# ELECTROMAGNETIC RADIATION INFLUENCE ON SOME PHYSIOLOGICAL AND CYTOGENETIC PARAMETERS IN *SECALE CEREALE L.*

**CRISTIAN S. CIMPEANU[2], MIRELA M. CIMPEANU[1*], CALIN L. MANIU[3]**

**Keywords**: microwave, *Secale cereale L.,* mitotic index, chromosomal abberations

**Abstract**: Microwave action on plant organisms it is of interest to specialists because of their influence on the activity of DNA from the cell nucleus, especially on the conformational aspects of the genome. Due to the application of microwave treatments were obtained valuable varieties of plants (particularly food such as cereals) with superior productive features, adequate to human needs. The aim of our research has been highlighting the impact of microwaves on cellular and genome dynamics in meristems from irradiated seeds. Our investigations establish the stimulatory effects of microwave treatments on mitosis (mitotic index values compared to the control) and also detect disturbances in the mitosis process, and at the chromosomal level, disturbances that typically occur after treatment with various chemical agents.

## INTRODUCTION

Mankind has known over time and especially in recent decades, an unprecedented development for technology in all its areas of activity. Medicine as a summation of all knowledge and practices to maintain health, recorded separately, one giant leap for technology, finding new methods of diagnosis and treatment, often extending a remedy to life in serious or incurable diseases. Unfortunately, in addition to beneficial applications, the undisputed, medical and personnel and environmental protection, experimental genetic studies have shown mutagenic action of various physical agents, chemical or biological in nature or produced by man. Diversification synthesis of medicinal products, many pesticides used in agriculture, in food preservatives, synthetic colorants or use of isotopes and radiation x diagnostic or therapeutic purposes, have now reached worrying levels.

Mutagens in animal and human ecosystems are involved in gamete molecular alterations and genetic diseases occur with increasing frequency. Electrical and magnetic phenomena such as cosmic, seismic, and the resulting impact on artificial life processes, are an integral part of modern human habitat, so it is necessary to refer to them and study the connections between natural and anthropogenic electromagnetic phenomena. Existing studies have vague conclusions, often contrary. Although many know of some negative effects of microwaves on health, electricity is considered, currently, an absolutely necessary faulty, comfort overlooked the shortcomings and risks of using those devices (microwave, computer, mobile phone etc).

In this paper we discussed the problem of non-ionizing radiation and their effects on plant body. In addition to the harmful effects of artificial radiation abusive used without adequate protection, geneticists reveal the importance of radiation (microwaves) in inducing the desired mutations and to obtain useful new forms of plants, often superior in terms of resistance to stressors, with a higher bioactive compounds content or productivity. Electromagnetic pollution will continue to exist with the development of science and new technologies. You need to realize that, with positive effects that have already received, there are negative effects, which although not immediately observable, then we can affect both us and future generations. Hence the necessity of protective methods when using such technologies and making a decision on their use, taking into account both benefits and risks to our health. Microwave action on plant organisms it is of interest to specialists because of their influence on the activity of DNA from the cell nucleus, especially on the conformational aspects of the genome. Due to the application of microwave treatments were obtained valuable varieties of plants (particularly cereals) with superior productive features.

The aim of our research has been highlighting the impact of microwaves on cellular and genome dynamics of microwave irradiated seeds. Our investigations aimed to establishing the stimulatory effects of microwave treatments on mitosis (mitotic index values compared to the control) and also to detect disturbances in the mitosis process and the chromosomal material. On the other hand, we aimed to establish the efficiency in producing mutations, using microwave.

## MATERIAL AND METHODS

All our investigations were conducted on an experimental micropopulaţie of *Secale cereale L.* grown on an experimental field in Botanical Garden of Iasi, between 2008-2010. The microwave treatments were conducted in the Biophysics Laboratory of the Faculty of Biology, „Al. I. Cuza” University from Iasi.

The seeds were exposed to the flow of low-intensity electromagnetic waves from a horn antenna (Fig.1) assembled in the Microwave Laboratory of the Faculty of Biology, „Al.I.Cuza” University from Iasi. Microwave frequency was 9.5 GHz (located in the „atmospheric window” of the microwave) with a power density of about 100

$mWcm^{-2}$ out of the horn antenna (square section of about 9 $cm^2$) on irradiated samples plane. Constant dielectric substrate (ε r = 1) has been adversely to the occurence of reflected waves (*Rai et al., 1994*).

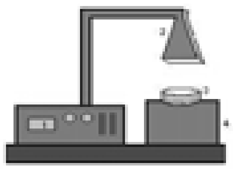

**Fig. 1. Microwave device**
**1 - microwave generator, 2 - horn antenna, 3 - sample, 4 - dielectric sample holder**

In order to test germination capacity, seeds were placed in Petri dishes on filter paper which was moistened with tap water daily. Environmental conditions were maintained constant both for control and for experimental variants: temperature $24^0$C, humidity of 98%, 12 h light and 12 h darkness. Exposure times for experimental variants were: 0,5 hours, 1,0 hours, 1,5 hours, 2,0 hours , 4,0 hours and 6,0 hours. After germination, meristematic roots were cytogenetically studied. The biological material were processed by Feulgen staining method for mitotic chromosomes observation. The samples were analyzed and photographed with fotonic microscope. Plantlets lenght test was achieved after 10 days using plantlets germinated from treated and control seed samples.

## RESULTS AND DISCUSSIONS:

In recent years many contributors have been reported obtaining valuable mutants for food and pharmaceutical industry, microwave treatment consequently. Any treatment, however, is accompanied by a certain percentage of chromosomal aberrations that are the result of genetic imbalances occurring in response to mutagen action. Induced mutagenesis process is influenced not only by nature and mode of irradiation, but also by hereditary factors. The same dose treatment trigger different degrees of changes in the genetic material of different species from the same genus or subspecies of the same species, which exibits a different radiosensitivity.

*Germination test on Secale cereale L.*

It is clear that germination is slightly stimulated by all doses of microwaves, the lowest level corresponding to control (Fig.2). It also notes the highest germination percentage of seeds, at 1 h microwave exposure. In this case, the average germination rates of irradiated seeds was 93,34%, a value higher to that obtained from control.

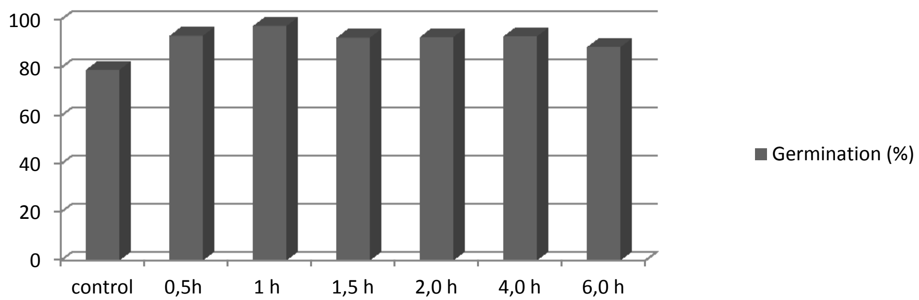


**Fig. 2 Seed germination test in *Secale cereale L.* grown in normal and microwave irradiated conditions**

*Plantlets grow test on Secale cereale L.*

The average length of plantlets is also higher for experimental variants compared with the control. The lowest values correspond to 0.5 h exposure time (average 59.3 mm), 2 h (average 52.42 mm) and 6 h (average 60.9 mm), while the highest values were recorded at 1.5 times h (average 68.7 mm) and 4 h (average 62.1 mm) (Fig. 3). These values confirm earlier studies in the literature (*Pavel et al., 1998*), that the low values of dry mass accumulated in wheat seedlings as a result of microwave treatment for 2h.

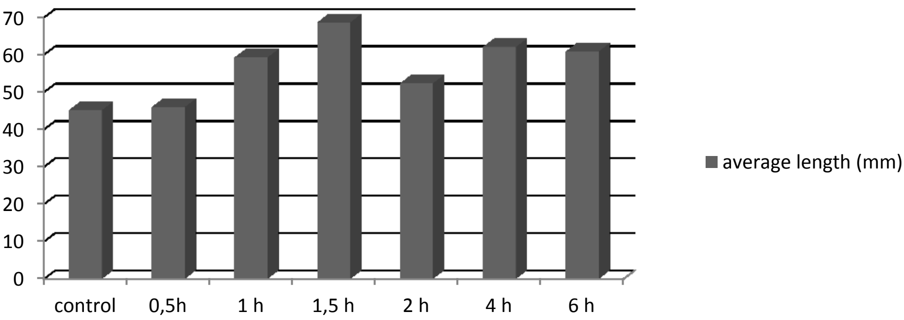


**Fig. 3 Plantlets lenght test in *Secale cereale L.* grown in normal and microwave irradiated conditions**

*Mitotic index on Secale cereale L.*

In Fig.4 are presented the results of cytogenetic tests. Highest percentages of interphase cells were obtained from version 4 h and 6 h microwave exposure. Cell division rates are lower for these samples, but some of them, for example, cells in anaphase of the variants of 2 h and 1 h respectively, were absent. Metaphase cells from samples exposed to microwaves for 6 h was equal to that obtained in control. On the other hand, the levels of cells in telophase at 1.5 h samples were equal to those of controls. Also, in anaphase cells from samples exposed to microwave for 4 h was equal to that obtained in control plants. There were times of exposure values where the mitotic index was below those of the control ie at 1 h and 6 h. At the same time, samples corresponding to treatment times of 0.5 h and 2 h were relatively high compared to the control.

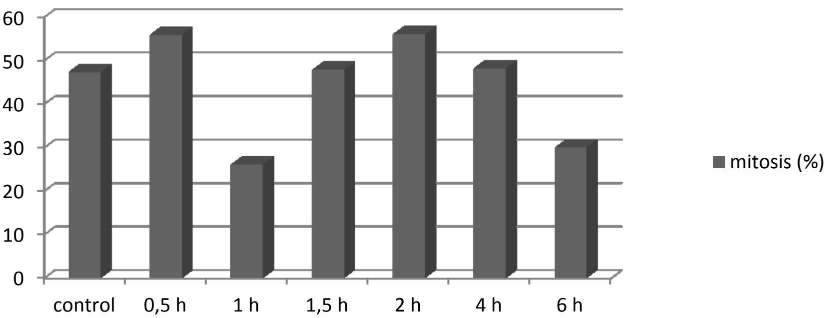


**Fig. 4 Mitotic index on *Secale cereale L.* meristematic roots grown in normal and microwave irradiated conditions**

*Chromosomal abberation frequency in Secale cereale L.*

Aberrant metaphases were more frequent at longer times of irradiation, the sample 4 h recorded the highest value. Low levels of aberrations were detected in exposure times of 0.5 h, 1 h and 2 h (Fig. 5).

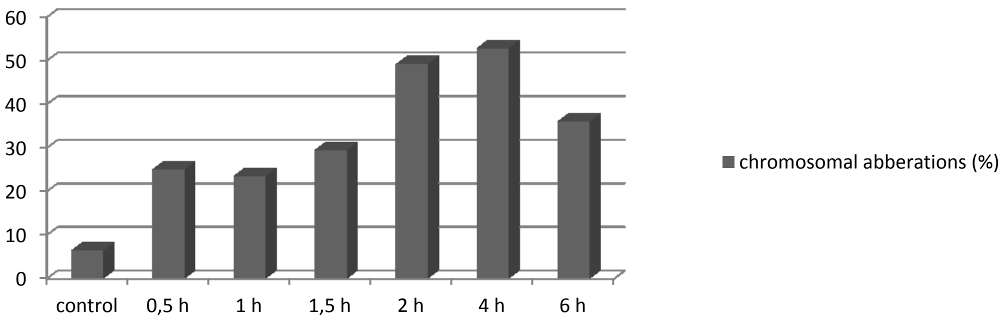


**Fig. 5 Chromosomial abberation frequency in *Secale cereale L.* grown in normal and microwave irradiated conditions**

The appearance of the most common chromosomal aberrations in ana-telophase of mitosis in our experiments is shown in these photos:

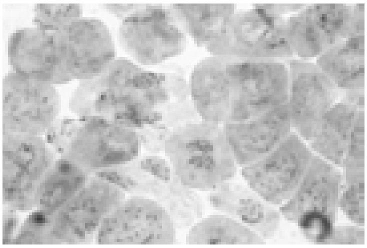

**Fig. 6 Multiplolar anaphase with bridges**

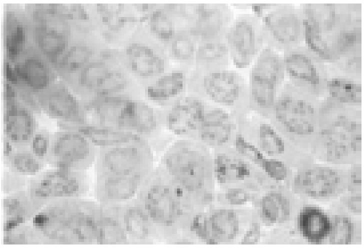

**Fig. 7 Anaphase with bridges and fragment**

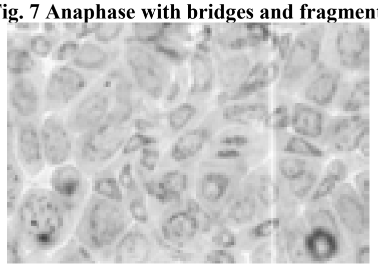

**Fig. 8 Telophase with bridge**

Chromosomal fragments which remained in the space between the two sister cells, will change the genetic information to daughter cells resulting from division. Because of chromatide bridges results in these experiments, the cells will exhibit an incomplete chromosomal sets.

The fact that chromosomal aberrations were more frequent at higher doses due to microwave heating its obvious, although the thermal effect is significantly reduced at such small intensity of microwave.

## CONCLUSIONS

Growing tests in all six microwave treatment variants exhibit germination rates significantly higher than those obtained from version control. Thus, low-intensity microwave showed that are capable of stimulating germination of seeds in *Secale cereale L.*, interpreted as a consequence of the thermal effect. With few exceptions, the mitotic index values in most variants of treatment were relatively comparative with the controls, which indicate stimulant effect of microwaves on mitotic division.

Research on the effects of microwave irradiation have shown significant changes in the morphology of somatic chromosomes in *Secale cereale L*. Chromosomal aberrations are present in small numbers and mainly to higher doses of exposure, so the influence of microwaves seems to be the cause of their occurrence. As a result of chromosomal alterations in mitosis ana-telophase were visible chromosomal aberrations (fragments, bridges, micronuclei , multipolar anaphases).

## REFERENCES

**Bâra, I.**, (1989): *Elemente de radiobiologie generală*, Ed. Ceres, Bucureşti, 5-9, 201-241
**Carr, D.H., Walker, J.E.**, (1961): *Carbol fuchsin as a stain for human chromosomes*, Stain Technol., 36, 233-236
**Câmpeanu, M.**, (2002): G*enetică - metode de studiu*, Ed. Corson, Iaşi, 5-23, 127-146
**Cullen, A.**, (1970): *Transmision de l'energie micro-onde*, OBE, D.Sc.(Eng.), FIEE, FIEEG, FCGI, in Endeavour, vol.XXIX, 107, 55-59
**Gapu, Gh.**, (1987): *Radiobiologie vegetală*, Ed. Academiei RSR, Bucureşti
**Grant, F.W.**, (1978): *Chromosome aberrations in plants as a monitoring system*, in Environmental Health Perspectives, 27, 37-43
**Miclăuş, S.**, (1999): *Introducere în bioelectromagnetica microundelor*, Ed. Univ. "Lucian Blaga", Sibiu, 11-15, 64-80, 110-119
**Pavel, A., Gasner, P., Creangă, D., Miclaus, S., Bâra., I.,** (1999): *Citogenetic modifications induced in Chelidonium majus by low thermal microwaves*, Ann. Sc. U. Fr. Comté Physique, Colloque OHD, Besançon, p. B5-B8
**Rai, S., Singh, U. P., Mishra, G. D., Singh, S. P., Samarketu, J.**, (1994): *Effect of Water's Microwave Power Density Memory on Fungal Spore germination*, Electro- and Magnetobiology, 13(3), 247-252
**Russello, V., Tamburello, C., Scialabba, A.,** (1996): *Microwave effects on germination and growth of Brassica drapanensis seeds*, Proceedings of 3rd internat. Congress of the european bio electromagnetics association, 26 febr.-3march, 89
**Stoicescu, Gh. D,** (1991): *Microunde*, Tipografia Univ. Craiova, Fac. de Stiinţe, 1-7
**Thaher, R. H.,** (1997): Metode de investigare bazate pe interacţiunea dintre microunde şi organisme (rezumatul tezei de doctorat), Bucureşti, 5-12, 17-30
**Zamfirescu, M.,** (2000): *Efecte biologice ale radiaţiei electromagnetice de radiofrecvenţă şi microunde*, Ed. Didactică şi Pedagogică, Bucureşti, 7-22, 97-214

[1*] Alexandru Ioan Cuza University
Faculty of Biology
Biochemistry and Molecular Biology Department
Laboratory of Genetics
mirela.cimpeanu@uaic.ro
[2] Alexandru Ioan Cuza University
Faculty of Biology
Biochemistry and Molecular Biology Department
Laboratory of Cell and Molecular Biology
[3] Alexandru Ioan Cuza University
Faculty of Biology
Biochemistry and Molecular Biology Department
Laboratory of Biophysics