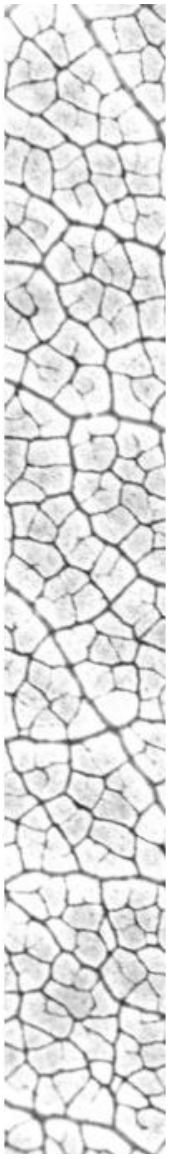

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Global problems of food security

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Abstract

Background. In the context of a rising problem of food security, agricultural technologies that could help effectively and efficiently improve the crop quality and productivity is of utmost importance these days. Considering all the existing environmental and agricultural problems, crop treatment with electromagnetic field appears to be one of the most promising techniques. This study thoroughly looks at the impact of low-frequency electromagnetic field treatment on the crop properties, with a special emphasis on the geomagnetic and cosmophysical fluctuations. **Materials and methods**. The study is built upon field experiment conducted in different regions of Kazakhstan, as well as a number of other countries. **Results**. In all of the locations where the experiment was conducted, positive results of the proposed technique were observed. The increase in crop was 30-40 %. The results were obtained for 11 crops, including wheat, barley, rice, corn, potato and others. **Conclusion**. The proposed technology can be widely used in agricultural production in order to obtain higher and better yields through pre-sowing treatment of seed material with electromagnetic modulator.

Keywords: pre-sowing stimulation, electromagnetic field, germination, seedlings, geomagnetic field, starvation

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INTRODUCTION

The evolution of the terrestrial life form, which emerged billions of years ago, was accompanied by the logic of the development of world history: the plant world — animal world — intelligence — human society — biosphere — noosphere – these are the key stages of life on our planet.

In the long process of struggling for life, people began to study themselves and the world around to learn its laws and to try to apply them correctly to increase own capabilities and meet their needs. Over seven millennia of development, humanity has accumulated experience and knowledge to realize responsibility for its future fate.

There have been many crises, conflicts and wars in history. But there has never been such a critical situation when the possibility of the existence of the terrestrial civilization as a whole was jeopardized, and the problem of limited land and resources has never required a science-based solution. The preservation of human civilization and the probability of its subsequent successful development are impossible without studying the general laws and proportions in the production-consumption system, developing the basics of reproduction cycles and managing global processes.

The need to develop an integral concept of transition to a post-industrial civilization is justified by the prerequisites and conditions for the formation of the logic of world historical development, which all world researchers and world community are trying to explain, considering the problem from various points of view.

A NEW METHOD FOR SOLVING FOOD SECURITY PROBLEMS IN THE 21ST CENTURY (WORLD DISCOVERY)

In recent years, the food problem in the world has sharply aggravated. One of the priority tasks for the planet is food security (Abdulwahed and Shneif, 2018; Shegelman et al., 2018). The key reason for this stems from the high rate of world population growth in comparison with the increase of food resources and a

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sharp decline in such basic resources as arable land, fresh water reserves and the rise in prices for energy resources needed for agricultural production. For example, the Food and Agriculture Organization of the United Nations (FAO) has recorded the annual loss of 7 million hectares of arable land.

Around the world, 1.3 billion people are chronically malnourished, more than 180 million children are underweight. In Africa, there are 175 million people that do not receive sufficient nutrition. Now there are about 7 billion people living on our planet. The annual population growth is 92-93 million. The International Institute for Applied Systems Analysis in Austria expects a total world population of about 9.5 billion by 2030. According to their calculations, the population is estimated to stabilize at the level of 12 billion people in the second half of the 21st century. In America, Europe, there are more than 20 million hectares of uncultivated land, in Africa this number reaches about 80 million. But with the annual loss of 7 million hectares of arable land, this is little consolation. In many countries, there are no funds for further development and use of land. In Nepal and the Philippines, the slopes of active volcanoes are being sown. In Brazil, forests are being burned, and humus-poor soils are rapidly being depleted. In the arid regions of India, intensive irrigation leads to salinization of the soil. Contradictions between agricultural land use and environmental protection are becoming more acute.

The true picture of the food situation is represented by production per capita. In 1950, grain accounted for 247 kg per person, and in 1984 this number reached 346 kg. According to various estimates, grain reserves will not be able to meet the minimum needs of people in 30-40 years. This means that people need technologies that would allow world population to produce high yields of both grain and raw cotton.

The presence of a significant number of hungry and malnourished people on various continents, including in a number of developed countries, indicates the lack of action being taken and the complexity of addressing the issue. A certain response to these difficulties is the development of the theory of food security and the development of new proposals to protect the population from the corresponding dangers and threats. Increasing attention to the food problem in these days is connected not only with the vital need, but also with the global, climate and social changes that are taking place in the world.

In this regard, one of the ways to solve the impending threat to humanity is the use of high technologies, including nanotechnology, to enhance the yield of agricultural crops, without increasing the area of arable land.

Kazakhstan's entry into the world market and upcoming accession to the World Trade Organization sharply raises questions about the competitiveness of our agricultural products. Lack of funds, low crop productivity, poor quality of seed grain – this is not a complete list of the problems faced by agricultural workers today.

The current stage of development of the agricultural economy is characterized by intensive land use. It is important for the land user to produce high yields, whereas improving soil fertility and ensuring the ecological well-being of the land plot only concerns so long as it serves to productivity growth. Therefore, it is particularly necessary to strengthen environmental measures in the land sector. It is estimated that about 75 % of the country's territory is at increased risk of environmental destabilization. The agricultural sector of Kazakhstan lost 12 million hectares of land due to erosion and decreased fertility. As a result, the quality of the grain itself decreases, about 70 % of the crop is attributed to the grain of the third quality level, 22 % - to the fourth. Quality is the main competitive advantage of Kazakh grain over foreign agricultural products (Abraliev 2011).

To these days, there have been invented various methods to enhance crop quality and capacity, among them are also physical ways to improve the crop properties. Electromagnetic field treatment of the crop deserves the highest attention of all the physical factors used in the practice of agricultural production, as it simultaneously meets several requirements: it is environmentally safe, quite beneficial from an economic perspective, is easy to operate and maintain, leads to an increase in yield and (or) improve the quality of products (Maginga et al., 2018; Verbitskaya et al. 2014). This method does not require large material costs and is easily repaid by increasing the yield. The perfect solution is a low-frequency electromagnetic field, which intensity does not exceed the Earth's magnetic field (Erokhin 2018).

One of the ways to improve the quality and quantity of seeds and planting material is environmentally friendly agricultural technologies based on electromagnetic biostimulation methods. The question of the mechanisms of influence of low-frequency electromagnetic fields (EMF) on various biological processes occupies an important place in the whole problem of EMF influence on living systems. Its importance is determined by the fact that this area includes the frequency of EMF in power lines, in various industrial plants and in household appliances, as well as the frequency of geomagnetic and cosmophysical fluctuations, which affect a wide range of biological objects (Nakhalnitskaya 1974, Nikberg et al. 1976, Mikhaylovskiy et al. 1981).

For plants, the magnetic field is as a necessary environmental factor as light, heat, and nutrients. It is believed that the mechanism of irradiation of seeds consists in the activation of the electronic complex of molecules that make up the seed, in the ionization of these molecules, the formation of free radicals, i.e., the

transition of molecules to an excited state. Despite the fact that the molecules are in the excited state for a fraction of a second, it is assumed that this is enough to strengthen the work of the enzyme systems that control the germination of seeds (Erokhin 2018).

As noted by Guruprasad and colleagues (2016), the Earth's magnetic field is a natural component of the environment and an inescapable environmental factor for living organisms including plants, however, it may be predicted that seeds and plant react differently at different frequencies and different intensity of magnetic fields. Magnetic fields have an effect on plant and seeds based on the field intensity, exposure time, signal form, flux density and source frequencies. Authors emphasize that the magnetic field may provide a feasible non-chemical solution in agriculture, offering advantages to protect environment and safety for the applicator.

The treatment of crop with high-frequency EMF, for example, has a positive effect on the germination and growth of plants. In turn, early germination of seeds leads to a shorter vegetation time of plants, whereas stimulation of metabolic processes enables obtaining well-developed plants, which ultimately leads to an increase in the yield and in much shorter term. Seed germination, when its nutrients undergo significant qualitative changes, is one of the critical periods of ontogenesis, which affects all stages of plant growth and development. Physical-chemical and physical-biological processes take place in seeds, as well as morphological modifications that lead to an increase in the permeability of the tegmen, the activity of hydrolytic and redox enzymes increases, cell division accelerates, and reactions that ensure normal functions of the embryo are activated. Electromagnetic stimulation helps to avoid using chemical growth stimulators, and thus has a positive effect on the environmental cleanliness of the source product and the environment (Kreslavski et al. 2009, Levina 2017; Toor, et al, 2016).

The use of the effect of electromagnetic field on the crop productivity has long been drawing attention of researchers. Thus, there is an opportunity to see the results from the conducted experiments to have a better understanding of the studied subject.

The study by Leo Rio and Marites Rio (2013) looked at the effect of electro-magnetic field on the growth characteristics of Okra, Tomato and Eggplants. In their study, authors used inductor that produces EMF, exposing on the Okra, Eggplants and Tomato. Authors also considered susceptibility of the plants to insects and pests. Founding of the study indicate that Okra plants when exposed to EMF grew faster and had its height, weight, sizes and number of fruits per plant significantly bigger and heavier than the Okra not exposed to EMF. However, authors noted that EMF brought negative effect on Tomato. Eggplants, both exposed and not exposed to EMF were found with no significant effects on its growth characteristics. Moreover, Okra, Tomato and Eggplant plants which were exposed to EMF were observed with fewer insects and pests compared to those not exposed to EMF.

Low-intensity electromagnetic radiation can cause a reaction of biosystems that cannot be caused by radiation of relatively high (thermal) intensity. There are the following hypotheses for the interaction of biosystems with low-frequency magnetic fields: changes in the properties of free and bound water; polarization of biomolecules and cells; stochastic resonance; changes in the probability of mutual collisions of chemical reagent molecules; resonant interactions (Vazhenin, 2013).

The study conducted by Sabu and colleagues (2018) sought to determine the effects of low electromagnetic field (EMF) exposures on seed germination rates and the plant growth phases. In their study, seeds of *Pisum sativum, Zea mays, Solanum Lycopersicum, Cyamopsis tetragonoloba, Cajanus cajan* were germinated at low electromagnetic fields (380 ± 20 μT). The authors indicated that ELF MF exposure to the seeds right from the beginning to the seedling stage resulted in enhanced growth, while the major increases occurred when seeds were continuously exposed to the EMFs.

In their study (2015), Jedlička and colleagues have investigated the impact of extremely low frequency electromagnetic fields on seed germination of tomato (*Solanum lycopersicum* L.) after treatment before sowing, as well as the subsequent growth of young plants after electromagnetic stimulation prior to planting in the field. Treatment of tomato seeds and young plants with electromagnetic field at the time before planting in field conditions also influences the production of fruit.

It is known that water carries information about the effects of the electromagnetic field after processing in biological objects. Many similarities have been found in the influence of electromagnetic fields on water and on biological systems (Lyashchenko 1991). The effects caused by low-frequency electromagnetic fields (LF EMF) are of the utmost interest (Travkin 1973).

The model of the mechanism of action of super-weak factors on biological systems (Nakhalnitskaya 1974) is based on the fact that in any living system there is an intermolecular water environment that has two initiators of structural organization: 1) the structural organization of water as a condensed phase of the substance H_2O, containing its own clusters and clathrates, built around organic and inorganic impurities and mixed with water elements from $(O\text{-}N^{+}\text{-}\ O)^{-}$ to $(OH)_nH_{n\text{-}x}$) (Lyashchenko 1991). This structural organization is characteristic of water and is present in living systems and forms the basis for the action of super-weak factors; 2) structural organization of water adjacent to biomolecules, initiated by energy transfer processes in living systems. This structural organization is formed by the periodic passage of polarization waves created in the processes of energy accumulation in the form of solitons when it moves along the chains of macromolecules, through the adjacent

layers of water biomolecules. This conclusion was made on the basis of the soliton theory of Davydov (1979) and the polarization solution of Frohlich (1980).

The research works that investigate the stimulating effects of low-frequency EMF on seeds have been conducted. It was found that the effects of stimulation of wheat seed germination under the influence of low-frequency EMF treatment depend on the degree of membrane stretching upon seed swelling (Travkin 1973). At the same time, it was noted that long-term exposure to EMF during the swelling of seeds leads not only to inhibition of the growth of seedlings, but also to a drop in their germinating capacity. This is associated with desynchronization of growth processes by stimulating the release of protein and inhibition of its binding. The proposed physical and chemical mechanism explains the principal features of the impact of low-frequency EMF on organisms, including sensitivity to magnetic storms and the weakening of effects with increasing EMF amplitude.

An important indicator of the sensitivity of a biological system to geophysical factors is magnetic susceptibility (Nakhalnitskaya 1974, Nikberg 1976). The circadian dynamics of fluctuations in magnetic susceptibility, as an integral indicator of the intensity of metabolism, coincided with the circadian cycle of photosynthesis. Regardless of the plant type, the magnetic susceptibility of the leaves increased with sunrise, reached a maximum at noon, decreased in the evening and had minimal values in the late night, but in 3-4 pre-dawn hours it reached the morning initial level, from which it was calculated.

MATERIAL AND METHODS

The study is built upon a field experiment conducted in different regions of Kazakhstan, as well as a number of other countries: at the Suleyman Demirel University, Sparta, Turkey, at the Research Institutes of Uzbekistan, Ukraine, Tajikistan. The technology has been tested in 6 regions of the Republic of Kazakhstan and 8 countries. The experiment showed that the farms where the technology will be applied will not need any additional energy consumption and manual labor during such seed treatment. The uniqueness of this technology lies in the fact that the previous agricultural techniques for growing crops remain unchanged.

Experiments conducted in many soil-ameliorative and climate zones have shown that this technology produces only positive results in all cases.

The proposed science-intensive technology is based on long-term fundamental research of research institutes of the former USSR. The theory of the effect of weak electromagnetic field pulsations on biological objects is not novel. It was developed by academicians A. Chizhevsky, V. I. Vernadsky, N. A. Kozyrev, and S. E. Shnol, a researcher of cosmogeophysical relationships. Achievements made by these researchers allowed to make conclusions about the unity of fundamental properties of the biopolymer functioning and initiated the scientific field named “Synergetics”, which is closely related to biological phenomena and environmental objects. For this contribution, the group of researchers (Prigozhin and others) was awarded the Nobel prize. A problem of solar-terrestrial relations or, more precisely, cosmophysical correlations of terrestrial processes, is increasingly attracting the attention of researchers of different scientific fields. It was found that negligibly small fluctuations in the interplanetary magnetic field can cause significant changes in climate, in the state of the biosphere, and in the physiology of animals and plants.

In order to rely on the more complete information on the problem under study, this research draws upon numerous works on related subject, among them are works by Skidelsky (2011), Stiglitz (2009), Yakovets (2011), Kaku (2012), Sabden (2014), Glazyev (2010), Subetto (2013), Moiseev (1999), Akaev et al. (2013).

RESULTS

The technology has been successfully tested in all of the research institutes and experimental stations subordinated to the Ministry of Agriculture of the Republic of Kazakhstan, Barayev Agricultural Research Institute, Kostanay Agricultural Research Institute, North Kazakhstan Agricultural Experimental Station, Priaralsky Rice Research Institute, Kazakh Cotton-Growing Research Institute, South Kazakhstan Agricultural Research Institute, as well as in foreign organizations – AO “Elite seeds of Tatarstan” of Kazan, Chelyabinsk Agricultural Research Institute, Deutsche-Russisches Institut für Biomagnettische Kybernetik und Nanotechnologie of Berlin.

A previously unknown pattern of increasing bioresonance activation of crop seeds has been experimentally established. It consists in the fact that during electromagnetic treatment of seeds with a frequency multiple to their biorhythms, during periods of minimum values of gravitational forces and maximum intensity of cosmic radiation, the degree of bioresonance activation of plant seeds increases, leading to a rise in the germination rate, yield, quality improvement, and other productivity indicators. In all of the above locations, the experiment has shown positive results. The increase in yield was 30-40 %. The results obtained for 11 crops, including wheat, barley, rice, corn, potato and others, indicate the universality, environmental friendliness, and adaptability of this technology (**Fig. 1**).

For Kazakhstan, which has 12.65 million hectares of cultivated land, the increase in yield only for grain will be 5-6 million tons, which will certainly contribute to solving the food security problem for the country. At a conservative estimate ($200 per ton of wheat), this will amount to 1.0-1.2 billion $ US. The economic effect

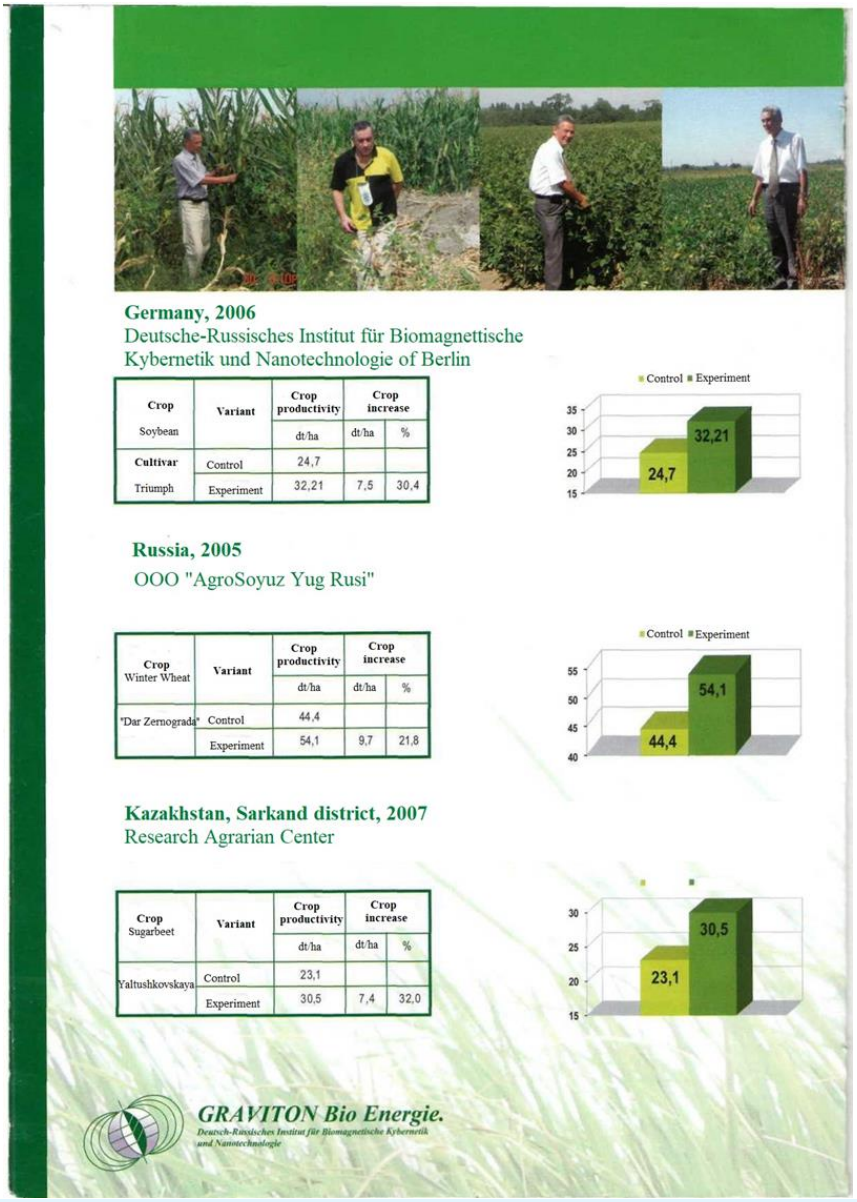

Fig. 1. Crop increase obtained after conducting an experiment

(excluding expenses) will be 0.9-1.0 billion $ US per year.

The main ideas presented in the work have been tested by the authors for many years in a number of world congresses, symposiums, conferences, forums, including in the cities of Shanghai, Beijing, Berlin, Moscow, St. Petersburg, Nur-Sultan, Almaty, Bishkek, Antalya, Bursa, Sparta, Alushta, Donetsk, Tashkent, Baku, Ashgabat, Kazan, Dushanbe, etc.

DISCUSSION

Pietruszewski emphasized in his work (2011) that the knowledge of the parameters of seeds (moisture content, growth rate, storage period) and electromagnetic field (field strength, frequency, time of exposure, polarity) as well as environmental parameters (temperature, light, moisture content of soil) is necessary to understand the correlations between the physiology and cytology of the growing seedlings and the electromagnetic stimulus. The energy carried in LMF (50 Hz) is much too low to break molecular or chemical bonds. The effects of exposure of seeds to LMF arise from non-thermal reactions – 50 Hz is a frequency of many enzymatic reactions and can stimulate the biosynthesis ‘stress response’ in cells (Pietruszewski 2011).

Viable seeds normally absorb water and swell at the beginning of germination, then the seed coat breaks and the first root appears. A positive geotropic reaction of the root directs it to the bottom, and numerous root hairs that develop below the root junction keep the seedling in the soil or substrate for germination (**Fig. 2**). The cotyledon

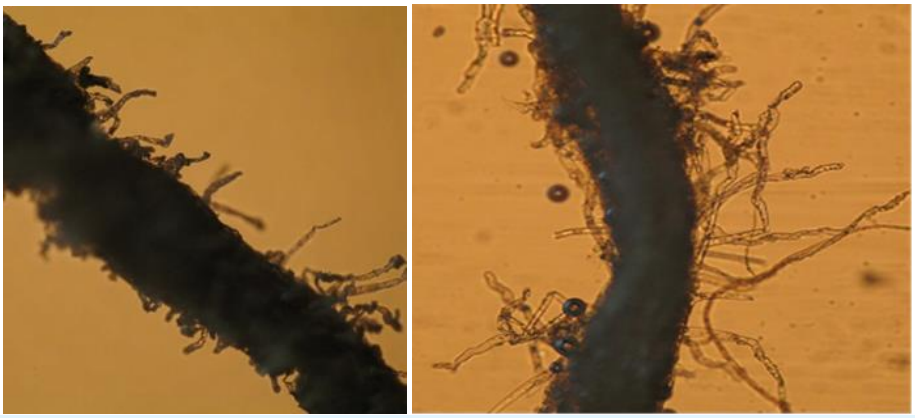

Fig. 2. Development of root hairs

is modified as an organ of absorption and also remains inside the seed, where it destroys the endosperm.

After rising above the soil surface, the tip of the sprout gradually forms leaves and nodes in the regular surface, separated by internodes; meristems in the leaf axils can give axillary sprouts, which form a system of branches on the main stem. The root system develops from adventitious roots that come from the stem, not from the primary root.

In practice, various methods of pre-sowing treatment of seeds and tubers are used. The most widespread are the methods of chemical treatment of seeds with growth-regulating substances and draining with organo-mineral mixtures, as well as physical methods of biostimulation: mechanical treatment, the use of electric and magnetic fields, optical, ultra-violet and microwave radiation, penetrating radiation, plasma treatment, etc. However, all these techniques are currently not technological, mainly due to the huge amount of manual labor. Moreover, the use of the larger part of the above methods produces chemical pollution of the environment, causes irreparable damage to the soil microflora, leads to the changes in the genetic program in plants, which results in undesirable mutations and impurity of cultivars. Conversely, chemical pollution of the external environment causes changes in the genetic program of the organism of animals, plants and people. An increase in the mutation frequency leads to the human malignant tumors and hereditary diseases. In plants, it results in a degradation of industrial varieties due to the appearance of plants with highly modified properties.

Scientific achievements of recent years have enabled, relying on the theory of integrity of the fundamental properties of the functioning of biopolymers, to observe ultra-weak physical effects on living organisms. There are collected facts about the significant results of these effects. It pertains to remote correction of weak connections, which allows treatment of various diseases in humans, animals and plants, increasing plant fruitfulness and product quality.

In view of the foregoing, as well as drawing upon the works of academician Kozyrev (1994) about the “energy-information exchange in nature”, there have been found patterns on the ability to manage biological objects, which enables harnessing the genetic capabilities of plants and animals by the help of low-frequency electromagnetic field, the parameters of which are calculated on the basis of special mathematical programs using space and time indicators.

The proposed technology for pre-sowing treatment of seed and planting material is a natural development of the above inventions and allows obtaining stable results, which have been repeatedly covered in the media.

This technology with greater accuracy enables:

- to correct and obtain from biological objects the properties that are inherent therein by nature;
- to predict future results and events with a higher degree of probability;
- to obtain new features and properties of biological systems that were previously considered impossible;
- to obtain high yields anywhere in the world and increase the yield of any crops without polluting the environment.

The features of pre-sowing treatment of seed or planting material with an electromagnetic field are described below.

The use of electromagnetic module helps to provide the impact of EMF on seeds or tubers before seeding. The parameters of the electromagnetic field are selected depending on the micro-pulsations of the Earth’s geomagnetic field at a specific treatment place. In this case, irradiation is performed in accordance with the calculations of natural fluctuations of the geomagnetic field. As a result of this effect on the seeds, the cell metabolism moves to a higher energy level, with enhancing the biological activity of cells as a whole.

The proposed technology can be widely used in agricultural production in order to obtain higher and better yields through pre-sowing treatment of seed material with electromagnetic modulator.

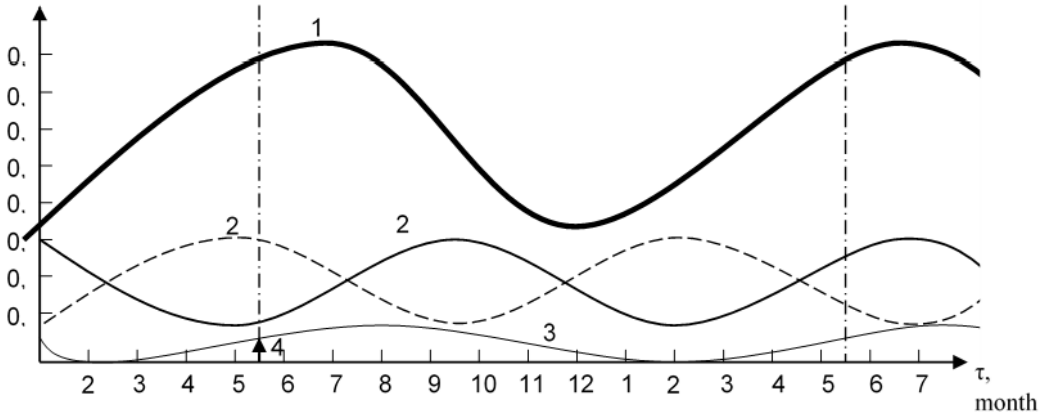

Fig. 3. Annual dependences of helioinsolation (1), moon gravity (2-2), natural (3) and artificial electromagnetic (4) radiation

The principle of operation of an electromagnetic modulator (EMM) lies in that the electromagnetic waves emitted by EMM activate a group of enzymes in seeds and tubers that provide rapid growth of germ and strong development of the root system. When the grains swell, the activity of alpha- and beta-amylase increases by 20 percent or more, which contributes to the hydrolysis of starches and dextrines of the endosperm to oligo-, di-, and monosaccharides that feed the seedlings and roots. This leads to the enhanced synthesis of gibberellin in the germ and its active transport, which affects the intensity of cell division. All this ensures an active start of the plant during germination and its rapid transition to autotrophic type of nutrition. This results in the formation of a strong photosynthetic apparatus that provides energy to the realization of genetic possibilities of the object: increasing photosynthetic surface, the amount of photosynthetic pigments per unit area of the leave, the size of the light-harvesting complex and the number of reaction centers (**Fig. 3**).

Strong development of seedlings provides active photosynthesis of plants, which is increased by 1.5 times. Such plants more fully assimilate mineral and nitrogen fertilizers, giving in the end not only higher yields, but also improving the quality of products: for example, it leads to the increased amount of protein and gluten in cereals and legumes, the increased amount of oleic acids in oilseed crop.

The results discussed in the article can give a fresh impetus to the strategy of human development in the 21st century and subsequent centuries, and especially in maintaining world security, including food supply for a billion hungry people in the world, which certainly deserves the attention of the world community of developed countries and development institutions.

CONCLUSIONS

Given that 1.3 billion the world's population is suffering from hunger, special attention is paid to the food supply to these populations. For the first time in the world, the authors applied a complex of cosmogeophysical characteristics in agriculture to solve food security, in particular to increase the yield of various crops. In 2004, after conducting relevant expertise appraisal at the Russian Academy of Natural Sciences and in Hanover (Germany), the authors were awarded a diploma for scientific discovery. The systemic effect of gravitational fields of the Sun, Moon, Earth and planets of the Solar system, electromagnetic fields periodically generated by the Sun, as well as additional artificial electromagnetic radiation with a frequency multiple to the biorhythms of plant seeds is explained for the first time.

Main application of the proposed technology is use in agriculture, for cotton and grain-crops (wheat, barley, rice, etc.). The innovative technology was successfully tested in all of research institutes and experimental stations subordinated to the Ministry of Agriculture of the Republic of Kazakhstan, such as Barayev Agricultural Research Institute and other research institutes, as well as in foreign organizations, such as AO "Elite seeds of Tatarstan" of Kazan, Chelyabinsk Agricultural Research Institute, Deutsche-Russisches Institut für Biomagnettische Kybernetik und Nanotechnologie of Berlin, at Suleyman Demirel University, Sparta, Turkey, in Canada in the organization "UP GREEN", at the research institutes of Uzbekistan, Ukraine, Tajikistan. The technology has been tested in 6 regions of the Republic of Kazakhstan and 8 countries. In all of the above locations, the experiment has shown positive results. The increase in yield was 30-40 %. The results obtained for 11 crops, including wheat, barley, rice, corn, potato and others, indicate the universality, environmental friendliness, and adaptability of this technology. The detailed information on the proposed technology is published in a number of media outlets in the Republic of Kazakhstan. The technology is implemented on the production sites of the countries where it was tested, with available implementation certificates, patents, certificates, and other documents of the relevant organizations.

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