Development of agrotechnical methods for growing tall blueberries in the open field

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Abstract. When growing tall blueberries in open ground on a substrate consisting of a mixture of high-moor peat, litter of conifers in a ratio of 2: 1, varietal differences of the studied varieties for the developed methods were revealed: planting on a flat surface; on ridges 25-35 cm high and 50-60 cm wide; on a flat surface with pine sawdust mulching (6-8 cm); on ridges 25-35 cm high and 50-60 cm wide with mulching with pine sawdust (6-8 cm); on a flat surface with root ball undercuts. When cultivating the Bluecrop variety, the best results were obtained when planting plants on ridges 25-35 cm high and 50-60 cm wide with additional mulching with pine sawdust, the total growth of the current year on average over two years of research was 758.0 cm against 516.8 cm in control, and the yield was 872.0 g versus 737.0 g. When growing the Elizabeth variety, the best results were obtained when planting plants on a flat surface with additional mulching with pine sawdust, the total growth of the current year on average for two years was 740.5 cm versus 605.1 cm in the control, and the yield - 428 g versus 216 g. Both studied varieties have a responsiveness to the use of mulching.

1. Introduction
Currently, it is important to study and develop various agrotechnical methods for the effective growth and development of tall blueberries in open ground, since this culture revealed a different removal and availability of nutrients to plants, depending on the hydrophysical and physicochemical properties of substrates, agricultural technology, and climatic conditions in the region of cultivation [10].

The root system of tall blueberries is fibrous, densely branched, located in the upper layer of the soil and has no root hairs. About 90% of the roots of this culture are located in the upper soil layer 15-30 cm thick, since in the deep soil layers soil moisture increases and aeration worsens, which adversely affects the development of the root system [3]. To solve this problem, plants are often planted on embankments or ridges 25-45 cm high, which helps to accelerate growth and increase the volume of their root system [2]. In addition, there is information in the literature that, when grown in containers, the roots of tall blueberries are tightly wrapped around a lump, and after transplanting into the ground, they are unable to independently change the direction of growth, break through the boundaries of a dense root ball, as a result of which often such plants after several years die [6]. In the nurseries of the Netherlands, when
transplanting tall blueberry seedlings from containers into open ground, incisions are made on the root ball to stimulate further growth and development of the root and aerial system, and better survival of the seedlings.

In addition, when growing tall blueberries, it is important to maintain moisture in the upper soil layer, since the absence of root hairs makes it sufficiently sensitive to soil moisture [11]. To solve this problem, mulching is used, which creates optimal conditions for the accumulation of moisture and organic matter. It also helps in the fight against weeds, protects plants from temperature fluctuations in winter and spring, and has a positive effect on the intensity of shoot growth and the uniformity of wood ripening, which contributes to the timely course of the processes of preparing shoots and buds for overwintering [7], [8], [12].

In July, generative buds form on the tops of the shoots and axils of the upper leaves of blueberries, forming the next year's harvest. In the axils of the lower leaves, vegetative buds are laid, from which second-order branching shoots develop next year, etc. [9]. Therefore, for the analysis of fruiting using various agrotechnical methods, it is necessary to pay attention to the growth and development of the aboveground system.

Therefore, at present, it is important to develop methods that allow creating optimal conditions for the development of the root and aerial system of tall blueberries.

The purpose of the research is to reveal the influence of agrotechnical methods on the growth and development of tall blueberry plants when grown in open ground.

2. Conditions, Materials and Methods

In 2016-2017. The experiments were carried out in the Republic of Belarus, in the Brest region, in the urban village of Domachevo, in the blueberry nursery of the farm "Matskevich PM". In the open field, when growing tall blueberries using various agricultural techniques, 5-year-old seedlings of the Bluecrop variety and 3-year-old Elizabeth varieties, planted after growing in 2.5 l containers, were used.

The substrate in the open field consisted of high-moor peat and coniferous litter in a ratio of 2: 1. For each variant of the experiment, the mineral fertilizer Florovit (for rhododendrons, heather plants and hydrangeas) for the Bluecrop variety was applied twice annually (in the II-III decade of May 2/3 and in the III decade of June 1/3 part) for the Bluecrop variety: in the first year 100 grams per running meter, in the second year 120 grams per running meter, for the Elizabeth variety: in the first gram per running meter, in the second year 80 grams per running meter. Experience options:

1. Landing on a flat surface (control)
2. Landing on ridges 25-35 cm high and 50-60 cm wide
3. Planting on a flat surface with pine sawdust mulching (6-8 cm)
4. Planting on ridges 25-35 cm high and 50-60 cm wide with mulching with pine sawdust (6-8 cm)
5. Planting on a flat surface with root ball undercuts (4 cuts at 90° to each other)

The experiments were repeated 4 times, 1 bush in one replication. Yield counts of the studied varieties were carried out as the fruits ripen, while the berries were weighed.

Content of nutrients in fertilizer Florovit (for rhododendrons, heather plants and hydrangeas), %: total nitrogen (amide nitrogen) (N) -9.5; phosphorus oxide (P2O5) -8.0 (phosphorus oxide (P2O5) (water-soluble in a neutral solution of ammonium citrate and water) -5, phosphorus oxide (P2O5) (water-soluble) -4, potassium oxide (K2O) -12.0 (water-soluble)); magnesium oxide (MgO) -2.0; solid sulfur trioxide (SO3) -40.0; solid boron (B) -0.06; solid copper (Cu) -0.1; solid iron (Fe) -0.2; solid manganese (Mn) -0.75 (chelate complexes); solid molybdenum (Mo) -0.005.

3. Results and Discussion

The effectiveness of the developed agricultural practices varied significantly during the years of research, which indicates a pronounced dependence of plant development on the hydrothermal coefficient. In this regard, in order to obtain the most objective picture of the response of the experimental plants, we focused on the integral result obtained in a two-year cycle of observations.
When growing in the open field of 3-year-old Elizabeth tall blueberry seedlings planted from containers, the data obtained during a two-year observation cycle indicate the effectiveness of planting plants on a flat surface with mulching with pine sawdust, since in this case significant differences were revealed with the control by factor b (year of research), the average total growth of the current year for 2 years was 740.5 against 605.1 cm in the control, and the yield of plants was 428 g against 216 g in the control (Tables 1-2, Figure 1).

**Table 1.** Influence of agronomic techniques on the development of 3 year old blueberry seedlings (Elizabeth variety) planted from containers in the open field

| Landing option                                                      | 2015 | 2016 | Average 2015-2016 |
|--------------------------------------------------------------------|------|------|-------------------|
| On a flat surface (control)                                        | 497.8| 712.5| 605.1             |
| On ridges 25-35 cm high and 50-60 cm wide                         | 460.5| 740.0| 600.3             |
| On a flat surface with pine sawdust mulching (6-8 cm)              | 544.8| 936.3| 740.5             |
| On ridges 25-35 cm high and 50-60 cm wide with pine sawdust mulching (6-8 cm) | 500.5| 721.3| 610.9             |
| On a flat surface with root ball undercuts (4 undercuts at 90 ° to each other) | 535.8| 781.3| 658.5             |

Least significant difference $P < 0.05$ was calculated by two-way ANOVA (factor a - container volume, factor b - year of research)

**Table 2.** Influence of agricultural practices on the yield in the open field of 3 year old highbush blueberry seedlings planted from containers (Elizabeth variety)

| Landing option                                                      | 2015 | 2016 | Average 2015-2016 |
|--------------------------------------------------------------------|------|------|-------------------|
| On a flat surface (control)                                        | 34.0 | 398.0| 216.0             |
| On ridges 25-35 cm high and 50-60 cm wide                         | 34.0 | 329.0| 181.5             |
| On a flat surface with pine sawdust mulching (6-8 cm)              | 28.0 | 828.0| 428.0             |
| On ridges 25-35 cm high and 50-60 cm wide with pine sawdust mulching (6-8 cm) | 41.0 | 307.0| 174.0             |
| On a flat surface with root ball undercuts (4 undercuts at 90 ° to each other) | 31.0 | 266.0| 148.5             |

Least significant difference $P < 0.05$ was calculated by two-way ANOVA (factor a - container volume, factor b - year of research)

When growing in open ground 5 summer blueberry seedlings Bluecrop cultivar planted from containers, the research results obtained over two years indicate that planting on beds with additional mulching with pine sawdust has a greater positive effect on plant growth, since in this case significant differences with the control, in terms of the total growth of the current year, which on average for 2 years amounted to 758.0 cm versus 516.8 cm in the control.
Also in this variant, the best results were revealed in terms of plant yield - 872.0 g, however, it should be noted that in this case the differences are significant only for factor b (year of research) (tables 3-4, Figure 2) [1].

**Table 3.** Influence of agrotechnical practices on the development of 5 summer tall blueberry seedlings (cultivar Bluecrop) planted from containers in the open field, 2015-2016.

| Landing option                                         | 2015  | 2016  | Average 2015-2016 |
|--------------------------------------------------------|-------|-------|-------------------|
| On a flat surface (control)                            | 489.3 | 544.3 | 516.8             |
| On ridges 25-35 cm high and 50-60 cm wide              | 498.0 | 518.8 | 508.4             |
| On a flat surface with pine sawdust mulching (6-8 cm)  | 522.3 | 533.8 | 528.0             |
| On a flat surface with pine sawdust mulching (6-8 cm)  | 658.5 | 857.5 | 758.0             |
| On a flat surface with root ball undercuts (4 undercuts at 90 ° to each other) | 503.3 | 756.3 | 629.8             |

Least significant difference P < 0.05 was calculated by two-way analysis of variance (factor a - container volume, factor b - year of research)

**Table 4.** Influence of agrotechnical methods on the yield in open ground of 5 summer tall blueberry seedlings planted from containers (Bluecrop variety), 2015-2016.

| Landing option                                         | 2015  | 2016  | Average 2015-2016 |
|--------------------------------------------------------|-------|-------|-------------------|
| On a flat surface (control)                            | 438.0 | 1035.0| 737.0             |
| On ridges 25-35 cm high and 50-60 cm wide              | 414.0 | 1243.0| 829.0             |
| On a flat surface with pine sawdust mulching (6-8 cm)  | 456.0 | 1300.0| 878.0             |
| On ridges 25-35 cm high and 50-60 cm wide with mulching with pine sawdust (6-8 cm) | 421.0 | 1323.0| 872.0             |
| On a flat surface with root ball undercuts (4 undercuts at 90 ° to each other) | 473.0 | 1044.0| 758.0             |

Least significant difference P < 0.05 was calculated by two-way analysis of variance (factor a - container volume, factor b - year of research)
Planting on a flat surface with pine sawdust mulching

Planting on ridges with pine sawdust mulching

Figure 1. The appearance of plants of tall blueberry varieties Elizabeth when planted in open ground with the use of various agricultural techniques

Planting on a flat surface with pine sawdust mulching

Planting on ridges with pine sawdust mulching

Figure 2. The appearance of blueberry plants of a tall Bluecrop variety when planted in open ground using various agricultural techniques
Thus, when growing tall blueberries in open ground on a substrate consisting of a mixture of high-moor peat and coniferous litter in a ratio of 2:1, depending on various agrotechnical methods, varietal differences of the studied varieties for the developed methods were revealed. When growing the Bluecrop variety, the best results were obtained when planting plants on ridges 25-35 cm high and 50-60 cm wide with additional mulching with pine sawdust, the total growth of the current year on average over two years of research was 758.0 cm versus 516.8 cm in control, and the yield - 872.0 g versus 737.0 g [1]. When growing the Elizabeth variety, the best results were obtained when planting plants on a flat surface with additional mulching with pine sawdust, the total growth of the current year on average over two years was 740.5 cm versus 605.1 cm in the control, and the yield was 428 g versus 216 g. Both of the studied varieties showed responsiveness to the application of mulching. It is known that tall blueberries react negatively to an increase in moisture in deep soil layers [4]. Planting plants on ridges improves soil aeration, however, there may be sharp temperature drops with periodic freezing of the upper soil layer [5], which could cause varietal differences in the methods being developed. The varietal response to the techniques developed was manifested in the advantage of planting Bluecrop on ridges, and Elizabeth on a flat surface. This is probably due to the fact that, according to our observations, the Bluecrop variety is more demanding to aerate the substrate, and it is better to plant it on ridges 25-35 cm high, while the Elizabeth variety is less demanding on aeration and more demanding on soil moisture, so it is better to plant it on flat surface.

4. Conclusion

In the open field of tall blueberry plantations, it is necessary to mulch with pine sawdust with a layer of 6-8 cm. Bluecrop variety, which requires aeration of the substrate, should be planted on ridges 25-35 cm high, and Elizabeth variety, which is demanding on substrate moisture, on a flat surface, while growing and plant development are 1.2-2 times higher than the control indicators.

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