World Journal of Agricultural Research, 2013, Vol. 1, No. 3, 39-43
Available online at http://pubs.sciepub.com/wjar/1/3/2

DOI:10.12691/wjar-1-3-2

Microwave Technology for Treatment Seed

G.A. Morozov[1], V.I. Blokhin[2], N.E. Stakhova[1], O.G. Morozov[1], N.V. Dorogov[1], A.S. Bizyakin[1,*]

[1]Kazan Nat'l Research Technical University, Kazan, Russia
[2]Centre for Breeding and Seed at the Agriculture Research Institute of Tatarstan, Kazan, Russia
*Corresponding author: alex_company99@mail.ru

Received December 24, 2012; Revised June 03, 2013; Accepted June 04, 2013

Abstract This article discusses the impact of dual-frequency method of EHF radiation of millimeter range on seed crops. The essence of the dual-frequency method is the selection of biologically active frequency, which tends to change in a narrow range and simultaneous processing of seeds to several biologically active frequencies. Results of laboratory and field studies in Tat NIISH show the positive impact of two-frequency method and a more effective stimulant effect.

Keywords: *treatment of wheat seeds, microwave technology, dual-band setup, a dual-frequency method, the informational impact UHF, microwave heating, the energy of germination, germination*

1. Introduction

Agricultural workers have long known the importance of quality seeds, which determines the value of the harvest and production quality. The seeds for sowing are prepared with high sowing and varietal characteristics, mainly recognized varieties. Any book on the seed, usually begins with the words of folk wisdom "from the bad seeds do not expect a good tribe."

It is known [1] that, before the germ of roots and stem are developed at the expense of nutrients of the seed: a set of amino acids, starch, gluten, vitamins of group B. The more of these substances and how quickly they are absorbed by cells of the embryo seed, so (at the optimum amount of moisture , oxygen, sufficient temperature) develops more powerful root system quickly occur all stages of growth and development of plants.

Starting in the 70-s, began to attract the attention of experts effects of electromagnetic fields (EMF), the short-millimeter (EHF) (40–60 GHz) and microwave (MW) (1–3 GHz) wavelengths on different biological systems [2]. It was found that under certain conditions, there are marked effects of incentive-based, including improved crop characteristics of seeds of different crops [2]. This is due to the fact that working on the seeds of the short-EMF millimeter (EHF):

1. active biochemical process contributes to a more rapid absorption of nutrients in the processed seeds, most clearly manifested in the effects of old and not certified [2];

2. increased immune suppression of seed due to a number of parasitic micro-organisms growing on the surface of the seed and cause various diseases [2,4].

It is important to note that these effects are the result of exposure to EMF is very low intensity (less than 10 mW/cm^2), have the frequency dependence of the resonant nature and are characterized by intensity thresholds at which the effect begins to show jump like manner [4].

For seed treatment EMF microwave, as well observed inhibition of harmful microorganisms on the surface of the seed, but this is due to the fact that the seeds are heated to the temperature 1-3°C, which increases the quality of sowing seeds and depressing number of parasitic organisms simultaneously. It should be noted that there is insignificant drying seed before laying for the winter. Since the breathing Seed dormancy is very weak, but increases sharply during germination and need for oxygen increases. Germinating seeds absorb not only oxygen, but also emit carbon dioxide, ie breathe. This is natural: after all the plants, like animals, living organisms.

During respiration generates heat. Raw seeds breathe vigorously dry. Therefore, they are composed of a thick layer of warm up quickly, and is said to be "burned", and Therefore, they are composed of a thick layer of warm up quickly, and is said to be "burned", and the embryos perish. The seeds not germinate [1]. Therefore, they are deposited only clean, dry and store in a dry, well ventilated, with air access to the seeds should be free and permanent but are known to lay the seeds for the winter does not always correspond to the desired moisture content and there is a need re-drying.

This article presents the results of laboratory and field studies, obtained by us in the processing of wheat, "Kazan 560" on the dual band (UHF and EHF) installation.

2. Results of Laboratory and Field Studies of Two-Setting Range

With the implementation of microwave technologies based on biological effects of electromagnetic energy of the microwave and EHF ranges, the condition of a given quality treatment can be achieved by defining different sets of parameters: energy, frequency, modulation parameters, polarization, duration and frequency of exposure, significantly different total cost microwave energy to take account of different costs of microwave energy in different frequency bands.

In view of the obscurity of the underlying mechanisms of biological effects, the only rational mode by choosing a complete listing of the set of experimental data.

Seeds is treated with "thermal " or "non-thermal (informational)" microwave and UHF fields.

2.1. Seed Treatment by Electromagnetic Fields

The basis of the physical nature of the heating medium of electromagnetic fields that are exposed to the electromagnetic effects of environment on their properties is an insulator with a rather large losses. The presence of losses in the medium leads to the appearance in it of conduction currents, and hence its heat. Thus, the interaction of environment with EMI appear continuously distributed throughout the volume of heat sources (currents). This leads to an internal uniform heating of the medium (in our case, the seeds).

To improve the quality of sowing seeds is enough to warm up for 1-3°C. To determine the time of heating the seeds to the desired temperature, it is necessary to establish a connection between the initial and final temperatures and electro physical parameters of seeds:

$$\Delta t = \frac{\rho cm(T_K - T_H)}{\omega\varepsilon\varepsilon_0 \mathrm{tg}\delta \cdot E^2} \quad (1)$$

where Δt – heating time, °C; ρ – density of the seeds, kg/m^3; c –specific heat, J/kg·degrees; m – mass of seeds, kg; T_K – the final temperature, °K; T_H – the initial temperature, °K; ω – angular frequency, rad; ε – relative dielectric constant of seeds; ε_0 – dielectric constant; tgδ – dielectric losses; E –electromagnetic field strength, V/m.

Equation (1) as a basis for drawing up the program of experimental studies on the dual-band setting in the microwave.

Thus, seed treatment with electromagnetic fields, microwave positive effect is observed upon heating the seeds at 1-3°C, then at work in the microwave can talk about mostly "thermal" effects on the processed seeds [2]. The effect of the EMF has been tested [2] in the laboratory energy of germination and germination of seeds of wheat, "Kazan 560".

2.2. Seed Treatment with EHF Electromagnetic Fields

Non thermal (information fields) are characterized by the fact that the biological effect of electromagnetic field is not related to the direct influence of surface energy on the processed seeds (less heating 0,1°C). Their effects, so-called "information signals, is to manage the biochemical processes occurring within the seed and causes depressing effect on the number of parasitic organisms.

Information fields in the greatest show its effect in the EHF (millimeter) range. The action of such a field does not depend on its intensity, but there is a threshold (1-10mW). The excess of the threshold value of EMF exposure leads to a change in the effectiveness of exposure, namely to reduce the positive effect [4]. The carrier of information is the frequency of the EMF, so the studies were conducted to determine the frequency of treatment, allowing to achieve the best quality crop seeds. The studies confirmed that the biologically active frequency (resonance) has the ability to change during processing, so the wetter the seeds have a resonance frequency different from the seeds of the same class, but drier. In this connection there is need for matching the resonant frequency prior to treatment and continuous monitoring during treatment.

Treatment of seeds produced by a particular program, and based on the dual-band unit (Figure 1), developed at the Scientific Research Center of Applied Electrodynamics of KNITU. Block diagram of dual-band system is shown in Figure 1.

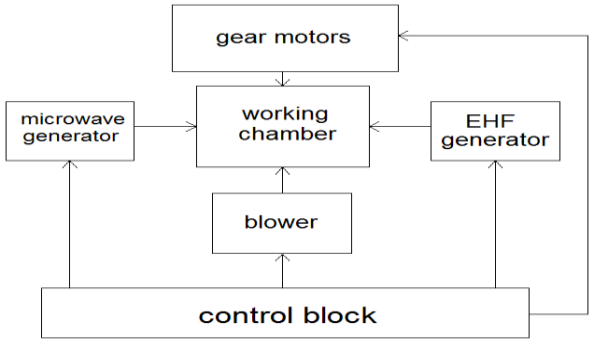


Figure 1. Block diagram of dual-band microwave installation for presowing treatment of seeds

3. Materials and Methods

For laboratory studies were selected batch of wheat seeds of Tat NIISH prepared for sowing in the field. These seeds divide into parts (100 pieces each) and spread in a gauze bag.

Optimal mode of seed is determined by searching parameters of processing, namely the frequency of the radiation of the generator and the processing time. The power of the generator remains constant.

The bags with seeds are placed in the working chamber systems for the treatment of seeds. The processing time sets by the microprocessor control unit installation. The frequency is varied in generators of EHF which are set on the installation, depending on the operating mode.

Study of the effects of radiation on seed make by germination in laboratory:

1. in Petri plates;
2. in the calcined river sand.

Repeat the test 5 times. During research study the vitality, germination rate, the quality of the root system for treated seeds and seeds of the control group.

Important that the seeds are germinated in a laboratory at room temperature and humidity not more than 60%.

After analyzing the results of laboratory germination identify optimal modes of seed treatment and conduct field research with Tat NIISH.

In field conditions process the seeds on the an installation for seed treatment on the optimal conditions identified in the laboratory study , and sow. As well make sowing the control strip is not treated seeds

4. Results of Laboratory Studies

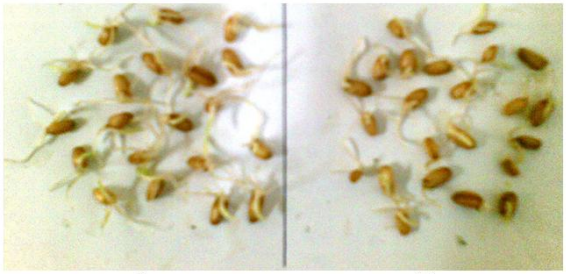
As a result, laboratory studies, it was determined the influence of thermal effects and information on planting seed quality of forest crops by seed germination.

Assessment and registration of seeds germinated in determining the germination energy and germination were carried out in accordance with GOST 12038-84, by definition, germination of crops and coniferous trees.

In the result the arithmetic mean of the outcome of the definition of vigor and germination of all samples analyzed. The most effective treatment regimens used in the studies listed in Table 1.

Table 1. Modes used in the treatment of seeds

Type of regime	Power of radiation	The frequency of radiation	Processing time	Note
Processing of electromagnetic fields EHF				
Treatment 1	10 mW	30 GHz	30 min	
Treatment 2	10 mW	30 GHz	20 min	
Treatment 3	10 mW	72 GHz	20 min	
Treatment with electromagnetic fields, microwave				
Treatment 4	30% P_{max}	2,45±0,05 GHz	4 min	P_{max} = 0.7kW



a) b)

Figure 2. Treatment of wheat seeds in a microwave field a) shows a lot of processed and germinated seeds, in b) shows the inspection lot germinated seeds

In all modes observed excess of the studied parameters in the experimental groups over the control.

The result of the laboratory germination is shown in Figure 2. The figure shows the excess of the studied parameters in the experimental groups over the control.

5. Results of Field Research

On the base of breeding and seed Tat NIISKH we conducted field tests of the treated seeds. Treatment of seeds produced by the definition of the program on the basis of dual-band installation developed in Research Center of Applied Electrodynamics [2].

The studies showed that EMF treatment of seeds with microwave and EHF ranges increases their vigor, germination and infection resistance to lodging, but also improves the growth of wheat (Table 2) and Figure 3.

Table 2. Effect of seed treatment on the growth properties of the EMF and the lodging of wheat

Option	Group germination,%	Emerged seedlings died, %		The average size of seedlings		
		by lodging	for other reasons	the height of seedlings, cm	the diameter of the neck of the root, mm	the length of the root of the beam, cm
30 GHz 20 min.	85,4	0,8	7	5,63	0,56	17,8
72 GHz 20 min	82,3	0,55	6,9	5,65	0,57	17,9
Control	68,9	3,0	7,8	2,10	0,37	11,9
Accuracy, %	3,0	4,0	-	3,6	4,6	4,9
$NSR_{0,5}$	4,3	0,8	-	0,27	0,08	3,2

Thus, based on laboratory and field studies we have shown that as a result of electromagnetic microwave and EHF exposure increased groundwater germination, reduced mortality among the illnesses, improves the growth of seedlings, and as a result of increased yield of the seedlings. Figure 4 shows the wheat crops treated with electromagnetic fields, microwave and EHF ranges and without treatment with electromagnetic fields, microwave and EHF bands.

Figure 3. Crops of winter wheat, "Kazan 560" (on the left control band without treatment

6. Analysis of Results

As a result of laboratory and field research have found that their treatment of EMF microwave and EHF ranges leads to a significant increase in energy of sprouting and germination. As can be seen from the data and Table 2, the best results were obtained in various ranges, with different frequencies cause different positive effects. At a frequency of 30GHz is increase energy of germination and seedlings were more powerful root system, and at frequency of 72GHz. The same good results on germination gives the processing mode electromagnetic field in the microwave range. The best option for all the positive effects is a complex treatment of seeds with different frequencies.

So, given all the above we can conclude that acting on the seeds first in a biologically active frequency affects the most positive example for germination, then on the other affects the most positive example in the germination energy can achieve the best results. However, this treatment option would lead to increase processing time and additional energy costs. Also, due to the resonant nature and frequency dependence of microwave exposure in UHF band, there is the problem of finding these

resonances, and operational tune in the processing with a change external conditions. As for the microwave treatment is the best effect was observed when the heating uniformity in the working chamber. This is a fairly complex and unsolved problem. Solving these problems is based on the use of dual frequency transformation method of single-frequency radiation in asymmetrical two-frequency [3].

This can be represented as follows. Single-frequency oscillation modulated in amplitude by a factor of modulation m = 1 oscillation of the form (2). Then the resulting phase of AM-oscillation is shifted at π on each pass a minimum.

$$S_2(t) = S_2 |\sin\ \Omega\, t| \qquad (2)$$

a)

b)

Figure 4. Crops of wheat, "Kazan 560" on a) shows the band after treatment, at b) shows the control band without treatment

The result of converting a single-frequency radiation in a symmetrical two-frequency does not depend on the order of operations.

Two-frequency radiation has the following advantages:

- the possibility of smooth tuning of the resonant frequency by given law at a given speed;
- ability to provide spectral purity and stability of dual-frequency of the radiation;
- ability to ensure equal amplitudes of the two spectral components;
- possibility of Automatic Tuning the resonant frequency.
- the possibility of solving the problem of seed treatment on several biologically active frequencies by using one generator.

We have modeled the conversion of single-frequency oscillations in a symmetric two-frequency oscillation in a professional design environment Microwave_Office.2008.

The basis of the elemental base for modeling were taken the following elements:

1. Transistor oscillator of SHF [5];
2. AM-modulator made by the scheme controlled attenuator on the PIN diodes [6];
3. Phase shifter on the PIN diodes [7].

7. For Continuing Research

A promising direction for improving crop quality seeds of wheat, due to microwave exposure is to implement an existing installation of dual band dual frequency conversion method.

The introduction of dual-frequency conversion method has several advantages:

4. Processing will be done on in individually selected resonant frequency;
5. Increasing the effectiveness of treatment with continuous monitoring of the resonance frequency and operational adjustments in real time;
6. The search for new biologically active frequencies from UHF oscillator tunable in the whole range of biologically active (30 - 300GHz);
7. Development of new methods of processing by the two-frequency radiation;
8. Treatment of seeds at two, three resonant frequencies due to separation of the two components of the two-frequency radiation;
9. Create modes simultaneous stimulation of seeds of parasitic microorganisms and oppression.

8. Conclusion

The object of this study was to identify new modes of microwave treatment of wheat seeds.

Based on these results it can be argued that the treatment of seeds at the same time at several frequencies, selection of the resonant frequency prior to treatment, monitoring and operational resonant frequency tuning in real time, the development of new techniques and modes through the introduction of dual frequency method can significantly increase yields over with traditional methods of treatment.

It is also important to note that the introduction of dual-frequency method does not entail a specific structural change and increasing energy costs.

It should be noted that the development of new methods, modernization and improvement of existing methods of seed treatment is a key challenge facing the agroindustrial complex. When maintaining a stable acreage main routes improve yields and reduce losses of seeds at all stages of production. One reason for low yields in our country is poor quality seeds.

The purpose further improve yield and seed quality suggests the use of dual-frequency method of seed treatment with electromagnetic fields, microwave, UHF,

as well as we planned to carry out experiments on the effects on the seeds of low intensity laser radiation.

References

[1] Ovcharov, K.E, *Physiology of the formation and germination of seeds*, Kolos, Moscow, 1976, 120.

[2] Morozov,G.A., Morozov,O.G., Stahova,N.E., Stepanov,V.V., Sedelnikov,Y.E., "Low-intensity microwave technology. Methods and apparatus", *Radio and Communication*, 128, 2003.

[3] Morozov,O.G, *Symmetric two-frequency reflectometry in laser systems control the parameters of natural and artificial environments*, Dis.:6.14.2004 - Kazan 2004.

[4] Devyatkov,N.D, Betsky,O.V, Golant,M.B, *Millimeter waves and their role in the processes of life*, Radio i Svyaz, Moscow, 1991.

[5] Krevsky,M.A., Kuznetsov,G.A, and others. *Solid state microwave generator*, RST/RU2004 0000090WO 2004/082128 A1

[6] Masharsky,EI, Shmilevich,MS, Perlin BG, *Controlled Attenuator*, Description of the invention to the inventor's certificate № 296182, 1969.

[7] Vambersky, MV, *Transmitting and other microwave devices*, Moscow High. wk., 1984.