Development of methods for preparing lignified cuttings of tall blueberry for rooting

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Abstract. When propagating tall blueberries by lignified cuttings, the optimal type of substrate and the method of preparing cuttings for rooting have been established. It has been experimentally proven that lignified cuttings before planting for rooting are effectively furrowed (wounding in the lower part of the cuttings along the shoot axis), treated with Ukorzeniacz B aqua growth powder (0.2%) and rooted in a substrate consisting of high peat. At the same time, the rooting rate of the Bluecrop variety was 69% versus 47% in the control rooted on high-moor peat and against 37% in the control rooted on a mixture of high-moor peat with perlite. And in the Northland variety - 79% versus 59% in the control rooted on high-moor peat and against 52% in the control rooted on a mixture of high-moor peat with perlite (1:1).

1. Introduction

In the Republic of Belarus, studies on the introduction of tall blueberries into culture were launched more than 30 years ago and the result was a scientific substantiation of the possibility of cultivating tall blueberries in the conditions of the country and large-scale introduction into industrial culture. In the Russian Federation, in terms of agroclimatic characteristics, tall blueberries are suitable for cultivation in many regions, however, at present, it is only at the origins of its introduction into industrial production. Since, due to the specific requirements for soil and climatic conditions, its introduction into the culture is associated with additional research to improve the methods of vegetative reproduction and cultivation agrotechnics [8].

Blueberry is a difficult-to-rooted crop, therefore scientists are constantly looking for means and methods of accelerated reproduction, allowing to increase the regenerative capacity and multiplication factor of this promising berry culture [1], [2], [3], [11]. Reproduction of tall blueberries by lignified cuttings has a number of advantages over the technology of green cuttings: firstly, the harvesting and planting of lignified cuttings is carried out in the fall when there are no other numerous works in the nursery; secondly, during the reproduction of tall blueberries in this way, the cuttings develop more rapidly and by the end of the first year of growing, standard seedlings can be obtained [6]. In addition, it is known that hard-to-root breeds and varieties of garden plants are successfully propagated by lignified cuttings [16].
Traditionally, when propagating blueberries with tall green cuttings, mixtures of high-moor peat with sand in a ratio of 1:1 or 3:1 are used. When studying the effectiveness of rooting of lignified cuttings of tall blueberry on substrates consisting of mixtures of high-moor peat, sand or perlite, they were planted in the spring without treatments with growth regulators.

Regeneration processes are part of the plant's regulatory system aimed at maintaining its integrity. However, it is difficult to say what causes the onset of cell division [18]. According to modern concepts, the leading role in plant root formation is assigned to auxins [13]. They control the differential growth, division and elongation of cells, activate the activity of the cambium, and stimulate the absorption and movement of plastic substances in the plant. Auxins affect different metabolic systems: synthesis of nucleic acids, protein, carbohydrate, lipid metabolism, synthesis of secondary substances, photosynthesis and respiration [4], [8], [17]. It was found that when the base of green cuttings is treated with auxins, cambium and root parenchyma cells become centers of attraction for water and nutrients. This leads to cell elongation, neoplasms of the cytoplasm and subsequent cell division, the emergence of new meristematic foci, from which adventitious roots are formed [5], [7], [9], [12], [14], [15].

The aim of the research is to study the effect of the type of substrate and methods of preparing lignified cuttings for rooting on the reproduction of tall blueberries.

2. Conditions, Materials and Methods

Subjects of research: Blueberry varieties (Vaccinium corymbosum): Bluecrop Northland. The experiments were carried out in 2015-2017, the cuttings were planted for rooting in the first decade of April in a greenhouse with a fogging device.

When determining the efficiency of vegetative reproduction, depending on the type of substrate, we used fine high-moor peat (P_m), perlite (P), sand (P_s). The cuttings were rooted without pretreatment with growth regulators. Experience options:

1. High-moor peat: Perlite in the ratio 1:1 (control);
2. High-moor peat;
3. High-moor peat: Perlite: Sand in a ratio of 0.5:0.35:0.15;

When revealing the effectiveness of various methods of preparing lignified cuttings for rooting, treatment with Ukorzeniacz B_aqua growth powder (NAA 0.2%) was used and planted for rooting in a substrate consisting of high peat and perlite. Experience options:

1. High-moor peat: Perlite in a ratio of 1:1, without treatment with growth regulators (control w/t);
2. High-moor peat: Perlite in the ratio 1:1, treated with Ukorzeniacz B_aqua, exposure time - 1 second.
3. High-moor peat, without treatment with growth regulators (w/t);
4. High-moor peat, treated with Ukorzeniacz B_aqua, exposure time - 1 second.

In addition, the effectiveness of furrowing (wounding in the lower part of cuttings along the shoot axis) was studied against the background of treatment of lignified cuttings with Ukorzeniacz B_aqua growth powder (NAA 0.2%). Rooting was carried out in a high-moor peat substrate. Experience options:

1. Without treatment with growth regulators (control w/t);
2. Ukorzeniacz B_aqua, exposure time 1 second
3. Without treatment with growth regulators (w/t) + furrowing
4. Ukorzeniacz B_aqua, exposure time 1 second + furrow

In the third decade of November, rooting rates were recorded, and the percentage of rooting, the number of roots and increments of the current year were determined, and the total length of roots and increments was measured.

All experiments were repeated four times, 25 cuttings in one repetition (Figure 1).
Variety Bluecrop

Variety Northland

Figure 1. Rooting of lignified cuttings of tall blueberry

3. Research results.

When planting lignified cuttings of tall blueberries in a greenhouse with a fogging installation on a substrate consisting of high-moor peat (P_{hm}) and a mixture of high-moor peat with perlite in a ratio of 1:1 (P_{hm}: P), Ukorzeniacz B_{aqua} was used to stimulate root formation. As a result, it was revealed that lignified cuttings of tall blueberry can be effectively rooted in a substrate from high-moor peat and treated with Ukorzeniacz B_{aqua} (0.2%) before planting. So, on average for two years of research, the rooting rate of the Bluecrop variety in a high-moor peat substrate was 47-66% versus 37-59% in the variants where a mixture of peat with perlite was used in a 1:1 ratio. Also revealed a significant advantage of experimental options with control for all considered indicators (Table 1).

Table 1. Influence of the Ukorzeniacz B_{aqua} preparation on the rooting rate and development of lignified cuttings of tall blueberry on various substrates (Bluecrop variety), 2016-2017

| Variety                  | Rooting, % | Average number of roots, PCs | Average total root length, cm | Average number of increments, PCs | Average total length of increments, cm |
|--------------------------|------------|------------------------------|------------------------------|----------------------------------|---------------------------------------|
| P_{hm}:P 1:1 w/t (control) | 37         | 2.7                          | 20.0                         | 1.1                              | 11.8                                  |
| P_{hm}:P 1:1 Ukorzeniacz B_{aqua} | 59         | 3.2                          | 36.3                         | 1.4                              | 18.4                                  |
| P_{hm} w/t                | 47         | 2.9                          | 29.2                         | 1.1                              | 12.1                                  |
| P_{hm} Ukorzeniacz B_{aqua} | 66         | 4.4                          | 51.8                         | 1.6                              | 23.0                                  |

Least significant difference P < 0.05

- 0.02 0.21 0.37 - 0.29
- 0.02 0.21 0.37 0.29
- 0.02 0.21 0.37 0.18 0.29
- 0.02 0.21 0.37 -
- 0.02 0.21 0.37 -
- 0.02 0.21 0.37 -
- 0.02 0.21 0.37 -
- 0.02 0.21 0.37 -

Least significant difference P < 0.05 ab - 0.48 0.84 -
Least significant difference P < 0.05 bc - 0.48 0.84 - 0.66

Least significant difference P < 0.05 abc - 0.82 1.44 -

In the Northland Blueberry variety rooted in a high-moor peat substrate, the rooting rate of lignified cuttings was 59-74% versus 52-67% in the variants where a mixture of peat and perlite was used. Also, there was a significant advantage of the experimental options with control for all considered indicators (Table 2).

In general, we can say that in both studied varieties, the best rooting rate of lignified cuttings was revealed in the variant where they were treated with Ukorzeniacz Baqua (0.2%) before planting and planted in a substrate consisting of high moor peat.
Table 2. Influence of the preparation of Ukorzeniacz $B_{aqua}$ on rooting and development of lignified cuttings of tall blueberry (variety Northland), 2016-2017.

| Variety                    | Rooting, % | Average number of roots, PCs | Average total root length, cm | Average number of increments, PCs | Average total length of increments, cm |
|----------------------------|------------|------------------------------|------------------------------|----------------------------------|----------------------------------------|
| $P_{hm}$:P 1:1 w/t (control) | 52         | 4.8                          | 47.0                         | 1.3                              | 14.5                                   |
| $P_{hm}$:P 1:1 Ukorzeniacz $B_{aqua}$ | 67         | 5.3                          | 61.4                         | 1.8                              | 26.2                                   |
| $P_{hm}$ w/t              | 59         | 5.9                          | 56.9                         | 1.2                              | 17.1                                   |
| $P_{hm}$ Ukorzeniacz $B_{aqua}$ | 74         | 6.3                          | 72.3                         | 1.8                              | 31.1                                   |

Least significant difference $P < 0.05$ a $0.01$ - $0.36$ - $0.44$
Least significant difference $P < 0.05$ b $0.01$ - $0.17$ - $0.17$ - $0.44$
Least significant difference $P < 0.05$ c $0.01$ - $0.17$ - $0.17$ - $0.44$
Least significant difference $P < 0.05$ ab - - - -
Least significant difference $P < 0.05$ ac - - - -
Least significant difference $P < 0.05$ bc - - - $1.00$
Least significant difference $P < 0.05$ abc - - $1.40$ - -

It is also known that to stimulate the root formation of lignified cuttings, it is effective to use furrowing - cuts in the bark at the base of the cuttings along the axis of the shoots, since this destroys the layer of tissues that prevent the formation of roots in woody cuttings and accelerates the rooting process. Therefore, experiments were laid with the combination of processing lignified cuttings of tall blueberries with the preparation Ukorzeniacz Baqua and furrowing.

In general, we can say that when propagating by lignified cuttings of the Bluecrop cultivar, significant differences were revealed for all the indicators taken into account with the control of all experimental variants. However, the best results were obtained in variants with the treatment of lignified cuttings with Ukorzeniacz Baqua, as well as when combining this treatment with furrowing, where the rooting rate was 66-69% versus 47% in the control, and significant differences were obtained with the control in the total length of roots - 51.5-51.8 cm versus 29.2 cm in the control; the average length of the growth of the current year is 23.0 cm versus 12.1 cm in the control (table 3, figure 2).

Table 3. Influence of the Ukorzeniacz Baqua preparation and furrowing of the bark at the base of lignified cuttings of tall blueberry cultivar Bluecrop on their rooting rate and development, 2016-2017.

| Variety       | Rooting, % | Average number of roots, PCs | Average total root length, cm | Average number of increments, PCs | Average total length of increments, cm |
|---------------|------------|------------------------------|------------------------------|----------------------------------|----------------------------------------|
| Control w/t   | 47         | 2.9                          | 29.2                         | 1.1                              | 12.1                                   |
| Ukorzeniacz $B_{aqua}$ | 66         | 4.4                          | 51.8                         | 1.6                              | 23.0                                   |
| Furrowing w/t | 56         | 4.2                          | 47.8                         | 1.4                              | 17.3                                   |
| Ukorzeniacz $B_{aqua}$ + furrowing | 69         | 4.4                          | 51.5                         | 1.6                              | 23.0                                   |

Least significant difference $P < 0.05$ a $4.06$ - $0.52$ - $0.75$ - $0.35$ - $0.7$
Least significant difference $P < 0.05$ b - - $0.39$ - - $0.37$
Least significant difference $P < 0.05$ ab - - - -

The Northland variety has a high root-forming ability. The best results, as in the previous case, were found in variants with the treatment of lignified cuttings with Ukorzeniacz $B_{aqua}$ (0.2%), as well as when combining the treatment with growth powder with furrow, where the rooting rate of plants was 74-79% versus 59% in the control. And also obtained significant differences with the control on the total length of the roots - 72.3-72.5 cm versus 56.9 cm; the average length of growth in the current year is 31.1-31.4 cm versus 17.1 cm (Table 4, Figure 2).
Table 4. Influence of the preparation Ukorzeniacz $B_{aqua}$ and furrowing of lignified cuttings of *Northland* tall blueberry on their rooting and development, 2016-2017

| Variety          | Rooting, % | Average number of roots, PCs | Average total root length, cm | Average number of increments, PCs | Average total length of increments, cm |
|------------------|------------|------------------------------|------------------------------|-----------------------------------|----------------------------------------|
| Control w/t      | 59         | 5.9                          | 56.9                         | 1.2                               | 17.1                                   |
| Ukorzeniacz $B_{aqua}$ | 74         | 6.3                          | 72.3                         | 1.8                               | 31.1                                   |
| Furrowing        | 68         | 6.2                          | 68.7                         | 1.5                               | 23.5                                   |
| Ukorzeniacz $B_{aqua}$ + furrowing | 79         | 6.3                          | 72.5                         | 1.8                               | 31.4                                   |

Least significant difference $P < 0.05$ a 5.13 - 1.05 0.28 0.89

Least significant difference $P < 0.05$ b - - 0.55 - 0.47

Least significant difference $P < 0.05$ ab - - - - -

Figure 2. Rooted woody cuttings of tall blueberry, 2016

Thus, it was revealed that lignified cuttings of high-growing blueberry varieties *Bluecrop* and *Northland*, before planting for rooting in greenhouses with fogging installations, are effectively furrowed, treated with Ukorzeniacz $B_{aqua}$ growth powder (0.2%) and rooted in a substrate consisting of high peat. At the same time, the rooting rate of the *Bluecrop* variety was 69% versus 47% in the control rooted on high-moor peat and against 37% in the control rooted on a mixture of high-moor peat with perlite. In the *Northland* cultivar - 79% versus 59% in the control rooted on high-moor peat and against 52% in the control rooted on a mixture of high-moor peat with perlite (1:1).

4. Conclusions

When propagating tall blueberries (*Bluecrop* and *Northland* varieties) by lignified cuttings, a high yield of viable rooted material is ensured by treating the cuttings with Ukorzeniacz $B_{aqua}$ growth powder (NAA 0.2%), furrowing and planting into a substrate from high-moor peat, as a result, the yield increases by 8-29% rooted cuttings, which are 1.3-2.9 times higher than the control in terms of development.

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