

Indicators of Growth and Development in the Second Field of Stock and Variety Root Stock Nursery

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Annotation: This article presents the results of an experiment conducted to study the growth indicators of the 2nd field of the nursery with a deep scientific analysis.

Keywords: nursery, 2nd field, growth indicators, ontogenesis, root stock, shrubs, dwarf apple.

Introduction

In addition to the dwarf apple (*Malus pumila*), Siberian apple (*Malus baccata*), and cultivated apple varieties (*Malus domestica*), dwarf and semi-dwarf forms also exist in other species of the *Malus* genus. Examples of these include Sievers apple (*Malus Sieversii*), Zhukovsky apple (*Malus manshurica* subsp. *Zhukowskyi*), Turkmen apple (*Malus turkmenorum*), Komarov apple (*Malus Komarovii*), Siebold apple (*M. Sieboldii*), Sargent apple (*M. Sargentii*), and others [1-4].

The presence of stunted forms in different apple species in different geographical regions indicates that the process of emergence of dwarf and semi-dwarf plants is not an absolute characteristic of any one species, but rather a characteristic of the entire genus *Malus* [5-12].

Dwarfing emerged as a morphophysiological phenomenon in the *Malus* genus during the evolutionary process. Dwarf apples are distinguished by their high ecological plasticity and wide adaptive potential compared to vigorous trees. It is known that herbaceous forms are highly progressive compared to woody ones [8]. Scientists argue that shrubs and herbs originated from their somewhat taller ancestors. [6]. The anatomical, morphological and physiological characteristics of dwarf apples: well-developed bark compared to wood [5], a relatively short period of cambium activity [2], a relatively short life span compared to vigorous trees [11], indicate their evolutionary proximity to shrubs and perennial herbs. It can be assumed that dwarf apples are a specific life form in the evolutionary process of the transition of trees to herbs.

Materials and methods

The experiments were carried out in 2021-2022 at the experimental fields of Hirosaki University in Japan and in 2023-2024 at the Bandikhon Experimental Farm of the Academician Mahmud Mirzayev Research Institute of Horticulture, Viticulture and Winemaking in the following options:

Sections of shoots and roots were fixed in a mixture of water, alcohol and glycerin (3:2:1). Transverse sections with a thickness of 40-60 μm were prepared from the fixed shoots using a hand microtome. Transverse sections of shoots were examined under a "BIOLAM-LOMO" microscope using an object micrometer. At low magnification (64 times), the diameter of the phloem, xylem and phloem was examined, and the number of vascular tubules in a conventional square of the micrometric grid was counted, and at high magnification (320 times), the diameter of the vascular tubules (large and small) was examined. Then, the area of the phloem, xylem and phloem was calculated, and the number of vascular tubules per 1 mm^2 was counted. The following parameters were also calculated.

Transpiration rate was determined using field transpyrometers according to the method of Spot (1960, 1979). The initial assessment of the growth force of rootstocks was determined by the following indicators:

- ✓ root hair length according to I.A. Muromtsev (1969);
- ✓ phloem and xylem ratio in the root according to Beakbane and Thompson (1947);
- ✓ stomata number per unit leaf area according to Karychev (1997).

Statistical analysis of the research results was carried out using a computer using the analysis of variance method (Dospekhov, 1979; Potapov, Kashin, Kursakov, 1997).

Research results and discussion

In the second field of the nursery, the study of growth indicators in variety-root stock combinations was continued (Table 1).

Experimental data show that the height of seedlings depends on both the variety and the root stock. One-year-old seedlings of the variety Wide David/M-27 were higher on all root stocks than seedlings of the variety Starkrimson/M-27.

Table 1. At the end of growth, the height of plants in the 2nd field of the nursery, cm

Variety-root stock combinations	Years of research	
	2023	2024
Wide David/M-27	-	93,0
Starkrimson/M-27	-	-
Wide David/M-25	-	-
Starkrimson/M-25	-	-
Wide David/M-9	-	96,4
Starkrimson/M-9	-	80,1
Wide David/M-26	-	97,2

Starkrimson/M-26	-	78,2
Wide David/MM-102	109,2	83,0
Starkrimson/MM-102	-	-
Wide David/M-7	106,6	80,3
Starkrimson/M-7	106,2	70,2
Wide David/MM-104	105,3	85,5
Starkrimson/MM-104	93,2	73,6
Wide David/MM-106	-	107,0
Starkrimson/MM-106	-	90,1
Starkrimson/MM-111	-	-

Comparing the sizes of the variety Batta on different root stocks, it can be noted that the plants on dwarf root stocks (except for plants grafted on M-7) were lower than those grafted on the medium-growing MM-106 root stock. This is especially true for the Starkrimson/M-27 variety. The difference between seedlings grafted on different root stocks was less noticeable for the Wide David/M-27 variety. Compared to other seedlings, the Wide David/M-27 variety grafted on a strong-growing seed root stock was the highest.

A study of the dynamics of the growth of annual seedlings showed that at the beginning of summer (the period of active growth), the most rapid growth of annuals was characteristic of dwarf root stocks (Table 2). At the end of the growth period, the growth rate of scion grafts on dwarf root stocks was slower than on semi-dwarf, medium-growing and strong-growing root stocks.

Table 2. Growth dynamics of plants in field 2 of the nursery, cm, 2023.

Variety-root stock combination	Observation date							
	15.05	05.06	15.06	25.06	01.07	16.07	01.08	20.08
Starkrimson/M-27	38,2	50,3	61,7	76,2	94,6	98,2	103,4	107,1
Wide David/M-25	44,7	57,8	67,9	73,2	80,4	86,3	93,2	97,4
Starkrimson/M-25	40,8	54,3	64,1	70,3	77,8	78,8	81,7	84,8
Wide David/M-9	46,7	59,1	70,2	79,1	88,2	92,4	97,1	101,8
Starkrimson/M-9	36,1	50,7	63,3	76,3	85,4	89,1	93,4	95,3
Wide David/M-26	47,7	58,1	71,6	84,2	95,5	102,5	107,8	111,2
Starkrimson/M-26	46,5	56,2	66,2	78,6	91,5	94,1	96,6	101,8
Wide David/MM-102	44,5	58,2	69,7	80,1	89,1	98,1	106,6	113,2
Starkrimson/MM-102	39,5	55,3	64,1	77,7	88,5	95,1	104,3	110,1
Wide David/M-7	44,8	58,8	70,2	83,5	99,0	105,7	116,2	121,1
Starkrimson/M-7	32,1	49,1	60,0	78,3	80,3	89,1	96,6	98,5
Wide David/MM-104	47,2	53,1	65,4	80,1	91,3	99,1	108,1	118,0
Starkrimson/MM-104	41,4	50,3	59,5	74,3	86,2	90,4	94,4	100,6
Wide David/MM-106	47,3	54,3	66,5	82,7	91,2	98,7	107,3	116,0
Starkrimson/MM-106	37,0	49,7	57,5	78,1	86,6	93,5	99,1	107,7
Starkrimson/MM-111	45,2	57,5	70,3	87,8	103,2	105,1	108,6	131,7

This growth pattern of one-year-old seedlings has been noted by a number of scientists. It has been emphasized that the growth vigor of seedlings in the second field of seedlings depends mainly on the biological characteristics of the rootstock used.

According to other scientists, the grafted variety has a strong influence on the growth vigor of one-year-old seedlings. Our experimental data have shown that the size of one-year-old seedlings depends on the interaction of the variety with the rootstock.

To characterize the growth processes in seedlings, the absolute growth rate of plants in the second field of the street was calculated (Table 3).

Table 3. Absolute rate of growth of annual plants in the nursery, cm/day

Variety-root stock combination	Years of research	
	2023	2024
Wide David/M-27	0,858	-
Starkrimson/M-27	-	0,714
Wide David/M-25	-	0,534
Starkrimson/M-25	-	0,440
Wide David/M-9	0,726	0,563
Starkrimson/M-9	0,639	0,608
Wide David/M-26	0,678	0,656
Starkrimson/M-26	0,457	0,567
Wide David/MM-102	0,633	0,712
Starkrimson/MM-102	-	0,731
Wide David/M-7	0,549	0,797
Starkrimson/M-7	0,517	0,688
Wide David/MM-104	0,641	0,737
Starkrimson/MM-104	0,559	0,608
Wide David/MM-106	0,834	0,712
Starkrimson/MM-106	0,641	0,737
Starkrimson/MM-111	-	0,911

Among the varieties studied, plants grafted onto the seed root stock and the medium-growing MM-106 root stock grew the tallest. At the same time, plants grafted onto superdwarf (M-27) and dwarf (M-7 and MM-102) root stocks were close to these plants in terms of growth rate. The lowest growth rate was observed in the Wide David/K102 and Starkrimson/M-25 variety-root stock combinations. The difference in growth rate of varieties within the same root stock, as a rule, was not significant.

Comparing the growth rates of grafted plants and rootstocks, it can be said that it is the rootstock that has the strongest influence on growth processes. In the first field, slow growth (relative to others) of the M-25 rootstock was observed. Varieties grafted on this rootstock grew more slowly than on other rootstocks in the second field of the nursery. Thus, the growth rate of grafted plants largely depends on the rootstock used.

Measurement of the length of the internodes in the seedlings showed the following results (Table 4). The tabular data show that the length of the internodes in one-year-old seedlings has a tendency to increase from the superdwarf M-25 root stock to the semi-dwarf MM-104 root stock. This indicator was highest in one-year-old seedlings of the Starkrimson variety grafted onto a strong-growing seed root stock. At the same time, it should be noted that grafted onto the superdwarf M-27 root stock.

Table 4. The length of the joint intervals of the grafted plants in the 2nd field of the nursery, mm, the 3rd ten days of August

Variety-root stock combination	Internode length, mm	
	2023 year	2024 year
Starkrimson/M-27	30,2	31,8
Wide David/M-25	23,1	24,2
Starkrimson/M-25	27,1	26,8
Wide David/M-9	23,5	24,2
Starkrimson/M-9	27,3	26,9
Wide David/M-26	25,7	25,9
Starkrimson/M-26	28,2	27,5

Wide David/MM-102	26,4	27,3
Starkrimson/MM-102	30,1	32,4
Wide David/M-7	26,1	29,3
Starkrimson/M-7	30,2	28,5
Wide David/MM-104	28,0	32,3
Starkrimson/MM-104	31,2	27,3
Wide David/MM-106	26,2	29,5
Starkrimson/MM-106	27,6	29,4
Starkrimson/MM-111	33,3	35,2

In Starkrimson seedlings, the internode length was at the level of seedlings grafted on the dwarf MM-102, and did not differ significantly from that on the Starkrimson/MM-104 rootstock. Seedlings on the medium-growing MM-106 rootstock had lower internode length than one-year-old seedlings on semi-dwarf and strong-growing rootstocks (on the Starkrimson variety - at the level of M-9, on the Wide David variety - at the level of MM-102).

In all rootstocks, the internode length was higher in the Starkrimson variety than in the Wide David variety.

As is known, internode length is a varietal characteristic of apples.[250]. In addition, this indicator varies depending on the age of the plant [45].

Conclusion

It should be noted that the nature of the difference in internode length in the first field of the nursery is also largely repeated in the varieties grafted onto these rootstocks in the second field of the nursery. In the first field, the shortest internode was on the M-25 rootstock, while in the second field - on the Wide David variety grafted onto this rootstock (relative to the options of this variety grafted onto other rootstocks). Thus, both the variety and the rootstock affect the internode length of one-year-old seedlings. As in the first field of the nursery, the length of the internode does not depend on the potential growth force of the variety-rootstock combination.

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