

# Effect of Electromagnetic Fields on Structure and Pollen Grains Development in *Chenopodium album* L

Leila Amjad, and Mahsa Shafighi

**Abstract**—The role of the pollen grain, with to the reproductive process of higher plants, is to deliver the spermatic cells to the embryo sac for egg fertilization. The aim of this project was study the effect of electromagnetic fields on structure and pollen grains development in *Chenopodium album*. Anthers of *Chenopodium album* L. were collected at different stages of development from control (without electromagnetic field) and plants grown at 10m from the field sources. Structure and development of pollen grains were studied and compared. The studying pollen structure by Light and Scanning electron microscopy showed that electromagnetic fields reduction of pollen grains number and male sterility, thus, in some anthers, pollen grains were attached together and deformed compared to control ones. The data presented suggest that prolonged exposures of plants to magnetic field may cause different biological effects at the cellular tissue and organ levels.

**Keywords**—Electromagnetic fields, pollen, *Chenopodium album* L.

## I. INTRODUCTION

THE effect of electromagnetic field on living cells during decades is mainly attributed to its guide in throwing light on major unsolved biological problems such as morphology, uncoiling immune defense and regulation of the cell division[1]. These electric fields are, practically, produced in all places by humorous sources, including nearby high voltage transmission lines, primary and secondary overhead utility distribution lines and the electrical grounding system.

Electromagnetic field is one kind of stress, which can affect directly or indirectly the plant exposed to it. Plant species vary in their sensitivity and response to environmental stresses because they have various capabilities for stress perception, signaling and response [2].

Several researches tried to define the effect of such field on the growth rate of the plant. Electromagnetic field can cause deformation inside grain through compression or tension of particular layers[3]. On the other hand, it has been proved that

the electromagnetic field inhibited the biological properties of the membrane protein[4],[6].

## II. MATERIALS AND METHODS

Buds and open flowers of *Chenopodium album* were collected at different developmental stages from control area (without electromagnetic radiation) and plants grown at 10m from the field sources (64 kv/m) in June 2009. The climatic and edaphic conditions in the 2 regions were the same.

Sample were fixed in FAA (formalin: acetic acid: alcohol ethyl 96° 2: 1: 17) dehydrated in a graded Alcohol series and embedded in paraffin. Serial section of 7 – 10  $\mu$ m were prepared and examined by Light microscopy (LM).Anthers were studied by Scanning electron microscopy (SEM).

Control and treatment under samples were coated with gold, these samples were analyzed using a Scanning electron microscope (Model SEM – x 130, Philips, Netherland).

## III. RESULTS

Results obtained by Scanning electron microscopy indicate that on the surface of control pollen grains have 50 – 70 apertures. Sculpturing was finely, granular pollen grains were generally circular and pollen grains size was almost 2 – 5  $\mu$ m (Fig 1, 2).

After contamination with electromagnetic fields, pollen grains become abnormal, also degeneration and fragiled of exine surface (Fig 3, 4).

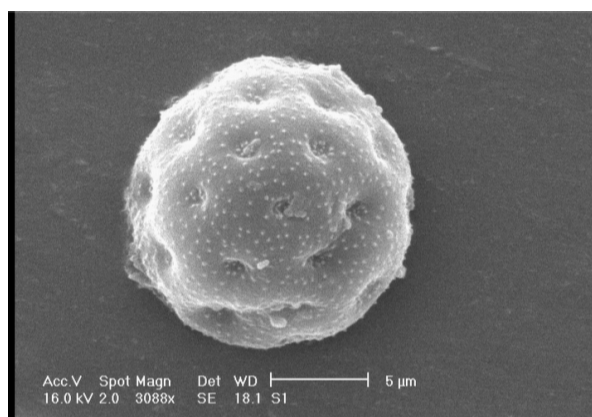


Fig. 1 Scanning electron micrographs of pollen grains of plant grown under condition of control (The pollen grains and exine are circular and regular)

L. Amjad is with Department of Biology, Islamic Azad University-Falavarjan branch, Esfahan, Iran (e-mail: amjadsadra@yahoo.com).

M. Shafighi is with Department of Biology and member of young researchers club, Islamic Azad University-Falavarjan branch, Esfahan, Iran (corresponding author to provide phone: 00989133051023; Fax: 00983112616436; e-mail: ashams987@gmail.com).

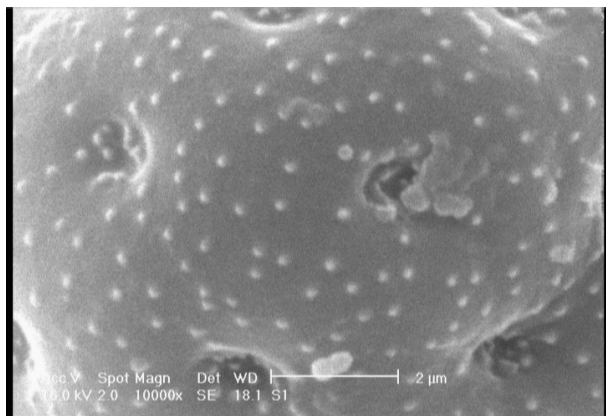


Fig.. 2 Scanning electron micrographs of pollen grains of plant grown under condition of control  
(The pollen grains and exine are circular and regular)

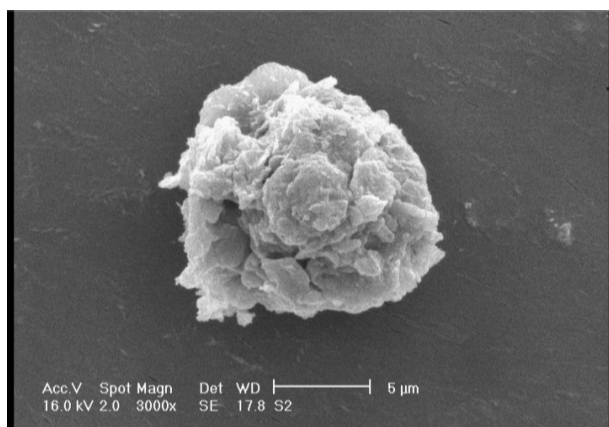


Fig. 3 Scanning electron micrographs of pollen grains of plant grown under condition of electromagnetic fields.  
(The pollen grains are abnormal , degeneration and fragiled of exine surface)

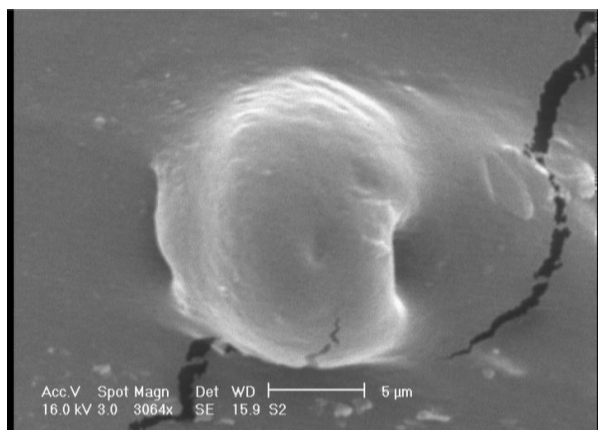


Fig. 4 Scanning electron micrographs of pollen grains of plant grown under condition of electromagnetic fields.  
(The pollen grains are abnormal , degeneration and fragiled of exine surface)

Study of anatomical structure of mature anthers collected from control area showed that these anthers contain polyantaporate, granular, spherical and normal pollen with a thick relatively exine. The exine surface is more or less rough, cribrate (Fig 5, 6). But those collected from treatment under area contain shrunked, destroyed, defective and fragile pollen. Also, degradation of exine surface was observed (Fig 7).

Therefore, electromagnetic fields reduction of pollen grains number and male sterility(Fig 8). Thus in some anthers, pollen grains were attached together and deformed compared to control ones (Fig 9).

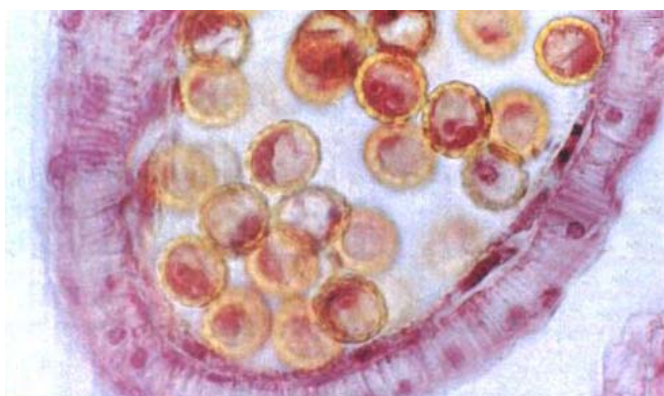


Fig. 5 Light microscopy photographs of pollen obtained from control area  
(Mature pollen grains)



Fig . 6 Light microscopy photographs of pollen obtained from control area  
(Mature pollen grains)



Fig 7. Light microscopy photographs of pollen obtained from plant grown under condition electromagnetic fields. (Degradation and shrinkage of exine surface)



Fig 8. Light microscopy photographs of pollen obtained from plant grown under condition electromagnetic fields. (Reduction of pollen grains number)



Fig 9. Light microscopy photographs of pollen obtained from plant grown under condition electromagnetic fields. (Abnormality of pollen, note to irregular size and fragility of pollen)

#### IV. DISCUSSION

Studies the effect of electromagnetic fields on pollen grains showed changes in structure and viability pollen. If a plant grows in the high voltage transmission lines, its physiologic function may change such as: high frequency of chromosomal abnormality, increase in the frequency of the nonviable pollen grains, increase in the stem length, decrease the number of grains in the spike, increase in the total chlorophyll content and the total carbohydrate in the grains, decrease the amount of protein in grains[1].

These results are similar to findings of our research. Studies of Germana, 2007 showed that exposure to electromagnetic fields to modify the biological behavior of seeds, roots, pollen grains and buds of several plants[6].

Thus Dattilo et al, 2004 showed that *Actinidia deliciosa* (Kiwi fruit) pollen grains were germinated in the presence of an alternating magnetic field (50 Hz). Therefore, pollen tube growth is affected by magnetic fields, but, the analysis of the observed anomalies in the pollen tube appear to be the result of changes in the ionic charges within the pollen tube cytoplasm[7].

From the present work, it is concluded that growing plants under high voltage transmission lines change their growth characteristics and also decreases plant yield. Therefore, the electromagnetic field is considered pollutant to the environmental. Hence, it is recommended to insert such transmission lines under the ground to minimize their hazardous effects.

#### REFERENCES

- [1] M. Hanafy, H. Mohamed, and E. Bddelhady, "Effect of low frequency electric field on growth characteristics and protein molecular structure of Wheat plant," *Romanian J. Biophys.* 2006. 16 (4): 253 – 271.
- [2] H. Bohrer, D. Nelson, and R. Jenson, "Adaptation to environmental stresses," *The plant cell.* 1995. 7: 1099 – 1111.
- [3] A. Sumorek, W. pietryk, "Influence of electric field on the speed of converctire removal of water from Wheat grains," *Int. Agrophysics.* 1999. 13 (4): 509 – 513.
- [4] M. Laberge, "Intrinsic protein electric fields," *Biochim. Biophys. Acta.* 1998. 18: 20 – 30.
- [5] R. J. Walter, A. Shitil, R. B. Roninson, D. Halian, "60 Hz electric fields inhibit protein kinase C activity and multidrug resistance gene (MDRI) up – regulation," *Rad. Res. Mar.* 1997. 147 (3): 369 – 378.
- [6] M. A Germana, B. Chiancone, M. R. Melati, and A. Firetto, "Preliminary results on the effect of magnetic fields on anther culture and pollen germination of *Citrus clementinahort*," *Inter. Soci. For Hort. Scie.* 2007.
- [7] A. Dattilo, L. Bracchini, S. Loiselle, E. Ovidi, A. Tiezzi, and C. Rossi, "Morphological anomalies in pollen tubes of *Actinidia deliciosa* (Kiwi) exposed to 50 Hz magnetic field," *Bioelectromagnetics.* 2005. 26 (2): 153 – 156.