Biological peculiarities of cherry growth and fructification on seedling and clonal rootstocks

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Abstract. Cherry is a stone fruit crop which is valued for early raping, yield capacity, fruit eating qualities. The drawback is growth of trees, absence of short rootstocks for cultivating in Central Chernozemic region. The Faculty of Agricultural Science conducts research on the selection of compatible cultivars and rootstocks with high winterhardness of the above-ground part and roots for their introduction into commercial orchards in the Voronezh region. Biometrical attributes of cultivar growth and development, crown parameters, weak-, medium, active plantings of the cherry on seedling and clonal rootstocks have been determined by the study. The effects of cultivar-rootstock combinations on the cherry yield have been determined. The content of sugar, organic acids, dry basis, and vitamin C have been determined. The cultivars for introduction and study have been suggested for intensive commercial orchards of the Voronezh region.

1. Introduction
Cherry is a stone fruit crop of rather early ripes, with high eating and nutritional qualities [1]. The fruit contain digestible sugars, acids, vitamins and other useful nutrients. Due to high sugar content and low acidity they are used fresh, for compotes and other products [2, 3].

Cherry plantations are characterized by intensive growth and large crowns [4]. Nowadays, cultivar-rootstock combinations with stem-tide trees are necessary for intensive orchards. These combinations should have early fructification, high efficiency of planting and high quality of fruit, that is why, this research is topical [5, 6].

By agronomic characteristics VSL-2 and LC-2 rootstocks are suitable for commercial planting. They decrease the cherry spreading by 30-50 %, increase productivity and commercial qualities of fruit [7].

The plantation development in the Voronezh region is restricted due to absence of stock planting material of the recognized variety. The cherry with seedling rootstocks takes the area of 40 ha in commercial orchards in the Voronezh region, their main part (36.3 ha) is taken by orchards of LLC “Rossoshanskaya fruit-berry station” in Rossoshanskiy region, 2.7 ha of cherry are in CJSC “Ostrogozhsk nursery garden” in Ostrogozhsk region [8].

For wider introduction of cherry into commercial gardens it is necessary to cultivate combinations which will give high yields [9, 10].

The Faculty of Agricultural Science at FSBEE HE “Voronezh State agrarian university” study cherry cultivars and their rootstocks suitable for forest steep in Central Chernozemic region [11].

The purpose is to study biological attributes of cultivar-rootstock cherry combinations by important economic traits and characteristics and determine the most suitable for introduction into the commercial orchards of monocultural farms in the Voronezh region. The objectives are to study the growth and
development of cherry cultivar with seedling and clonal rootstocks; determine the effects of a cultivar and rootstock on yield and fruit quality; estimate the biochemical composition of fruit by the most important attributes.

2. Materials and methods
Cherry plantations with different periods of ripening: Revma, Iput’, Bryansk (к) selected by FSBSI All-Russian SRI of lupine” (Bryansk); Adelina, Poesia selected by FSBSI “All-Russian SRI of fruit crop selection” (Orel) and All-Russian SRI of fruit plants selection and genetics” (Michurinsk), Rannyaya rozovaya (к) selected by LLC “Rossoshanskaya fruit-berry station”, Voronezhskaya krasnaya selected by FSBE HE Voronezh SAU with cherry seedling rootstock (к) and clonal rootstocks – VS-13, VSL-2, RVL-2, RVL-10 have been studied.

The orchard was planted in 2013 on the territory of Voronezh SAU. The landing pattern is 6×4m. The crown form is thinned layered.

These cultivar-rootstock combinations were estimated by common methods of fruit berry and nut crop estimation [12]. The cherry fruit were analyzed for chemical analysis in the laboratory of Mass analysis laboratory at Voronezh State University: the content of vitamin C and dry basis were determined by B. P. Pleshakov method (1976), the sugar content was measured by Kh. N Pochink method (1976), acidity by Ermakov A. I. (1979).

3. Results
For three years (2016-2019) the growth, development and yield of cherry had been observed. The data analysis of the cherry trees height with seedling rootstocks (к) showed that at the 8th year of their growth their height changed depending on the cultivar from 2.8 m (Rannaya rozovaya) (к) to 5.3 m with Bryanskaya rozovaya (Figure 1). Adelina (3.4 m) also had stemmed tide.

![Figure 1. The parameters of cherry tree height and cherry tree body on the seedling rootstock (к) in 2018.](image)

The most important index of tree development is the tree diameter where water and nutrients reach the tops [13].

The diameter of the tree body showed that Rannyaya rozovaya (к) (7.5 cm) and Adelina (8.0 cm) had the stemmed growth and cultivars Poesiya (10.5 cm) and Bryanskaya rozovaya (10.6 cm) had high attributes.
The analysis of height and diameter parameters of the tree body in cherries on the clonal rootstock VSL-2 (figure 2) has been done.

![Figure 2. The parameters of cherry tree height and cherry tree body on the seedling rootstock VSL-2 in 2018.](image)

Cherry plantings on the rootstock VSL–2 decrease the height of the trees comparing with the trees on the seedling rootstocks from 0.5 m in Adelina, to 1.8 m in Malysh, but the tree body diameter in Malysh cultivar on the studied rootstocks is the same.

The cherry trees Rannyaya rozovaya (k) on the root stock VSL–2 have the greatest tree body diameter. Comparing with the seedling rootstock this parameter was higher by 4.2 cm, that evidences the cultivar selectiveness to the rootstocks, which is manifested in growth and the development of the over ground part. Clonal rootstocks also reduced the tree height in cultivars Adelina and Poesiya.

Table 1 shows that cherry seedlings (k) in cultivar Rannyaya rozovaya (k) shoot formation, their average and overall length is less than in the same cultivar on the clonal rootstock VSL-2.

| Cultivar                  | Rootstock  | shot number, units. | Average length, cm | overall shoot length, m |
|---------------------------|------------|---------------------|--------------------|------------------------|
|                           |            | existing sidelong   | existing sidelong  |                        |
| Rannyaya rozovaya (k),    | cherry     | 14 54               | 38 24              | 18.3                   |
|                           | VSL-2      | 17 68               | 36 26              | 23.8                   |
| Poesiya                   | cherry     | 24 79               | 31 25              | 27.2                   |
|                           | VSL-2      | 16 53               | 41 29              | 21.9                   |
| Voronezhskaya krasnaya    | cherry     | 23 68               | 46 43              | 39.8                   |
|                           | VSL-2      | 20 83               | 43 33              | 36.0                   |

In cultivars Poesiya and Voronezhskaya krasnaya these parameters are higher on seedling rootstocks than on clonal ones that proves the influence of cultivar-rootstock combinations of cherry.

The overall shoot length on trees of Rannyaya rozovaya cultivar – of the early ripening is lower than in Voronezhskaya krasnaya – of later ripening. It depends on the duration of shoot growth until phonological phase “fructification” and tillering.
Data analysis of cherry trees growth activity on seedling and clonal rootstocks showed that cultivar-rootstocks combinations manifest selective ability. It should be taken into account when planting them in the orchard [14,15].

Data analysis of cherry yielding showed that this parameter depends on the cultivar. The highest yield was in Iput’ (29.8 c/ha), Rannyaya rozovaya (k) (24.5 c/ha), Revna (21.6 c/ha) and Adelina (21.0 c/ha), and low – in Malysh cultivar (9.7 c/ha). It depends on delicate shooting and their growth activity (figure 3).

Figure 3. Yield in cherry cultivars in 2018, c/ha.

It has been determined that the yield in cherry cultivars depends on rootstock spreading. Thus, Voronezhskaya krasnaya when cultivated on seedling rootstocks (κ) has yield to 20 c/ha, on clonal rootstocks VC-13 and VCL-2 – 17.5 c/ha, rootstock RVL-10 – to 14.6 c/ha, and RVL-2 – 13.7 c/ha (fig.4).

Fruit size is a characteristic feature of every cultivar [16].

Table 2 shows quality attributes of these cherry fruit. Fruit color is different from yellow (Malysh) to dark red (Iput’).

Cherry plantings prove themselves good in edaphoclimatic conditions of the Voronezhskaya region, have high flowering, but fructification depends on weather conditions during “flowering” phase. Accessing the average fruit mass the fruit has been chosen from a tree of every cultivar.

Table 2. Cherry quality attributes, 2019

| Cultivar                  | fruit color    | flowering parameter | fruit mass, g | flesh mass, g | stone mass, g |
|--------------------------|----------------|---------------------|---------------|---------------|---------------|
| Rannyaya rozovaya (k)    | creamy-yellow  | 5                   | 3.3           | 2.6           | 0.7           |
| Revna                    | dark-red       | 5                   | 3.6           | 3.0           | 0.6           |
| Iput’                    | dark-red       | 5                   | 4.4           | 3.8           | 0.6           |
| Bryanskaya rozovaya      | pink           | 4                   | 3.4           | 3.0           | 0.4           |
| Adelina                  | dark-red       | 5                   | 4.5           | 4.0           | 0.5           |
| Voronezhskaya krasnaya   | dark-red       | 5                   | 3.6           | 3.0           | 0.6           |
| Malysh                   | yellow         | 3                   | 5.0           | 4.3           | 0.7           |
| Poesiya                  | yellow-red     | 4                   | 8.2           | 7.3           | 0.9           |

It has been determined that the average cherry fruit mass can change depending on the cultivar from 3.3 g in Rannyaya rozovaya (k) to 8.2 g in Poesiya. Flesh mass varied from 2.6 g in Rannyaya rozovaya (κ) to 7.2 g in Poesiya, and stone mass from 0.4 to 1.0 g correspondingly.
The large-fruited cherries are: Poesiya, Malys, Adelina, Iput’, medium-fruited cherries are Revna, Voronezhskaya krasnaya, and small-fruited cherries are Bryanskaya rozovaya and Rannyaya rozovaya (k).

The modern nutrition theory is based on the conception of balanced chemical nutrients necessary for exchange reactions in the organism [17, 18]. That is why commercial and biochemical estimation of cherry fruit is necessary [19]. The characteristic feature of cherry fruit is their sweet taste caused by high sugar content [20].

Total sugar in cherry fruit was from 9.1% in Rannyaya rozovaya (k) to 19.7% in Poesiya and Malys. Depending on the cultivar the amount of organic acids in cherry fruit changed from 2.7% in Voronezhskaya krasnaya, Bryanskaya rozovaya, Rannyaya rozovaya (k) to 8.8% in Malys (figure 4).

![Figure 4. Total sugar and organic acid content in cherry fruit.](image)

Sugar-acid content changed according to the cultivar from 2.2 in Malys to 5.8 in Voronezhskaya krasnaya. According to sugar relative to acid the cultivars do not exceed 12.5 relative units, which characterizes their taste as sweet-sour. According to the data received per two years approximately the cherries flesh contains dry basis from 12.7% in Malys to 23.7% in Rannyaya rozovaya (k).

As cherry is the first fruit in the season it is desirable for them to contain a lot of micronutrients (figure 5).

Special usefulness of cherry is in ASA content which takes part in restorative and oxidizing processes in a human body and is a powerful antioxidant in preventing different diseases [21].

The study has shown that ASA content in cherry can vary from 0.8 mg % (Malys) to 3.4 mg % (Iput’).

Besides important nutrients cherry contains dietary minerals, one of which is phosphorus [22]. The highest content of phosphorus is in Malys (4.9 mg/100 g), the least in Rannyaya rozovaya (k) (1.5 mg/100 g).
In the Voronezhskaya region harvesting cherry starts with Iput’ and Revna (the first decade of June), finishes with Poesiya and Adelina (the third decade of June). The period of fresh cherry consumption is 20 days.

Even ripening of cherry fruit was in Malysh, Voronezhskaya krasnaya and Poesiya, long term of ripening had Adelina, Revna, and Iput’.

4. Conclusion

- Cultivar-rootstock combination of cherry in Central chernozemic region of RF have good combinability, tolerance to the growing conditions can provide annual yield, start the period of fresh fruit consumption.
- Relative to rootstock cherry cultivars are selective, for some seedling rootstock (κ) reduces tree growth, for others increases. It is manifested by the intensity of shoots formation and growth as well as their total length. On seedling rootstocks – seedlings of Rannyaya rozovaya (κ) the shoots are of weak growth, and Voronezhskaya krasnaya – are of good growth, other cultivars are in intermediate position.
- Iput’, Rannyaya rozovaya, Revna, Adelina have high fructification, low fructification is in Malysh; Voronezhskaya krasnaya has greater yield on seedling rootstocks, whereas has no yield on the clonal rootstock VSL-2.
- Large fruited cultivars are: Poesiya, Malysh, Adelina, Iput’, medium-sized are: Revna, Voronezhskaya krasnaya, small-fruited are: Bryanskaya rozovaya and Rannyaya rozovaya (κ).
- There is high content of organic acid and sugars in Poesiya and Malysh, dry basis in Rannyaya rozovaya (κ), ASA in Iput’, Revna, high phosphorus content is in Malysh and Revna.

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