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Impact of electromagnetic energy on the increasing yield capacity and growth stimulation of plants

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Abstract: *Impact of electromagnetic energy on the increasing yield capacity and growth stimulation of plants.* The problems of electromagnetic energy impact as a stimulating factor of plants growth as well as the improvements in the yield capacity of crop are considered. Based on the analysis of researches carried out by scientists all over the world rich potential and prospects of electrotechnology are stated as an alternative to already existing technologies. The basic directions of electrotechnology application in the processes of stimulation of plants growth as well as the germination increasing by means of improving the methods of electric power supply of the processing objects, including electrotechnical equipment and both improvement of the efficiency ratio and energy saving are revealed.

Key words: electromagnetic energy, electric field, stimulation of plants growth, germination, yield capacity

INTRODUCTION

Today, agricultural production appeared to be under the circumstances when the implementation of traditional technologies has reached critical values, and in fact exhausted its possibilities in the sphere of energy efficiency, increasing productivity and processing of agricultural products. Recent studies in Ukraine, Russia, the USA, Germany and Japan [Sale 1988, Nikiforova 2004, Inozemcev 2006, Inozemcev 2009, Bereka 2011, Bogatina 2011] found that the increase in productivity can be achieved through advanced science-intensive technologies and, above all, electrotechnologies, which electromagnetic energy positively effect on the stimulation and activation of living processes in the seeds and the plants growth.

Many studies confirm the hypothesis [Armstrong and Mitchell 1988, Bogatina 2011, Inozemcev et al. 2012] that every living organism as a biological object has its own personal "natural card", that energy influence helps to change the bioenergy resources of plants, activates qualitative and quantitative changes in the metabolic and oxidative processes etc. Use of above mentioned dependences definitely has great prospects, especially within the pre-treatment processes, increasing the germination of seeds, cultivation and storage of agricultural products.

MATERIAL AND METHODS

The researches carried out in Ukraine, Russia, the USA, Japan, Germany during the period of various seeds pre-treatment using different types of electromagnetic energy (electrostatic field, the field of corona discharge, electromagnetic fields, electromagnetic radiation, etc.) showed

the possibility of increasing the yield of different crops to 10–24%. For example, seed treatment led to the growth of spring wheat yield capacity by 17–22%, barley seeds, by 14–20% and sugar beet by 8–10%. Electromagnetic processing also increases the germination of vegetables by an average of 20–41% (33% cucumbers, 22% carrots, 14% parsley, 21% cabbage). Experimental and practical materials accumulated in sufficient quantity in different countries [Sale 1988, Borodin 1996, Ono 1999, Inozemcev 2006] proves that in some cases electrotechnologies can't be replaced with any other modern technology. This primarily relates to purposeful effect on the physiological and biological processes in the seeds, forming of resistant to stress factors germs, varietal signs transfer from generation to generation.

In many cases, increased anthropogenic impact on ecosystems presupposes the necessity to exercise the management over productivity processes, eco-friendly cultivation of vegetables in greenhouses with the minimum energy and material expenses. The high growth rates of investments in this area in developed countries is a manifesting evidence of the possibilities and prospects of electrotechnology application with the purpose of improving crop yields capacity as well as obtaining plants resistant to pests and various microorganisms, cultivating of crops with improved inherited characteristics. Duration and timeliness of such solutions are confirmed by numerous studies on the application of electrotechnology in the sphere of crop cultivating with the purpose of germination and yield capacity enhancing of different crops (e.g. wheat, barley, corn) and vegetables (e.g. cucumbers, tomatoes, carrots, peppers, eggplant) by 15–20% and 12–18%, respectively. The achieved experience gives ground to affirm with high enough probability the existence of personal development programs in living organisms, seeds and plants recorded in their genes by nature. Researches carried out by scientists from Belgium, Germany, Russia and the USA reveal the opportunity to activate the metabolic processes in the biological objects by influencing on their current living programs by means of application of extra energy. However, the physiology of plants gives us the information that each biological object, for instance the seeds of various crops has its "natural specification" that causes dependence on specific technology and electricity options and electromagnetic modes of treatment.

RESULTS AND DISCUSSION

Analyzing the results of researches carried out with the application of energy of the electric field, author found out that the determinant factor is the electric field intensity [Inozemcev 2006, Inozemcev et al. 2012] that determines the amount of electric energy or treatment dose:

$$W_n = \varepsilon_o \varepsilon_n \frac{E^2}{2} \quad (1)$$

where:
ε_o – the dielectric permittivity of air;
ε_n – the dielectric permittivity of seeds;
E – the dielectric permittivity of an electric field.

The geneticists from the USA (Iowa State University of Science and Technol-

ogy) draw attention to the positive effect of energy of the electric field on biological processes. They also emphasize its potential [Armstrong and Mitchell 1988], a significant alternative to existing methods of stimulation of seeds before sowing.

Studies dedicated to the plants reaction on various forms of the electromagnetic energy, and particularly on all of electric and magnetic fields, electromagnetic radiation, electric current of different frequencies demonstrate the existence of the energy resource thresholds for each plant generated by the nature on the genotype level.

It gives ground for the possibility to describe the dynamics of the development (growth) of plants with the following differential equation [Antomonov 1977, Tornili 1987, Inozemcev et al. 2012]:

$$\frac{dE}{dt} = f(E,t) \text{ or } \frac{dE}{dt} = \beta E \qquad (2)$$

where:
E – the growing capacity of plant;
t – the treatment duration;
β – the parameter determining the rate of growth of plant substance by transformation of the electromagnetic energy.

The solution of the equation (2) makes it possible to obtain the following equation of plant growth:

$$E = E_0 \cdot e^{\beta \cdot t}, \text{ for } t \geq 0; t < t_\infty \qquad (3)$$

where:
E_0 – the initial value of germination energy.

The graph of expression (2) will be as follows on Figure 1.

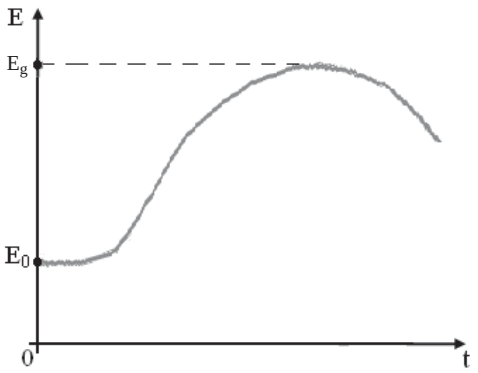

FIGURE 1. Dependence of growth of germination energy (E) from exposition (t). E_g – maximum limit of energy germination that the plant can possibly get depending on its energy resource

Analyzing the dependence (Fig. 1) we can confirm the existence of maximum level of germination energy (E_g) that plant can get according to its energy resource. This conclusion is confirmed by many numerical experiments that reveal the ambiguity of the impact of electromagnetic energy on viability of plants, demonstrating the existence of both stimulating and depressing effects. The abovementioned shows that the main focus of experts' interests must concern the problems of plants responses to external electromagnetic interference, its influence on the mechanisms of plants substances growth (germination energy and viability) and the change of internal energy connected with activation of so-called dynamic (transport) functions.

Today good prerequisites for the key role of electromagnetic energy as a factor of algorithm changes in the life of biological objects are observed. Finally, we can assume that the activation of life processes in plants can be achieved by

means of redistribution and imbalance of energy in biological objects, improvements in transportation by increasing the permeability of cell membranes.

The following problems of assimilation regimes that are used by plants to absorb the provided energy remain unsolved: the absence of differentiation of doses, the effect of exposure and internal energy on the field germination, formation of structural elements of yield capacity, the dependence of energy transfer processes from variety and specific species of crop, biological characteristics, metrological conditions of the growing season, vitality of plants.

Despite undeniable benefits (functional, economic, ergonomic) of influence of electromagnetic energy, regardless of its source, on the growth processes of plants, these studies didn't find wide implementation in Ukraine and some other countries.

In our opinion, this situation is caused by several reasons.

1. Lack of reliable information on the mechanisms of interaction with the plant, the response of the latter to the external interference, the information about the required amount of supplied power, its influence on the physiological potential of the plant (internal energy inherited by the plant). However, lack of information and objective assessment of reaction of biological objects on the immediate reaction of energy sources requires a deep and clear theoretical elaboration based on the full understanding of the nature of influence of energy provided to living organisms, plants, seeds, which are one of the most complicated elements of nature.
2. The existence of a contradiction concerning the impact of treatment dose (the amount of energy absorbed by the seed or plant) and efficiency of effect of different types of energy on the processes of stimulation of plants, for example the germination, shortcomings of existing methods of energy supply, efficiency ratio and energy saving possibilities.

   It should be stated that in addition to the necessity of further theoretical researches, the development of electrotechnologies is largely constrained by the following reasons:

– inadequate treatment of electrotechnologies by many experts that mainly refer to simple electrification of technological processes or electric equipment;
– low susceptibility of scientific achievements in the agricultural sector its commitment to the traditional farming technologies;
– the lack of appropriate equipment, despite its high efficiency in case of practical approbation;
– the lack of popularization of the use of electrotechnologies, underestimation of its functionality, scientific and technical potential.

CONCLUSIONS

Obtained dependences demonstrate the key role of electromagnetic energy as a factor of changes in the sphere of plants facilities and a significant correlation between the amount of power supplied and power resources of plants.

Researches carried out in the sphere of the application of electrotechnologies

in recent years give grounds to assert that implementation of these proposals will significantly increase the efficiency of energy processes and implement them in the agricultural production especially taking into account the possibilities of targeted regulation of development processes of plants.

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Streszczenie: *Wpływ energii elektromagnetycznej na zwiększenie plonu i stymulację wzrostu roślin.* Przedstawiono problemy wpływu energii elektromagnetycznej jako czynnika stymulującego wzrost roślin i zwiększenie plonu. Opierając się na wynikach światowych badań, wykazano znaczny potencjał i perspektywy elektrotechniki jako alternatywy dla aktualnie istniejących technologii. Wskazano podstawowe kierunki zastosowania elektrotechniki w procesie stymulacji wzrostu i kiełkowania roślin, obejmujące poprawę metod zasilania elektrycznego obiektów przetwarzania, w tym zastosowania sprzętu elektrotechnicznego w celu poprawy sprawności i uzyskania oszczędności energii.

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