Influence of pre-sowing sunflower seeds treatment in electric field and plant growth stimulant on water consumption and yield

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Abstract. The work presents the results of the 2015-2017 field studies on the effect of pre-sowing treatment of seeds of sunflower hybrids NK Neoma, ES Petunia and LG 5550 in an electric field of alternating voltage with an established electric field intensity of 8 kV/cm and 60 seconds exposure and a growth regulator Zerebra Agro on the yield and quality of sunflower seeds. The studies were carried out in laboratory conditions and aimed to determine the optimal mode of seed treatment in an electric field of alternating voltage, at which the maximum viability and germination energy are achieved relative to the control. The effect of the growth regulator Zerebra Agro during pre-sowing treatment was studied using the dosage of the drug recommended by the manufacturer. The influence of the studied methods of pre-sowing seed treatment on the total water consumption and the coefficient of water consumption was experimentally established. On the options with pre-sowing treatment, less moisture was required to form 1 ton of seeds. Without pre-sowing treatment, the water consumption coefficient varied from 1258.4 m³/t for the hybrid NK Neoma to 1407.7 m³/t for the hybrid ES Petunia. Moisture was most economically consumed by hybrid LG 5550 when treating seeds in an electric field of 1172.2 m³/t. When implementing pre-sowing treatment with a growth regulator, the minimum indicator of the water consumption coefficient for the hybrid NK Neoma was 122.89 m³/t and the maximum for the hybrid ES Petunia was 1318.5 m³/t. Depending on the pre-sowing treatment method, the yield increased from 8.97% in the hybrid ES Petunia when being treated with the growth regulator to 14.78% in the hybrid NK Neoma with the treatment in an electric field.

1. Introduction
The Volgograd region is a rather favorable region for the cultivation of sunflower in terms of soil and climatic characteristics. At the same time, the region belongs to the category of risky agriculture with high temperatures in summer and precipitation in the form of short-term rainstorms, which affects the productivity of cultivated crops. Growing sunflower being the main oilseed crop cultivated in the region has been increasing for the last 15 years, which has enabled producers to receive a stable income from the steady demand for the sunflower seed crop. In 2018, the area sown with sunflower reached 820 thousand hectares. Thus, the Volgograd Region got in the top five regions in terms of the area sown with sunflower. For the most part, the gross yield increased due to the expansion of sown areas and a slight increase in yield compared to the genetic potential of imported sunflower hybrid sown. However, growing costs for seeds, maintenance of agricultural machinery and fuel, as well as a
low average yield in the region being 1.6 t/ha at the background of potentially possible seed genetics, drying the soil with sunflower for the crops to be sown afterwards led to a decrease in areas sown with sunflower as early as 2019.

The tasks of agricultural production include both the improvement of the cultivation technology leading to an increase in the yield of sunflower and measures aimed at resource conservation.

To achieve the highest yield, a whole range of sequential measures is needed. The primary role with this regard is assigned to seed material determined by the genetic productivity of the variety, pre-sowing preparation of seed material to protect against diseases and pests, soil cultivation technology and plant care, as well as meteorological conditions during the growing season [1, 2].

Pre-sowing treatment of seed material enables to improve the conditional quality of seeds, which is an important agricultural practice. The classical scheme implies pre-sowing treatment by disinfection with chemical or biological preparations [3]. Every year new drugs presented by manufacturers as safe for the crop and the environment appear on the market. However, under the influence of growth regulators, in addition to the visible effects expressed in a quantitative increase in the yield, there are also invisible effects on the quality and safety of the products obtained and on nature in general. Pre-sowing treatment methods using factors of a physical nature, which simultaneously suppress pathogenic microflora both on the surface and inside the seed and have a stimulating effect on growth processes, are an alternative to disinfection with biological products. Out of the variety of existing pre-sowing treatment options, the use of exposure to various electric fields is rather promising.

Scientifically substantiated and proven facts of an increase in yield during pre-sowing treatment by electrophysical methods is an increase of 10-20% to the control [4, 5]. Consequently, the choice of the applied treatment should be guided by economic criteria for the manufacture and maintenance of the system for seed treatment on a commercial scale. Installations for processing in an alternating voltage electric field are the easiest to implement both technically and in terms of economic indicators of manufacture and operation.

The aim of the research was to compare the effects of the electric field and the growth regulator Zerebra Agro during the pre-sowing treatment of seeds of sunflower hybrids NK Neoma, ES Petunia, LG 5550 to increase the crop yield.

2. Materials and methods
At the farm Egorushin A.Yu. located in Mikhailovsky district of the Volgograd region, a three-year two-factor experiment was implemented based on the method of B.A. Dospekhova at three replications. Factor A implied studying sunflower hybrids (NK Neoma, LG 5550 and ES Petunia), factor B included pre-sowing seed treatment (treatment in an electric field of alternating voltage, with a voltage of 8 kV/cm and an exposure of 60 seconds [6, 7]; treatment by semi-dry disinfection with a growth regulator Zerebra Agro, 10 ml of the drug per 1 liter of water). The crop sown for all years of research before the considered one was winter wheat.

The soil of the experimental site was thin southern chernozem, medium loamy with a humus content of 4.7%, pH equal to 7.6, low soil supply with nitrogen, increased supply of potassium.

The farm has adopted a traditional system of soil cultivation for sunflower managing established by zonal recommendations. In July, after harvesting winter wheat, the first stubble plowing was carried out at the depth of 0.06 ... 0.08 m. The second stubble plowing was implemented when weeds germinated at the end of August. At the end of October, before the onset of frost, moldboard plowing was carried out to a depth of 0.28 m to incorporate plant residues and weeds.

In the spring, upon reaching the physical ripeness of the soil, harrowing and two cultivation were carried out.

For sowing, an SPB-8 seeder with a working width of 5.6 m, a width of the main row spacing of 0.7 m was used. The seeding rate was 60 thousand units of germinating sunflower seeds per 1 ha according to zonal recommendations.

Taking into account the actual meteorological conditions in 2015, 2016, 2017 regarded by meteorological station “Reconstructsia” and the calculations with regard to the actual value of the hydrothermal index in the years of the experiments, the hydrothermal index equal to 0.84 in 2015 was...
obtained. In 2016 it was equal to 0.91, which refers to the arid zone and the arid subzone, and in 2017 the hydrothermal index was 0.74, which corresponded to a very arid subzone.

The deposits of productive moisture in the soil by the years of research differed slightly in 2015 and 2016. In 2015 they were 150.4 mm, in 2016 equaled 158.6 mm, but in 2017 they were much lower, specifically, 135.2 mm, still being within the range satisfying for growing sunflower and harvesting. Lack of precipitation during the growing season can lead to a decrease in crop yields. At the same time, an uneven precipitation during the growing season, in particular, a large amount of precipitation at the end of the growing season has a negative impact on productive processes.

3. Results and Discussion

The studies were carried out in an arid agroclimatic zone, on the steppe soils of southern chernozems. Precipitation is not evenly distributed over the warm and cold seasons, on average it gives out 370 mm, out of which one third falls on the cold running time and forms the accumulation of moisture in a meter layer of soil.

**Table 1.** Total water consumption of sunflower hybrids depending on the method of pre-sowing seed treatment, average for 2015-2017

| Indicator                                                                 | sunflower hybrid NK Neoma | Sunflower hybrid LG 5550 | Sunflower hybrid ES Petunia |
|---------------------------------------------------------------------------|----------------------------|--------------------------|----------------------------|
| Productive moisture in a layer of 0.0 ... 1.0 m before sowing, mm         | 148.07                     | 148.07                   | 148.07                     |
| Precipitation for vegetation, mm                                          | 241.67                     | 241.67                   | 241.67                     |
| Moisture available in the soil before harvesting, mm                      | 55.97                      | 44.73                    | 44.03                      |
| Total water consumption, m³/ha                                            | 2892.7                     | 3005.1                   | 3103.9                     |
| Yield, t/ha                                                               | 2.26                       | 2.44                     | 2.53                       |
| Water consumption coefficient, m³/t                                        | 1258.4                     | 1228.9                   | 1226.8                     |

The sunflower is a drought-resistant crop. The core root system of the plant penetrates into the soil on average to a depth of 1.5-1.8 meters, which enables to get moisture from the deep layers of the soil and is not characteristic of other crops. In terms of the efficiency of using water and processing it into a crop, sunflower is the best plant among the broad-leaved ones. However, insufficient amount of moisture leads to a decrease in yield due to an increase in empty grains in the basket, decrease in the fullness of seeds. Therefore, moisture is a limiting factor in the formation of a high crop yield for sunflower in arid conditions of the Volgograd region. Moisture consumption by sunflower in the
research area reaches 4000 t/ha, which, in conditions of a precipitation shortage, creates a need to search and apply technologies to save moisture and reduce water consumption by sunflower while maintaining a high yield.

The duration of the growing season of agricultural crops is influenced by both weather conditions, specifically, the total air temperature, relative humidity and amount of precipitation during the growing season, and the application of agricultural practices being the use of fertilizers and plant growth stimulants.

In the first months of plant growth and development, in May and June, it was not the air temperature that was decisive but the initial moisture reserve in the upper soil layer. However, the temperature regime played a key role during the reproductive period of development in July-August when the root system was already fully formed, which enabled to get moisture from deep soil layers.

Accumulated positive temperature for the growing season in 2015 was 2622.1 °C, in 2016 it slightly exceeded the previous year and was equal to 2756.1 °C, and in 2017 the sum of positive temperatures was the lowest for all the years of research, specifically, 2614.7 °C. At the same time, the obtained sums of positive temperatures exceeded the minimum 1900 °C and equaled to 2300 °C for growing sunflower in the Volgograd region.

In 2015, 2016 and 2017, 232 mm, 288 mm and 205 mm, respectively, precipitated during the period under consideration. Precipitation over the years of research varied significantly. According to the total value, 2016 was the most abundant in precipitation, and 2017 turned out to be dry.

In the experiments, the main components of the total water consumption were the formed reserves of available moisture for the cold periods of the year and precipitation during the growing season. On the control, the total water consumption was the lowest for all studied sunflower genotypes, the minimum average water consumption in the hybrid ES Petunia was 2863.3 m³/ha, the maximum was observed in the hybrid NK Neoma and was equal to 2892.7 m³/ha. When applying the pre-sowing treatment with a growth regulator and the treatment in an electric field, all the studied sunflower genotypes consumed a greater amount of moisture relative to the control. The minimum reserves of productive moisture before harvesting were in the hybrid NK Neoma with pre-sowing treatment in an electric field and it equaled 34.85 mm, the maximum was in the hybrid ES Petunia when applying seed treatment with a growth regulator and totaled 49.98 mm.

During the growing season, sunflower does not evenly consume moisture. Therefore, conservation and rational use of the accumulated moisture in the soil is of particular importance. If there is insufficient moisture supply at a certain stage of the growing season, the yield and quality of seeds may decrease. An important indicator when assessing measures to preserve moisture reserves is the water consumption coefficient, which shows the amount of moisture consumed per 1 ton of seed harvest. The water consumption coefficient in the case without pre-sowing treatment varied from 1258.4 m³/t for the hybrid NK Neoma to 1407.7 m³/t for the hybrid ES Petunia. Moisture was most economically consumed by hybrid LG 5550 when applying seed treatment in an electric field, specifically, it was 1172.2 m³/t. With pre-sowing treatment with a growth regulator, the minimum indicator of the water consumption coefficient for the hybrid NK Neoma was 1228.9 m³/t, the maximum one for the hybrid ES Petunia was 1318.5 m³/t.

The yield changed depending on the method of pre-sowing seed preparation before sowing. On average for three years, the yield of the hybrid NK Neoma on the control was 2.26 t/ha. When using the growth regulator, the yield exceeded the control by 0.18 t/ha. With the electric field it exceeded the control by 0.27 t/ha. The minimum yield was obtained on the control of the hybrid ES Petunia and was equal to 2.03 t/ha, the maximum yield of the hybrid LG 5550 with pre-sowing treatment in an electric field equaled 2.57 t/ha.

4. Conclusion
The three-year field research on the influence of the electrophysical and biological method of pre-sowing treatment of seeds of sunflower hybrids on water consumption and crop yield enables to draw the following conclusions:
- total water consumption of the studied hybrids by sunflower in the option without pre-sowing seed treatment was in the range of 2863.3 - 2892.7 m³/ha, when processing in an electric field the indicator
varied within 3012.1 – 3103.9 m³/ha, in the option with treatment with a growth regulator in the range 2952.6-3026.3 m³/ha.

- the coefficient of total water consumption in the control was the highest for the hybrid ES Petunia and equaled 1407.7 m³/ha, the minimum water consumption for the hybrid LG 5550 in the option with processing in an electric field was 1172.2 m³/ha.

- the maximum yield on the treatment option in the electric field was in the hybrid LG 5550 and equaled 2.57 t/ha, which exceeded the control by 14.78%, the minimum yield increase on the treatment with the growth regulator was obtained in the hybrid ES Petunia equal to 2.23 t/ha, the control was exceeded by 8.97%.

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