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RESULTS OF PRELIMINARY LABORATORY STUDIES AFTER PRE-SOWING ELECTRIC TREATMENT OF PEA SEEDS

Ivan Palov^{*}, Kiril Sirakov, Emil Kuzmanov, Svetoslav Zahariev

*Angel Kanchev University of Ruse, Faculty of Electrical and Electronic Engineering and
Automation, Department of Electrical Power Engineering, Ruse, Bulgaria*

Abstract: In many countries, the possibilities for stimulation of the sowing qualities and yield of cultivars after pre-sowing electric treatment of their seeds have already been identified.

At the University of Ruse, Bulgaria, for more than 20 years studies have been conducted on the pre-sowing stimulation of the sowing qualities of seeds of various agricultural crops that are subjected to pre-sowing electromagnetic treatment.

This article discusses the preliminary results of pre-sowing electric (electromagnetic and electrostatic) treatment of pea seeds.

It has been established that after electro-magnetic or electrostatic pre-sowing treatment it is possible to obtain a stimulant effect on pea seeds. This effect takes place after 14 days of rest from treatment to sowing, and with the other controllable factors has following values:

- for the three-step electromagnetic treatment initial value of the applied voltage is $U_1 = 4$ kV, and duration of treatment $\tau_1 = 5$ s;

- for the electrostatic treatment voltage is $U = 6$ kV, and duration of treatment $\tau = 70$ s.

The treatment applied to pea seeds leads to an increase in the germination capacity by 2,6%, in the length of the sprouts by up to 5,5% and of the rootlets by up to 18,6%, and increase in the mass of the plants by 6,9% as compared to the reference specimen.

Key words: *three-step electromagnetic treatment, electrostatic treatment, pea seeds, sprouted seeds mass, length of sprouts and rootlets.*

^{*} Corresponding author. E-mail: ipalov@uni-ruse.bg

INTRODUCTION

Vegetables are particularly essential to human health. In this sense, increasing yields of vegetable plants is not insignificant.

It has already been established that there is a possibility for favourable effect on the seeds of some agricultural crops by subjecting them to pre-sowing treatment in different electric fields. Since the increase of yields and food supplies is a primary concern of any society, it is necessary to look for opportunities to increase the fruitfulness of vegetable crops, such as peas.

At the University of Ruse, Bulgaria, for over 20 years now studies have been performed of the pre-sowing stimulation of the sowing qualities of various agricultural crop seeds that are subjected to pre-sowing electromagnetic treatment. Consequently, the values of the controllable factors for pre-sowing electromagnetic treatment of cereals have already been determined - maize [5], wheat [3], cotton [1,2], beans [4].

The purpose of this study is to identify the existing opportunities for the effective influence of electromagnetic and electrostatic fields on the sowing qualities of pea seeds.

MATERIAL AND METHODS

For the purpose of the research, pea seeds of the Bulgarian cultivar "Ran" were used, with declared germination capacity of 90%.

Pea (*Pisum sativum* L.) is a plant in the legumes family (*Fabaceae*). It is rich in the following nutrients: proteins, carbohydrates, fat, fibers, vitamin C and beta carotene, and its energy value is 218 kJ [6]. The foregoing indicates that in its characteristics, the plant is particularly close to beans. This suggests that such treatments should be applied that have brought to results in the pre-sowing electric treatment of beans and other seeds high in fat [4].

For the selection of the values of controllable treatment factors, those factors were taken into consideration which produced the best effect on cotton seeds [1,2] and bean seeds [4].

The plan for the experiment with pea seeds included the options described below:

Treatment options No. 1 (electromagnetic treatment - *EM1*) and No. 2 (electromagnetic treatment - *EM2*) – the treatment of the seeds was performed in a chamber with plate electrodes, as with bean seeds [4]. A three-step electromagnetic treatment was conducted for the purpose, with the seeds being placed in an electromagnetic field created between plate electrodes. At the first step, high voltage was briefly supplied to the electrodes. At every subsequent step, the value of the voltage U [kV], supplied to the electrodes of the chamber, was reduced, while the duration of treatment τ [s], was increased.

The values of controllable factors in treatment options No. 1 and No. 2 are shown in Table 1.

Treatment option No. 3 – the seeds were treated in an electrostatic field (*ES*) with voltage between the electrodes $U = 6$ kV and duration of treatment $\tau = 70$ s.

Treatment option No. 4 – reference specimen (untreated seeds).

Pea seeds were treated on the following dates:

- on 27.03.2010, and set for laboratory examinations in a thermostat on 27.04.2010, i.e. 31 days after treatment;

- on 29.03.2011, and placed for laboratory examinations respectively on 05.04.2011, i.e. 7 days after treatment, and on 12.04.2011, i.e. 14 days after treatment.

Table 1. Three-step electromagnetic treatment of pea seeds by treatment options No. 1 and No. 2

Treatment options	Treatment steps					
	First step		Second step		Third step	
	U_1 [kV]	τ_1 [s]	U_2 [kV]	τ_2 [s]	U_3 [kV]	τ_3 [s]
1 (EM1)	4	5	2,5	15	2	25
2 (EM2)	5,5	5	4	15	3,6	25

RESULTS AND DISCUSSION

The results of the study of laboratory-determined germination capacity and mass of sprouting pea seeds are shown in Fig. 1. The results from Fig. 1 are expressed as a percent (%/R) of the results of the reference (untreated) specimen.

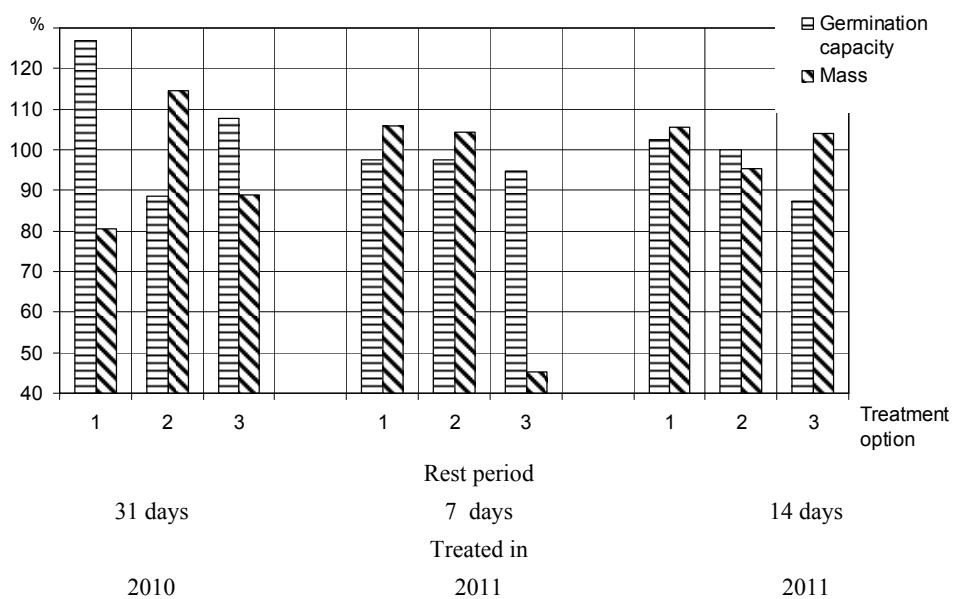


Figure 1. Results of the study of laboratory-determined germination capacity and sprouted mass

From Fig. 1 it can be concluded that the rest period of 31 days from treatment to sowing (in 2010) had a favorable effect on the germination capacity of pea seeds. The three-step electromagnetic treatment with values of the factors in the first step $U_1 = 4$ kV and $\tau_1 = 5$ s contributed for the achievement of a germination capacity (option 1) which

was 26,9% higher than that of the reference specimen. The increase in the treatment voltage in option No. 2 from 4 kV to 5,5 kV (for the first step), with the same duration of electromagnetic treatment, had a suppressive effect – the germination capacity in this case was only 88,5% of that of the reference seeds.

After the treatment in an electrostatic field (option No. 3) the laboratory-determined germination capacity had increased by 7,7% compared to that of the reference specimen.

Regardless of the improved germination capacity, in the above mentioned treatment options No. 1 and No. 3, the mass of the sprouted plants was lower than that of the reference specimen - 80,6% and 89,0%, respectively. The described situation can be explained with the long period of rest (31 days) of the seeds from the time of treatment until their sowing.

From Fig. 1 it can be concluded that the relatively short period of rest (7 days) in 2011 led to the lower germination of the seeds. It was 97,4%, 97,4% and 94,8%.

The rest period of 12 days in 2011 contributed to a 2,6% increase in the germination of pea seeds and 6.9% increase in the mass of the sprouted plants.

For the seeds germinated in laboratory conditions, the length of their sprouts and rootlets was studied. These results are shown in Table 2.

The analysis of the data in Table 2 indicates that, using the given parameters for the treatment:

- In 2010., with treatment options No. 1 and No. 3, the rest period had a suppressive effect, whereby the resulting lengths of the seed sprouts were respectively 78.3% and 89.8% of that of the reference specimen. Only in Option No. 2 the lengths of the sprouts were 15.1% higher than in the reference specimen. The examination of the length of the rootlets of the treated seeds showed that no statistically significant difference occurred in comparison with the reference specimen;

- The short rest period (7 days) in 2011 showed an even more suppressive effect – the lengths of the sprout and rootlets were 60.2% and 80.2% of those of the reference specimen.

Table 2. Results of the studies of the lengths of sprouts and rootlets of pea seeds after pre-sowing electromagnetic treatment

№	Kind of treat-ment	2010				2011									
		Set after the treatment:													
		31 days				7 days				12 days					
		Sprout		Root		Sprout		Root		Sprout		Root		Germination capacity	
mm	%/R*	mm	%/R*	mm	%/R	mm	%/R*	mm	%/R*	mm	%/R*	mm	%/R*	%	%/R*
1	EM1*	13,4	78,3	24,9	103,1	26,9	104,4	66,0	90,5	37,0	105,5	85,7	115,7	100	105,3
2	EM2*	19,6	115,1	23,8	98,4	27,8	97,8	72,1	98,5	33,4	95,3	74,8	100,9	92,5	97,4
3	ES*	15,3	89,8	23,9	99,1	17,1	60,2	58,5	80,2	36,7	104,6	87,9	118,6	85	98,5
4	Reference specimen	18,1	100	24,2	100	28,4	100	72,6	100	35,1	100	74,1	100	95	100

*EM1, EM2 – in accordance with Table 1,

*ES – electrostatic treatment,

*%/R – percent of the reference specimen.

As the seeds rested for 14 days (in 2011) before being sown, in treatment option No. 1 the sprouts were 5,5% longer, the rootlets were 15,7% longer, while in option No. 3 these numbers were 4,6% and 18,6%, respectively. This fact, in combination with the mentioned higher mass of the plants (Fig.1) shows that the pre-sowing electric effect is favorable. After a 7-month drying in laboratory conditions it has been found that the mass of 1 seed (its sprout and rootlets inclusive) is, for the respective treatment options, as follows: No. 1 - 0,193 g (102,1%/R), No. 2 - 0,187 g (98,99%/R) No.3 - 0,199 g (105,3%/R) and for No. 4 (reference specimen) - 0,189g (100%). This comes to show that, except for treatment option No. 2, in the other two options the seeds have accumulated more dry substance during their growth in laboratory conditions than have the seeds from the reference specimen (R).

From the analysis of the obtained results it can be concluded that with the selected values of the controllable factors (voltage and duration of treatment), the effect of the electromagnetic and electrostatic field on the monitored parameters (germination capacity, lengths of sprouts and rootlets, mass of the plants) after a 14-day period of rest is equally favorable.

From the foregoing it can be established that the short (7 days) and the long (31 days) period of rest of the seeds from their treatment to the time of sowing, with unchanged values of the other controllable factors, has an unfavorable effect of the subsequent development of the seeds. This is acts as a restraining factor, since in bad weather conditions the sowing of the seeds in the field might not take place within the prescribed time period of 14 days.

During future research activities it is to be taken into account that the agro-technical time period for sowing pea seeds in Bulgaria is in the second half of February and early March. The analysis of various other studies on different seeds shows that, prior to the said time limit for sowing; activating changes start in the seeds that prepare them for the time of sowing. This, combined with the pre-sowing electric treatments, has a favorable effect on the quality of seeds. In this respect, the time of treatment mentioned (27.03.2010 and 29.03.2011) is after the agro-technical time limit.

CONCLUSIONS

1. It has been established that after an electromagnetic or electrostatic pre-sowing treatment it is possible to produce a stimulant effect on pea seeds. This is achieved by allowing a rest period of 14 days between the treatment and the sowing, and values of the other controllable factors, as follows:
 - for the three-step electromagnetic treatment: initial values of the applied voltage $U_I = 4$ kV and duration of treatment $\tau_I = 5$ s;
 - for the electrostatic treatment: voltage $U = 6$ kV and duration of treatment $\tau = 70$ s.

The said kinds of treatment result in an increase in the germination capacity by 2,6%, increase in the length of sprouts by up to 5,5%, in the length of rootlets by up to 18,6% and in the mass of plants by up to 6,9%, as compared to the reference specimen.

2. For the shorter rest period (7 days), and for the longer rest period (31 days), with the same values of the other controllable factors of treatment, a

suppressive effect on the pea seeds has been observed. The same effect takes place when applying higher voltage at the first treatment step, i.e. $U_1 = 5,5$ kV.

3. A study of the pre-sowing electric treatment of pea seeds is to be carried out before the agro-technical time limit for sowing them.

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REZULTATI PRELIMINARNIH LABORATORIJSKIH ISPITIVANJA ELEKTRIČNOG TRETMANA SEMENA GRAŠKA PRE SETVE

Ivan Palov, Kiril Sirakov, Emil Kuzmanov, Svetoslav Zahariev

*Univerzitet Angel Kančev, Fakultet za elektrotehniku, elektroniku i automatizaciju,
Institut za elektro-pogonsko inženjerstvo, Ruse, Bugarska*

Sažetak: U mnogim zemljama su već identifikovane mogućnosti za stimulisanje setvenog kvaliteta i prinosa sorti posle električnog tretmana semena pre setve.

Na Univerzitetu u Ruse, Bugarska, više od 20 godina se sprovode istraživanja stimulacije kvaliteta semena, elektromagnetnim tretmanom pre setve, kod raznih poljoprivrednih kultura.

Ovaj rad predstavlja preliminarne rezultate električnog (elektromagnetnog i elektrostatičkog) tretmana semena graška.

Utvrđeno je da je posle elektro – magnetnog ili elektrostatickog tretmana pre setve moguće postići stimulatívni efekat na seme graška. Ovaj efekat se ispoljava 14 dana posle tretmana za setvu, a drugi kontrolisani faktori imaju sledeće vrednosti:

- za tro-stepeni elektromagnetni tretman inicijalna vrednost primenjenog napona je $U_1 = 4$ kV, a vreme trajanje tretmana $\tau_1 = 5$ s;
- za elektrostaticki tretman napon je $U = 6$ kV, a vreme trajanje tretmana $\tau = 70$ s.

Tretman primenjen na seme graška dovodi do povećanja kapaciteta klijanja od 2,6%, dužine klijanaca do 5,5% i korena do 18,6% i povećanje mase biljaka od 6,9 %, u poređenju sa referentnim uzorkom.

Ključne reči: *tro-stepeni elektromagnetni tretman, elektrostaticki tretman, seme graška, masa klijavog smena, dužina klijanaca i korena.*

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