Comparison of the effect of various drugs on the survival rate of hop cuttings

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Abstract. In the territory of modern Russia over the previous 40 years, the production of hops has decreased tenfold. Since hop raw materials are in demand in the world community and in Russia, the government is taking measures to support the revival of hop production as an increase in agricultural production. In this regard, albeit extremely slowly, but, the interest of individual agricultural enterprises in hop seedlings begins to increase. There is a shortage of planting material. In the production of seedlings, one of the main problems is the survival rate of hop cuttings (on average over the years - 50-55%). Among other reasons, the incidence of rooted hop cuttings is of great importance. To increase the yield of standard hop seedlings, various preparations are being tested at the Chuvash Research Institute of Agriculture, which reduce the damage to cuttings by external factors and increase the percentage of their survival. The article presents data on tests of biological fungicides and growth stimulators, not previously studied on hops, for 2 years of research.

1. Introduction
In the world community at the moment there is a high demand for hop raw materials. If 40 years ago in modern Russia there were almost 7000 hectares of hoppers and hop cones were exported, today the whole country accounts for less than 500 hectares, so the domestic needs for hop raw materials are not satisfied [1]. The country is not able to meet the domestic needs of the brewers, not to mention export. To revive the hop-growing industry, the government is taking measures to support and subsidize this industry. This led to the fact that at a slow pace, individual agricultural organizations began to increase the area under hoppers. And this, in turn, led to an increase in the need for hop seedlings.

The peculiarity of hops is that, for household needs, its reproduction occurs exclusively vegetatively. As the main planting material, stem cuttings and annual seedlings are used. The main method of production of hop seedlings is their cultivation from cuttings, shoots in specially designated areas - nurseries [2]. Nursery farming is one of the most labor-intensive agricultural sectors. The criterion of its effectiveness is to obtain the output of high-quality planting material per unit area at the lowest cost. High-quality planting material is one of the factors that increase the efficiency of hop production in market conditions. A significant role here is played by the environmental sustainability of the rooted hop variety [3]. Many years of experience show that, on average, about 50 - 55% of cuttings take root over the years. In some years, up to 65%. The main problems that result in such a low percentage of survival are the soil and climatic conditions, the phytosanitary condition of the soil, the moisture content and structure of the soil, etc. One of the significant factors is damage to cuttings by pathogenic
microflora. Studies show that cultures stimulated by green cuttings can be actively influenced by various growth stimulants and drugs that reduce the incidence of rooted cuttings [4]. To solve the problem of the survival rate of rooted hop material, studies were carried out at the Chuvash Research Institute of Agriculture on the effect of various preparations on the survival rate of hop cuttings.

2. Materials and methods
The objective of the research is to choose the most effective drugs that have a positive effect on the survival rate, growth and development of hop seedlings.

To solve the problem of obtaining complete, standard seedlings, biological preparations Trichocin, Vitaplan and the growth regulator Melafen were used.

Vitaplan is a biological fungicide based on the beneficial microflora of Bacillus subtilis. for pre-sowing treatment of potato tubers, seeds of cereal and other crops, as well as spraying during the growing season of cereals, row crops, industrial, vegetable and fruit crops against pathogens of fungal and bacterial diseases.

Trichocin, SP - a biological fungicide based on the soil fungus Trichoderma harzianum when applied to the soil, as well as when spraying during the growing season, it effectively suppresses pathogens of fungal diseases (root rot, spotting) of cereal crops, vegetables, fruits, and flower crops.

Melafen is a plant growth regulator with a wide spectrum of action in small and ultra-small doses, which increases the growth and shaping processes, increases yield, improves the quality of root crops. Active ingredient: Melamine salt of bis (oxymethyl) phosphinic acid.

The experiment was based on the hop-growing site of the Chuvash Research Institute of Agriculture, which contains the only collection of common hop (Humulus lupulus L.) in Russia [5]. Experience in studying the effectiveness of drugs in the nursery for growing seedlings included options:

1. Control (St. without processing);
2. Soaking in water;
3. Melafen – 100 ml / 10 l water;
4. Vitaplan – 20 g / 10 l of water;
5. Trichocin – 20 g / 10 l of water.

Experience is laid in 5 options. The repetition in the experiment is threefold. Cuttings were planted manually according to the scheme 0.2 x 0.15 m. On each option, 60 cuttings were planted. The allocation of plots is systematic. The area of one plot of 1.8m². Only 15 plots.

During the growing season, plant care (weeding, cultivation) and phenological observations were carried out [6]. The dates of emergence of shoots were noted. Observation of seedlings of cuttings was carried out every 5 days. Root plants were counted, the survival rate of cuttings was determined. In addition to taking into account the survival of cuttings, the growth and development indicators of plants were taken into account, which consisted in calculating the main roots and buds according to OST 10-04-07-86. Also studied the effect of drugs on the development of the root system of hop seedlings. The development of the root system was determined by the gravimetric method, its quality was evaluated according to OST. Ten seedlings were subjected to biometric analysis in all variants in triplicate. Mathematical data processing was performed by analysis of variance.

The place for the bookmarking of the experiment is the nursery of reproduction of seedlings of the Chuvash Research Institute of Agriculture. To study the effect of drugs on increasing the yield of high-quality planting material, standard stalk cuttings of the Podvyazny variety were used, which were harvested during spring pruning. On the hop culture, these drugs were tested for two years.

Studies were conducted on gray forest soil. The mechanical composition of the soil is heavy - loamy. Depth of arable layer 22 cm. It has a slightly acid reaction of the soil solution (pH salt – 5.3).

The experience was laid down in 2018, held on April 30, and in 2019, on May 2. Before planting, the cuttings were soaked in aqueous solutions of drugs (Melafen, Vitaplan and Trichocin) for 3 hours. For comparison, the option of soaking cuttings in water for the same period of time was introduced. The control was the non-soaking option (St.). When preparing the site and growing seedlings, all agricultural
techniques used in the cultivation of seedlings in nurseries were followed. Ten seedlings were subjected to biometric analysis in all variants of the first and third repetition.

Weather conditions for the studied periods were very diverse. In 2018, the growing season, although it was very hot, was at the same time accompanied by increased rainfall, which allowed plants to grow intensively and water was not a limiting factor. In 2019, the start of the season was accompanied by high temperatures and low rainfall. This contributed to the rapid drying of the soil and could adversely affect the initial stage of plant development. In the middle of the season, the picture has changed significantly. An increased amount of precipitation often led to flooding of the root system, although the temperature was higher than the annual average. At the end of the season, the temperature regime dropped below normal. As a result, during the season, the temperature regime reached the average annual indices, but individual critical periods were unfavorable for the plant. This led to a slight decrease in individual survival rates of tender hop cuttings for most of the studied preparations, compared with the previous year, which can be seen in the following tables.

3. Results
As a result of studies conducted in 2018-2019, it was found that soaking the cuttings before planting in drug solutions and in water significantly improved the biometric parameters of hop seedlings. In the treated plants, seedlings appeared 2-3 days earlier. In the control case, there were no seedlings at the time of determination. Based on this, we can conclude that the pre-planting treatment of hop cuttings both in preparations and soaking in water during the same time gives positive results.

The effectiveness of the preparations is characterized by the responsiveness of the cuttings to their processing, which is expressed in an increase in the established cuttings and the yield of full-fledged seedlings. According to the results of two years of research, it is evident that the tested preparations had a positive effect on the survival rate of hop cuttings (table 1).

Table 1. The effect of drugs on the survival of hop cuttings for 2018-2019.

| Options                | Survival, % | Deviation from control, % |
|------------------------|-------------|---------------------------|
|                        | 2018       | 2019 | average | 2018 | 2019 | average |
| Control (without processing) | 71.6 | 65.0 | 68.3 | 100 | 100 | 100.0 |
| Water                  | 78.3 | 73.3 | 75.8 | 9.4 | 12.8 | 11.1 |
| Melafen                | 80.0 | 78.3 | 79.2 | 11.7 | 20.5 | 16.1 |
| Vitaplan               | 83.3 | 80.0 | 81.6 | 16.3 | 23.1 | 19.7 |
| Trichocin              | 90.0 | 91.0 | 90.5 | 25.7 | 40.0 | 32.8 |

* NSR05* - The smallest significant difference is a value indicating the boundary of possible random deviations in the experiment; this is the minimum difference in yields between medium crops, which in this experiment is considered significant at a 5% (NSR05) significance level [7].

As studies over 2 years show, even a simple soaking of rooted cuttings in water for 3 hours gives a positive result, increasing the rooting percentage on average from 11% when soaked in water to 32.8% in the variant with the biological fungicide Trichocin. Other drugs also show a positive result for two years. As you can see, all the options, except for soaking in water in 2018, give a reliable result and exceed the error of experience in NSR05. In this case, it can be judged that each of the listed preparations has a positive effect on the increase in the survival rate of hop cuttings and the final yield of seedlings.

Other important indicators of the development and survival of seedlings are the development of the root system (table 2). An increase in kidney formation was most actively affected by simple soaking of
the cuttings in water. Of the drugs, Vitaplan had the greatest effect. In all cases, an increase in the number of kidneys was obtained in comparison with the control.

Melafen showed itself as the best root-forming agent over an average of 2 years, significantly exceeding NSR$_{05}$. The same drug showed a significant increase in the weight of seedlings in comparison with the control, exceeding the experimental error. Other drugs also gave a positive result, but within the limits of experimental error. It is noteworthy that with a minimum of water costs, soaking seedlings in it also has a positive effect on increasing the studied biometric indicators.

### Table 2. Influence of drugs on quality indicators of seedlings over the years.

| Option                | The number of plant buds, pcs | Number of roots, pcs | Seedling weight, gr |
|-----------------------|-------------------------------|----------------------|---------------------|
|                       | 2018  | 2019  | average | 2018  | 2019  | average | 2018  | 2019  | average |
| Control (without processing) |     |       |         |       |       |         |       |       |         |
| Water                 | 30.4  | 26.5  | 28.3    | 4.7   | 4.0   | 4.4     | 77.2  | 48.5  | 62.8    |
| Melafen               | 27.1  | 24.1  | 25.6    | 6.0   | 4.5   | 5.3     | 98.3  | 51.7  | 75.0    |
| Vitaplan              | 29.0  | 24.9  | 27.0    | 4.6   | 3.5   | 4.1     | 83.9  | 41.3  | 63.0    |
| Trichocin             | 25.3  | 25.7  | 25.5    | 6.0   | 3.8   | 4.9     | 90.0  | 51.0  | 70.5    |
| NSR$_{05}$            | 0.27  |       |         | 0.4   |       |         |       |       | 15.5    |

### 4. Conclusions

Summing up, we can definitely say that the effect on the seedlings by both the studied drugs and water had a positive result. The number of surviving seedlings increases, by at least 11% on average for 2 years when exposed to cuttings with water, and up to 32.8% when using Trichocin biofungicide. The weight of rooted seedlings also increases with any of the listed effects on the cuttings. Melafen growth regulator had the best effect on the increase in the number of roots. According to research, it is possible to recommend production of biological fungicide Trichocin, based on the soil fungus Trichoderma harzianum, to increase the yield of seedlings per unit area.

### References

[1] Ivanova A O and Dementiev D A 2019 The state of hop production in the Chuvash Republic *International Scientific Agricultural Journal* 2 20-5

[2] Promising resource-saving technology for the production of hops: *Methodological recommendations* 2008 (Moscow: FGNU Rosinformagroteh)

[3] Osipova Yu S, Ivanova I Yu and Leontieva V V 2020 Assessment of the environmental sustainability of common hop varieties. *Siberian Bulletin of Agricultural Science* vol 50 1 32-9

[4] Polikarpova F Ya 1990 Propagation of fruit and berry crops by green cuttings. (Moscow: Agropromizdat)

[5] Fadeev A A and Nikonova Z A 2015 The results of the study of hop varieties of different ripeness groups according to economically important signs and resistance to major diseases *Agricultural Science of the Euro-North-East* 5 (48) 29-33

[6] Moiseichenko V F et al. 1996 *Fundamentals of scientific research in agronomy* (Moscow: Kolos)

[7] Trifonova M F, Zaveryukha A X and Yeshenko V E 1996 *Fundamentals of scientific research in agronomy* (Moscow: Kolos)