



Effect of the Using combined Environmentally Friendly Methods on Increasing the Yield of Agricultural Products

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ABSTRACT

The paper presents results of the combined use of environmentally friendly methods in order to increase the quantity and quality of a wheat harvest by intensifying the biological processes occurring in the seed with the use pre-seeding irradiation with a low-frequency acoustic range electromagnetic field (EMFAR) and with addition of natural zeolite - clinoptilolite to the soil. The experiment was carried out in eight variation, each in four replicates. The sowing qualities of wheat seeds were previously established. Laboratory germination of the test culture was 94%. Before sowing part of the seeds were soaked in water into the vegetation vessels, the other part – in a diluted solution NPK, and then exposed to the electromagnetic field of the acoustic range (EMFAR). The optimal parameters of EMFAR (frequency, voltage, exposure time) were established on the basis of previously testing. Prepared seeds were sown in vegetation vessels with composites containing soil and zeolite (clinoptilolite of the Handaki deposit, Georgia) on a 1: 1 ratio. The results of the carried out experiments showed that the life-sustaining activity parameters of test plants grown from seeds treated with EMFAR exceeded those of plants grown from untreated seeds. The proposed methods will increase the productive potential of wheat by improving the water- and energy-supply of plants (percent of germination, growth and yield parameters).

Keywords: Seeds, Stimulation, Electromagnetic field, Productivity, Natural zeolites, NPK.

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Introduction

Today, the development of agriculture is in accordance with global trends in the transition from an extensive to an intensive way of managing.

Agriculture is one of the most important sector of the state's economy, not only from the point of view of ensuring food security, but also from the perspective of a common contribution to the development of the economy [1].

High productivity of crop species is one of the main indicators of the effectiveness of agricultural industry. In modern technologies, great importance is given to various methods of treating seeds and plants of grain crops with environmentally friendly methods that stimulate the growth and development

of plants, increase their productivity and resistance to stress.

The solution of this problem is possible in two ways. The first way includes methods aimed at changing of environmental factors, creating favorable conditions for the growth and development of plants, such as fertilizing and feedings, the necessary agricultural activities, etc. In the process of evolution plants adapt to the environment, which determines their placement on land and in water. Within the area of distribution and biocoenosis, living conditions do not remain unchanged. In some years, changes in environmental factors are so significant that they make the plant need to mobilize all adaptive resources. The second way is associated with stimulating the growth and development of the

plant itself and includes the use of various agents, growth regulators, as well as presowing treatment that stimulate the development of plants. In countries where the most agricultural lands is at risk zone or unsustainable farming, the second way, i.e. the use of specimens and methods that increase plant resistance to uncomfortable growing conditions is the most relevant [2-3]. Development of new methods for increasing the viability of agricultural crops is the most important task of agrobiological sciences and agricultural industry. Over recent years in order to intensify plant growing, electrophysical methods of influencing plants and seeds of grain and vegetable have begun into the agriculture industry with the purpose of their stimulation (growth acceleration, yield enhancement and improvement of product quality). Stimulating effects such as electric and magnetic fields, sunlight, infrared and laser irradiation, high and ultrahigh frequency current have been tested in laboratory and field conditions. The influence of electrophysical factors on seeds is well reasoned and repeatedly tested in agriculture and has become widespread in many countries [4-11]. However, the response of the seeds to the same affecter may be different depending on the variety and quality of the seeds, duration of the treatment and radiation dose, waiting time from the moment of processing to sowing, on natural factors and other circumstances. For this reason, getting identical results of the efficiency of electrophysical processing is very difficult. Studies have established that under the influence of an electromagnetic field, forces are mobilized and the organism's energy reserves are released. Physiological and biochemical processes are activated in the early stages of seed germination; increasing in intra-exchange processes and a steady increase in germination energy, germination, initial growth strength, spring-summer survivorship rate takes place. All this favorably affects the entire subsequent period of plant development. A common drawback of all existing technologies using pre-sowing seed treatment by electrophysical methods is the low repeatability of the treatment results, and, as a consequence of this, the inability to determine the desired values of parameters of the acting electromagnetic field, which would provide a stable positive effect. Stimulation of plant growth is a complex problem. The difficulty of this study is insufficient knowledge of the metabolism of the plant organism, including such integral processes as growth and productivity. In many cases, the researchers' approach to the problem of seed stimula-

tion remains empirical, because there are no sufficiently deep theoretical and experimental studies of the mechanism of action of various physical factors on seed.

Diseases and seed insects have a negative effects on the sowing quality of seeds. Chemical etching methods are currently used to prevent seed diseases. However, the use of toxic chemicals has a number of negative environmental consequences [12-14]. Therefore, it is necessary to stimulate seeds, improve their sowing properties and compensate for the inhibitory effect of etching.

In the framework of this study, the stimulation and intensification of the development of biological processes in the "seed + soil" system is assumed by the activation of elements at the nanolevel [15-17]. To implement research in this direction, it is necessary to harmonize processes that occur both at each stage of plant development and in the soil; i.e. the optimal set of field and soil parameters should be selected: field intensity and frequency, exposure time, ratio of the amount of zeolite and organic component. A significant improvement in the conditions of plant growth and development is achievable by stimulation and intensification of metabolic processes in plants via improving the supply of plants with water and nutrients from introducing organic-zeolite mixtures into the soil, as well as by pre-sowing seed treatment in an EMFAR (low frequency electromagnetic field of the acoustic range).

A number of researchers [14-16] have noted the high sensitivity of biological systems to the effects of low intensity electromagnetic fields of low-frequency range. According to some authors, the high sensitivity of seeds to a low-frequency electromagnetic field is explained by a change in the pH of the medium and by the release of proteins from the bound state into the aqueous medium. This, in turn, accelerates exiting of seeds from a dormant state and stimulates the development of restoration processes in them [17-19]. As a result, the impact of EMFAR contributes to an increase in crop productivity. At the same time, all types of electromagnetic radiation when exposed to seeds have stimulation and inhibition zones depending on the radiation dose. The use of electrophysical methods for pre-sowing seed treatment in agriculture is universal and the degree of their impact is mainly regulated by changing the power or exposure depending on the purpose of the treatment. Seeds initial quality and their viability is also affected on processing effect. We did not find any information on the combined use in agricul-

ture of natural zeolites and a low-frequency electric field of the acoustic range for the cultivation of organic crops. It should be noted that the ecological efficiency of using zeolite tuffs in the soil + plant system has been confirmed by researchers to improve the agrophysical and physical-chemical properties of soils, increase the yield and quality of plant products [20-27]. It has been experimentally established that introduction of unconventional mineral agricultural resources into the soil is economically viable and environmentally friendly agricultural method for increasing soil fertility and environmental resistance of both soils and plants to extreme conditions. In areas of environmental risk this agricultural method has a positive effect on the most important vital signs of grain, crop formation and grain quality parameters. Under certain environmental conditions natural zeolites, introduced into the soil are long-acting and able to change the ratio of cations in the soil absorption complex. Zeolite-containing species, in principle, are silicon-containing polymineral fertilizers because the main part of the chemical composition of various zeolites, just like the soil, is silicon. Silicon fertilizers and ameliorants on degraded soils of agricultural lands and soils with a low level of fertility can increase the provision of plants with silicon and effectiveness of the applied mineral and organic fertilizers, as well as plant protection products. The main function of silicon in plants is to ensure the organism's resistance to adverse environmental conditions, accelerate the growth and development of the root system, bind toxic compounds, and also ensure the synthesis of the necessary antioxidant protection enzymes and stress proteins. A positive reaction to the introduction of silicon is characteristically not only of siliophilous cereal plants, but also for other families.

Objects and Research Methods

Based on the foregoing, it seemed to us interesting to combine two methods: treatment of test seeds (wheat) with a low-frequency electromagnetic field of the acoustic range (EMFAR) and the introduction of natural zeolite into the soil. Due to this a laboratory mini-generator was designed. The optimal parameters of the electromagnetic field of the low-frequency acoustic range (frequency, voltage, exposure time) were established on the basis of earlier experiments. The sowing qualities of wheat seeds were established before the experiment. Seeds with good germination and high germination ener-

gy always give friendly and full-fledged seedlings. Seed germination energy – the ability of seeds of agricultural crops to grow together. This indicator is determined simultaneously with germination – the number of germinated seeds (as %) during a certain period for each crop. Determination of germination is one of the most important types of assessing the sowing qualities of seeds, since with poor germination the yield is reduced. Seed germination is understood as the number of normally germinated seeds in a sample taken for analysis (as %). Laboratory germination is the percentage of normally germinated seeds within 7-10 days in a sample taken for analysis. Germination should be close to 100% [6, 14]. In this case, the germination of the test culture (wheat) was 94%. Germination of seeds treated in EMFAR began one day earlier than in untreated seeds.

The experiment was carried out in eight variants, each in four replicates. Garden soil (gray-brown) and zeolite-clinoptilolite of Handaki deposit (Georgia) with a mineral content of 60-70% (ratio soil/zeolite was 1:1) were placed in vegetative vessels.

Before sowing the seeds (in vegetation vessels) were soaked in water or in a diluted solution of (0.5%) NPK. Some of them were treated with EMFAR, and then sown in prepared composites. Duration of the experiment was seven months (09.11.2017. -22.06.2018).

Results and its Discussion

First option – clean soil (absolute background) + wheat (test plant)+ water

Second option – soil + wheat + solution NPK.

Third option – soil + wheat + water, EMFAR.

Fourth option – soil + wheat + solution NPK +EMFAR.

Fifth option – soil + zeolite + wheat + water.

Sixth option – soil + zeolite + wheat + solution NPK.

Seventh option – soil + zeolite + wheat + water + EMFAR

Eighth option – soil + zeolite + wheat + solution NPK +EMFAR.

Table. *Biometric indicators of wheat development in various variants*

| Variants | I | II | III | IV | V | VI | VII | VIII |
|--|---|-----------------------------------|--|---|----------------------------------|---|--|---|
| Indicators of plant development | soil + water treated seeds (control) | soil + water treated seeds+ EMFAR | soil +seeds treated with solutions NPK | soil + seeds treated with solutions NPK + EMFAR | soil+zeolite+water treated seeds | soil+zeolite+water treated seeds+ EMFAR | soil +zeolite + seeds treated with solutions NPK | soil + zeolite + seeds treated with solutions NPK + EMFAR |
| Germination (%) | 80 | 85 | 85 | 90 | 90 | 95 | 95 | 95 |
| The average length of the stem (cm) | 34,3 | 34,7 | 35,2 | 41,0 | 41,7 | 46,3 | 49,9 | 51,6 |
| Average spike length (cm) | 4,5 | 4,8 | 5,1 | 5,6 | 5,7 | 6,22 | 6,5 | 7,0 |
| 1000 seed weight (g) | 19,7 | 20,0 | 25,0 | 25,00 | 26,3 | 26,32 | 29,00 | 31,5 |
| Number of spike /m ² | 255 | 349 | 382 | 400 | 410 | 440 | 450 | 502 |
| The number of stems per 1 m ² | 254 | 270 | 270 | 286 | 286 | 302 | 302 | 302 |
| Green mass per 1 m ² (g) | 127,4 | 140,1 | 219,8 | 226,1 | 232,5 | 251,6 | 264,4 | 267,5 |

It is seen from the tabular data that the combination of the methods used (treating the seeds of the test culture with a low-frequency electromagnetic field of the acoustic range and introducing natural zeolite into the soil) positively affects the germination rate, green mass of plants and the increase in grain mass. It is likely that seed treatment (using EMFAR) before sowing activates the enzyme system in the initial period of seed development, which positively affects the final yield. The number of productive stems in plants from untreated seeds is less than in plants from treated seeds. Plant height and spike size in plants obtained from treated seeds is greater than from untreated seeds. Introduction of zeolite into the soil, as well as the preliminary soaking of seeds in an NPK solution, have a positive effect on the development of test plants. It is known that the number of grains in a spike is the main indicator of productivity. A mass of 1000 seeds shows what mass (in g) a thousand "pure seeds" have. As can be seen from the tabular data when combining all the options used in the experiment, the best results were obtained by sowing seeds soaked in an NPK solution and treated with EMFAR and sown in soil with zeolite.

Conclusion

Thus, the combination of the above methods contributes to reliable and stable activation of the physiological potential of plants, reduce environmental pollution and obtain environmentally friendly products. Vegetative plants grown from treated seeds are superior to untreated plants in terms of parameters.

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