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The treatment of rape (*Brassica napus L.)* seeds with the help of electrical field

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Abstract. The paper presents data about the sorting and stimulation of germination of rape seeds with the help of corona discharge field (CDF). The seed- preparing machines used the electric field to sort seeds according to the unit of mechanical and electrical features and improve germination.

A survey of literature discussing the methods of the increasing of seed germination of electro–physical nature and the duration of the various periods from the stimulation to sowing time has been viewed.

The conveyer type electric separator designed in the institute was used for the seed processing. The 3×10^5 V m^{-1} field strength was used for seed sorting according to the biological value in the electric separator. The change of the germination stimulation effect during the one-month seed storage period was determined for the seeds with conditional moisture content but two different initial germination rates. The same strength of corona discharge field was used in research of the germination dynamics. The duration of seed treating in the field was 2 s.

During the research the following facts were established: that by the sorting of non - conditional rape seeds it is possible to get 80% of seed to correspond to the requirements of the standard; CDF has positive influence on germination dynamics of treated seeds; density function of the seeds treated with CDF is described by lognormal distribution and that of untreated seeds, by normal distribution; the average increase of the germination of stimulated seeds has been reliable during the one-month period from stimulation to sowing. Statistical processing of the test data shows that the increase in germination of the seeds treated with CDF is reliable in comparison with the control.

Key words: Rape seeds; corona discharge field; sorting; germination.

INTRODUCTION

The seeds are duly prepared for sowing when they are cleaned, sorted and processed by one of several methods stimulating the germination. The seed cleaning machines used at present separate seeds according to their mechanical properties but cannot sort them according to their biological value.

A superposition principle of different physical nature is realised in separators, which use an electric field. Seeds are sorted according to the unit of mechanical and electric features and this enables separation of a biologically valuable seed (Shmigel, 2004). The electrical properties of seeds should be regarded while sorting according to their biological value, because these characteristics are closely connected with their physiological maturity (Yadov, 2000). The use of an electric field is most expedient

from the point of view of technology, versatility, and energy saving (Bobryshev, 2000). Thus the electric separators should be used at the finishing stage of seed preparation.

The seed separation methods on the sloping cloth plane (Podobedov et al., 2000) or on a belt moving in the corona discharge (Lynikiene, 2001) or in the electrostatic field (Borodin et al., 2000) are known.

There are many ways to improve seed germination: hydrothermal and aerothermal processing, treatment with the chemically active materials, etc. The review of scientific-technical literature during the last 7 years enabled researchers to conclude that the most intensive work is done in the field of seed processing with electromagnetic origin factors (Palov et al., 2003; Martinez et al., 2006; Rybinski et al., 2004). It has been observed that electromagnetic origin factors cause physiological-biochemical changes in seeds. Water assimilation becomes faster, breathing and photosynthesis of germinating seeds intensifies; all these factors improve germination of the viable seed (Podlesny et al., 2004).

The literature offers various opinions about the time period from stimulation to sowing. The stimulation of germination qualities of pea (*Pisum sativum L.*), barley (*Hordeum sativum L.*), and wheat (*Triticum dicocum Fi*) with electromagnetic field has enabled determining that the period of 7–20 days before sowing is the best time for seed stimulation (Bobryshev et al., 2000). When the electromagnetic field of super-high frequency has been used for the grain stimulation, the period between processing and sowing has been 20 days (Pachomov et al., 2004). Bulgarian researchers who have treated maize (*Zea Mays L.*) seeds with magnetic field have recommended a 13–17-day period before sowing (Palov et al., 2004). Lettuce (*Lactuca sativa L.*) seeds should be laser-processed 14 days before sowing (Takeuchi et al., 2002). Barley seeds should be laser-processed 5–10 days before sowing (Rybinski et al., 2004). When the CDF has been used for stimulation of germination qualities of other seeds from crucial families (radish (*Raphanus* sativus) and cabbage (*Brasica olearacca L.*)), there should be a 10–15-day period before their sowing (Lynikiene et al., 2006; Lynikiene&Pozeliene, 2006).

The object of the research is to test the possibility of improving the quality of the rape seeds with the corona discharge field.

MATERIALS AND METHODS

The rape seeds have been processed with the corona discharge field in the conveyer- type electric separator. The scheme of the separator is presented in Fig 1.

The criteria of seed sorting are the abscissa of contact point (Lynikiene, 2001) and enable us to analytically select the operation regime indispensable to the separation of biologically valuable seeds.

The strength of electric field 3×10^5 V m^{-1} and cylinder rotation frequency ω_b =6.7 s^{-1} is used for seed sorting according to biological value. The following were determined: seed output to each fraction of the sizer; 1000-seed mass and germination in fractions.

To determine the influence of CDF on seed germination dynamics ill-conditional germination seeds were chosen. The strength of CDF– $E=3\times10^5$ V m^{-1}. The duration of seed treating in the field was t =2 s. Control germination of rape seeds, 70%.

The relationship of germination change on the length of period from stimulation to sowing has been defined for conditional moisture seeds with various germinations. The seeds were stimulated once in the CDF for 2 seconds. The germination ability of control and stimulated seeds has been defined four times a month (with 7-day intervals). Seeds with the initial germination of 80% and 67% have been stimulated. Each variant of stimulated and control seeds has used 1 kg of seeds for every test.

The seeds treated with CDF were seeded 7 days after the action. Each variant was germinated in 4 repetitions at 100 seeds. The number of germinated seeds in all variants was calculated every day. To evaluate mean germination values of control seeds and those treated with the field, Student's criterion was used. To evaluate how experiment data correspond to lognormal and normal distributions the Pearson criterion was used.

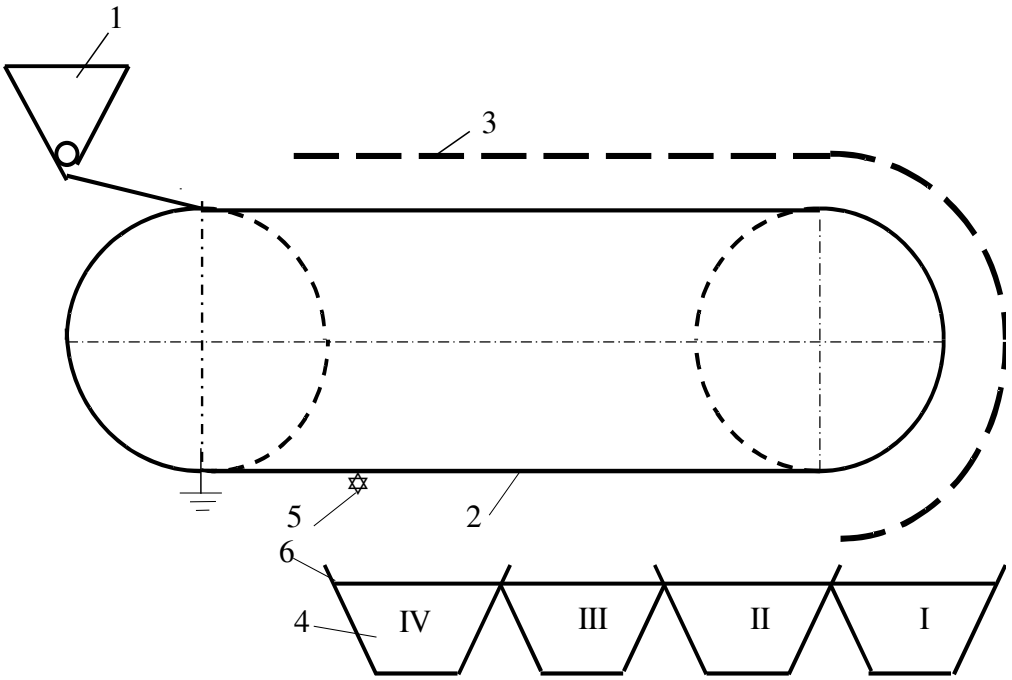

Fig. 1. Scheme of the conveyer type electric separator: 1–batcher; 2–conveyer belt (grounded electrode); 3–corona discharge field electrode; 4–reception sizer; 5–brush; 6–partitions between fractions

RESULTS AND DISCUSSION

As mentioned above the conveyer-type electric separator has been used for seed sorting. Fig. 2 shows the sorting results of rape seeds.

With the average quality indices in mind we can see that the heavier seeds have fallen into the first fractions of the reception sizer and the lighter-than-control seeds have passed to last fractions of the sizer. The results show that it is possible on average to separate 80% of the seeds, which is a greater mass than the control. The average increase of germination in first fractions has been 10–12%; in last fractions the germination has been by 2–8% greater than the control. Thus we can state that the utilization of the electric field enables us to separate biologically valuable seeds.

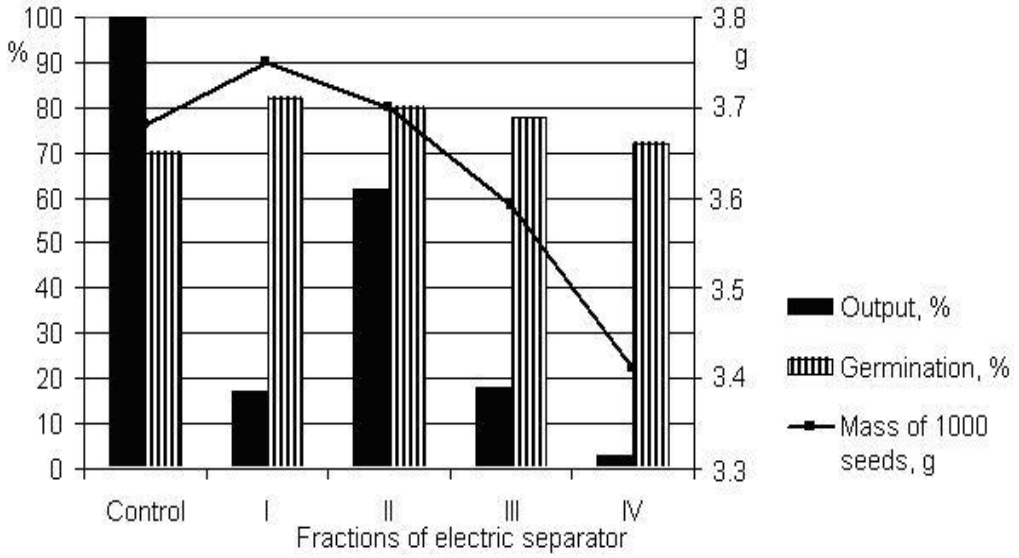

Fig. 2. The results of rape seeds sorting

The germination dynamics of rape seeds are shown in Fig. 3 and are also characteristic of the dynamics of radish and cabbage seed germination that we had investigated (Lynikiene et al., 2006; Lynikiene&Pozeliene, 2006).

During the analysis of obtained results it was observed that the germination density function of untreated (control) seeds was described by using normal distribution. Lognormal distribution was used for describing seeds treated with CDF (Kruopis, 1993).

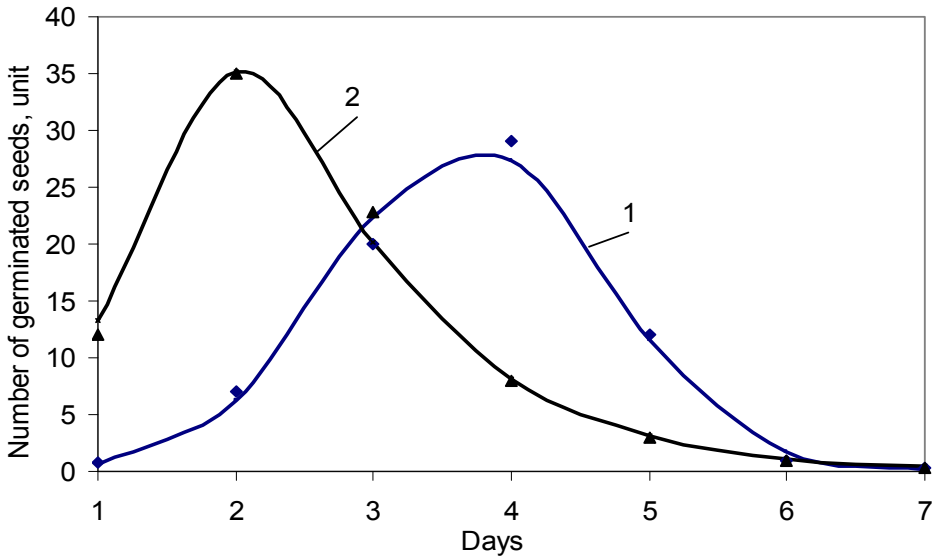

Fig. 3. Germination dynamics of rape seeds: 1–control seeds; 2 –treated seeds

Numerical values of normal and lognormal distribution are given in Table 1. Lognormal distribution which is typical to the germination density of seeds treated with CDF proves the proposition that seeds treated in such a field germinate several days earlier. By analysing standard deviations of germination density functions of control seeds and seeds treated with CDF (Table 1) we can see that germination of treated seeds is much more compatible. Germination diffusion of field-treated seeds is 2–3 times less than that of control.

Table 1. Parameters of distributions and evaluation of results of CDF impact on seed germination

Variants	μ	σ	χ^2	Distribution	$\bar{x}$	s	$t_{calc.}$	$t_{(0.05;6)}$	Notes
Control	3.80	0.97	1.04	Normal	70.0	2.11		2.45	
Electric field	0.82	0.44	0.57	Lognormal	82	3.05	8.56		Substan-tial
At f=6 and P=0.05: $\chi^2_{0.05}$=1.63									

Note: f–number of respective degrees of freedom; P–probability level; μ– mean; σ–standard deviation; χ^2–Pearson criterion; $\bar{x}$ –arithmetic mean of germination; s–estimated standard deviation; $t_{calc.}$, $t_{(0.05;6)}$–calculated Student's criterion and Student's criterion value form the table.

Statistical processing of data shows that the increase in germination of seeds treated with CDF is reliable in comparison with control.

The obtained results show that seeds treated with CDF not only germinate faster and more compatibly but their germination is also better than that of control seeds. Germination of seeds treated with CDF is higher by 12%. Evaluation of the influence of CDF on seed germination is given in Table 1.

The change of germination of control and stimulated seeds during one month (from stimulation to sowing) is shown in Fig. 4.

The germination changes of seeds during this period show that the control seeds have been in a dormant state for some time, and their germination increases by itself with time (curve 2 in Fig. 4). The impact of the electric field has dislodged seeds from this dormant state and in a week's time we can notice the reliable 10% germination increase. The average increase of the germination of stimulated seeds during the month has been 8% and it has been reliable. The stimulation of the old seeds with low germination shows 4–9% germination increase, but it has not been reliable.

The difference between averages of germination abilities of stimulated and control seeds during the tested month were equal to 5% and were reliable. These relationships have the form of a parabola when the factor of reliability has been $P = 0.05$ and correlation ratio has been in range of 0.7 - 0.99.

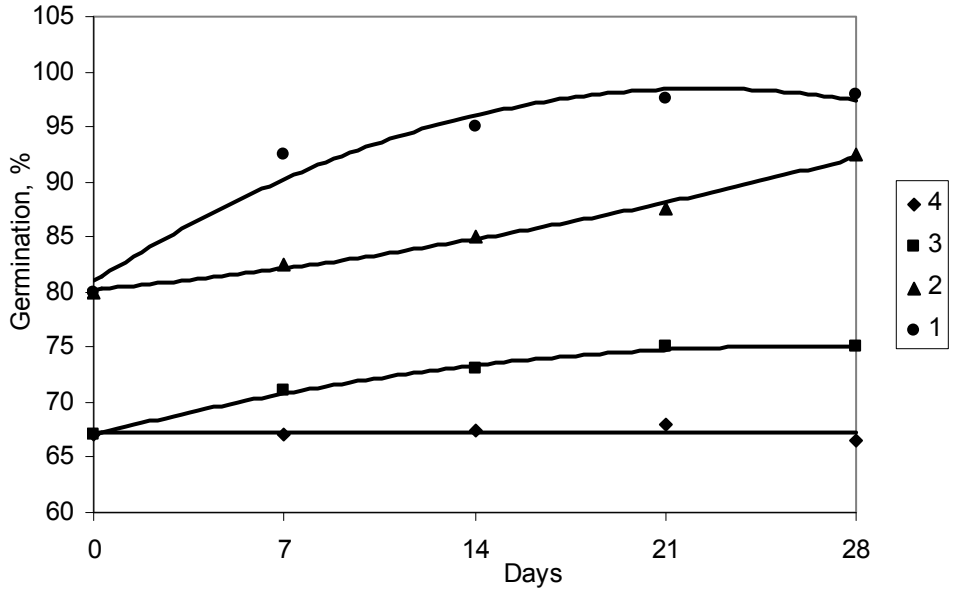

Fig. 4. The relationship of the stimulation effect on the seed treatment and sowing time: 1 – stimulated seeds with the 80% of initial germination; 2 – control seeds with the 80% of initial germination; 3 – stimulated seeds with the 67% of initial germination; 4 – control seeds with the same germination

CONCLUSIONS

1. It was determined by technological experiments that sorting ill-conditional rape seeds, it is possible to achieve 80% of seed correspondence to the standard requirements.
2. Corona discharge field has positive influence on germination dynamics of seeds with low germination. It speeds up seed germination by 2–3 days and increases germination reliability. The germination density function of seeds treated with a corona discharge field is described by lognormal distribution and that of untreated seeds by normal distribution.
3. The average germination increase of stimulated seeds has been reliable during the one-month period from stimulation to sowing.

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