

parasite relationship. Also the researches made to the patho-system *Beta vulgaris* – *Cercospora beticola* have emphasized that there are fluctuations depending on the catalase activity with the appearance of the first symptoms of disease (Roșu Crăița – Maria).

The data concerning the attack of the *Melampsorella caryophyllacearum* on the catalase activity are presented in figure 2, from which resulted that in the Izvorul Muntelui stationary this enzyme had the value 65.60 UC mg/min. in the diseased leaves and 70.00 UC mg/min. in the healthy leaves; in the Cerebuc stationary the value of this enzyme had been of 60.80 UC mg/min. in the diseased leaves and 85.70 UC mg/min. in the healthy leaves.

These results don't confirm the obtained dates after the researches made to other species of plants (Antohe Anca et al., Pistică - Donose Alice et al.).

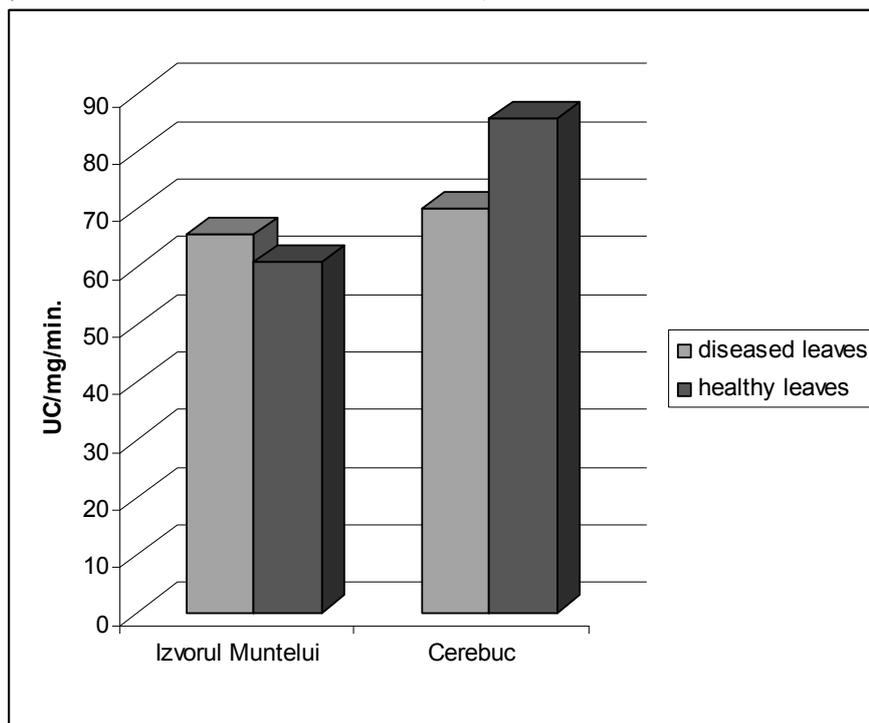


Fig. 2. The influence of *Melampsorella caryophyllacearum* attack on catalase activity

CONCLUSIONS

The attack of *Melampsorella caryophyllacearum* determined a growth of peroxidase activity in diseased leaves, comparatively in healthy leaves in both stationeries taken in the study.

Instead the attack of *Melampsorella caryophyllacearum* a diminution of catalase activity in diseased leaves, comparatively in healthy leaves in both stationeries taken in the study.

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PRELIMINARY STUDY CONCERNING THE RADIOFREQUENCY ELECTROMAGNETIC FIELD INFLUENCE ON THE CATALASE ACTIVITY IN THE HIPPOPHAE RHAMNOIDES SEEDS GERMINATION

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Keywords: electromagnetic field, oxidative stress, reactive oxygen species, catalase.

Abstract. The data accumulated by now shows that the topic of biological effects of electromagnetic radiation is far from being exhausted. It is undoubtedly that a non-ionizing radiation field maintained on a biological entity has some effects on it. To try shaping issues regarding this, this work aims to study the impact of radiation generated by an emission-reception radio station that emits on 462.6875 MHz frequency. For this purpose, were used *Hippophae rhamnoides* L. seeds which germinated in the laboratory, under controlled conditions, concentrically arranged around the radiation source, in which case electromagnetic radiation has a different impact. Seed germination lasted 35 days, while the device has continuously worked, and the seeds were constantly irradiated. The intensity of the magnetic component of the field was precisely measured in all places where the seeds were placed for germination. It was calculated the percentage of germination and it was determined the catalase activity involved in eliminating the oxidative stress effects. Accordingly to the distance from the source, significant variations of the parameters mentioned above in conjunction with the radiation intensity were found.

INTRODUCTION

Accelerated and widespread use of different electric and electronic devices increased the exposure to radio and microwave frequency electromagnetic fields (EMFs). These EMFs are classified as non-ionizing radiation but they can cause damage depending on the power level, frequency, and the properties of exposed tissue. There is some evidence that microwaves (300 MHz–300 GHz) produces changes in the cell membrane's permeability and cell growth rate as well as interference with ions and organic molecules, like proteins (Kwee et al., 1998, 2001; de Pomerai et al., 2003; Repacholi, 2001; Pologea-Moraru et al., 2002; Banik et al., 2003). Plants are essential components of a healthy ecosystem and have important role in the living world as main primary producers of food and oxygen; therefore it would be beneficial to investigate their interaction with today's increased exposure to radio and microwave frequency fields. Additionally, higher plants are useful test organisms for environmental studies because they are eukaryotic multicellular organisms. Many of them are sensitive to different kinds of stresses and are easy to grow in controlled laboratory conditions without too much expense (Wang, 1991). During the years it became more and more interesting to test the effects of EMFs on higher plants (Tkalec et al. 2005, 2007). Considering the increasing interest for the subject, this work focus on the influence of 462.6875 Mhz EMF on the oxidative stress during the *Hippophae rhamnoides* seeds germination. This species was chosen because of the following aspects. Firstly, the period of germination is relatively long, the experiment is held over a period of 35 days, this issue was important because the seeds were irradiated for a long time, unlike other species that germinate very fast (3-5 days). Secondly, sea buckthorn (*Hippophae rhamnoides* L.) is a species which has some interesting biochemical characteristics: vitamins B, C, E, K, carotenoids (the most dominant carotenoid in sea buckthorn, it's admitted to be associated with reduced risk of breast, stomach, esophageal, and pancreatic cancers), flavonoids (it have been found in controlling arteriosclerosis, reducing cholesterol level, turning hyperthyroidism into euthyroidism and eliminating inflammation), tannins, metallothionein (acts as detoxifying agency for heavy metals and as free radical scavenger for most toxic radical) and 5-hydroxytryptamine (5-HT), a chemical neurotransmitter substances (Lian, 2000; Thomas, 2003).

MATERIALS AND METHODS

To seek evidence of the influence of electromagnetic field (EMF) of radio frequency on oxidative stress, during the germination of seeds, was used a source consisting of two Motorola T5725 emission-reception radio stations that have been programmed to automatically call one another throughout experiment. The communication system frequency is set on channel 6 at 462.6875 MHz with 500mW transmit power. Thus, around the two emission-reception radio stations were delimited four concentrically levels (different distances from the source), with four groups with five Petri Dishes (A1-A5; B1-B5; C1-C5; D1-D5), in each plate with about 20 seeds. The control lots, consisted in six Petri Dishes (M1-M6), were positioned sufficiently far from the EMF source. It was monitored the temperature and the humidity, which were

maintained constant in both irradiated and control lots. Experiment diagram is depicted in the Appendix fig.1 and fig.2. The magnetic induction (B) of the field was measured with a digital teslameter in the indicated points on the drawing. The values are in μT . After germination period (35 days), the plant material was processed to determine the activity of the catalase, enzyme involved in the removal of oxidative stress (Artenie et al., 2008). Also it was determined the total protein synthesis and was calculated the percentage number of the germinated seeds. From each sample was counted the number of germinated seeds and reported to the total number of seeds. Data were represented graphically in the diagrams (Appendix at the end of the paper) which appear after the statistical processing. On the charts, the vertical error bars shows the 95% (0.05) confidence level for mean. Interval estimates are often desirable because the estimate of the mean varies from sample to sample. The interval estimate gives an indication of how much uncertainty there is in our estimate of the true mean. The narrower the interval, the more precise is our estimate (Kotz et al., 1988-2008).

RESULTS AND DISCUSSION

After investigations, it was obtained a number of results regarding the catalytic activity of catalase. Catalase is an enzyme present in large quantity in peroxisomes where neutralize H_2O_2 resulting from redox processes.

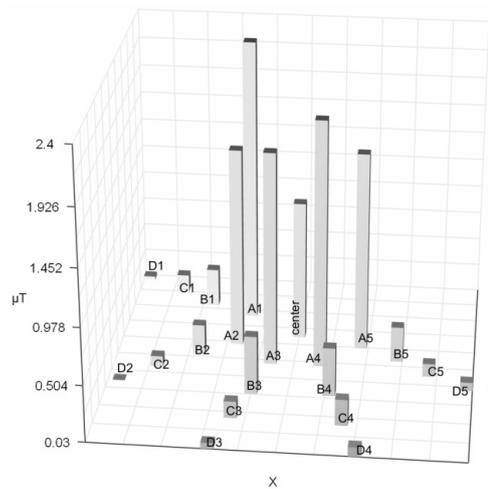


Fig.1. Spatial representation of the intensity of magnetic induction (μT) in relation to the probes arrangement.

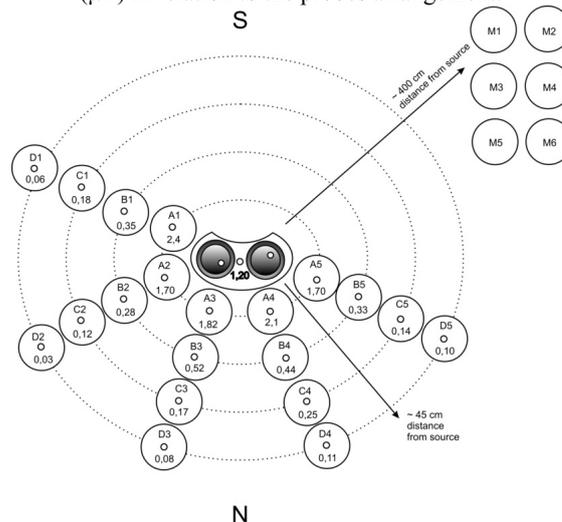


Fig.2. Schematic representation of the experiment. At the center are the two radio stations, around which were arranged the Petri Dishes. In the center of each plate is indicated the magnetic induction in μT .

Peroxisomes are a common constituent of eukaryotic cells. In plants there are two important differentiated forms: the leaf peroxisomes, which participate in photorespiration and the glyoxysomes, which are present in seeds containing oils (triacylglycerols) and play a role in the conversion of triacylglycerols to carbohydrates. They contain all the enzymes for fatty acid β -oxidation (Heldt, 2005). The experiment conducted, shows a significant decrease in the catalase activity in relation to the control. The profile of these decrease is similar in both activity expressed in enzyme units at 100g material and for specific activity (enzyme units per 100 mg protein) as is illustrated by the fig. 3 and fig. 4.

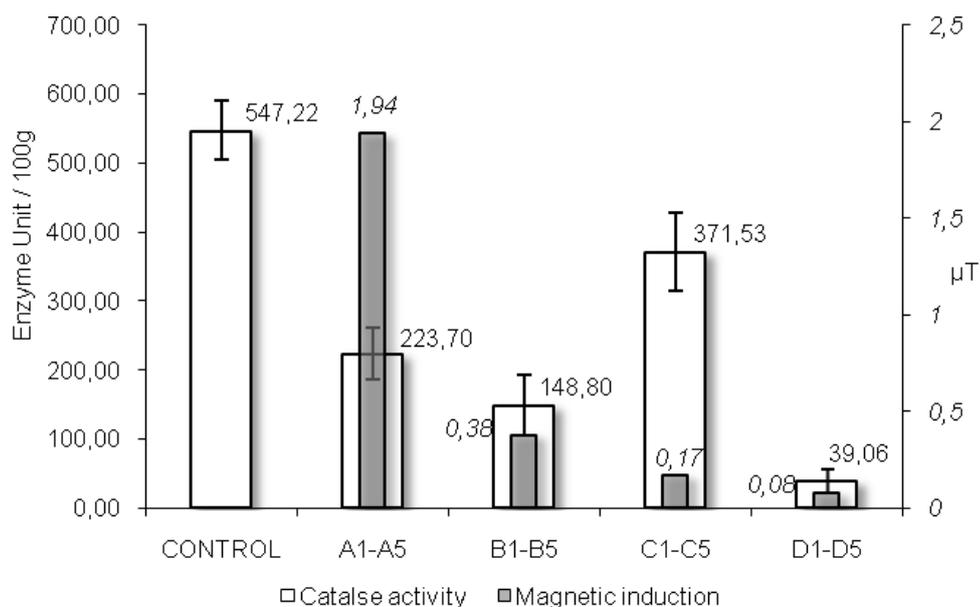


Fig.3. Variation of the catalase activity and magnetic induction.

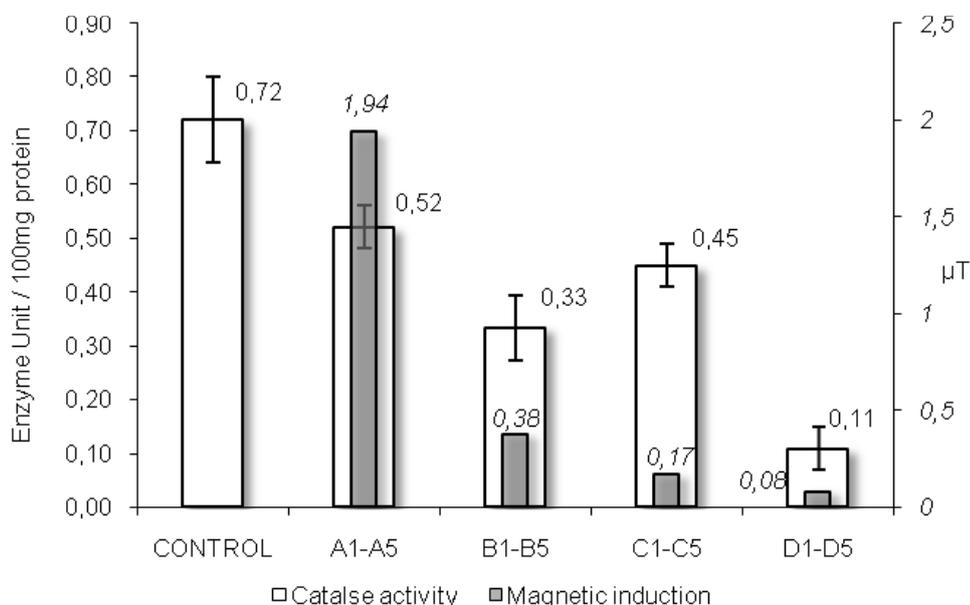


Fig.4. Variation of the catalase specific activity and magnetic induction.

The amount of protein highlighted by Bradford method shows a significant variation for A1-A5, B1-B5 and D1-D5 in relation to the control (fig. 5), in such cases were founded decreases. C1-C5 samples, shows an amount of protein approximately equal to control lots. The proteins highlighted in the experiment comes both from the reserve proteins of seeds and "de novo" synthesis.

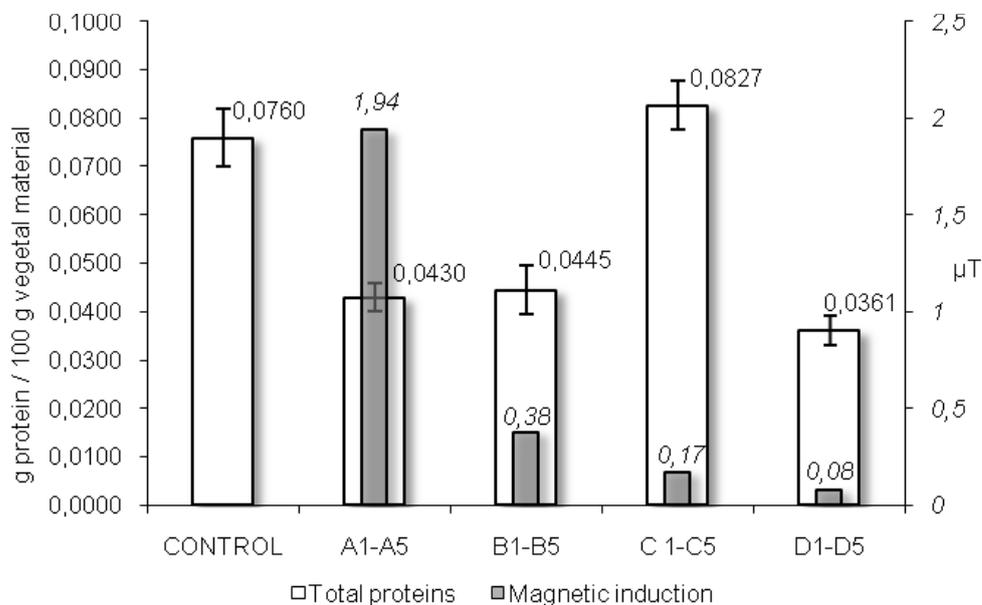


Fig.5. Variation of the total protein quantity and magnetic induction.

Percentage of seeds germinated (fig. 6) during the experiment indicates that low intensity magnetic induction can have a stimulating effect. This is observed for samples B1-B5 and D1-D5, where the percentage of germination reached very high values, 97% respectively 94%.

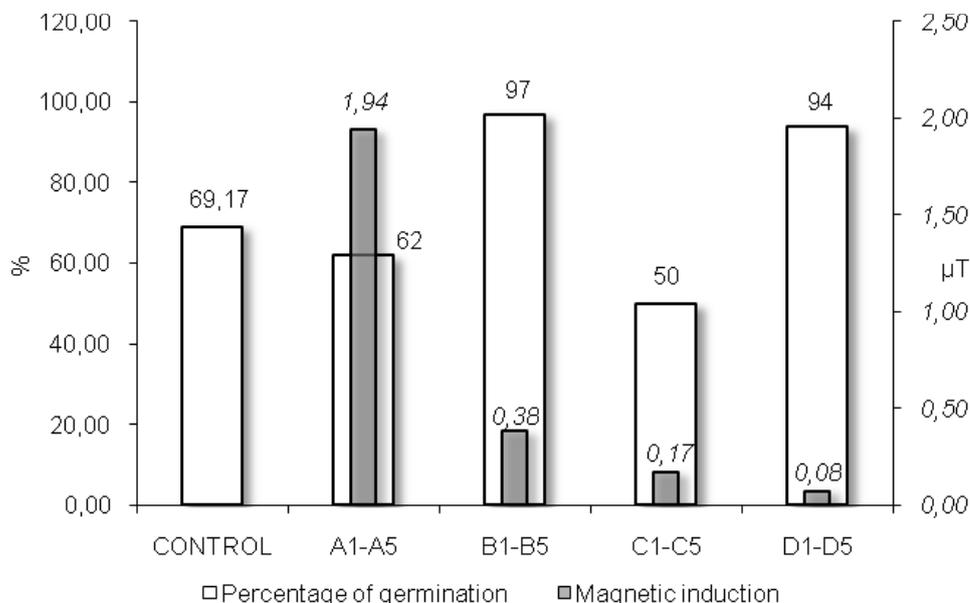


Fig.6. The percentage of seeds germination and the variation of magnetic induction

In the other two cases, compared with the control, there is a negative trend in germination. In case of A1-A5, high intensity magnetic induction does not seem to have affected germination (percentage difference being only 8% compared to control), where C1-C5 can be considered a decrease of 19%. From germination behavior of toward various intensities of magnetic induction, it may find a correlation between enzyme activities involved in removing the effects of oxidative stress. In cases B1-B5 and D1-D5, a high percentage of germination is correlated with a decreased oxidative stress, due to a weak catalase activity, correlate with a low amount of total protein. Low values identified in the total proteins quantity may be due to a greater consumption of resources during germination where samples B1-B5 and D1-D5 had the highest percentage of germination.

CONCLUSIONS

The performed experiment, with 462.6875 MHz electromagnetic radiation frequency, obtained from two emission-reception radio stations, has demonstrated that there is no direct proportionality correlation between the intensity of induction and the effects caused by the different magnetic induction during the seeds germination. Thus, there are cases where electromagnetic radiation may be used as a stimulatory agent since two cases were found with a very high percentage of germination in correlation with a low catalase activity and low total protein amount. In these circumstances, it is required more detailed investigations, particularly targeted on that induction values that caused the stimulation of germination.

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