

Results from a preliminary research on the pre-sowing electromagnetic treatment of rape seeds

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Abstract. A possibility has been established to stimulate the sowing quality of rapeseeds through subjecting them to a pre-sowing treatment in an electromagnetic or electrostatic field. It has been confirmed that, after a period of rest of the seeds (up to 7 days) between treatment and sowing, a beneficial effect of the pre-sowing electric impact is observed – up to 18% increase in the length of roots and up to 22% increase of the germs. It has been determined that 21 days after the said treatment, the effect has already become suppressive. The application of increased voltage values (12kV for the electromagnetic treatment and 6 kV for the electrostatic one) has resulted in no statistically significant influence on the monitored parameters - length of roots and germs. The pre-sowing electric impact helps to obtain better nourished seedling roots and germs which have up to 25% higher mass than those of the reference seeds.

Key words: *electromagnetic field, electrostatic field, germs, roots*

INTRODUCTION

The explosive increase in human population on Earth requires the production of more food and energy. A well-known fact is also that traditional fuel reserves are not inexhaustible. The use of artificial fertilizers on agricultural crops indeed leads to higher yields but at the same time pollutes the soils. For several decades now it has been determined that another way of increasing the productivity of grain and industrial crops is through a pre-sowing treatment of seeds in a magnetic (Martinez et al., 2004), electrostatic (Pozeliene et al., 2005) or electromagnetic (Palov et al, 2001; Palov et al, 2008) field, in a corona discharge field (Pozeliene A. & S. Linikiene 2009), where the stimulation of seeds is made together with their separation.

Rapeseed, which has high oil content, is one of the crops already being used for producing biofuel. No sources have been identified in the specialized literature that present stimulation of rape seeds by applying electric or electromagnetic fields. Based on the data from the pre-sowing electromagnetic treatment of seeds of similar crops, such as sunflower, cotton, and maize (Palov et al., 2010), some preliminary results

from the electric impact on rape seeds have been shown. It has been determined that when seeds are sown 5 days after electric treatment, a stimulating effect is produced on the growth of the germ and the root of an individual seed. However, 21 days after the treatment, its effect is already growth-suppressing. The purpose of this research is to determine the extent to which the different periods of rest between the electric treatment and sowing influence the sowing quality of seeds.

MATERIALS AND METHODS

The object of this research is the sowing quality of rape seeds of the variety 'Elvis'. The pre-sowing treatment of rape seeds is carried out in an electromagnetic field (Palov et al., 1994) and an electrostatic field (Palov et al., 2008).

Both types of treatment require placing the seeds in cells between flat electrodes (Palov et al., 2008). The electromagnetic (EM) treatment consists of supplying increased, 50 Hz alternating voltage U , kV of a fixed value to the electrodes, for a time duration of τ , s (Table 1). Thereafter, the voltage value is reduced and the duration of exposure is increased. In the manner described, treatment is repeated three consecutive times. The specificity here is that the first voltage value applied is much higher compared to those that follow. Thus, in the short period of initial treatment, a "shock" impact on the seed is achieved. This is done to penetrate its oil shield (Palov et al., 2010). After that, the seed becomes susceptible to the subsequent electromagnetic treatment. This is the so-called processing in steps (Palov et al., 1994).

The electrostatic (ES) treatment consists of supplying rectified increased direct voltage to the electrodes for a fixed period of time (Palov et al., 2008). The plan of the experiment employing a pre-sowing electric treatment is shown in Table 1.

Table 1. Plan of the experiment of pre-sowing electric treatment.

Treatment Option	Type of treatment	Processing Steps					
		I		II		III	
		Controllable Factors		Controllable Factors		Controllable Factors	
		U_1 kV	τ_1 s	U_2 kV	τ_2 s	U_3 kV	τ_3 s
1	EM 1	8	5	6,5	15	5	25
2	EM 2	12	4	9,75	11	7,5	25
3	ES 1	4	5	*	*	*	*
4	ES 2	6	20	*	*	*	*
5	Reference seeds/ specimen	*	*	*	*	*	*

* - no electric treatment has been carried out.

The types of treatment appearing in Table 1 as EM1 and ES1 have parameters which are in compliance with the results shown in Palov et al. (2010). Moreover, the treatment parameters in EM1 are equal to those designated as EMII in Palov et al. (2010), and the parameters in ES1 are equal to those in ES2. Since rape seed has very high oil content, a conclusion can be made from Table 1 that the EM2 and ES2 types of

treatment have increased values of voltage as the impact factor. Thus, the result from the shock impact on the seed can be experimentally verified. The treatment duration values τ , s for EM2 are compatible with the electric breakdown that occurs through the seeds into the inter-electrode space.

After the treatment, the seeds are left to rest for 1, 3, 5, or 7 days. Then they are sown in Petri dishes in four repetitions of 100 seeds each. The germination capacity, root length and germ length of each seed are examined. The pre-sowing treatment was performed to meet the needs of the published in European project of the 7th Framework Programme BIOMASS MOBILIZATION, No.245449 (Palov et al., 2010). For the studies in Palov et al. (2010), the pre-sowing electric treatment was carried out on 09.07.2010, and the one included in the present paper – on 21.08.2010. Since rapeseed is sown in spring, it should be noted that the specified types of treatment were carried out at a time of the year when spring activation of seeds does not take place. The purpose here was only to determine whether rapeseeds would respond to the pre-sowing electric treatment.

RESULTS AND DISCUSSION

The research results show that the germination of the reference seeds is 97.5%. For the seeds sown on the 1st and the 3rd day after treatment, it has been reported that the germination of the treated seeds for all treatment options has increased to 99–100%. For seeds sown on the 7th day after the treatment, the germination of the seeds treated by EM1, ES1 and ES2 decreases to that of the reference seeds. It is worth noting that after treatment with increased voltage values (EM2, option No.2 of Table 1) the germination noticeably decreases to 92.4 %, thus falling below that of the reference seeds (97.5%). This indicates a suppressing effect as a result of the increased voltage value of 12 kV at the first step of the electromagnetic treatment.

The resulting lengths of the roots of reference seeds are assumed to be 100%. All measurement results for seed roots from the various treated options are represented as a percentage of the reference results (%/k).

The results from the studies on the length of roots are shown in Figure 1. From Figure 1 it can be concluded that, after treating the seeds with the specified values of the impact factors and at the specified time intervals for germination, a faster sprouting of the treated seeds occurs. The influence of the pre-sowing impact is strongest when seeds are placed for germination during the first day after treatment. Furthermore, longer roots sprout in seeds treated in an electrostatic field in comparison with the electromagnetic treatment. After a rest of 3 or 5 days, the intensity of root growth is reduced. Moreover, roots are shorter in length in seeds placed for germination on the 5th day as compared with those placed on the 1st day, but they still correlate with the data given in Palov et al. (2010). Here, the electromagnetic treatment gives better results than the electrostatic one. In treatment options 1 and 2, the sprouting roots have lengths respectively 108 percent and 108.7 percent compared to the reference seeds, while those subjected to an electrostatic treatment (3 and 4) – 104.5% and 105.9% respectively.

The analysis of the data in Figure 1 shows that, as a rule, treatment at increased voltage values (No. 2 and No.4 – ref. to Table 1) does not result in statistically

significant differences in the measured lengths of sprouting roots. A disadvantage of applying such voltages lies in the fact that they are accompanied by electric breakdowns (under electromagnetic impact) causing further difficulty in accomplishing the process. Additional labour safety measures are necessary as well for performing an electrostatic treatment (No. 4) with a voltage of 6 kV.

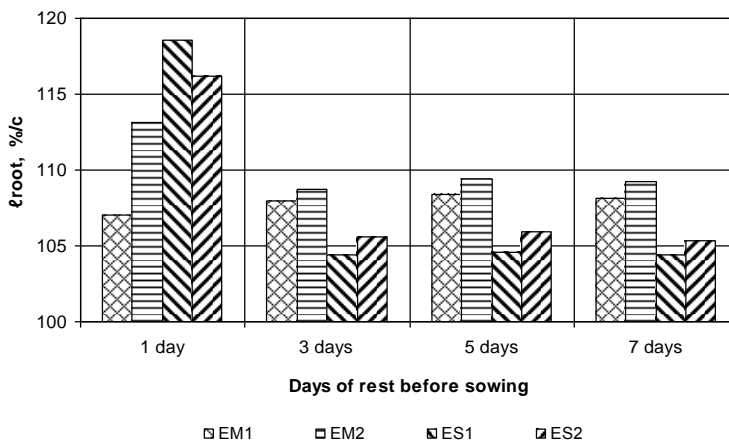


Figure 1. Lengths of roots of rape seeds of the variety ‘Elvis’ (as a percentage of the reference seeds), placed to germinate on different days after pre-sowing electric treatment.

From the foregoing observations it can be concluded that increased voltage values should not be employed for the conducting of pre-sowing electric treatment of seeds. The research results after the 7th day of rest show a trend, though not a significant one, of a weakening impact of the pre-sowing treatment. This also correlates with the findings in Palov et al. (2010), where, on the 21st day of rest, the impact is already suppressing. The results from the research on the length of germs are shown in Table 2.

Table 2. Research results for the length of germs of rape seeds of the variety Elvis, placed for germination on different days after pre-sowing electric treatment*.

Treatment No.	Ist Day		IIIrd Day		Vth Day		VIIth Day	
	mm	%/k	mm	%/k	mm	%/k	mm	%/k
1	51.8	111.2	54.9	114.1	46.7	114.2	52.8	113.5
2	52.2	112.2	52.5	109.1	45.9	112.3	52.1	112.0
3	55.7	119.5	53.7	111.7	44.8	109.5	50.6	108.9
4	57.1	122.5	49.9	103.8	44.5	108.7	50.5	108.5
5	46.6	100.0	48.1	100.0	40.9	100.0	46.5	100.0

* The parameters of each electric pre-sowing treatment are according to Table 1.

The comparison of the research results for germs and for roots shows a similarity in the alteration of the respective monitored parameter. Here, too, the effect is most powerful in seeds that have been placed for germination on the 1st day of treatment. With the increase of the rest period from treatment to sowing, the electrostatic

treatment impact noticeably drops. For example, after a rest of one day the lengths of the germs are 11% to 22% greater in treated seeds as compared to the reference seeds. Following a rest period of 7 days, the resulting germs are only 8% to 13% longer.

In the course of this research, a study was carried out of the mass of plants grown in the Petri dishes. The results from the statistically processed data in this research are shown in Figure 2. The mass of the reference plants is assumed to be 100%.

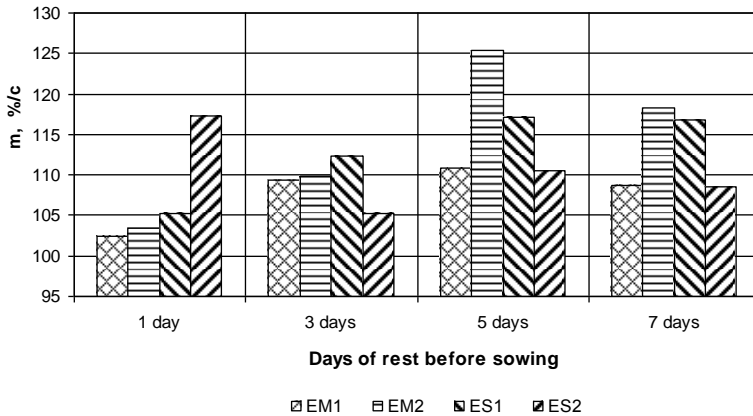


Figure 2. Average mass of a plant grown from sprouting rape seeds of the variety Elvis (as a percentage of the reference seeds), placed for germination on different days after pre-sowing electric treatment.

From Figure 2it can be concluded that all types of pre-sowing treatment have a beneficial effect on the development of plants - their roots and sprouts have a mass greater than that of the reference seeds.

The data analysis for the mass of plants shows that sowing on the 5th day after treatment gives the best results in all treatment options. The examined data for seeds sown on the 7th day after treatment, albeit with slightly smaller values, correlate well with those of the 5th day. The resulting greater mass of roots and germs suggests a better development of the plants in field conditions, and thus higher yields of grain, without using fertilizers, which are already a major pollutant of the soil.

Thus, seeds subjected to pre-sowing electric treatment can be used to sow irretrievably polluted agricultural areas and obtain higher yields, which will make good farm land available for use to safely feed the population and livestock. In a number of research works, the method adopted is of seed treatment in magnetic (Martinez et. al., 2004) and electric (Pozeliene et. al. 2005, Pozeliene et. al. 2009) fields. In the preliminary studies of the pre-sowing treatment of oil-rich rape seed, the electromagnetic treatment has been the option of choice, since both living and non-living nature exist in the electromagnetic field of the Earth. It is a known fact that this field has two components – a magnetic, and an electric one.

Thus, the combined pre-sowing electromagnetic field resembles that of the Earth, and its increased intensity values are expected to have a faster effect on the seeds.

CONCLUSIONS

A possibility has been established to stimulate the sowing quality of rape seeds through subjecting them to a pre-sowing treatment in an electromagnetic or electrostatic field. It has been confirmed that, after a short period of rest (up to 7 days) between treatment and sowing of the seeds, a beneficial effect of the pre-sowing electric impact is observed – up to 18% increase in the length of roots and up to 22% increase of the germs. The application of increased voltage values (12kV for the electromagnetic treatment and 6 kV for the electrostatic one) has resulted in no statistically significant influence on the monitored parameters – length of roots and germs. The pre-sowing electric impact helps to obtain better nourished seedling roots and germs which have up to 25% higher mass than those of the reference seeds. Sowing irretrievably polluted areas with seeds of plants used for fuel production, after subjecting them to a pre-sowing electric treatment will, on the one hand, leads to increased yields without using chemical fertilizers (already regarded as pollutants), and on the other hand, makes good farm land available to be used for plant production needed to feed people and livestock.

REFERENCES

- Martinez, E., Florez, M., & Carbonel, M.V. 2004. Study of germination rate of serial seeds subjected to 125 mT stationary magnetic field. *Curvets Environment*.
- Palov, Iv., Stefanov, St.P. & Bozhkova, Y. 1994. Results from pre-sowing electro-physical treatments of cotton seeds in different time periods of a year. *Agric. engineering*, **1**, 3–6 (in Bulgarian).
- Palov, Iv., Stefanov, St.P., Zlatev, Zl.T. & Stankovski, M. (patentees) 1994. A method for pre-sowing electromagnetic treatment of peanuts. Patent of invention № 42681, Sofia, (in Bulgarian).
- Palov Iv., Demirev, Zh., Georgiev, Dr. & Yankov, P. 2001. Results from Pre-sowing electromagnetic treatment of sunflower seeds. *Perspective sustainable technological processes in agricultural engineering. Proc. Int. Conf. Lithuania*, pp. 135–140.
- Palov Iv., Sirakov, K., Kuzmanov, Em. & Andreev, H. 2008. *Results of the contrastive research of maize seeds pre-sowing electrical treatment results. Proc. Int. Conf. Biosystems engineering and processes in agricultural N13. Raudondvaris, Lithuania*, pp. 239–245.
- Palov Iv., Stefanov, St., Sirakov, K., Kuzmanov, E. & Neikov, Y. 2010. Increasing the production of grain and technical crops biomass by preliminary electromagnetic treatment of seeds. *Biomass Mobilization, Project № 245449 Seventh Framework Programme, European Union, Short exchange in Bulgaria, University of Rouse*.
- Pozeliene, A., Lynikiene, S., Synkevichiene, I. & Dabkyavichus, Z. 2005. Influence of ecologically pure impacts on the infection and germination of wheat seeds. *Proc. Univ. Rouss Bulgaria*, **44**, 68–72 (in Russian).
- Pozeliene, A. & Lynikiene, S. 2009. The treatment of rape (*Brassica napus* L.) seeds with the help of electrical field. *Agron. Res.* **7**(1), 39–46.