USE OF THE MAGNETIC FIELD TO STUDYTHE PLANT GRAVIPERCEPTIVE APPARATUS («Greenhouse» Project)

Kordyum V. A.

Institute of Molecular Biology and Genetics, NAS of Ukraine
150 Zabolotny St., 252143 Kyiv, Ukraine
tel/fax: (380) +44 +2662024, e-mail: alf@imbg.kiev.ua

«Gradient» Experiment

EFFECT OF THE GRADIENT MAGNETIC FIELD ON PLANTS UNDER THE CONDITIONS OF THE GRAVITATIONAL FIELD WEAKENING

Bogatina N. I.

Special Research and Development Bureau for Cryogenic Technologies
of the B. I. Verkin Institute for Low Temperature Physics and Engineering, NAS of Ukraine
47 Lenin Ave., Kharkiv 61164 Ukraine
Tel/fax: (380) +572 +322293, e-mail: sktb@ilt.kharkov.ua

Kordyum E. L.

M. G. Kholodny Institute of Botany, NAS of Ukraine
2 Tereschenkivska St., Kyiv 01601, Ukraine
tel. /fax: (380) +44 +2123236, e-mail: ekord@botan.kiev.ua

A universal mechanism of the influence of the magnetic, electric and gravitational fields on biological objects was suggested by one of the authors [1].

The following evidences were taken into account to develop a model. As each of these fields produces the ion concentration gradient, they affect the ion permeability of membranes in the same way. The change in the ion concentration is equal to 10^{-10} — 10^{-11} of the initial value, i. e., it is negligible due to the negligibility of the magnitude of these fields. It is known, however, that even such slight changes could result in changes of the ion transport through the membrane and changes of growth rate of plants as well. Calculations carried out by such a model [1] were in fairly good agreement with the experimental evidence on the threshold values for all the three fields. So, we advanced a hypothesis that substitution of an absent field (for example, the gravitational field) by another field (for example, the magnetic field) may compensate a negative effect of the absence of gravity on plants during the space flight.

We have carried out a set of ground-based experiments concerning the effect of a gradient magnetic field on the growth rate and root orientation of wheat seedlings under simulated microgravity.

The following valid results were obtained:

— Weakening of the magnetic field induction to the level of $2 \cdot 10^{-3}$ T increases the growth inhibition caused by weakening of the gravitational field.

— The gradient magnetic field with magnetic induction of about 10^{-3} T and the gradient magnetic induction of about $2 \cdot 10^{-2}$ T/m, could partially compensate the negative effects caused by simulated microgravity.

— The magnitotropism of the wheat roots is observed only under the conditions of weakening of the gravitational field.

We have applied two methods of simulated microgravity, namely, sprouting of plants in the water and rotation of plants on the clinostate. Neither of the methods resulted in complete weightlessness of all the parts of the plant simultaneously. Therefore, no conclusions can be made so far either on the possibility of compensation of the absence of gravity by means of a gradient magnetic field, or on the mechanism of its influence. For this reason, we are planning to carry out the same experiments under the actual microgravity conditions on board the space station at the acceleration level below the threshold value, i. e. $10^{-5}g$.

References:

1. Bogatina N. I. // Electronnaya obrabotka materialov.—1986.—N 1.—P. 64.

«Magnet» Experiment

USE OF THE MAGNETIC FIELD FOR EVALUATION OF THE PLANT GRAVIPERCEPTIVE APPARATUS AND FOR COMPENSATION OF THE ABSENCE OF THE VECTOR OF GRAVITY

Kondrachuk A. V.

Institute of Physics, NAS of Ukraine
46 Nauka Ave., Kyiv 03039 Ukraine
tel: (380) +44 +2650823, fax: (380) +44 +2651589

Belyavskaya N. A.

M. G. Kholodny Institute of Botany, NAS of Ukraine
2 Tereschenkivska St., Kyiv 01601 Ukraine
tel/fax: (380) +44 +2123236

It is suggested that the influence of the high-gradient magnetic field (HGMF) on a plant is determined by the displacement of starch statoliths in the statocytes by ponderomotive forces generated by HGMF. For this reason, it is highly useful to implement the HGMF for study and simulation of the root gravitropic response in microgravity.

The purpose of the experiment is to study the role of statolithic and non-statolithic mechanisms in gravisensitivity of higher plants. The purposeful stimulation of statocytes by HGMF under gravity (1*g*) and microgravity will be applied.

The main objectives are as follows:

— to develop the optimal HGMF configurations with the uniform spatial distribution of the high-intensity ponderomotive force;

— to study mechanisms of the gravitropic response using the HGMF effects;

— to design equipment for HGMF application to stimulate gravisensitive cells in microgravity.

It is proposed to use the graviresponsive primary roots of cress and pea as convenient objects for such a study. The following indices, which are affected by the HGMF, will be analysed by various methods, including the electron microscopy and electron cytochemistry:

— dynamics of root curvatures and root elongation;

— spatial distribution of pH along the roots;

— topography of cellular organelles;

— distribution of calcium ions.

The data on the ultrastructural changes in statocytes and their interrelation with calcium balance in HGMF under microgravity will be obtained. It will allow checking the statolith and non-statolith mechanisms of graviperception in higher plants and the signal role of calcium in statocytes. These data will be also useful to design equipment for HGMF application for stimulation of gravisensitive cells in microgravity and for simulation of the microgravity effects in these cells during ground-based experiments.