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Assessment of Electric Impedance Varieties of Grain, Treated in Magnetic Field

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Introduction

The demand of food in the world grows annually and constantly. Grain cultures survive as basic food source for many people of Universe. Many scientists research the problems of growth of grain cultures productivity. It is sure that the growths of grain cultures productivity depend to growth germination power [1]. The germination power of grain can by enlarge in some ways: chemical way, influence of electrical and magnetic field treatment [2].

Some authors are researching the dependence of grain germination power on influence of magnetic field [3, 4, 5].

The aim of research is not to research the growth of germination power after influence of seed on adequate magnetic flux density, but estimate what influence to biological signs has magnetic field [6]. It was done by measuring electrical impedance frequency characteristics of seeds.

Methods

There are used the methods of the biotronic [9,10,11]. For research purpose there are used the grains of yield 2009, the oscillator of controlled direct magnetic field, system of electrodes, A/D converter, and special computer program.

Seeds were numbered and grouped to five subgroups. There were ten seeds in every subgroup.

Experimental research was fulfilled under room temperature and normal weather humidity. The data of each experimental measure were saved in the computer memory. It was used two experimental data written in computer for compare and estimation differences.

Grains were under the sway of magnetic field once to make equal researching situation for all grains in subgroups.

The structural diagram of research the grain impedance transfer function (ITF) frequency characteristics is shown in Fig. 1.

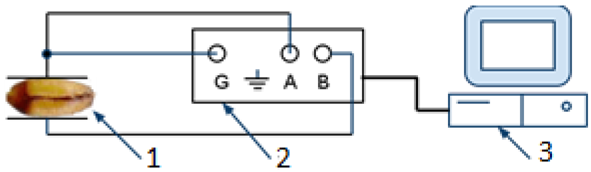

Fig. 1. Structural diagram of research ITF frequency characteristics: 1 – grain and electrodes; 2 –A/D converter; 3 – PC, G – output of oscillator; A,B – inputs of A/D converter

The grains of every subgroup were located in the paper box in the two lines separately. By experiment grains were under sway of magnetic field ten minutes.

ITF data image of grain was found by mathematical analysis of experimental research of input and response signals.

Estimating of grain seeds impedance frequency characteristics

The estimating of grain impedance transfer function frequency characteristics (Magnitude – phase frequency characteristics) is prosecuted in the two stages.

A/D converter (Fig. 1) are measuring electrical input signal applied to grain on channel A. The output signal is measured on output channel B. Computer program calculate the relationship between output and input signal magnitudes. This is grain impedance transfer function image amplitude. The difference of output and signals phases is grain impedance transfer function image phase.

Computer program controlling the measurement process chose and set the wave frequency ω and point to converter to fulfill the measurement. At the same time the program in memory construct two functions sin(ωt) and cos(ωt) which have an amplitude of unity and a phase of zero degrees.

The input signal to the grain on the channel A may be represented by

$$u_{\mathrm{ref}} = U_{\mathrm{ref}} \sin(\omega t + \alpha). \quad (1)$$

We can treat the output signal u_{out} in exactly the same fashion of the reference signal u_{ref}. Suppose the output on the channel B can be represented as

$$u_{\mathrm{out}} = U_{\mathrm{out}} \sin(\omega t + \theta). \quad (2)$$

Let we capture u_{ref} with the oscilloscope and then multiply it by sin(ωt) and the result of this is

$$u_{\mathrm{Ai}} = \frac{U_{\mathrm{ref}}}{2}\left(\cos(\alpha) - \cos(2\omega t + \alpha)\right). \quad (3)$$

Multiplication process in frequency domain supplies us the frequency difference and sum of frequencies. The frequency difference is DC part of captured signal

$$u_{\mathrm{Aidc}} = u_{\mathrm{ii}} = \frac{U_{\mathrm{ref}} \cos(\alpha)}{2}. \quad (4)$$

The sum of the frequencies is AC part of captured waveform at twice larger than the reference signal frequency

$$u_{\mathrm{Aiac}} = \frac{U_{\mathrm{ref}} \cos(2\omega t + \alpha)}{2}. \quad (5)$$

By integrating (3) over fewer complete cycles of the waveform, the AC component u_{Aiac} (5) will become zero, leaving to us only DC component of (3).

We repeat the steps mentioned above with the multiplying digitized reference signal u_{ref} by cos function of the internal sine wave, cos(ωt). The result of multiplication gives us u_{Aq}

$$u_{\mathrm{Aq}} = \frac{U_{\mathrm{ref}}}{2}\left(\sin(\alpha) + \sin(2\omega t + \alpha)\right). \quad (6)$$

By integrating the output signal of the u_{Aq} (6) over fewer complete cycles of the waveform give us u_{iq}

$$u_{\mathrm{iq}} = \frac{U_{\mathrm{ref}} \sin(\alpha)}{2}. \quad (7)$$

The equation (4) and (7) is the vector of two sides of a right angle triangle, where the hypotenuse equal to magnitude of $U_{\mathrm{ref}}/2$. It we can solve for the magnitude of U_{ref} with

$$U_{\mathrm{ref}} = 2\sqrt{u_{\mathrm{ii}}^{2} + u_{\mathrm{iq}}^{2}}, \quad (8)$$

the phase angle α can be found from

$$\alpha = \tan^{-1}\left(\frac{u_{\mathrm{iq}}}{u_{\mathrm{ii}}}\right). \quad (9)$$

The α is the angle of the u_{ref} signal, at the input to the network, with respect to the generated sine wave signal in computer based program.

The output signal we can process in the exactly the same fashion as a reference signal.

Now our reference and output signals are obtained and it can be generalized by the equations:

$$u_{\mathrm{ref}} = U_{\mathrm{ref}}\, e^{\mathrm{j}\alpha}, \quad (10)$$

$$u_{\mathrm{out}} = U_{\mathrm{out}}\, e^{\mathrm{j}\Theta}. \quad (11)$$

The transfer function of the investigated grain, magnitude and phase can be found from

$$G(w) = \frac{U_{\mathrm{out}}}{U_{\mathrm{ref}}}\, e^{\mathrm{j}(\theta - \alpha)}. \quad (12)$$

Results and Discussion

The scientists research the dependences of grain germination power on magnetic field influence note clear dependence magnetic flux density on change of grain germination power [5]. But we don’t know the studies of scientist what show quality changes in the grain determined the changes of grain germination power after magnetic field influence.

The aims of this work was to research impedance transfer function frequency characteristics images and compares their interdependent and evaluate influence of magnetic flux density on frequency characteristics (amplitude-phase frequency characteristics).

Thereto one of five grain subgroups was influenced on magnetic flux density 20 mT. Analogue we influenced other subgroups on magnetic flux density of 40 mT, 60 mT, 80 mT, 100 mT respectively.

For intention to compare ITF image frequency characteristics at first we measured ITF images of grain unimpressed by magnetic field.

We picked such process of measuring because the ITF of grain unimpressed by magnetic field can differ from greatly (for physical – chemical structure of grain) other grains then it would be impossible to compare and open fundamental differences between seeds ITF images.

We analyzed the differences between ITF amplitude frequency characteristics (AFCh) and phase frequency characteristic (PFCh) in comparison ITF images of impacted and unimpressed by magnetic field grains.

Our research showed that by growing the magnetic flux density since 40 mT to 100 mT the difference of ITF images AFCh of impacted and unimpressed by magnetic field grain grow pro rata (Fig. 2). The same we can see on diagrams of differences between ITF images of PFCh (Fig. 3).

It let us to do conclusion that under influence the grain by magnetic field vary the parameters of grain equivalent electrical diagram. And we can evaluate quantitatively the influence of strength of magnetic field to changes of mechanism of grain germination power.

The images of grain ITF AFCh and PFCh (Fig. 2, Fig. 3) let us to graphical evaluate of influence of the strength magnetic field to grain ITF changes. Though it is impossible to estimate quantitatively and clearly the influence of magnetic flux density to grain ITF. There for it is necessary to use method what estimate the difference between grain IFT images given impacted and unimpressed by magnetic field.

There are a few methods, the first one – the looking for digital equivalent ITF in approximation experimental data in to ITF intercoefficient comparison [8]. The second method – the approximation grain ITF image to equivalent electrical diagram and comparison the values of elements of equivalent electrical diagram [8].

The above mentioned methods are complicated and they unwarranted enough precision. Except above mentioned methods there are some mathematical – statistical methods [7].

Mathematical- statistical estimation is used when experimental tendencies are divided widely sign – wise. And it isn't simple to estimate fundamental tendencies of changes.

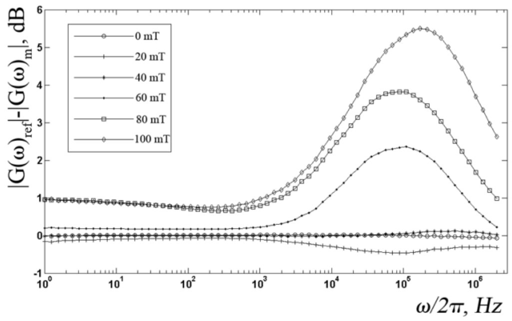

Fig. 2. Diagram of differences between AFCh of ITF images of seed impacted and unimpressed by magnetic field

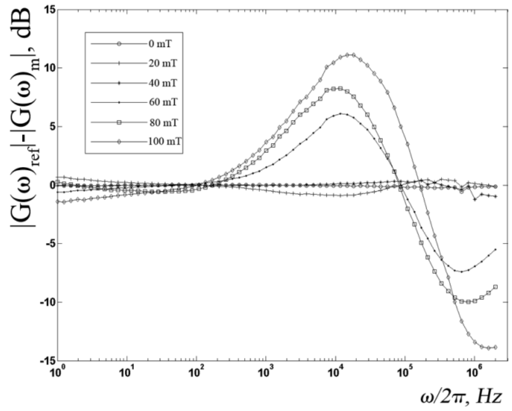

Fig. 3. Diagram of difference between PFCh images of seed impacted and unimpressed by magnetic field

We used four mathematical – statistical methods for estimation the differences of grain ITF images impacted and unimpressed by magnetic field.

The first is correlation coefficients calculation [7]. The second - the maximum absolute difference

$$\mathrm{DABS}(x,y)=\frac{\sum_{i=1}^{N}|y_i-x_i|}{N}. \qquad (13)$$

The third is minimum–maximum estimation [7]. The fourth absolute logarithmic difference

$$\mathrm{ALSE}(x,y)=\frac{\sum_{i=1}^{N}|20\cdot\log_{10}y_i-20\cdot\log_{10}x_i|}{N}, \qquad (14)$$

there x_i and y_i comparative experimentally measured impacted and unimpressed by magnetic field grain ITF frequency characteristics.

The grain ITF image AFCh compare results when grain was impacted (0 mT) and unimpressed (20 mT, 40 mT, 60 mT, 80 mT, 100 mT) of direct magnetic flux density are shown in Table 1. From Table 1 data we can see the clear change of grain ITF AFCh images by different strength of magnetic field. In Fig. 2 there were the graphical data of compare.

Correlation coefficient of ITF AFCh images given impacted an unimpressed by magnetic field is near the one (0.99175±0.01038).

It show form grain ITF image AFCh don't diverge practically or diverge constant magnitude in all frequency band for amplitudes respect.

Table. 1 The comparison of grain ITF AFCh images differences, when the magnetic field strength varies between 0mT to 100mT by using mathematical –statistical methods CC, DABS, MM and ALSE

Magnetic flux density, mT	**Magnitude response assessment method**			
	ALSE	**DABS**	**CC**	**MM**
0	0.0875	0.0054	0.9999	0.9933
20	0.4851	0.0296	0.9973	0.9642
40	0.1951	0.0111	0.9997	0.9867
60	0.7776	0.0371	0.9945	0.9486
80	1.8615	0.0975	0.9830	0.8680
100	2.2465	0.1245	0.9761	0.8404

In compare data in Table 1 it is showed that ALSE, DABS criteria are more sensitive greatly than MM. Also we can see that ALSE and DABS values grow and MM, CC decrease when magnetic flux density grows.

The data of the Table 1 also show that applied magnetic field has not influence to grain impedance transfer function amplitude scale but to shift in frequency band. It can be because magnetic field has stronger influence to reactance elements of grain equivalent electrical circuit.

Table. 2. The comparison of grain ITF PFCh images differences, when the magnetic field strength varies between 0mT to 100mT by using mathematical –statistical methods CC, DABS, MM and ALSE

Magnetic flux density, mT	Magnitude response assessment method			
	ALSE	DABS	CC	MM
0	0.2423	0.0066	0.9995	0.9891
20	1.3143	0.0365	0.9922	0.9433
40	0.6622	0.0143	0.9988	0.9777
60	2.6379	0.0413	0.9731	0.9306
80	4.5785	0.1025	0.9252	0.8533
100	5.4866	0.1156	0.9109	0.8258

The results of comparison of grain ITF PFCh images has analogue tendency that as AFCh. We can see from Table 1 and 2 data that PFCh differences are large than AFCh has. It confirms assumption that magnetic field influence stronger to reactance elements of grain equivalent electrical circuit elements.

Conclusions

1. The research methods of grain impedance frequency characteristics can be used for estimation influence of magnetic flux density to grain germination power.
2. Grain ITF difference quantitative estimation with ALSE and DABS methods gives best results.
3. Grain ITF image PFCh has larger change character in compare to AFCh changes. It shows that magnetic field more influence reactance elements of grain equivalent electrical circuit elements.

Reference

1. **Kobraee S., Shamsi K., Rasekhi B., Kobraee S.** Investigation of correlation analysis and relationships between grain yield and other quantitative traits inchickpea (Cicer arietinum L.) // African Journal of Biotechnology. 2010. – Vol. 9(16). – P. 2342–2348.
2. **Linikiene S., Poželiene A.** Effect of Electrical Field on Barley Seed Germination Stimulation // Agriculture Engineering International: the CIGR Journal of Scientific Reasarch and Development, 2003.– Manusscript FP 03 007. – P. 1–8.
3. **Amaya J. M., Carbonell M.V., Martinez E.** Effects of stationary magnetic fields on germination and grow of seeds // Agriculture, 1996. – Vol. 65(113). – P.1049–1050.
4. **Pietruszewski S.** Effects of magnetic of magnetic biostimulation of wheat seeds on germination, yield and proteins // Int. Agrophysics. 1996. – Vol. 10. – No. 1. – P. 51–55.
5. **Stašelis A., Optažas R., Pečkytė A.** The processing summer barley seeds "Ūla" with electromagnetic field // Agriculture engineering, 2003. – No. 3. – P. 61–68.
6. **Stašelis A., Poželienė A., Linikienė S.** The dynamics of seeds germination power treater with electromagnetic field // Agriculture engineering, 2003. – No. 2. – P. 66–70.
7. **Firoozi H., Shishehchian M.** Frequency Response Analysis– Condition Assessment of Power Transformers Using Mathematical and Statistical Criteria // Proceedings of the 9th International Conference on Properties and Applications of Dielectric Materials, 2009. – P. 253–256.
8. **Mofizul S., Kathryn M.** Coates and Gerald Ledwich. Identification of high frequency equivalent circuit using matlab from frequency domain data // 32nd IAS Annual Meeting. Conference Record of the IEEE Industry Applications Conference. – New Orleans, Louisiana. 1997. – P. 357–364.
9. **Balaišis P., Valinevičius A., Eidukas D., Keras E., Dzingus N.** Biological Purpose Electronic Systems Improvement Motives // Electronics and Electrical Engineering. – Kaunas: Technologija. 2009. – No. 2(90). – P. 30–42.
10. **Vėjelis R., Zajančkauskas A.** The Research of Pulse Width Modulation in Agriculture Automatic Micromotors Systems // Electronics and Electrical Engineering. – Kaunas: Technologija. 2009.– No. 2(90). – P. 85–94.
11. **S. Gečys, P. Smolskas.** Parametrical Optimization of Equivalent Circuit Parameters of Copper–squirrel–cage Solid Rotor Induction Motor supplied through Long Geophysical Cable // Electronics and Electrical Engineering. – Kaunas: Technologija. 2009. – No. 2(90). – P. 73–76.

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R. Vėjelis, A. Zajančkauskas. Assessment of Electric Impedance Varieties of Grain, Treated in Magnetic Field // Electronics and Electrical Engineering. – Kaunas: Technologija, 2011. – No. 1(107). – P. 71–74.

It is sure that for growth grain cultures productivity depends to growth germination power. The germination power of grain can by enlarge in some ways: chemical way, influence of electrical and magnetic field treatment. The aim of our research is not to research the growth of germination power after influence of seed on adequate magnetic flux density, but estimate what influence to biological signs has magnetic field. It was done by measuring electrical impedance frequency characteristics of seeds by using electronic equipment. Our research showed that grain ITF image PFCh has larger change character in compare to AFCh changes. It shows that magnetic field more influence reactance elements of grain equivalent electrical circuit elements. Ill. 3, bibl. 11, tabl. 2 (in English; abstracts in English and Lithuanian).

R. Vėjelis, A. Zajančkauskas. Grūdų, paveiktų magnetiniu lauku, elektrinės nuosavos varžos pokyčių įvertinimas // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2011. – Nr. 1(107). – P. 71–74.

Yra žinoma, kad grūdinių kultūrų derlingumo didėjimui turi įtaka grūdų sėklų daigumo energijos didinimas. Grūdų daigumo energiją galima didinti keliais būdais: cheminiais būdais, paveikus elektriniu lauku ar magnetiniu lauku. Atliktas tyrimas matuojant grūdo elektrinės nuosavos varžos dažninį pasiskirstymą. Nustatyta kokią įtaką grūdo biologiniams požymiams turi magnetinis laukas. Tyrimas parodė, kad grūdo nuosavos varžos perdavimo funkcijos vaizdo fazinės–dažninės charakteristikos turi didesnį kitimo charakterį lyginant su amplitudinėmis-dažninėmis charakteristikomis. Tai rodo, kad magnetinis laukas smarkiau veikia reaktyviuosius grūdo ekvivalentinės grandinės elementus. Il. 3, bibl. 11, lent. 2 (anglų kalba; santraukos anglų ir lietuvių k.).