The growth and development depending on the pre-sowing sunflower treatment method in the southern chestnut soils zone of the Volgograd region

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Abstract. The work contains the results of research carried out in 2015...2017, the seeds pre-sowing treatment methods influence in the alternating voltage electric field with the intensity of 8 kV/cm with an exposure of 60 seconds, by a Zerebra Agro growth regulator with an aqueous solution of 100 ml/1 liter of water. The decrease in the period from sowing to germination by 1 day, the decrease in the duration of the germination phase - basket formation by 3...5 days in the NK Neoma hybrid, by 1 day in the LG 5550 hybrid, by 2 days in the EU Petunia hybrid was established. The duration of the basket formation phase - flowering in the NK Neoma hybrid increased significantly in the EU Petunia hybrid by 6...7 days, not significantly in the LG 5550 hybrid by 1 day. The flowering-maturation phase lasted 51...56 days for the NK Neoma hybrid, 49...52 days for the LG 5550 hybrid, and 42...46 days for the EU Petunia hybrid. The duration of the germination-maturation phase in the NK Neoma hybrid increased by 2...3 days, in the LG 5550 hybrid by 2...3 days.

1. Introduction
The share of the main three oilseeds cultivated in Russia (sunflower, soybeans, rapeseed) accounts for 95% of the gross oilseed crop, while sunflower accounts for about 80%. Vegetable oil obtained from sunflower seeds is an essential product that is widely used in households for cooking, in confectionery, bakery and other industries.

Over the past 7 years, according to the Federal State Statistics Service there was a steady increase in oil production to 5722 thousand tons in 2013 to 9457 thousand tons in 2020, the internal Russian consumption rose to 5412 thousand tons in 2013 to 6842 thousand tons in 2020, and at the same time, the export of vegetable oil increased more significantly by 85%, which reached 3528 thousand tons in 2020. The rapid growth of production in Russia sunflower oil is linked primarily to the increase in oilseeds gross yield and construction of modern processing plants, using local domestic raw materials. Stable demand for sunflower oil abroad contributes to the increase in purchase prices for sunflower seeds by processing enterprises. In September 2020, the average purchase price for sunflower seeds reached 28,500 rubles, compared with 2019 - the increase of 49%, allowing sunflower cultivation to be classified as highly profitable crops. However, with the increase in purchase prices for sunflower
seeds, the costs associated with sunflower cultivation also increase, ranging from the cost of fuel to plant protection products, fertilizers and the seed seeds themselves, which are overwhelmingly represented by imported hybrids and depend on the currency price. The genetically based sunflower hybrids yield admitted for cultivation in the Volgograd region is 4...4.5 t/ha, in fact, the average yield does not exceed 1.6 t/ha, there are farms with a sunflower yield of 2.5...3.0 t/ha. Therefore, the issue of increasing yields and reducing costs is relevant. The key to a high yield is, first of all, the quality of seeds, which is determined by germination and growth energy, soil fertility and its processing methods, suppression of weeds and protection of plants from pests [1, 2]. To increase germination and growth energy, various methods of stimulating seeds are used, from classical agricultural methods - treatment by growth stimulants [3, 4], to the introduction of innovative electrical technologies that have undeniable advantages in terms of environmental safety of both the resulting crop and the environment. Seed pre-treatment in the alternating voltage electric field of different strength, the electromagnetic field of different intensity, microwave fields, various crops and seeds of conifers showed a significant increase in the germination and growth of energy, increase yield [5, 6]. There are very few studies on the effect of sunflower seeds pre-sowing treatment in the alternating voltage electric field on the sunflower plants growth and development, and they are not always characterized by technological completeness.

The objective of our research was to compare sunflower seeds pre-sowing treatment methods by growth regulator Zerebra Agro electric field and an AC voltage of commercial frequency voltage 8 kV/cm on the plants sunflower growth and development, cultivated in chestnut soils zone of the Volgograd region.

2. Materials and methods

To implement the formulated research goal in the period 2015...2017, a two-factor field experiment was laid in the peasant farm Egorushin A.Yu. Mikhailovsky district of the Volgograd region. By factor A, we studied sunflower hybrids NK Neoma, LG 5550 and EC Petunia, by factor B, the influence of the method of pre-sowing seed treatment was studied.

The treatment of seeds in the alternating voltage electric field was carried out at the optimal mode established in the laboratory conditions: the electric field strength was 8 kV/cm, the processing time was 1 minute [7, 8]. The treatment of seeds by the growth regulator Zerebra Agro, by preparing a working solution according to the manufacturer's recommendations: 100 ml of the preparation + 1 liter of water, per 100 kg of treated seeds.

The soil of the experimental field is thin southern chestnut, alkaline soil reaction on average over three years 7.59. The humus content varied over the years of research from 4.70 to 4.83%, nitrogen content was 100.7 mg/kg, potassium one was 340.5...346.2 mg/kg, phosphorus one was 35.18...40.76 mg/kg [9, 10].

Maximum hygroscopicity in layer 0.00-1.00 was equal to 9.74%, wilting moisture calculated with a coefficient of 1.34-13.05%.

Soil cultivation technology was adopted according to regional recommendations, double disc stubble plowing, moldboard plowing at the depth of 0.28 m. In spring, pre-sowing soil cultivation included cover harrowing, to level the field and cover moisture, cultivation to the depth was of 0.08...0.1 m, pre-sowing cultivation to the depth was of 0.06...0.08 m [11, 12].

Sowing for all years of experiments was carried out in the second decade of May in one day, with a precision seeding machine SPB-8, with a seeding rate of 60000 germinating seeds per hectare [13].

3. Results and discussion

Condition obtaining high productivity sunflower is compliance culture cultivation technology conditioning properties seeds, genetic resistance to diseases, fertility of the soil, and determined the content of humus in the soil micronutrients necessary for the development and favorable weather conditions for all phases of plant development. To aid in growth and development, plant growth regulators are used, which accelerate the processes occurring in the embryo when it enters moist soil at a soil temperature favorable for germination. Electrophysical influences also accelerate the development
of the seeds, stimulate the consumption of more water for swelling from the soil. It is customary to define the development of plants by the main phases: sowing-seedlings; seedlings-basket formation; basket formation-flowering; flowering-ripening. Depending on the prevailing weather conditions, methods of external influence, the interphase periods can either decrease or increase in duration. In years with little rainfall, the interfacial periods are reduced, the harvest ripens faster. With enough moisture, some periods are lengthened allowing for a larger crop.

The provision of the soil with reserves of productive moisture, over the years of research, did not differ significantly in 2015 and 2016, and amounted to 150.4 and 158.6 mm, respectively, in 2017 the reserves were much less - 135.2 mm. At the initial stages of development after sowing, the productive moisture in a 10 cm soil layer, soil temperature, the amount of precipitation during the sowing-germination period are of importance. Productive moisture reserves in a ten-centimeter layer by year did not differ significantly, from 10.3 mm in 2017 to 12.3 mm in 2016. A more significant difference was observed both in the average temperature of 23.1...24.2 °C in 2016 and 2015 and significantly lower in 2017 - 18.1 °C, and in the sum of positive temperatures for the sowing-emergence period. Lack of rainfall in 2017, in the sowing period - the shoots, the lower temperature is a factor, in which for the entire study period is set as the minimum germination control, and at the option of processing carried out seedbed (Table 1).

### Table 1. Hydrothermal conditions during the sowing period by years of research.

| Index                                           | 2015     | 2016     | 2017     |
|------------------------------------------------|----------|----------|----------|
| Culture sowing date                             | May, 15  | May, 20  | May, 12  |
| Productive moisture in layer 0.0...0.1 m before sowing, mm | 11.7     | 12.3     | 10.3     |
| Productive moisture in layer 0.0...1.0 m before sowing, mm | 150.4    | 158.6    | 135.2    |
| The sum of positive temperatures, °C            | 150.4    | 158.6    | 135.2    |
| Average air temperature, °C                     | 24.2     | 23.1     | 18.1     |
| Precipitation during the sowing-emergence period, mm | 9.7      | 12.2     | 0        |

Observations showed that the influence of the studied agricultural practices on the seeds pre-sowing treatment is manifested already in the period of emergence. On the control without seed treatment, the sowing - germination phase of the NK Neoma hybrid for all years of research was 12 days, on the variant of seed treatment in the electric field, the duration was reduced to 11 days, on the variant of treatment by the growth regulator Zerebra Agro, the duration of the phase in 2015 and 2016 reduced to 11 days, in 2017 being less favorable in terms of weather conditions, no decrease in the period duration was observed relative to the control one. The longest period of the sowing phase - shoots was observed in the hybrid LG 5550 - 13 days, on the variants of treatment in the electric field and by the growth regulator Zerebra Agro was reduced to 12 days, on the control of the hybrid EU Petunia the duration of shoots was 12-13 days by years of research, the growth regulator Zerebra Agro influence in 2015, 2016 was not established, in 2017, seedlings appeared on the 12th day, with control one - 13 days. Seeds, treated in the electric field, emerged 1 day earlier than control (Table 2).

The germination density on average over the years of observation on the control was the highest in the NK Neoma hybrid - 82.03%, in the LG 5550 hybrid - 80.53%, in the EU Petunia hybrid the lowest indicator of the studied hybrids - 80.00%. On the variant of seed treatment by the growth regulator Zerebra Agro, field germination increased in all hybrids by 3.13...3.77%, the most responsive was the NK Neoma hybrid, the field germination increased to 85.80%, the EU Petunia hybrid was less responsive - 83.13%.
Table 2. Sunflower seeds pre-sowing treatment methods influence on the sowing-germination period duration.

| Option                      | The period duration, days | NK Neoma | LG 5550 | EU Petunia |
|-----------------------------|---------------------------|----------|---------|------------|
| Control without processing  |                           | 12       | 13      | 12         |
| Zerebra Agro                |                           | 11       | 12      | 12         |
| Electric field              |                           | 11       | 12      | 11         |
| 2015 year                   |                           |          |         |            |
| Control without processing  |                           | 12       | 13      | 12         |
| Zerebra Agro                |                           | 11       | 12      | 12         |
| Electric field              |                           | 11       | 12      | 11         |
| 2016 year                   |                           |          |         |            |
| Control without processing  |                           | 12       | 13      | 13         |
| Zerebra Agro                |                           | 12       | 13      | 12         |
| Electric field              |                           | 11       | 12      | 11         |
| 2017 year                   |                           |          |         |            |
| Control without processing  |                           | 12       | 13      | 13         |
| Zerebra Agro                |                           | 12       | 13      | 12         |
| Electric field              |                           | 11       | 12      | 11         |

When treating seeds in the electric field, field germination increased in the NK Neoma hybrid by 6.07%, in the LG 5550 hybrid by 5.07%, in the EU Petunia hybrid by 5.47%, and amounted to 88.10, 85.60 and 85.47%, respectively (Table 3).

Table 3. Field germination depending on the investigated methods pre-sowing treatment.

| Option                      | Average for 3 years (2015...2017) | Sunflower hybrid NK Neoma | Sunflower hybrid LG 5550 | Hybrid sunflower EU Petunia |
|-----------------------------|----------------------------------|---------------------------|--------------------------|-----------------------------|
|                            | field germination, % | deviation from control, % | field germination, pcs/ha | deviation from control, pcs/ha |
| Control without processing  | 82.03                             | -                          | 49218                    | -                           |
| Zerebra Agro                | 85.80                             | +3.77                      | 51480                    | +2262                       |
| Electric field              | 88.10                             | +6.07                      | 52860                    | +3642                       |
| Control without processing  | 80.53                             | -                          | 48318                    | -                           |
| Zerebra Agro                | 84.20                             | +3.67                      | 50520                    | +2202                       |
| Electric field              | 85.60                             | +5.07                      | 51360                    | +3042                       |
| Control without processing  | 80.00                             | -                          | 48000                    | -                           |
| Zerebra Agro                | 83.13                             | +3.13                      | 49878                    | +1878                       |
| Electric field              | 85.47                             | +5.47                      | 51282                    | +3282                       |

Three-year field experiments established the influence of pre-sowing seed treatment on the development of sunflower hybrids, which consists in changing the duration of interphase periods both upward and downward. On the variant of seed treatment by the growth regulator, the duration of the germination phase - the formation of a basket was reduced by 3 days in the NK Neoma hybrid, by 1 day in the LG 5550 hybrid and 2 days in the EC Petunia hybrid; in the control, the longest phase was observed in the NK Neoma hybrid, short in the hybrid LH 5550 - 30 days. On the variant of seed treatment in the electric field, no change was found in the phase duration in the LG 5550 hybrid, in the
NK Neoma hybrid, the phase period was 33 days, and in the EU Petunia hybrid - 32 days. The duration of the basket formation phase - flowering was minimal on the control one in the NK Neoma hybrid - 23 days, with the seed treatment options the duration increased by 2-3 days, a slight effect of the change in duration was observed in the LK 5550 hybrid - a deviation from the control one towards the increase of 1 day, a prolonged phase of the formation of a basket - flowering was established in the hybrid EC Petunia on the variant of processing in the electric field - 40 days.

The flowering - maturation phase in the control of the NK Neoma hybrid was 51 days in duration, the LG 5550 hybrid - 49 days, and the EU Petunia hybrid - 42 days. On the variant of treatment by the growth regulator Zerebra Agro, the increase in the duration of the interfacial period was established by 3 days in the hybrid NK Neoma and LH 5550, by 2 days in the hybrid EC Petunia. On the variant of treatment in the electric field, the period was not significantly lengthened by 1 day in the LG 5550 hybrid, more significantly by 5 days in the NK Neoma hybrid, and in the EU Petunia hybrid by 4 days (Table 4).

**Table 4.** Duration of sunflower hybrids interphase periods depending on the pre-sowing treatment studied factors, days (average for 2015...2017).

| Option pre-sowing treatment | Sowing-seedlings | Shoots-basket formation | Flower basket formation | Flowering - ripening | Seedlings-maturation |
|-----------------------------|------------------|-------------------------|------------------------|----------------------|----------------------|
| Sunflower hybrid NK Neoma   |                  |                         |                        |                      |                      |
| Control without processing  | 12               | 38                      | 23                     | 51                   | 112                  |
| Zerebra Agro                | 11               | 35                      | 26                     | 54                   | 115                  |
| Electric field              | 11               | 33                      | 25                     | 56                   | 114                  |
| Sunflower hybrid LG 5550    |                  |                         |                        |                      |                      |
| Control without processing  | 13               | 30                      | 26                     | 49                   | 105                  |
| Zerebra Agro                | 12               | 29                      | 27                     | 52                   | 108                  |
| Electric field              | 12               | 30                      | 27                     | 50                   | 107                  |
| Hybrid sunflower EU Petunia |                  |                         |                        |                      |                      |
| Control without processing  | 12               | 34                      | 34                     | 42                   | 110                  |
| Zerebra Agro                | 12               | 32                      | 41                     | 44                   | 117                  |
| Electric field              | 11               | 32                      | 40                     | 46                   | 118                  |

The duration of the growing season was influenced by both weather conditions (air temperature, humidity and the amount of precipitation) and the pre-sowing seed treatment studied methods. In all hybrids, the duration of the growing season increased relative to the control on all variants of pre-sowing treatment. The germination-maturation phase duration in the NK Neoma hybrid increased by 2...3 days, in the LG 5550 hybrid by 2...3 days, more significantly the increase in the duration of the growing season in the EU Petunia hybrid by 7...8 days to 118 days was established, with control one of 110 days.

4. Conclusion

Depending on the method of pre-sowing treatment, a slight increase in the growing season duration the was found by 2...3 days in hybrids NK Neoma and LG 5550, more significant by 7...8 days in hybrid EC Petunia. The influence of pre-sowing treatment options on the interfacial periods passage was established, the period of seedlings - the formation of a basket was shortened by 1...5 days, the duration of the basket-flowering formation phase by 3...6 days, flowering-maturation - 2...5 days increased. The duration of the growing season was of great practical importance for production, the longer the growing season, the higher the yield of sunflower.
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