The influence of growth stimulators on the rooting of green cuttings of the Cypress family in the conditions of the city of Omsk

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Abstract. Coniferous species of the Cypress family are widely distributed in the landscaping of Europe and the United States. Every year their popularity grows in our country as well. Obtaining the planting material grown and adapted to the conditions of the city of Omsk is currently relevant. The study is devoted to the study of the effect of growth stimulators on the rooting of green cuttings of representatives of the Cypress family, the growth, development and preservation of cuttings. It was found that the rooting of green cuttings of the studied thuja species has a significant positive effect on all the studied drugs: heteroauxin, kornevin, ribav-extra, zircon. Green cuttings of the studied junipers were better rooted under the influence of heteroauxin, kornevin and ribav-extra. Thickening of the root neck in thuja and juniper trees was observed under the influence of kornevin. Ribav-extra contributed to the increase in growth. Ribav-extra and heteroauxin had a significant positive effect on the overwintering of annual and biennial cuttings.

1. Introduction

Active improvement of city parks, squares and other recreational facilities is an ongoing process. Green spaces in the city improve the microclimate of the urban environment, create good conditions for outdoor recreation, and protect the soil, building walls, and sidewalks from excessive overheating [1, 2]. The issues of the correct selection of the assortment of tree and shrub species, in particular the species used in ornamental gardening, and the placement of these plantings on the territory remain relevant to the present time [3].

Recently, representatives of the Cypress family, whose reproduction is of great practical importance, have become interesting for landscaping the city of Omsk. Royal plants of this family grow in the arboretum parks of the city [4]. Cypress (Cupressaceae Neger) is the largest in the number of genera and the third in the number of species of the coniferous family. One of the values of these plants is the huge amount of essential oils that evaporate from the leaves, which purify the air from microbes. Cypress is evergreen long-lived (90 - 800 years) shrubs and trees, which are a valuable material for park construction. Since the flora of the Omsk region is not rich in species diversity of coniferous species, and the advantages of these plants are well-known: durability, the color of needles...
that persists in winter and summer, high decorative qualities, and health-improving properties, research on the technology of growing introduced species in the conditions of the southern forest-steppe of the Omsk region has undeniable practical significance \[5, 6\].

In the course of evolution, the ability to root has been formed in many plants. In this case, the conditions of their growth have a great influence. It has long been established that increased humidity facilitates the root formation of many plants. In herbaceous plants, root formation is more pronounced than in shrubs, and the latter, as a rule, take root more easily than tree forms \[7\]. Adventitious roots are formed by the stem of the green stalk endogenously, most often in the area of the cambium of the core ray. Under the influence of auxin growth regulators, the direction of the work of the cambium changes, leading to the formation of adventitious roots in the cambial zone of the meristem. With the further development of the meristem, the apex of the root is formed with a well-developed root cover. The growing root is mechanically pushed through the stem tissues and the roots on the stalk most often begin to appear from the leaf side, in close proximity to the axillary bud \[8\].

Based on a number of studies, it was found that a complex of acids, derivatives of indole, naphthol, phenol, esters and a number of salts of these acids are effective root formation stimulators. They are most widely used in the production of heteroauxin or indolylacetic acid (IAC), \(\beta\)-indolylbutyric acid (BCI) and \(\alpha\)-naphthylacetic acid (ANU). It is well known that the stimulating effect of growth regulators on the process of root formation in cuttings is manifested only under favorable environmental conditions. In production conditions, weakly concentrated aqueous solutions of growth regulators are most often used for processing cuttings, less often concentrated alcohol solutions and growth powder.

In our experience, we studied the effect of various growth stimulators on the rooting of green cuttings in the conditions of the city of Omsk. The plant growth regulator “ribav-extra” contains a natural complex of biologically active substances produced by mycorrhizal fungi isolated from ginseng root: L-glutamic acid (0.00196 g/l), L-alanine (0.00152 g/l). In the composition of heteroauxin, the active substance \(\beta\)-indolylacetic acid, a chemical of high physiological activity affects growth processes. Zircon contains a mixture of hydroxycinnamic acids (chlorogenic, chicory and kaftaric). Kornevin is a biostimulating drug for plants, which includes indolylbutyric acid (5 g/kg), which, getting on the plant, irritates its integumentary tissues, stimulating the appearance of callus and roots.

2. **Materials and methods of research**

The experiments were conducted in 2018-2020 in the training laboratory "Arboretum" of the training-experimental farm: propagation by green cuttings - in a film greenhouse. In the experiment, we studied the effect of growth regulators on the regenerative ability of green cuttings of representatives of the Cypress family.

For laying the experiment, we used stem cuttings of 10-15 cm representatives of the Cypress family (thuja occidentalis, thuja occidentalis forma sphaerica, juniperus sabina, juniperus communis). Before planting, the green cuttings were treated with growth regulators by immersing the cuttings: for 8 hours in a 1% solution of kornevin, for 14 hours - in a 1% solution of heteroauxin, for 16 hours - in a 1% solution of ribav-extra, for 12 hours - in a 1% solution of zircon. Cuttings without treatment with growth stimulators were used as a control. The scheme of planting green cuttings is 7x4 cm or 357 pieces per 1 m\(^2\), the feeding area of 1 cuttings is 0.0028 m\(^2\). The substrate is a mixture of sand and peat 1:1 by volume.

All experiments were carried out in three-fold repetition, in each repetition of 25 cuttings. After 5 days after planting, by carefully pulling out the cuttings, systematic monitoring of the development of the callus and the formation of roots was carried out. The processing of the research results was carried out using analysis of variance. The research was carried out using the equipment of the center for collective use of Omsk State Agrarian University "Additive Technologies and Materials Processing".
3. Results and Discussion

Studies have shown that different forms of the same species can be propagated by cuttings with more or less success (fig. 1, 2). In the control variant of western thuja, planted without treatment with growth stimulants, the rooting rate was: in 2018 - 78.2%, in 2019 - 79.2%, in 2020 - 80.8%, and in the control variant of thuja western of the spherical form: in 2018 - 73.3%, in 2019 - 74.2%, and in 2020 - 76.8%. In general, the highest rooting of green cuttings of *Thuja occidentalis* was in experiments with treatment with heteroauxin, zircon, ribav-extra, and in *Thuja occidentalis* form spherical in variants using heteroauxin and ribav-extra. The smallest significant difference at a significance level of 95% (LSD$_{0.05}$) confirms the correctness of judgments.

![Figure 1. The rooting of green cuttings of *Thuja occidentalis*, LSD$_{0.05}$ = 1.09](image1)

![Figure 2. The rooting of green cuttings of *Thuja occidentalis* of spherical shape, LSD$_{0.05}$ = 1.12](image2)

Studies have shown that when rooting green cuttings of Cossack juniper in the experiment with the use of zircon, the percentage of rooting was lower than the control (fig. 3). Treatment of green cuttings of *Juniperus sabina* with heteroauxin, ribav-extra, and kornevin positively affected rooting. In the control variant of the *Juniperus communis*, planted without treatment with growth stimulants, the rooting rate was 79.9% in 2018, 80.6% - in 2019, and 80.1% - in 2020 (fig. 4). Whereas in the variants with heteroauxin, kornevin, ribav-extra, the rooting of green cuttings of junipers was more successful. At the same time, the percentages of rooting with the use of zircon were lower than the control.

![Figure 3. The rooting of green cuttings of *Juniperus sabina*, LSD$_{0.05}$ = 1.08](image3)

![Figure 4. The rooting of green cuttings of *Juniperus communis*, LSD$_{0.05}$ = 1.16](image4)

Thus, in the vegetative propagation of representatives of the genus *Thuja*, growth stimulators
heteroauxin, kornevin, zircon, ribav-extra increased the rooting of cuttings, and in the propagation of junipers, an increase in the percentage of rooting was observed when using heteroauxin, kornevin, ribav-extra.

Based on the data in table 1, an increased increase in relation to the control was observed when treated with growth stimulants ribav-extra and zircon. The growth of rooted cuttings in the treatment variant with kornevin was at the control level. While the growth of green cuttings of *Thuja occidentalis* treated with the stimulant heteroauxin was lower than the control. When rooting green cuttings of *Thuja occidentalis* in comparison with the control, the root formation stimulator kornevin contributed to the formation of a larger diameter of the root neck. Whereas the diameter of the root neck in green cuttings treated with ribav-extra, heteroauxin, zircon was smaller compared to the control.

| Biometric indicators | Year | Control | Ribav-extra | Heteroauxin | Kornevin | Zircon |
|----------------------|------|---------|-------------|-------------|----------|--------|
| Growth, cm           |      |         |             |             |          |        |
| 2018                 | 5.8  | 5.78    | 5.2         | 5.0         | 6.4      |
| 2019                 | 5.0  | 5.36    | 4.78        | 4.86        | 5.09     |
| 2020                 | 6.92 | 7.02    | 6.66        | 6.93        | 8.68     |
| LSD_{0.05}           |      |         |             |             | 0.12     |
| Diameter of the root neck, mm |      |         |             |             |          |
| 2018                 | 0.27 | 0.26    | 0.21        | 0.3         | 0.24     |
| 2019                 | 0.28 | 0.28    | 0.23        | 0.31        | 0.26     |
| 2020                 | 0.25 | 0.22    | 0.2         | 0.28        | 0.24     |
| LSD_{0.05}           |      |         |             |             | 0.01     |

Thus, when propagated by green cuttings of *Thuja occidentalis*, kornevin contributed to the production of stronger cuttings of seedlings.

| Biometric indicators | Year | Control | Ribav-extra | Heteroauxin | Kornevin | Zircon |
|----------------------|------|---------|-------------|-------------|----------|--------|
| Growth, cm           |      |         |             |             |          |        |
| 2018                 | 4.2  | 5.2     | 4.8         | 4.0         | 4.2      |
| 2019                 | 4.6  | 5.3     | 5.1         | 4.1         | 4.4      |
| 2020                 | 5.3  | 6.4     | 5.8         | 4.3         | 4.8      |
| LSD_{0.05}           |      |         |             |             | 0.13     |
| Diameter of the root neck, mm |      |         |             |             |          |
| 2018                 | 0.23 | 0.22    | 0.3         | 0.33        | 0.21     |
| 2019                 | 0.24 | 0.25    | 0.32        | 0.3         | 0.23     |
| 2020                 | 0.27 | 0.23    | 0.3         | 0.29        | 0.24     |
| LSD_{0.05}           |      |         |             |             | 0.01     |

Based on the data in Table 2, an increase in comparison with the control was observed when treated with growth stimulants ribav-extra and heteroauxin. Whereas green cuttings of the *Thuja occidentalis* form are spherical, treated with the stimulants zircon and kornevin, had an increase below the control. The root formation stimulators heteroauxin and kornevin contributed to the formation of a large diameter of the root neck in cuttings the *Thuja occidentalis* form spherical in comparison with the control. Whereas green cuttings treated with ribav-extra and zircon, in comparison with the control, had a smaller diameter of the root neck.

In green cuttings of *Juniperus sabina* in the variant with ribav-extra and kornevin treatment, the growth and diameter of the root neck were higher in comparison with the control (table 3).
Table 3. Biometric indicators of rooted green cuttings of *Juniperus sabina*

| Biometric indicators | Year | Control | Ribav-extra | Hetero-auxin | Kornevin | Zircon |
|----------------------|------|---------|-------------|--------------|----------|--------|
| Growth, cm           | 2018 | 11.2    | 13.8        | 12.0         | 13.4     | 10.0   |
|                      | 2019 | 13.8    | 14.6        | 12.1         | 14.1     | 11.2   |
|                      | 2020 | 12.7    | 15.6        | 11.8         | 14.0     | 11.2   |
| LSD<sub>0.05</sub>   |      | 0.15    |             |              |          |        |
| Diameter of the root | 2018 | 0.3     | 0.32        | 0.25         | 0.36     | 0.27   |
| neck, mm             | 2019 | 0.31    | 0.31        | 0.29         | 0.35     | 0.3    |
|                      | 2020 | 0.32    | 0.35        | 0.28         | 0.36     | 0.29   |
| LSD<sub>0.05</sub>   |      | 0.01    |             |              |          |        |

The growth of green cuttings in *Juniperus communis* when treated with growth stimulators exceeded the control variant in all experimental variants, except for the experiment with the use of heteroauxin (table 4). The diameter of the root neck in green cuttings was higher than the control only in the version with kornevin.

The preparations heteroauxin, ribav-extra, and zircon had a significant stimulating effect on root growth in *Thuja occidentalis* (table 5). In comparison with the control, the number of roots in the *Thuja occidentalis* increased by 29.7-162.5%, and in the *Thuja occidentalis* of the spherical form increased by 60.5-147%. At the same time, the length of the roots increased from 3 to 32.4% *Thuja occidentalis*, and from 4.8 to 34.2% in *Thuja occidentalis* of the spherical form. The study of the effect of kornevin on the growth of the root system of green cuttings showed that the stimulator inhibited the process of root formation. The root-forming ability of cuttings of different forms of *Thuja* treated with this stimulant is significantly lower than in the control. The growth regulators heteroauxin, ribav-extra, and zircon consistently exceeded the control variant in the number of roots, but had a lower value in the length of the roots.

In the studied junipers, the number of roots and the length of the roots exceeded the control variant under the influence of all the tested growth regulators (table 6). In all experimental variants, the number of roots and the length of the root system were higher than the control at a significance level of 95%.
| Experience variant | Year | Number of roots | Root length |
|--------------------|------|-----------------|-------------|
|                    |      | pc. | % to control | cm | % to control |
| control            | 2018 | 3.5 | 100 | 9.51 | 100 |
|                    | 2019 | 3.7 | 100 | 9.24 | 100 |
|                    | 2020 | 3.2 | 100 | 9.73 | 100 |
| heteroauxin        | 2018 | 7.6 | 217.1 | 12.03 | 126.6 |
|                    | 2019 | 7.8 | 210.8 | 12.24 | 132.4 |
|                    | 2020 | 6.8 | 212.5 | 11.87 | 121.9 |
| kornevin           | 2018 | 3.3 | 94.3 | 8.5 | 89.4 |
|                    | 2019 | 3.5 | 94.6 | 8.8 | 95.2 |
|                    | 2020 | 3.8 | 118.8 | 8.9 | 86.9 |
| zircon             | 2018 | 4.75 | 135.7 | 8.46 | 103 |
|                    | 2019 | 4.8 | 129.7 | 10.2 | 110.3 |
|                    | 2020 | 4.7 | 146.9 | 11.93 | 122.6 |
| ribav-extra        | 2018 | 8.6 | 250.6 | 11.0 | 115.7 |
|                    | 2019 | 8.9 | 245.4 | 12.2 | 132 |
|                    | 2020 | 8.4 | 262.5 | 11.4 | 122.3 |
| LSD<sub>05</sub>   |      | 0.32 | - | 0.64 | - |

**Thuja occidentalis**

| Experience variant | Year | Number of roots | Root length |
|--------------------|------|-----------------|-------------|
|                    |      | pc. | % to control | cm | % to control |
| control            | 2018 | 3.4 | 100 | 4.62 | 100 |
|                    | 2019 | 4.3 | 100 | 5.16 | 100 |
|                    | 2020 | 3.6 | 100 | 6.1 | 100 |
| heteroauxin        | 2018 | 8.4 | 247 | 6.2 | 134.2 |
|                    | 2019 | 8.52 | 198.1 | 6.28 | 121.7 |
|                    | 2020 | 8.8 | 244.4 | 6.5 | 106.6 |
| kornevin           | 2018 | 3.38 | 99.4 | 4.03 | 87.2 |
|                    | 2019 | 3.5 | 81.4 | 4.25 | 82.4 |
|                    | 2020 | 4.2 | 116.6 | 4.3 | 70.5 |
| zircon             | 2018 | 6.2 | 182.4 | 4.84 | 104.8 |
|                    | 2019 | 6.9 | 160.5 | 4.95 | 95.9 |
|                    | 2020 | 6.0 | 166.6 | 5.0 | 82 |
| ribav-extra        | 2018 | 7.2 | 211.8 | 5.08 | 112.2 |
|                    | 2019 | 7.8 | 181.4 | 5.42 | 105 |
|                    | 2020 | 8.0 | 222.2 | 5.2 | 85.2 |
| LSD<sub>05</sub>   |      | 0.22 | - | 0.56 | - |
**Table 6.** Effect of preparations on root formation of cuttings of different juniper species, 2018-2020

| Experience variant | Year  | Number of roots | Root length |
|--------------------|-------|-----------------|-------------|
|                    |       | pc.             | % to control cm | % to control |
| **Juniperus sabina** |       |                 |              |             |
| control            | 2018  | 2.8             | 100          | 7.6         | 100         |
|                    | 2019  | 3.0             | 100          | 8.2         | 100         |
|                    | 2020  | 3.1             | 100          | 8.6         | 100         |
| heteroauxin        | 2018  | 6.8             | 242.9        | 12.6        | 165.8       |
|                    | 2019  | 7.1             | 236.7        | 12.1        | 147.6       |
|                    | 2020  | 7.6             | 245.1        | 12.7        | 147.7       |
| kornevin           | 2018  | 4.6             | 164.3        | 10.1        | 132.9       |
|                    | 2019  | 4.4             | 146.7        | 10.2        | 124.4       |
|                    | 2020  | 4.8             | 154.8        | 9.3         | 108.1       |
| zircon             | 2018  | 4.8             | 171.4        | 10.6        | 139.5       |
|                    | 2019  | 4.9             | 163.3        | 11.0        | 134.1       |
|                    | 2020  | 5.0             | 161.3        | 10.2        | 118.6       |
| ribav-extra        | 2018  | 7.8             | 278.5        | 10.6        | 139.5       |
|                    | 2019  | 6.9             | 230          | 10.8        | 131.7       |
|                    | 2020  | 7.2             | 232.3        | 11.2        | 130.2       |
| **LSD**<sub>0.05</sub> |       | 0.28            | -            | 0.66        | -           |

| **Juniperus communis** |       |                 |              |             |
| control            | 2018  | 2.6             | 100          | 7.4         | 100         |
|                    | 2019  | 2.7             | 100          | 7.8         | 100         |
|                    | 2020  | 3.0             | 100          | 7.8         | 100         |
| heteroauxin        | 2018  | 5.6             | 215.4        | 11.1        | 150         |
|                    | 2019  | 5.9             | 218.5        | 10.9        | 139.7       |
|                    | 2020  | 6.5             | 216.7        | 10.3        | 132.1       |
| kornevin           | 2018  | 4.2             | 161.5        | 10.0        | 135.1       |
|                    | 2019  | 4.0             | 148.1        | 9.5         | 121.8       |
| zircon             | 2018  | 5.0             | 192.3        | 10.8        | 145.9       |
|                    | 2019  | 4.2             | 155.6        | 11.0        | 141         |
|                    | 2020  | 4.6             | 153.3        | 10.4        | 133.3       |
| ribav-extra        | 2018  | 6.8             | 261.5        | 9.8         | 132.4       |
|                    | 2019  | 7.2             | 266.7        | 10.4        | 133.3       |
|                    | 2020  | 7.6             | 253.3        | 10.6        | 135.9       |
| **LSD**<sub>0.05</sub> |       | 0.33            | -            | 0.62        | -           |

The number of overwintered plants in 2019 ranged from 53.3% in the control of *Thuja occidentalis* to 73.3% in the variant with heteroauxin (fig. 5); in *Thuja occidentalis* form spherical from 60.2% in the control to 82.3% in the variant with heteroauxin. In the *Juniperus sabina*, the percentage of overwintered annual plants varied from 62.8% in the control to 80.3% in the variant with ribav-extra. Annual *Juniperus communis* plants overwintered from 74.3% in the variant of the experiment with the use of zircon to 88.9% and 89.2% in the variants of the experiment with the treatment of ribav-extra and kornevin, respectively.
In 2020, the number of overwintered plants of *Thuja occidentalis* varied from 63.3% of the control variant to 88.8% in the variant with heteroauxin treatment (fig. 6). In spherical *Thuja occidentalis*, it was respectively from 69.8% to 84.9%. In the *Juniperus sabina*, the percentage of overwintered annual plants varied from 60.1%; in the variant using zircon - to 85.8% in the variant with ribav-extra. In *Juniperus communis* it was from 72.6% in the variant with zircon treatment to 84.8% in the variant with ribav-extra growth stimulator. Within the error range, the highest values were noted in the kornevin variant (84.6%).

Analyzing two years of overwintering of annual plants of the Cypress family, it can be stated that cuttings of *Thuja occidentalis*, *Thuja occidentalis* being spherical, *Juniperus sabina* and *Juniperus communis* consistently well overwinter with treatment with heteroauxin and ribav-extra.

The output of two-year-old plants after overwintering is shown in table 7.
Table 7. Output of biennial plants after overwintering, 2019

| Variant | Number of annual plants | Overwintered, total | Waste after overwintering |
|---------|-------------------------|---------------------|--------------------------|
|         | pc. | %   | pc. | %   | pc. | %   |
| **Thuja occidentalis** | | | | | | |
| control | 59  | 78.2 | 31  | 53.3 | 28  | 46.7 |
| heteroauxin | 72  | 96.4 | 53  | 73.3 | 19  | 26.7 |
| ribav-extra | 74  | 98.2 | 53  | 72  | 21  | 28  |
| kornevin | 67  | 88.7 | 46  | 68.8 | 21  | 31.2 |
| zircon | 72  | 96  | 51  | 71.4 | 21  | 28.6 |
| **Thuja occidentalis, spherical** | | | | | | |
| control | 55  | 73.3 | 33  | 60.2 | 22  | 39.8 |
| heteroauxin | 65  | 86.7 | 53  | 82.3 | 12  | 17.7 |
| ribav-extra | 64  | 85.3 | 50  | 78.4 | 14  | 21.6 |
| kornevin | 60  | 80.3 | 43  | 71.8 | 17  | 28.2 |
| zircon | 60  | 80.2 | 44  | 73.6 | 16  | 26.4 |
| **Juniperus sabina** | | | | | | |
| control | 56  | 75.2 | 35  | 62.8 | 21  | 37.2 |
| heteroauxin | 67  | 88.9 | 52  | 78.2 | 15  | 21.8 |
| ribav-extra | 70  | 92.6 | 56  | 80.3 | 14  | 19.7 |
| kornevin | 62  | 82.4 | 42  | 67.4 | 20  | 32.6 |
| zircon | 45  | 59.2 | 24  | 52.4 | 21  | 47.6 |
| **Juniperus communis** | | | | | | |
| control | 60  | 79.9 | 46  | 76.6 | 14  | 23.4 |
| heteroauxin | 64  | 85.2 | 54  | 84.6 | 10  | 15.4 |
| ribav-extra | 65  | 86.2 | 58  | 88.9 | 7   | 12.1 |
| kornevin | 64  | 84.8 | 57  | 89.2 | 7   | 10.8 |
| zircon | 57  | 75.7 | 42  | 74.3 | 15  | 25.7 |

In 2019, the fall of plants after overwintering in *Thuja occidentalis* was 26.7-46.7%, in *Thuja occidentalis* being spherical - 17.7-39.8%, in *Juniperus Sabina* - 19.7-47.6%, in *Juniperus communis* - 10.8-25.7% when treated with growth regulators (table 7). Overwintering was better in rooted cuttings treated with a growth stimulator - heteroauxin - in *Thuja occidentalis* and *Thuja occidentalis* being spherical, in *Juniperus sabina* in the version with ribav-extra, and in *Juniperus communis* in the variants of treatment with heteroauxin, ribav-extra, kornevin. Plants treated with zircon, in the Cossack and common junipers during overwintering, mostly died.

A relatively large death of cuttings of seedlings of the Cypress family is not associated with frosts, but, on the contrary, with unfrozen soil during the establishment of snow cover. In 2019, winter set in abnormally early – in mid-October, snow fell on the thawed ground, which created favorable conditions for the root system to ripen. The overwintering of plants is affected by the amount of precipitation (snow), so the height of the snow cover should be slightly higher than the level of the cuttings.

The fall of plants after overwintering in 2020 in the *Thuja occidentalis* was 16.7-28%, in the *Thuja occidentalis* being spherical - 15.1-21.8%, in the *Juniperus sabina* - 14.2-39.9%, in the *Juniperus communis* - 15.2-27.4% when treated with growth regulators (table 8). Overwintering was better in
annual plants treated with growth stimulants: heteroauxin, ribav-extra, kornevin, zircon in *Thuja occidentalis* and *Thuja occidentalis* being spherical in comparison with the control, and in *Juniperus sabina* and *Juniperus communis* in the treatment options with heteroauxin, ribav-extra, kornevin. Plants treated with zircon in the *Juniperus sabina* and *Juniperus communis* mostly died during overwintering.

**Table 8. Output of two-year-old plants after overwintering, 2020**

| Variant         | Number of annual plants | Overwintered, total | Waste after overwintering |
|-----------------|-------------------------|---------------------|--------------------------|
|                 | pc. | %  | pc. | %  | pc. | %  |
| *Thuja occidentalis* |     |    |     |    |     |    |
| control         | 59  | 79.2 | 37  | 63.3 | 22  | 36.7 |
| heteroauxin     | 73  | 96.6 | 58  | 78.8 | 15  | 21.2 |
| ribav-extra     | 74  | 98.4 | 62  | 83.3 | 8   | 16.7 |
| kornevin        | 67  | 88.9 | 48  | 72   | 19  | 28   |
| zircon          | 73  | 96.8 | 59  | 81.4 | 14  | 18.6 |
| *Thuja occidentalis* being spherical |     |    |     |    |     |    |
| control         | 56  | 74.2 | 39  | 69.8 | 17  | 30.2 |
| heteroauxin     | 67  | 88.6 | 57  | 84.9 | 10  | 15.1 |
| ribav-extra     | 66  | 88.4 | 55  | 83.4 | 11  | 16.6 |
| kornevin        | 60  | 80.5 | 47  | 77.5 | 13  | 21.5 |
| zircon          | 62  | 82.3 | 48  | 78.2 | 14  | 21.8 |
| *Juniperus sabina* |     |    |     |    |     |    |
| control         | 57  | 76.3 | 41  | 72.4 | 16  | 27.6 |
| heteroauxin     | 68  | 90.2 | 57  | 84.2 | 9   | 15.8 |
| ribav-extra     | 73  | 96.7 | 63  | 85.8 | 10  | 14.2 |
| kornevin        | 63  | 84.2 | 51  | 81.6 | 12  | 17.4 |
| zircon          | 45  | 60.6 | 27  | 60.1 | 18  | 39.9 |
| *Juniperus communis* |     |    |     |    |     |    |
| control         | 60  | 80.6 | 47  | 78.4 | 13  | 21.6 |
| heteroauxin     | 63  | 84.6 | 53  | 82   | 10  | 18   |
| ribav-extra     | 65  | 86.8 | 55  | 84.8 | 10  | 15.2 |
| kornevin        | 65  | 86.2 | 55  | 84.6 | 10  | 15.4 |
| zircon          | 56  | 74.8 | 41  | 72.6 | 15  | 27.4 |

4. **Conclusion**

1. During vegetative reproduction of *Thuja* species, active callus formation and high rootability were influenced by growth stimulators – heteroauxin, kornevin, zircon, ribav-extra, and during reproduction of *Juniper* species – heteroauxin, kornevin, ribav-extra.

2. The greatest stable increase in growth was found for thuja and juniper trees when they were treated with ribav-extra.

3. The greatest increase in the diameter of the root neck was found in all the studied species of thuja and junipers when they were treated with kornevin.

4. All the studied growth regulators had a positive effect on the increase in the number and length of the roots of thuia and junipers, except for the recorded inhibitory effect of kornevin on cuttings of *Thuja occidentalis* seedlings.
5. Heteroauxin and ribav-extra had a stable positive effect on the overwintering of annual and biennial plants of the Cypress family under study, and kornevin also had a positive effect on Juniperus communis.

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