To utilize the magnetic field intensity decay when distance increase, to choose the three kinds different magnetic field intensity (such as 875mG,155mG and 1.8mG rms value). We used three groups of mung beans (each group is 50 beans) were exposed to the three kinds different magnetic field intensity separately, and observed the lengths of stems and leaves of mung beans after five days growth. The results indicate that the magnetic field intensity is 875mG and 155mG have an enhancing effect on the early growth of mung beans. [Journal of American Science 2009: 5(1), 49-54] (ISSN: 1545-1003)

Key words: ELF MF; biological effect,AC electric power,mung bean

1. INTRODUCTION

Because popularization of electricity and modernization of life, to place in the electric power line generally and use home electrical appliances frequently on the human inhabitancy space, there are ELF MFs produced also exists around the living space. We used a magnetic meter (TES-1390 ELF Magnetic Field Meter, Bandwidth:50~300Hz,TES Electrical Electronic Crop. made in Taiwan) to measure the root mean square value of ELF MF intensity of home electrical appliances such as hairdryer, desk lamp, razor, etc. We can get magnetic field intensity greater than 100mG (rms value), when to measure home electrical appliances closely (5cm to 10cm away). Because most countries adopt the reference levels which were announced by ICNIRP in 1998 for general public exposure to time-varying electric and magnetic fields as the standard. The formula of reference level for general public is 50/f (f is the frequency ,unit:KHz), the reference level is 833mG when f is 60Hz. For understanding the biological effect of different kinds magnetic field intensity, we made a toroidal magnetic coil by self, the coil produced the maximum ELF MF intensity is 950mG. To utilize the magnetic field intensity decay when distance increase, to choose the three kinds different magnetic field intensity (such as 875mG,155mG and 1.8mG rms value). We exposed

test materials (mung beans) in the three kinds different magnetic field intensity, and observed different magnetic field intensities act upon the early growth of test materials.

2. MATERIALS AND METHODS

2.1 Plant material

Mung beans were used as the test subject in this study. We selected 150 mung beans of almost the same weight (0.09 g) and similar appearance, so that the sample error can be greatly reduced, and divided into three groups of 50 mung beans. Two groups of them are grown in a magnetic field (exposed group 1 under higher magnetic intensity and exposed group 2 under lower magnetic field intensity), and the other group is placed in an ambient weak magnetic field (control group). We used a rectangular culture plate (dimension is 47×27× 3.5cm) which was spread the fine sand of depth 3cm to grow three groups of mung beans together. The environmental parameters of three groups that were maintained in the test room were almost the same, and the light was supplied by white fluorescent lamps .The close environmental parameters of three groups can be achieved so that the growth difference between them only comes from the magnetic field variable. The environmental parameters such as temperature is 28±2℃, humidity is 60±6% ,illumination is 1120±50LUX(day) and 563LUX(night).

2.2 Exposure System

The purpose of this study is mainly to assess the influence on the early growth of mung beans exposed to the different magnetic field intensities. The equipment needed in this experiment included a 60-Watts incandescent lamp, a toroidal magnetic coil, an oscilloscope/ frequency analyzer, etc. In order to produce the environment of higher magnetic intensity, we made a toroidal magnetic coil with air gap by self is shown in Figure 1.

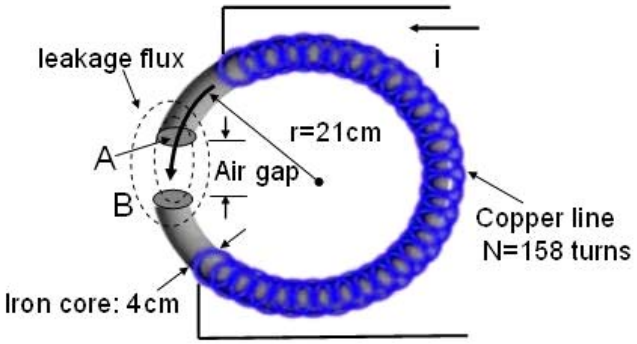


Fig 1: The toroidal magnetic coil with air gap

We entwined Iron wire (cross-section diameter =2mm) to become a toroidal iron core with diameter of 21cm and a 9 cm air gap (cross-section diameter=4cm). The core was wound 158 turns with copper wire (cross-section diameter =2mm) to become a toroidal magnetic coil. The magnetic flux density (B) circulating in the coil and air gap can be theoretically expressed in the following equations:

$$B = \frac{Ni}{RA}, \qquad R = \frac{l_c}{\mu A} + \frac{l_g}{\mu_0 A}$$

where R is total magnetic reluctance of the core and air gap, μ and μ_0 are the magnetic permeability of the core and air respectively (μ ~5000 μ_0), A is the cross-section area of the toroidal iron core, N is the

number of turns of coil, i is the current flowing through the coil, lc and lg are the core circumference and air gap distance, respectively. The exposure system is shown in Figure 2. We used 60Hz 110Vrms AC electric power as the source and a 60-Watts incandescent lamp as the load, and covered on lamp with an iron bucket to hide the light of lamp, to avoid other interference for mung beans growth.

We measured the highest magnetic field intensity of the air gap of coil is 950mG. The air gap of coil was to be placed the mung beans of exposed group one. In order to get more experimental data for statistics, we used 50 mung beans of each group which were put on culture plate will take larger area. Because the magnetic field intensity decay when distance increase, we measured the magnetic field intensity of the relative position of each group on culture plate is shown in Figure 2. We got more accurate data were the magnetic field intensity of exposed group one is 875±75mG, exposed group two is 155±55mG, control group is 1.8±0.8mG.

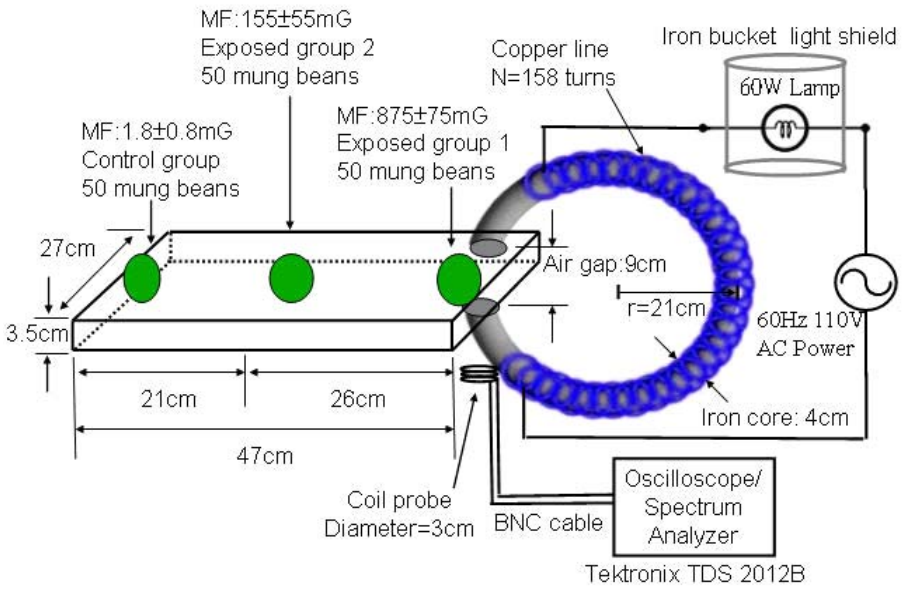


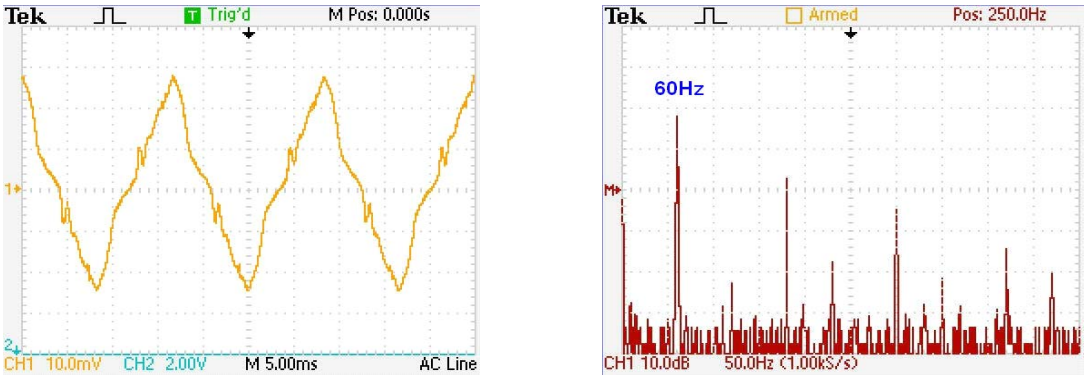
Fig 2: The exposure system of this experiment

The MF source came from the toroidal magnetic coil that was driven by the 60Hz 110V AC electric power. To measure the waveform and spectrum of the ELF MF, we used a little probe coil of diameter 3cm (Misakian, 1993) to induce an electromagnetic force close to the coil . The probe was connected to an oscilloscope/frequency analyzer (Tektronix TDS2012B, Bandwidth:100MHz) to obtain the components of 60Hz 110V AC electric power magnetic field in time and frequency domain are shown in Figure 3 a and b. We found the waveform of 60Hz 110V AC electric power is distortion and the frequency spectrum with harmonics.

2.3 Methods

We prepared three cylindrical containers with diameters of 5cm and poured into 50ml distilled water, then put three groups of mung beans in the cylindrical container, respectively. We moved three cylindrical containers in the positions of rectangular culture plate be shown in Figure 2. After the three groups of mung beans have been imbibing water for 8 hours, so dehydrated beans were simply rehydrated to allow enzyme reactivation, they

were taken out. The three cylindrical containers were removed and three groups of beans were put back in their original positions of culture plate to continue growing, and then were sprayed into appropriate distilled water by a sprinkler every 12 hours. Because three groups of mung beans grew on culture plate together, so the environmental parameters of three groups were almost the same. After mung beans have been growing for 5 days are shown in Figure 4, three groups of mung bean sprouts were taken out, in general mung bean sprout have two leaves, and the stem length and leaves length of each mung bean sprout was measured.



(a) (b)

Fig 3: (a) The waveform of 60Hz 100V AC electric power magnetic field is distorted sine wave. (b) The frequency spectrum of 60Hz 100V AC electric power have harmonics, the measured bandwidth of analyzer is 500Hz.

3. RESULT

We observed the growth of two exposed groups was faster than the growth of control group during 5 days. The average stem lengths and average leaf lengths of each group mung bean sprouts were recorded are shown in Figure 5. We analyzed experimental data by statistical method are shown in Table 1. The average stem lengths of mung bean sprouts exposed to 875±75mG and 155±55mG ELF MF were great than those of control mung bean sprouts ($P<0.01$,one-tailed paired sample t-test). The average leaf lengths of mung bean sprouts exposed to 875±75mG and 155±55mG ELF MF were great than those of control mung bean sprouts ($P<0.01$, one-tailed paired sample t-test), too. We can find an enhancing effect on the growth of mung bean is exposed under 875±75mG and 155±55mG ELF MF. Otherwise, there is no significant different between the exposed group one and exposed group two mung beans ($P>>0.05$, one-tailed paired sample t-test).

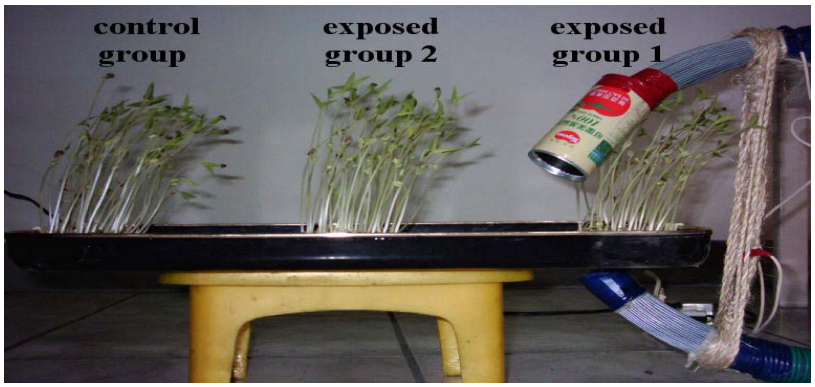


Fig 4: The early growth of exposed 1,exposed 2 and control group mung beans after five days

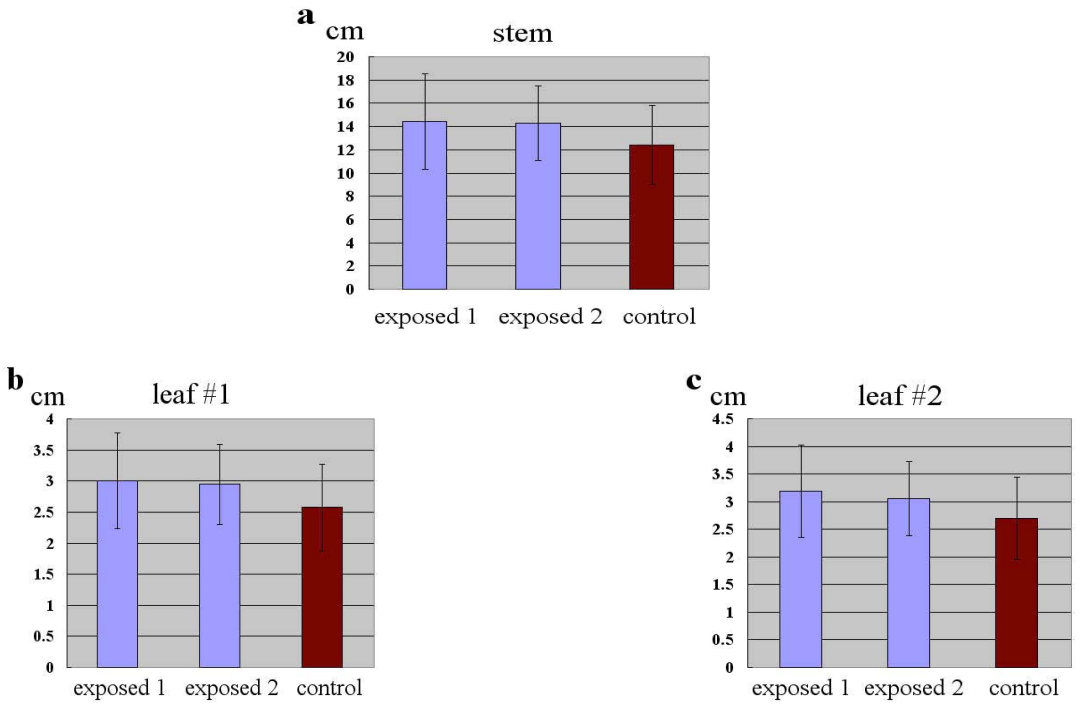


Fig 5 a: The average stem lengths of each group mung beans. b: The average lengths of first leaf of each group mung beans. c: The average lengths of second leaf of each group mung beans.

Table 1

The statistical analysis of three groups mung beans growth

statistics	analyze exposed 1 and control group	analyze exposed 2 and control group	analyze exposed 1 and exposed2 group
P value for stem	0.0054	0.0043	0.4213
P value for leaf#1	0.0025	0.0039	0.3709
P value for leaf#2	0.0017	0.0088	0.2156

4. DISCUSSION

According to the reference levels which were announced by ICNIRP in 1998 is 833mG (f=60Hz) for general public exposure to time-varying electric and magnetic fields, to prevent the influence that may cause to the nervous function of human. However, the experiment results show that the magnetic field intensity is 875±75mG and 155±55mG have an enhancing effect on the growth of mung beans (Smith,1993;Davies,1993; Soja,2003 ;Huang,2007). So, the growth of plant would be modified when plant exposed ELF MF intensity above 100 mG for a long time. The enhancing influence is abnormal phenomenon for growth of plant, because the motion of Ca^{++} ion on the cells of plant is changed (Lednev,1991;Smith,1993). Therefore, we worry about body health would be influenced when human exposed ELF MF intensity above 100 mG for a long

time. We can get magnetic field intensity greater than 100mG (rms value), when to measure home electrical appliances closely (5cm to 10cm away). To use home electrical appliances closely then we would expose higher magnetic field intensity, maybe influence the health of human body. So should avoid exposing ELF MF intensity above 100 mG for a long time in order to reduce the biological effect of extremely low frequency magnetic fields. For electrical appliances and high-voltage line can induce higher magnetic field, we should keep the appropriate distance to protect the health of human body.

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