Sunflower yields increase by pre-sowing seed treatment in the electric field

M P Aksenov¹, N Yu Petrov¹, T V Daeva¹, A I Belyaev² and A M Pugacheva²
¹ Volgograd State Agricultural University, University Avenue, 26, Volgograd, 400002, Russia
² Federal Scientific Centre of Agroecology Complex Meliorations and Protective Afforestation Russian Academy of Sciences, University Avenue, 97, Volgograd, 400062, Russia

E-mail: aksenovmp@mail.ru

Abstract. At present, the problem of the seeds sowing qualities and the produced crop quality improving is still urgent. The solution to this problem is carried out mainly through the use of various preparations for pre-sowing seed processing. A promising direction in the pre-sowing seed-processing field is the application of seed processing electrophysical methods before sowing. The research results on the industrial frequency of 50 Hz alternating electric field influence on the sunflower hybrids NK Neoma, LG 5550, ES Petunia laboratory germination seeds are presented in the article. It was found that with the electric field density of 6-8 kV/cm, the processing time from 60 to 95 seconds, it increases laboratory germination in the ES Petunia hybrid by 11%, in the NK Neoma and LG 5550 hybrid by 8%. It is proposed to process seeds in the electric field with set-up effective modes to improve the condition properties.

1. Introduction
The main raw material for the production of vegetable oil in Russia is sunflower. In the Volgograd region, the area of crops for oilseeds increases annually, reaching 820 thousand hectares in 2019, of which 707.8 thousand hectares are used for sunflower cultivation [1]. The increase in the gross yield in the region is achieved mainly due to the expansion of the sown area, while the yield of the Volgograd region is significantly behind the neighboring regions. The seeds of imported sunflower hybrids, according to the manufacturers, have a high genetically potential, and allow to obtain a yield of 3 -3.5 t/ha, however, the actual yield on average in the region is no more than 1.6 t/ha. The increase in purchase prices for seed material, plant protection products, fuel for machinery, significantly reduces the crop cultivation profitability at low yields. It is necessary to improve the technology of crop cultivation to increase yields. The improvement of the seed material condition properties is an effective agricultural technique, which is achieved through the pre-sowing seed processing. The most common is the seeds processing by the growth regulator [2, 3], the disadvantage of this method is the preparation influence on the environment through gradual accumulation in the soil. At present, scientists successfully use agricultural seeds pre-sowing processing environmentally friendly and safe methods; they are the influence of electric, electromagnetic, impulse fields. The use of seed processing by electrophysical methods, in addition to the absence of harm to the environment, is economically more expedient in relation to the use of plant growth stimulants, which purchase price rises every year. In addition to the stimulating effect, that increases the initial growth germination rate and development [4], the electric seed processing also has a bactericidal effect [5]. A limiting factor in the widespread application of this technology is the insufficient knowledge of the influence of the alternating electric field on the germination and growth rate of sunflower seeds.
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introduction of electrophysical methods in agriculture is the need to determine effective modes for a particular crop. The purpose of the research was to establish the influence of the alternating voltage electric field on the sunflower seeds laboratory germination, to establish effective modes at which the maximum sunflower seeds responsiveness to the influence of the electric field is achieved, for the implementation of the industrial seed processing plant and recommendations for production.

2. Materials and methods

Three imported sunflower hybrids, included in the state register of breeding achievements approved for cultivation in the Volgograd region, were selected to study the sunflower seeds responsiveness to the influence of the electric field: NK Neoma, LG 5550, ES Petunia.

The seed processing was carried out on the laboratory facility, the structural diagram of the experiment is shown in the Figure 1. The source of high voltage generation was the SKAT-70 test apparatus, consisting of two blocks: the first block was connected to a 220 V network, there were operator controls for setting the magnitude and parameters of voltage, digital voltmeter and signal lamps on the front panel. The second block consisted of the autotransformer capable to deliver the alternating voltage of 50 kV and the direct voltage of 70 kV, connected to the first block by the information and control cable.

![Figure 1. The scheme of the experiment: 1 - control unit; 2 - high-voltage unit; 3 - chamber for seed processing; 4 – thermostat.](image)

Based on the carried out by the scientists research analysis and the influence of electric fields on the agricultural seeds responsiveness [6, 7], 5 electric field densities were selected: from 2 kV/cm to 10 kV/cm with the interval of 2 kV/cm, and the exposure time from 15 to 105 seconds, at 15 second intervals.

The seeds were packaged in 100 pieces and placed for processing in the chamber between two parallel steel plates - electrodes, the lower electrode was rigidly fixed and grounded, the upper electrode was able to move in the horizontal plane with the help of two screws, reducing or increasing the air gap between the electrodes and the processed seeds layer, a high voltage potential was applied.
to the upper electrode. The layer of processed seeds was constant - 20 mm, the distance between the electrodes was 25 mm [8].

After the processing, at the same day, the seeds were placed in Petri dishes on filter paper moistened with distilled water and placed in the thermostat maintaining a constant temperature of +20°C. The laboratory germination was determined on the 5th day, according to the All Union State standard 12038-44 method.

3. Results and Discussion

In one variant, the seeds were placed in the thermostat for germination, without processing in the electric field, to establish laboratory germination on the control, which was 87% for the NK Neoma hybrid, 85% for LH 5550, and 83% for ES Petunia.

**Table 1.** Sunflower hybrids laboratory germination dependence on the electric field density and exposure time.

| Exposure time, sec | Electric field density, kV / cm | Laboratory germination, % |
|-------------------|--------------------------------|--------------------------|
|                   |                                | hybrid NK Neoma | hybrid LG 5550 | hybrid ES Petunia |
| 15                | 87                             | 85            | 83            |
| 30                | 87                             | 85            | 83            |
| 45                | 87                             | 85            | 83            |
| 60                | 87                             | 85            | 83            |
| 75                | 88                             | 86            | 84            |
| 90                | 89                             | 86            | 84            |
| 105               | 89                             | 87            | 85            |
| 15                | 87                             | 85            | 82            |
| 30                | 88                             | 86            | 83            |
| 45                | 89                             | 86            | 85            |
| 60                | 89                             | 87            | 85            |
| 75                | 90                             | 87            | 86            |
| 90                | 90                             | 88            | 86            |
| 105               | 91                             | 88            | 87            |
| 15                | 88                             | 86            | 84            |
| 30                | 90                             | 88            | 85            |
| 45                | 91                             | 88            | 87            |
| 60                | 92                             | 90            | 89            |
| 75                | 94                             | 92            | 91            |
| 90                | 95                             | 93            | 92            |
| 105               | 95                             | 93            | 93            |
| 15                | 89                             | 87            | 86            |
| 30                | 90                             | 89            | 88            |
| 45                | 93                             | 90            | 90            |
| 60                | 95                             | 92            | 92            |
| 75                | 95                             | 93            | 93            |
| 90                | 95                             | 93            | 94            |
| 105               | 95                             | 93            | 94            |
| 15                | 90                             | 88            | 86            |
| 45                | 91                             | 89            | 89            |
| 60                | 93                             | 90            | 90            |
| 75                | 95                             | 92            | 92            |
| 90                | 95                             | 93            | 93            |
| 105               | 95                             | 93            | 93            |
Table 1 shows the results of the carried out research on the influence of the electrophysical factor - the electric field, on the sunflower seeds laboratory germination.

All three hybrids, when processed by the mode of 2 kV/cm, increased laboratory germination by 2%, while responsiveness was manifested at the processing time of 75 to 105 seconds, the processing time of 15 to 60 seconds did not have either a positive or a negative effect.

The processing mode of 4 kV/cm already at 30 seconds showed the seeds responsiveness, the highest germination was observed in hybrids NK Neoma and ES Petunia. + 4% each relative to the control, although the hybrid LG 5550 responded already after exposure of 30 seconds, during the entire experiment at the given mode, the positive increase in germination was +3%.

With the increase in the electric field density, the decrease in the minimum time at which laboratory germination began to increase was noted. Therefore, at the processing mode of 6 kV/cm, all the studied hybrids added 1% to the control already at 15 seconds. The maximum germination rate in the given mode was 91% for the NK Neoma hybrid, 93% each for the LG 5550 and ES Petunia hybrids.

The maximum germination rate was recorded at 95% in the NK Neoma hybrid, 93% in the LG 5550 hybrid, 94% in the ES Petunia hybrid at the processing modes of 6-10 kV/cm and the processing time of 60-75 seconds. Further increase in the processing time did not have a positive effect.

Analyzing the experimental data obtained from the Table 1, one can conclude that during the processing, laboratory germination is both dependent on the electric field density and the exposure time. The maximum effect was obtained at lower density but longer exposure, and at higher density with shorter processing time.

4. Conclusion
It is advisable to carry out sunflower seeds pre-sowing processing in the alternating voltage electric field, since it leads to the increase in seed germination. The degree of the studied sunflower hybrids responsiveness differed slightly depending on the genotype. Optimum processing conditions were experimentally obtained for the NK Neoma hybrid, 6-8 kV/cm at the processing time of 60 to 90 seconds, for the LG 5550 hybrid, 6-8 kV/cm at the processing time of 75 to 90 seconds, for the ES Petunia hybrid -10 kV/cm with the processing time of 90 seconds.

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