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RESULTS OF RESEARCH OF ELECTRICAL RESISTANCE OF MAIZE SEED GERMS AFTER THEIR PRE-SOWING ELECTROMAGNETIC TREATMENT

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Abstract: A pre-sowing electromagnetic treatment of maize seeds was carried out.

A laboratory setup was designed for measuring the resistance of maize seed germs at signal frequency 10 kHz. The setup is appropriate for use in the process of student training.

The resistance values were determined for the seed germs of French maize hybrid LG 34.75, treated and untreated in an electromagnetic field.

The parameter S , expressing the ratios of measured resistance values of electromagnetically treated to untreated seeds, was analyzed.

The resulting values for the parameter S , after a 14-day rest of the seeds, were closest to and smaller than 1. This correlated with the time limit determined from practical experience for sowing the seeds following their electromagnetic treatment.

It was established that for the seeds of the French maize hybrid LG 34.75, the parameter S values were more dispersed around the value 1 in comparison to the values obtained by other authors. This could be attributable to the genetic specifics of the examined maize hybrids.

Key words: *maize seeds, pre-sowing electromagnetic treatment, resistance of a seed germ*

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INTRODUCTION

New technologies of pre-sowing seed treatment are used to satisfy the population's growing food demand [7]. They aim to increase the yields [4] [7] while reducing energy costs [8]. Questions are therefore raised with regard to the reasons for increasing the yields once new technologies of pre-sowing seed treatment have been applied.

In [3] [6] a possibility has been established for research on the conductivity (resistance) and dielectric permittivity of maize seeds. In [5] it has been demonstrated that a maize seed may be considered to be a dielectric object. In the same paper it has been noted that, under certain conditions during the pre-sowing electromagnetic treatment, the electric field generated in the seed has its greatest-magnitude component in the direction of the germ. The latter is the living object in the surrounding nutrient medium in which no vital processes take place.

The objective of the research was to establish the electrical resistance of maize seed germs of the French hybrid LG 34.75.

MATERIAL AND METHODS

The object of research was the resistance of germs undetached from the maize seeds of the French hybrid LG 34.75, a mid-early cultivar from FAO 480 group, which were provided by the company Safari-M of Ruse, Bulgaria.

The seeds were subjected to a pre-sowing electromagnetic treatment with the setup [2] under applied voltage between the electrodes $U=1,65$ kV and duration of impact $\tau=10$ s. The seeds were not disinfected before the treatment.

The measurements of the germ resistance were carried out on the 1st, 7th, 14th and 60th day after the treatment of the seeds. The pre-sowing electromagnetic treatment was carried out on 24.07.2013, at the following times: for option No. 1 at 7:00, for option No. 11 at 12:00, and for option No. 12 at 19:00.

From the preliminary laboratory examinations, it had been proven sufficient to measure the electric resistance of 20 seed germs in each experiment. Each seed was measured only once. The measurements in the above mentioned days after the treatment were carried out with new batches of 20 seeds each.

The analysis of the size and structure of the maize seeds provided grounds to bring forward the following requirements to the laboratory setup for measuring the resistance of maize seed germs:

The resistance must be measured using electrodes made of chemically inert steel, such as nickel-chrome steel. They must be needle-type electrodes in order to allow easier penetration in the seed germ. The electrodes must be inserted in the maize seed germ at a certain distance from one another. To this end, micrometer screws installed upon swivel-type movable stands must be used. To improve the accuracy of attaching the electrodes to the germ it is necessary to use a microscope and appropriate lighting. Each single seed must be positioned upon a glass slide by means of a micrometer ruler and a fixing mechanism.

The setup for measuring maize seed germs resistance, developed according to the specified requirements, is shown in Fig. 1.

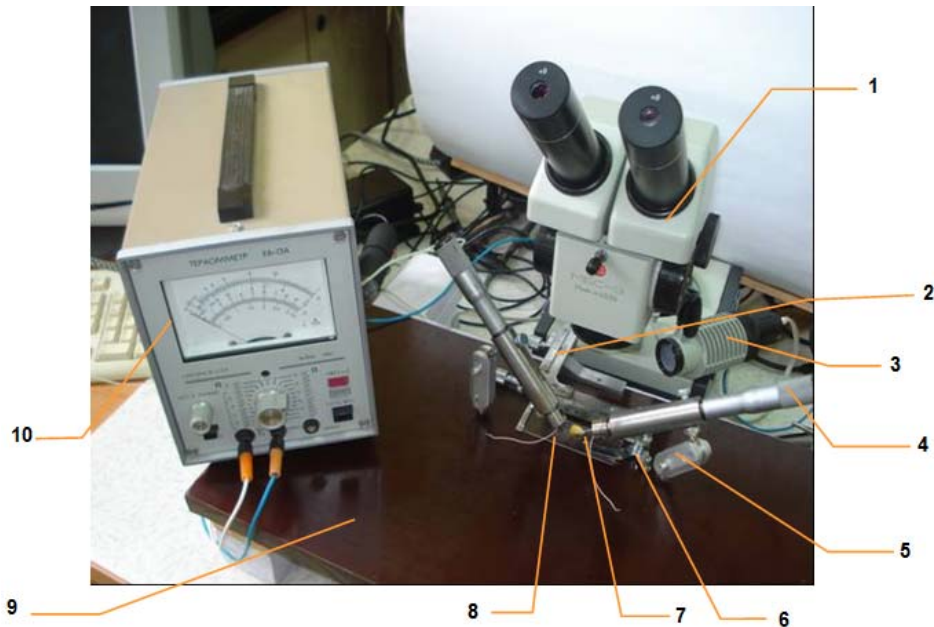


Figure 1. Experimental setup for measuring the electric resistance of a seed germ:
 1. microscope, 2. micrometer ruler, 3. light source, 4. micrometer screw, 5. swivel-type movable stands, 6. fixing mechanism, 7. nickel-chrome electrodes, 8. glass slide, 9. insulation base plate, 10. teraohmmeter

From the preliminary studies carried out, the following sequence of actions was determined to operate the measurements setup: The light source 3 is turned on. The glass slide 8 is fixed immovably through the fixing mechanism 6. The tested seed is positioned upon the glass slide with the use of the micrometer ruler. The nickel-chrome electrodes 7 are brought in contact with the seed thus positioned. They are electrically insulated from the micrometer screws 4 and, in view of the length of the maize seed germ, are positioned at a distance of 3 mm from one another. This is possible owing to the swivel-type movable stands 5 and the microscope 1. Once in contact, the electrodes are inserted in the seed at a depth of 2 mm by making use of the micrometer screws 4. After the electrodes have penetrated to the required depth, the teraohmmeter is switched on and the germ resistance is measured. The frequency of the measurements is 10 kHz.

Due to the specifics of the setup described above, seeds of approximately the same size must be used for the tests.

RESULTS AND DISCUSSION

In Tab. 1 are presented the averaged results from the measured resistances of the maize seed germs and the calculated values of the variability ratio and the parameter S .

It was established, that the average values of the resistance Z for the different treatment options vary within the range of 1,96 to 5,36 G Ω . From Tab. 1. can be

concluded that a correlation exists between the length of rest of the seeds after the treatment and the measured resistance values. The low resistance values were obtained 7 days after the treatment, while the high ones –60 days after the treatment.

An assessment of the dispersion of the obtained results was done through the variability ratio [1]. The calculated values (Tab. 1) are in the range of 12,081 to 27,905%. This shows a comparatively small dispersion of the measured quantity.

Table 1. Averaged resistance values of the germs of maize seeds LG 34.75

Treatment options – hour of taking the measurement	Number of days after the treatment of the seeds					
	1			7		
	Z, GΩ	V, %	S	Z, GΩ	V, %	S
No.1- 07:00	2,66	18,201	0,779	2,30	24,285	1,191
No. 2- 12:00	3,22	24,798	0,658	2,20	12,531	1,245
No. 3- 19:00	3,92	18,843	0,541	1,96	18,139	1,398
c- untreated	2,12	12,081	1,000	2,74	27,076	1,000
Treatment options – hour of taking the measurement	Number of days after the treatment of the seeds					
	14			60		
	Z, GΩ	V, %	S	Z, GΩ	V, %	S
No.1- 07:00	3,40	13,542	0,682	5,36	27,856	0,527
No. 2- 12:00	2,54	27,905	0,926	5,14	26,493	0,560
No. 3- 19:00	2,26	24,008	1,027	2,70	24,343	1,067
c- untreated	2,32	19,160	1,000	2,88	22,331	1,000

For the comparison of the obtained results given in Tab. 1, and in similarity to [6], the parameter S was introduced:

$$S = \frac{Z_c}{Z_{tr}} \quad (1)$$

Where:

Z_c [Ω] - averaged resistance value of the seed germs from the control batch

Z_{tr} [Ω] - averaged resistance value of the seed germs from the treated batch.

Other authors [6] who have carried out studies of the resistance of Bulgarian maize hybrids state in their works that the parameter S is a number smaller or larger than, but in any case close to 1 (0,9 - 1,1).

From the data contained in Tab. 1 it can be concluded that the parameter S takes values within the range of 0,527 to 1,398. These values, regardless of their higher dispersion around the value 1, correlate with the results obtained in [5]. The dispersion of the values of the parameter S can be accounted for by the genetic differences between Bulgarian and French hybrids.

CONCLUSIONS

1. A laboratory setup was designed for measuring the resistance of maize seed germ.
2. The resistance values of the germs of maize seeds of the French maize hybrid LG 34.75, treated and untreated in an electromagnetic field, were determined.
3. The calculated variability ratio values were within the range of 12,081 to 27,905%, showing a relatively small dispersion of the measured value.
4. A parameter S was used to express the ratio between the measured resistance values Z of the seeds untreated in an electromagnetic field and the treated seeds.
5. The obtained values for the parameter S after a 14-day period of rest of the seeds were closest to and less than 1. This correlates with the time limit determined from practical experience for sowing the seeds following their electromagnetic treatment
6. It was established that for the seeds of the French maize hybrid LG 34.75, the values of the parameter S have a higher dispersion around the value one in comparison to the findings of other authors. This could be accounted for by the genetic specifics of the studied maize hybrids.

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REZULTATI ISPITIVANJA ELEKTRIČNOG OTPORA KLICA SEMENA KUKURUZA POSLE ELEKTROMAGNETNOG TRETMANA PRED SETVU

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Sažetak: U ovom istraživanju je izveden elektromagnetni tretman semena kukuruza pre setve.

Laboratorijski uređaj je postavljen tako da meri otpor klica semena kukuruza na signalnoj frekvenciji od 10 kHz. Ovako podešen uređaj se može koristiti i za obuku studenata.

Vrednosti otpora su merene na klicama semena kukuruza francuskog hibrida LG 34.75, sa i bez tretmana u elektromagnetnom polju.

Analiziran je parametar S , koji izražava odnose merenih vrednosti otpora tretiranog prema netretiranom semenu.

Rezultujuće vrednosti parametra S , posle 14 dana odmora semena, bile su najbliže i manje od 1. Ovo je bilo u korelaciji sa vremenskim ograničenjem određenim na osnovu praktičnog iskustva za setvu semena posle elektromagnetnog tretmana.

Ustanovljeno je da su za seme kukuruza francuskog hibrida LG 34.75 vrednosti parametra S bile više rasute oko vrednosti 1 u poređenju sa vrednostima dobijenim kod drugih autora. Ovo može biti karakteristično za genetičke specifičnosti ispitivanih hibrida kukuruza.

Ključne reči: *seme kukuruza, elektromagnetni tretman pre setve, otpor klice semena*

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