The morphobiological specificities of the growth and development of promising hawthorn seedlings with different crown shapes in the conditions of the Central Black Earth Region

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Abstract. In the literature there is very little information about fruiting, growth activity of various hawthorn species. Therefore, a comprehensive study of hawthorns is necessary in order to improve the health and living conditions in cities, as well as to obtain the highest quality harvest of fruits with valuable traits. The article presents data on the development of phases of vegetation of elite hawthorn seedlings using natural, improved vase-like and sparse-tiered crown forms in the Central Black Earth Region. It was found that the greatest annual growth of shoots was observed in the elite seedling Michurinsky Dessertniy with an improved vase-like crown shape. The largest fruits were obtained from an improved vase-like crown shape of hawthorn trees, (Karamelka, 3.7 g; Tambovskiy Volk, 3.4 g).

1. Introduction

In recent years, the use in agriculture and medicine of useful and promising fruit and berry crops for the improvement of living conditions in cities and towns have become increasingly topical. The introduction into the culture of new non-traditional food plants, rich in biologically active substances, resistant to abiotic and biotic stressors, the cultivation of which excludes the use of pesticides, is a promising direction. In scientific institutions, comprehensive research is being carried out to study the biological characteristics of the formation of the yield in the main fruit crops. Particular attention is paid to the selection of an ecologically sustainable assortment and the selection of productive scion-rootstock combinations, including both native and introduced plants.

The nature of our zone is very rich in varieties and types of ornamental plants intended for use in medicine and gardening. Wild species have nutritional value for humans and adapt well to local climatic and ecological conditions [1-3]. Also, many wild species can be widely used to meet various human needs and are raw materials for some industrial production. The introduction of hawthorns in the Central Black Earth Region began at the VNIIS n.a. I.V. Michurin (now the Federal Research Center named after IV Michurin”) in 1988 in the department of selection of berry crops under the leadership of E.P. Kuminov (doctor of sciences in agriculture). More than 30 species of hawthorns were introduced, including Crataegus submollis Sarg (Emerson's thorn). One of the ways to obtain hawthorn seedlings is grafting [4]. Using the method of improved copulation, a high-quality planting
material of promising varieties was obtained for establishing technological experience. From the hybrid fund of E.P. Kuminov 17 promising seedlings were identified, including Karamelka, Michurinsky Dessertniy and Tambovskiy Volk [5-7]. In 2007, years’ experience began in the study of crown formation, quality of fruits, yield and growth activity in industrial plantings of hawthorn. The aim of this work is to study the growth and quality of fruits of selected forms of hawthorn in fruit-bearing industrial plantations with different crown shapes in the Central Black Earth Region.

2. Materials and methods
The research was carried out in experimental plantations of hawthorn of the department of berry crops of the Federal Research Center named after I.V. Michurin. Plants of promising seedlings Caramelka, Michurinsky Dessertniy and Tambovskiy Volk were selected as objects of research using natural improved vase-like and sparse-tiered crown forms.

3. Results and their discussion
The beginning of the growing season in 2013 in promising seedlings obtained on the basis of Emerson’s thorn, Karamelka, Tambovskiy Volk and Michurinsky Dessertniy (Figs. 1–3) was noted on April 19. The flowering time was 6-7 days. Fruit ripening began on August 20, and the duration of this period was 37 days. Leaf fall was observed from September 19 to October 2.

Figure 1. Hawthorn fruits of a promising seedling Karamelka

The growing process in 2014 began on April 4. The average air temperature during this period was 8.3 °C. The beginning of flowering in promising seedlings Karamelka, Michurinsky Dessertniy and Tambovskiy Volk was noted on May 10, at an average temperature of 19.2 °C. The duration of this phenophase ranged from 5 to 7 days for all varieties. The beginning of fruit ripening was noted on August 17; they ripened within 51 days.

Figure 2. Hawthorn fruits of a promising seedling Tambovskiy Volk
The duration of flowering in 2015 for all cultivars was 6-13 days. The studied seedlings: Michurinsky Dessertniy, Tambovskiy Volk and Karamelka were assigned to the early flowering group (May 11).

The beginning of fruit ripening was observed on August 5-8; ripening duration was 34-37 days; leaf fall occurred on October 8-10.

Figure 3. Hawthorn fruit of elite seedling Michurinsky Dessertniy

The analysis of 3-year data showed that the rates of development of hawthorn plants in 2013 and 2015 were similar and slightly different from the results of 2014. The growing season for all varieties in 2013 and 2015 began quite late (April 18-27) due to the insufficient amount of heat over that period.

In 2014, the growing season was early and lasted from 4th to 8th of April, the sum of effective temperatures was 16.5 °C. The duration of the growing season on average for 3 years was 182-184 days for all cultivars.

The formation of tree crowns in hawthorn plantations in the technological experiment was carried out using pruning in the winter-spring period. The tree crowns of promising seedlings Karamelka, Michurinsky Dessertniy, Tambovskiy Volk in 2013 significantly varied in width. Trees with an improved vase-shaped crown had the greatest width indicators: Michurinsky Dessertniy reached 1.4 m, Karamelka reached 1.8 m.

In 2014, in terms of the average crown width, a significant difference was observed in the Tambov wolf in the control variant (1.9 m) and with an improved vase-like crown shape (1.3 m).

According to the results of three-year studies, it was revealed that all varieties of hawthorn with a natural crown shape form the tallest plants. Analyzing the parameters of the crown in the section of all the studied varieties, it was found that its width varied from 1.1 to 2.0 m, depending on the variant of the experiment [2].

In order to analyze the influence of varietal characteristics on the growth activity of shoots of hawthorn trees, we studied the dynamics of growth of shoots of promising seedlings with different crown formations.

In 2013, the growth of shoots in elite seedlings, starting from April 26, increased gradually. The largest increase in annual timber fell on the period from 20 to 30 May. Weather conditions in the first ten days of June deteriorated significantly, so the growth activity of the shoots ceased.

In 2014, in the period from May 7 to May 29, the greatest increase in shoots was observed in the studied varieties with a sparse-tiered crown shape. The length of the growth of the shoots was up to 20 cm. Later, the shoots stopped their growth.

In 2015, Karamelka and other variants with a natural and sparse-tiered crown shape from May 7 to May 28 demonstrated increased length of the shoots by 4-6 cm. Then the growth slowed down. From May 28 to June 4 it amounted to only 1-2 cm, and after June 4th, shoot growth stopped (Fig. 4.). With
an improved vase-like crown shape, active growth of shoots was observed from May 7 to May 14; the growth was 11.1 cm. And at the end of growth activity (June 4) it was 33.9 cm.

**Figure 4.** Growth dynamics of plant shoots of the promising seedling Karamelka, 2015

The growth rates of promising seedlings Michurinsky Dessertniy, Tambovskiy Volk and Karamelka in 2015 were similar (Figs. 4, 5 and 6). The largest indicators of the length of the growth of shoots in Michurinsky Dessertniy plants were obtained in the variant with an improved vase-like crown shape (36.0 cm).

**Figure 5.** Growth dynamics of plant shoots of a promising seedling Michurinsky Dessertniy, 2015
Another activity was carried out to assess the terms of the potential productivity of promising hawthorn seedlings depending on the shape of the crown under the conditions of the Central Black Earth Region.

When calculating the potential productivity in 2013 in hawthorn plants, the most significant difference was noted between the number of flowers and the number of formed ovaries: apparently, due to insufficient pollination, the flowers were discarded and did not form an ovary. The number of flowers per 1 rm of a branch varied in promising seedlings of the Tambovskiy Volk (278-349 pcs.), Michurinsky Dessertniy (199-307 pcs.) and Karamelka (202-293 pcs.) (see Table 1).

However, much less ovaries per 1 running meter of branch survived: 122-289 pcs. of the Tambovskiy Volk and 62-156 pcs. of Karamelka seedling. The promising seedling Michurinsky Dessertniy has the least number of ovaries in comparison with other varieties (104-135 pcs.). The maximum saturation of branches with fruit wood was noted in the forms of the Emerson's thorn Tambovskiy Volk (up to 247 pcs.) and Michurinsky dessert (120 pcs.) with an improved vase-like crown shape. As a result of the studies carried out, significant differences were established between the varieties of hawthorn in terms of the average weight of the fruit. For the Michurinsky Dessertniy and the Tambov Volk, the maximum fruit weight was observed in the variant with a sparse-tiered crown shape. As for the elite seedling Karamelka the maximum was noted in the control variant.

Evaluation of potential components of productivity in hawthorns for the 2015 study showed that the branches with the maximum number of fruits per 1 running meter were demonstrated by the varieties Karamelka and Tambovskiy Volk with a sparse-tiered crown shape.

As a result of the three-year research, it was revealed that according to the maximum number of fruits per 1 running meter of the branch, the plants of the promising seedling Tambovskiy Volk were distinguished in the variant with an improved vase-shaped crown shape (165 pcs.). In plants of seedlings Karamelka and Michurinsky Dessertniy, the largest number of fruits was noted in the control variant with a natural crown shape (82 and 108 pcs.).
Table 1. Summands of the potential productivity of hawthorn plants with different crown shapes (on average for 2013-2015)

| Variety       | Crown shape              | Number, [pcs. per running meter] | Average fruit mass [g] |
|---------------|--------------------------|----------------------------------|------------------------|
|               |                          | Head flowers ovaries fruits      |                        |
| Karamelka     | Natural (k)              | 12 215 90 82                     | 3.5                    |
|               | Improved vase-like       | 15 168 63 59                     | 3.7                    |
|               | Sparse tiered            | 18 215 81 67                     | 3.6                    |
|               | LSD0.5                   | 5 15 9 6                        | 0.4                    |
| Michurinsky   | Natural (k)              | 22 203 116 108                   | 3.3                    |
| Dessertniy    | Improved vase-like       | 22 199 95 82                     | 3.8                    |
|               | Sparse tiered            | 19 279 116 106                   | 3.9                    |
|               | LSD0.5                   | 5 20 6 9                        | 0.6                    |
| Tambovskiy    | Natural (k)              | 18 288 150 123                   | 3.2                    |
| Volk          | Improved vase-like       | 22 272 186 165                   | 3.4                    |
|               | Sparse tiered            | 21 236 161 141                   | 3.2                    |
|               | LSD0.5                   | 5 15 6 7                        | 0.7                    |

4. Conclusion
The greatest total growth was noted in the seedling Karamelka (33.9 cm) in the control variant. Promising seedlings Michurinsky Dessertniy and Tambovskiy Volk grew most actively with an improved vase-like crown shape (31.8-35.3 cm).

The maximum fruit weight of 3.3-3.9 grams was characteristic of the Michurinsky Dessertniy seedling. The crown shape did not have a significant effect on the fruit weight of the studied varieties; the average fruit weight depended more on the varietal characteristics.

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