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Seed Treatment by Pulsed Electric Field Before Sowing.

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ABSTRACT

The paper presents results of researches about influence pulsed electric field (PEF) to seeds with the frequency from 300 to 600 Hz. Confirmed the improvement sowing qualities seeds of cabbage variety Glory by their processing pulsed electric field. Determined optimal modes PEF for treatment of cabbage seeds. Confirmed the theoretical assumption about reducing time treatment for seeds with increase in the repetition frequency of pulse.

Keywords:pulsed electric field, sowing, seeds, cabbage, treatment, frequency.

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INTRODUCTION

The main objective of agricultural production - increasing productivity of crops through the use modern technologies of cultivation. One of the effective ways to solve this problem - improving the quality seed by physical factors. To this end, in agricultural practices used variety of techniques preplant seed treatment - heating, effect of high-frequency currents, and others. [1, 2].

Germination of seeds - one of the most important and complex processes affecting the passage for all the subsequent stages to development of an organism. It is characterized by an intense exchange, spare nutrients undergo significant changes, in turn vital for a young body connections for embryo growth and especially the primary root [3, 6].

The natural conditions are not always favorable for the normal development an organism, especially in the initial period. In this regard, the agricultural practices applied a set of measures aimed to improving the productivity of plants. Primarily need such means of influence that can trigger seed germination and enhance the livelihoods of the embryo at an early stage.

MATERIALS AND METHODS

Preplant seed treatment by PEF is that the seed has been placed in the box for a certain period of time. The main parameters of the electric field are:

- The electric field strength (V / m);
- Exposure (measured in seconds);
- Time of storage seeds from treatment to favorites germination (days).

We have carried out studies about effects of pulsed electric field PEF for sowing qualities seeds of cabbage cultivar Glory. The pulse frequency from 300 to 600 Hz. Research sowing qualities, carried out in accordance with options 1-7. Seven studies of each of the options.

Option 1 (IEP)

Installation Options for treatment by PEF.
f = 300 Hz, $E_{max} = 1{,}5\times10^5\times\frac{B}{M}$, U=1500 V
Exposure - from 10 to 15 minutes;
Time of storage seeds from treatment to favorites germination - 3 days.

Option 2 (IEP)

Installation Options for treatment by PEF.
f = 350 Hz, $E_{max} = 1{,}5\times10^5\times\frac{B}{M}$, U=1500 V
Exposure - from 7 to 10 minutes;
Time of storage seeds from treatment to favorites germination - 3 days.

Option 3 (IEP)

Installation Options for treatment by PEF.
f = 400 Hz, $E_{max} = 1{,}5\times10^5\times\frac{B}{M}$, U=1500 V
Exposure - from 6 to 10 minutes;
Time of storage seeds from treatment to favorites germination - 3 days.

Option 4 (IEP)

Installation Options for treatment by PEF.
f = 450 Hz, $E_{max} = 1{,}5\times10^5\times\frac{B}{M}$, U=1500 V

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Exposure - from 5 to 9 minutes;
Time of storage seeds from treatment to favorites germination - 3 days.

Option 5 (IEP)

Installation Options for treatment by PEF.
f = 500 Hz, $E_{max} = 1{,}5\times10^5\times\frac{B}{M}$, U=1500 V
Exposure - from 4 to 9 minutes;
Time of storage seeds from treatment to favorites germination - 3 days.

Option 6 (IEP)

Installation Options for treatment by PEF.
f = 550 Hz, $E_{max} = 1{,}5\times10^5\times\frac{B}{M}$, U=1500 V
Exposure - from 4 to 8 minutes;
Time of storage seeds from treatment to favorites germination - 3 days.

Option 7 (IEP)

Installation Options for treatment by PEF.
f = 600 Hz, $E_{max} = 1{,}5\times10^5\times\frac{B}{M}$, U=1500 V
Exposure - from 3 to 7 minutes;
Time of storage seeds from treatment to favorites germination - 3 days.

RESULTS AND DISCUSSION

Germination energy checked on day 5. Results of experiment are present in figures 1 - 7.

As expected, processing time with increasing frequency decreases exponentially (Fig. 8). It can be assume that further value increase of the pulse repetition rate will further reduce exposure.

Analysis of experimental data showed that dependence of the optimal time $t_{treat}^{opt}$from frequency pulse generator *f*,can be expressed in the form of an empirical formula:

$$t_{treat}^{opt} = A\times e^{-\alpha\times f}, \qquad (1)$$

Necessary parameters for seed treatment PEF is "treatment dose» - D, which can be represented according to the expression:

$$D = E_{max}\left(\frac{t_{real}}{t_{dif}}\right) = E_{max}(\tau+\alpha)\times f\times\left(\frac{t_{treat}}{t_{dif}}\right), \qquad (2)$$

The physical meaning of formula (2) is that the value of the maximum electric field - and processing time - IEP are increase the dose of exposure. Therefore, it is proportional to their product. However, storage time attenuates the biological effect of CEI for seeds, thus in (2) parameter - should be place in the denominator.

$$t_{real} = (\tau+\alpha)\times f\times t_{treat}, \qquad (3)$$

where:
treat - time seed treatment, as measured by the clock;
(τ + α) ≈5,0 microseconds - the effective duration of each pulse of the electric field.
Pulsed electric field is a fundamentally new physical factor for pre-treatment of crop seeds. The duration of the voltage pulse applied to the waveguide electrodes τ = 5,0ms.

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Mathematical processing experimental results on the effects of PEF for sowing qualities seeds of cabbage variety Glory the regression analysis was selected model extrapolation of experimental data to functional dependence based on the quadratic polynomial that contains the appropriate degree of changing parameters PEF: pulse frequency and treatment time (at a constant pulse amplitude). The result of factor analysis wereobtaine the corresponding regression equations:

σ = 79,697 - 0,1179t + 0,0007t2 (for f = 300 Hz)
σ = 77,697 - 0,1074t + 0,0008t2 (for f = 350 Hz)
σ = 71,263 - 0,1379t + 0,0017t2 (for f = 400 Hz)
σ = 65,397 - 0,1020t + 0,0025t2 (for f = 450 Hz)
σ = 64,787 - 0,0072t + 0,0002t2 (for f = 500Hz)
σ = 63,844 - 0,0068t + 0,0018t2 (for f = 550 Hz)
σ = 62,686 - 0,0056t + 0,0021t2 (for f = 600 Hz) (4)

Based on equations (4), we obtained the best times for pre-treatment of seeds by PEF, which are present in Table 1.

where:
$K \times f_{opt}$- the dimensionless ratio of the frequency range of the spectral sensitivity of seeds. In general, the ratio $K \times f_{opt} \leq 1$ should be determined for each type of seed being processed FEP experiment. To simplify the analysis of the experimental results of seed processing FEP when the range of variation of the pulse repetition frequency is not large, we can assume that$K \times f_{opt}=1$, if the expression (1) is simpler and has the form:

$$D(f \times t_{treat}) = E_{max} \times t_{real}, \quad (5)$$

Table 1 shows the values of amplitude dose PEF processing for optimum times and corresponding pulse frequency (at constant E_{max} = 1,6 × 105 V / m and (τ + α) = 5 ms). From the table it follows that in this frequency range 300 Hz - 600 Hz, the amplitude increases monotonically treatment dose. This can be explaine by a change (decrease) the sensitivity of seeds with increasing frequency PEF [5, 8].

The effectiveness of treatment of crop seeds by physical factors determined by the dose, treatment regimen, which is now for each crop, and even varieties of the same culture are selected empirically, through a sufficient number of laboratory experiments [4, 7].

Negative results can be obtain by properly selected dose exposure PEF.

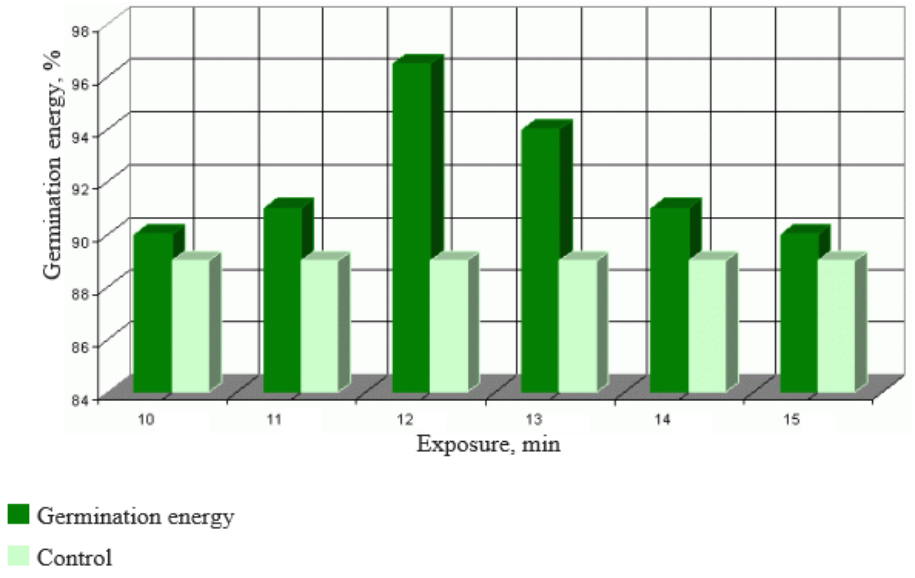

Figure 1: Germination energy of option 1

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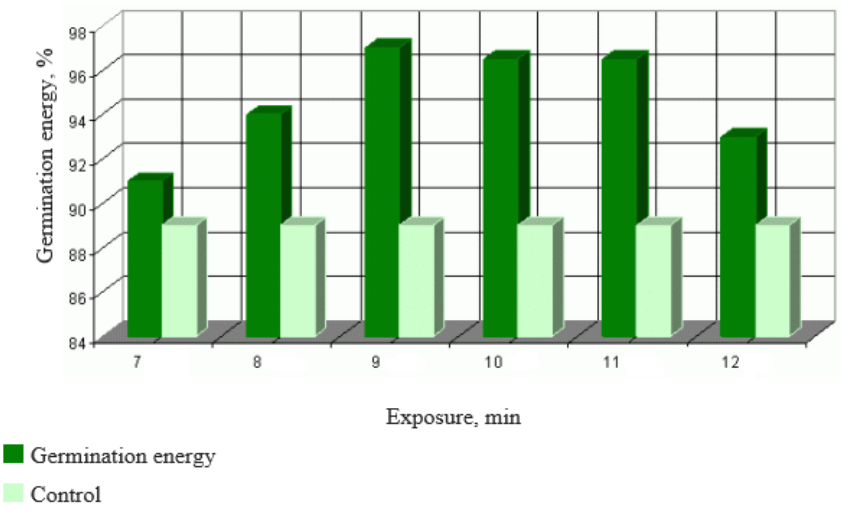

Figure 2: Germination energy of option 2

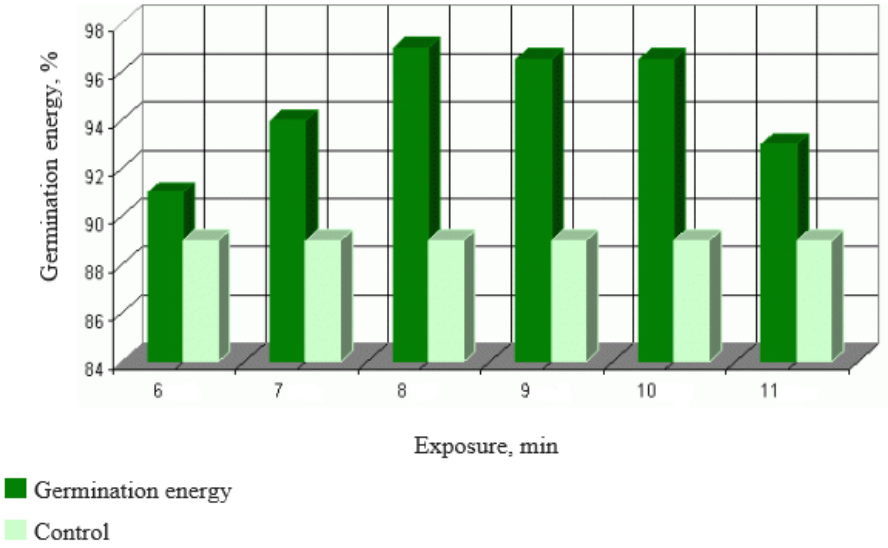

Figure 3: Germination energy of option 3

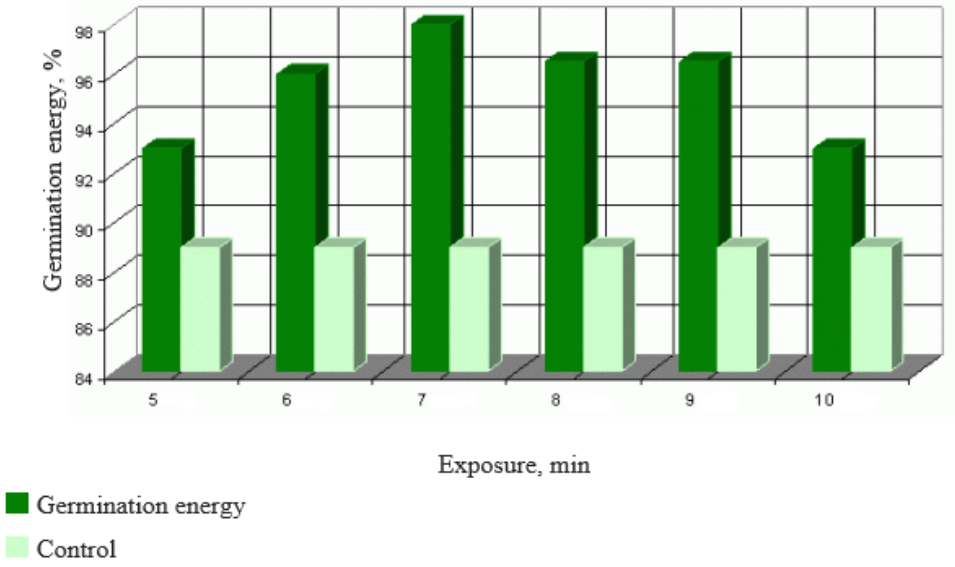

Figure 4: Germination energy of option 4

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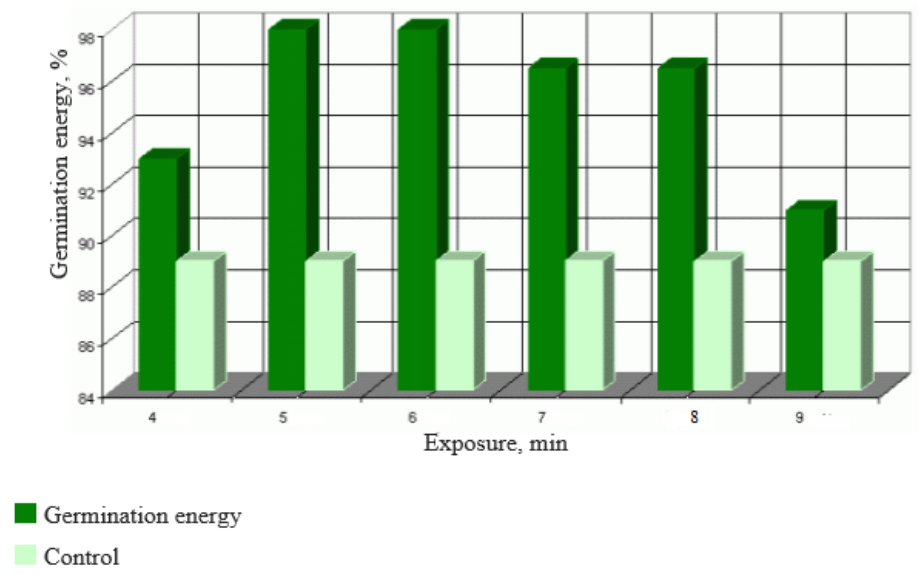

Figure 5: Germination energy of option 5

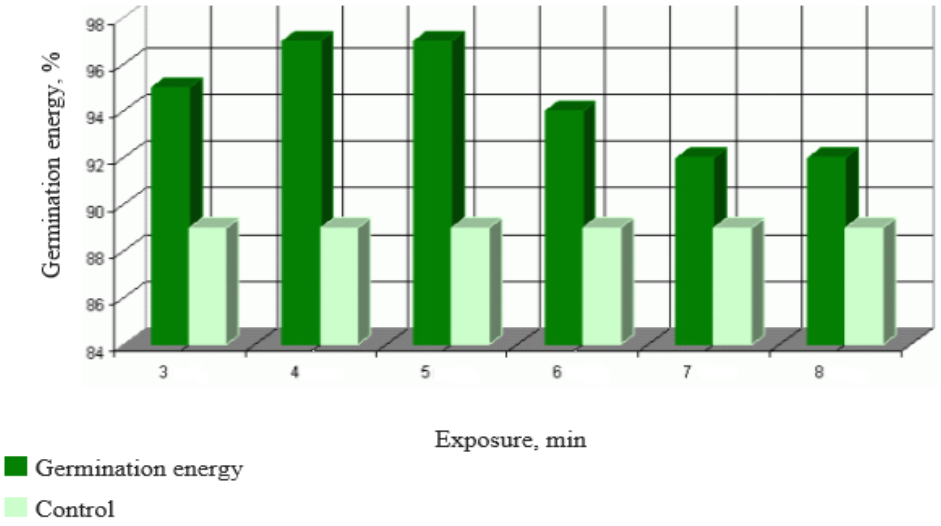

Figure 6: Germination energy of option 6

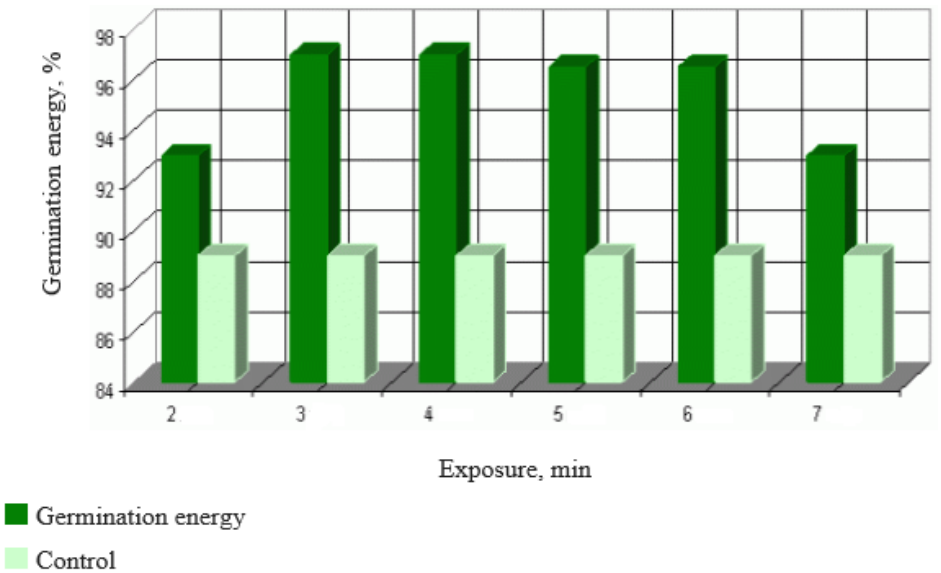

Figure 7: Germination energy of option 7

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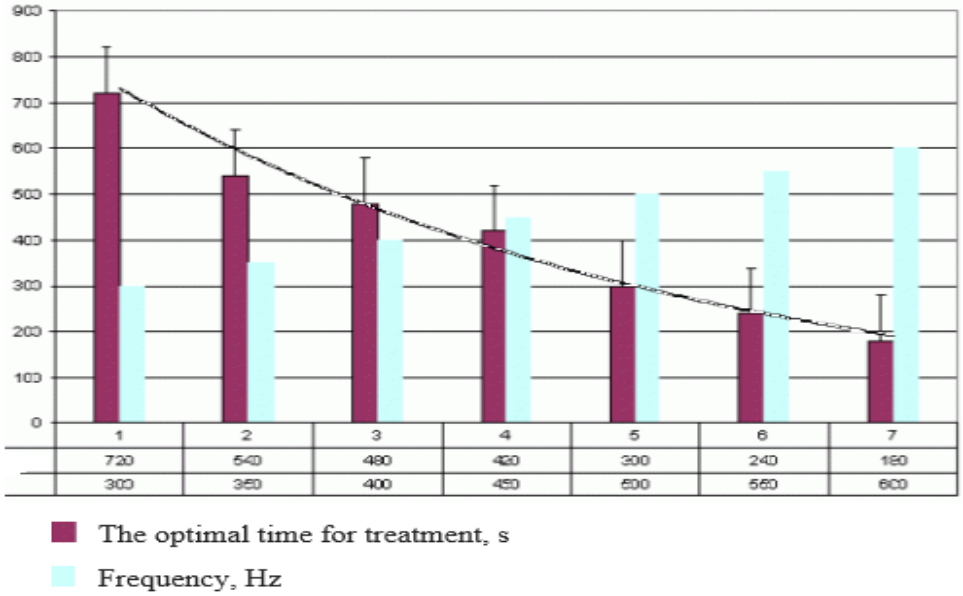

Figure 8: The dependence of optimal processing time from pulse repetition frequency

Table 1: The calculated optimal dose and regimes for pre-treatment seeds by PEF

Parameter	Value						
ν, Hz	300	350	400	450	500	550	600
t_{treat}, min	11-13	9-11	7-9	6-8	4-7	3-5	2-4
$t_{treat\ average}$,min	12	10	8	7	5	4	3
D, (V/м)s	1827	2214	2370	2430	2460	2467	2485
K×f_{opt}	0,78	0,83	0,89	0,96	0,90	0,87	0,90

CONCLUSION

Thus, because of pre-processing of cabbage seed varieties thank pulsed electric field (PEF) with a pulse repetition rate of 300 to 600 Hz, with the following results:

- Confirmed improved sowing qualities of seeds of cabbage varieties of Fame because of pre-processing of pulsed electric field.
- Confirmed the correctness of the formula for calculating the dose EPI impact.
- Optimum modes of seed treatment IEP cabbage.

Based on an experimental study of pre-processing modes cabbage seeds pulsed electric field, built the mathematical regression equation, using which you can theoretically calculate the optimum time of seed treatment, thereby reducing the number of laboratory experiments to a minimum.

Confirmed the theoretical assumption that the reduction of seed processing time with an increase in the pulse repetition rate

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