Influences of Extremely Low Frequency Electromagnetic Fields on Germination and Early Growth of Mung Beans

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***Abstract*-- This study aims to assess extremely low frequency electromagnetic field (ELF-EMF), which is similar to Schumann resonance (SR) frequency. Schumann resonance frequency which is part of the geomagnetic field frequency, affects to mung beans to increase germination rate and early growth. The aim of the study is to evaluate the effects of SR ELF-EMF on mung beans germination rate and growth rate. SR ELF-EMF pretreatment increases the germination rate since the applied SR ELF-EMF promotes level of Ca^{2+} and K^{+} contents. Three groups of mung beans were exposed by SR ELF-EMF of 0.3 mT at swapped frequency 7.83 Hz ±0.1Hz. The experiment results show that germination rates of experimental groups with SR ELF-EMF exposing have 8% to 23.3% higher than control groups. Moreover, the length of stem of the experimental groups have the maximum 14% longer than control groups after 72 hours growth.**

Keywords: extremely low frequency electromagnetic field (ELF-EMF), Schumann resonance frequency, germination rate

I. INTRODUCTION

The commercial crops, such as soybeans and mung beans, are important in many countries. However, agricultural productivity has usually affected by weather and environment pollution. Therefore, improve growth conditions and quantity of output is a critical issue. Plants and other living things interact with magnetic field in daily life. The geomagnetic field involves continuous extremely low frequency (ELF). Resonant oscillations in the ionosphere of the Earth and oscillations in the plasmasphere and the magnetosphere is called the Schumann resonance [1,2], and reside approximately on 100, 21, 14.1, 7.8, 5.7, 4, 1, 0.1 and 0.001 Hz [3]. The most common geomagnetic frequency is 7.8 Hz. There also studies show that the geomagnetic resonating oscillation between earth's surface and ionosphere occurs at a frequency approximately 7.83 Hz [4]. Plants, animals and humans living in such environment are known to benefit from it [3,5]. Recent years, the biological effects of extremely low frequency electromagnetic field (ELF-EMF) on living organisms had been explore in many studies.

Researches in recent years have shown that magnetic field treatment on seeds and plants promotes plant growth and quantity output. EMF probably affects the signal transduction mechanisms in the cell membrane and the cellular levels of calcium [6]. EMF has stimulatory effects that depend on plant species, treatment duration and EMF intensity [7].

The ELF-EMF exposure on soybeans affects the stem length and germination rate [8]. The mechanism of ELF-EMF treatment is to change the electrostatic balance of the plant cell membrane Ca^{2+} and K^{+} ion level. According to the extremely low energy impact of low-intensity ELF-EMF, it is difficult to cause radiation damage on cells of living organisms, such as DNA damage and genetic mutations [9,10]. In this research, we develop an ELF-EMF system to transmit SR frequency and help to observe germination rate of mung beans. This study aim to provide further experimental evidence for bio-effects of weak SR ELF-EMF on plant seeds responses.

II. EXPERIMENTAL

As the block diagrams shown in Fig.1, the SR ELF-EMF system contains a signal generator, a power amplifier, a system power and a coil. The signal generator of the SR ELF-EMF system includes a microprocessor (C8051F983, Siliconlab) and outputs $5V_{dc}$ square waveform in adequate frequency as the driving signal to the power amplifier. The power amplifier consist a NMOS (2N7002, Willas) transistor. Then, the power amplifier boosts the driving signal to $12V_{dc}$ and drives the coil (300 T, Φ0.1 mm) to output a SR magnetic field. The driving current for the coil is about 20 mA to generate 0.3 mT intensity of EMF. The mung beans been selected as the test subject and were divided into two groups, one is the experimental group and the other one is the control group. There are three rounds of experiment in this study. All mung beans have similar appearance and same weight in 0.06g. The environmental conditions such as temperature and humidity of three rounds of experiment are list in Table I.

Table I
Experimental conditions

	Round 1	Round 2	Round 3
Temperature(℃)	25.4±0.1	25.9±0.1	24.9±0.1
Humidity (%)	45±1	40±1	44±1

The ELF-EMF pretreatment to the experimental group of mung beans for increasing seeds germination rate. There are four steps including: (1) put the seeds in front of the ELF-EMF coil device; (2) SR ELF-EMF pretreatment to seeds; (3) seeds to germination; (4) calculate seeds germination rate. First, SR ELF-EMF system outputs square sweep frequency (7.83 Hz ± 0.1Hz, 12Vdc) EMF to the coil. Secondly, the SR ELF-EMF pretreats to mung beans. Each group has 50 pcs of mung beans.

The seeds that stored for over one year were select for this experiment. The mung beans been exposed under the SR ELF-EMF for 15 days. Thirdly, the seeds of experimental group and the control group placed into the culture dish to germinate for 72 hours. Finally, seeds germination rate is calculated.

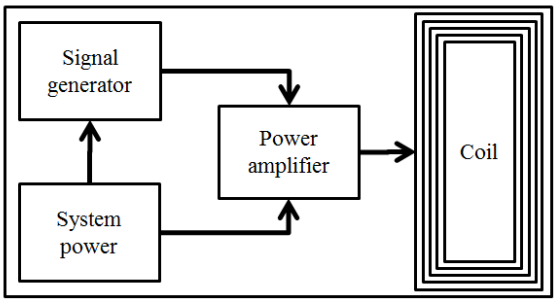

Fig.1 Block diagram of the ELF-EMF system

III. RESULTS AND DISCUSSION

Figure 2 shows the experimental environment of mung beans germination. Figure 3 and 4 show the experimental results about germination rates and growth length of three rounds of experiments. As shown in Fig.3, when mung bean seeds pretreated by the SR ELF-EMF for 15 days, the germination rates have 8%, 8% and 23.3% higher than the control group respectively at the 72th hour. In Fig.4, the experimental results show that experimental group has longer growth length than the control group. Therefore, mung beans which pretreated by the SR ELF-EMF for 15 days have better growth than the control groups. Therefore, the SR ELF-EMF pretreatment increases the germination rate since the applied SR ELF-EMF promotes level of Ca^{2+} and K^{+} contents.

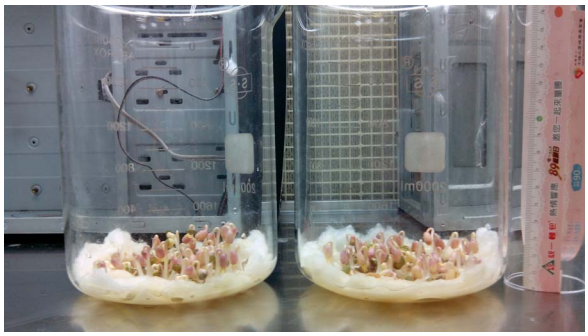

Fig.2 The experimental environment.

IV. CONCLUSIONS

The experimental results show that germination rate accelerated about 8 to 23.8% when mung beans pretreated under the SR ELF-EMF. According to the experiment results, these SR ELF-EMF seed pretreatment method can provides higher seed germination rate. The Schumann resonance frequency has claimed to be extremely helpful to existence of the biological cycle phenomenon of plants, animals and humans living. In the future, the SR ELF-EMF seed pretreatment system will increase farming efficiency for agriculture applications.

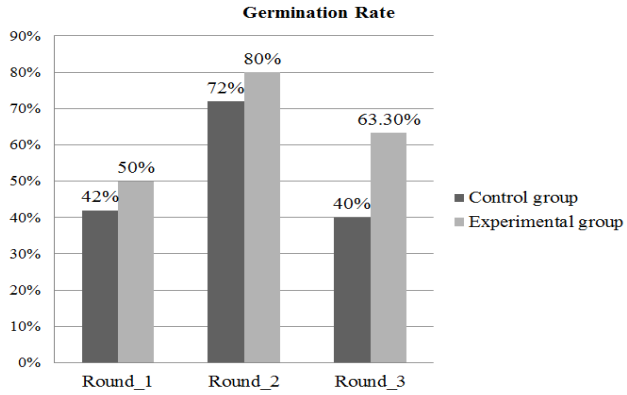

Fig.3 Experimental results of mung beans germination rate.

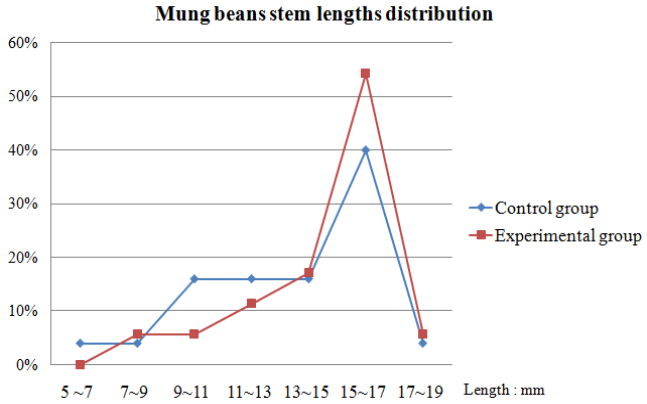

Fig.4 The mung beans lengths distribution.

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