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RESULTS OF RESEARCH CONDUCTED ON VARIOUS APPLE ROOTSTOCKS UNDER THE SOIL AND CLIMATE CONDITIONS OF FERGANA REGION

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Abstract

Studies conducted under low-fertility, stony-gravelly soil conditions confirmed that apple trees on dwarf and semi-dwarf rootstocks come into bearing earlier than seedlings with a strong (vigorous) root system. Because the growth vigor of interstock (interkalyar) seedlings is limited, such seedlings can be planted more densely per unit area, making it possible to establish intensive orchards with at least 1,000 trees per hectare.

Keywords

rootstock, adaptive, M-9, MM106, interstock, vigorous, yield, dwarf, semi-dwarf, trunk girth, cross-sectional area.

FARG‘ONA VILOYATI TUPROQ-IQLIM SHAROITIDA OLMANING TURLI PAYVANDTAGLARI BO‘YICHA O‘TKAZILGAN TADQIQOT NATIJALARI

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Akademik Mahmud Mirzaev nomidagi bog‘dorchilik, uzumchilik va vinochilik ilmiy-tadqiqot instituti Farg‘ona ilmiy tajriba stansiyasi direktori ‘rinbosari, q.x.f.n.

Annotatsiya. Unumdorligi past tosh-shag‘alli tuproq sharoitida o‘tkazilgan tadqiqotlar pakana va yarimpakana payvandtagli olma daraxti kuchli ildiz tizimiga ega bo‘lgan ko‘chatlarga nisbatan hosilga ertaroq kirishini tasdiqladi. Interkalyar k’chatlarda ‘sish kuchining cheklanishi sababli, bunday k’chatlarni maydaon birligida zichroq, gektariga kamida 1000 tupgacha joylashtirib intensiv bog`lar barpo qilish mumkin.

Kalit so‘zlar. Payvandtag, adaptiv, M-9, MM106, interkalyar, kuchli o‘suvchi, hosildorlik, pakana, yarimpakana, tana aylana uzunligi, ko‘ndalang kesim yuzasi.

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РЕЗУЛЬТАТЫ ИССЛЕДОВАНИЙ РАЗЛИЧНЫХ ПОДВОЕВ ЯБЛОНИ В ПОЧВЕННО-КЛИМАТИЧЕСКИХ УСЛОВИЯХ ФЕРГАНСКОЙ ОБЛАСТИ

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Аннотация. Исследования, проведенные в условиях каменисто-гравийных почв с низким плодородием, подтвердили, что яблоня с карликовым и полукарликовым подвоем начинает плодоносить раньше, чем саженцы с сильной корневой системой.

В связи с ограничением силы роста в интеркалярных саженцах, такие саженцы можно размещать более плотно, не менее 1000 штук на гектар, создавая интенсивные сады.

Ключевые слова. Подвой, адаптивный, М-9, ММ106, интеркалярный, сильнорастущий, урожайность, карликовый, полукарликовый, длина окружности тела, площадь поперечного сечения.

Introduction

Intensifying horticulture requires the use of low-vigor rootstocks that enable dense tree planting and the creation of new orchard structures, forming a canopy that makes more efficient use of the substances produced within plant tissues, and correctly choosing the tree-planting scheme [8; 11]. It is known that designing an intensive orchard consists of developing variety–rootstock combinations and canopy-formation systems suited to growth vigor, which in turn gives fruit trees optimal optical and physiological characteristics [4].

For this reason, the rootstock is an essential component of an intensive orchard, since the variety's valuable economic traits, productivity, earliness of fruiting, growth vigor, fruit quality, and adaptability all depend on it [1].

In particular, a number of studies have confirmed that interstock seedlings with a strong root system show increasing yields over the years and, in terms of long-term indicators, outperform dwarf rootstocks [2; 3; 7; 9; 12].

The rootstock selected for a given soil and climate condition determines the degree

of adaptability to environmental stress factors, the dynamics of increasing yield, the stability of fruit-bearing for the variety–rootstock combination, and the commercial and consumption quality of the fruit.For this reason, a long-term experiment was established at the Fergana Scientific Experimental Station with the aim of selecting rootstocks suited to local conditions, giving them an objective evaluation, and covering the full multi-year cycle from planting through orchard maturity to the decline of yield.

Materials and Methods

Research on four types of rootstocks — M-9, MM-106, interstock, and vigorous seedling rootstocks — planted in 2020 in low-fertility, stony-gravelly soil conditions of Fergana region is being conducted using generally accepted methodology [12].

Statistical analysis was performed according to the method of B.A. Dospekhov [13]. M-9 rootstock was used in preparing the interstock seedlings.

Results and Discussion

In the fourth year after planting, the yield of 'Golden Delicious' apple seedlings varied depending on the rootstock. In particular, in 2023 the yield per hectare was 64 centners (quintals) for M-9, 32 centners for MM-106, 17.3 centners for the interstock, and 7.6 centners for the vigorous rootstock (Table 1). Observations showed a steady increase in apple yield over time. In 2023, apple trees on M-9 rootstock produced 2.8 kg per tree (56 c/ha); in 2024, 5.6 kg (112 c/ha); and in 2025, 10.2 kg and 204 c/ha, respectively.

On MM-106 rootstock, the yield per tree was 3.2 kg, giving 32 c/ha. In 2024 this rose to 8.3 kg and 83.3 c/ha, and in 2025 to 15.6 kg and 156 c/ha. Yield on the interstock rootstock rose from 14 c/ha in 2023 to 59.9 c/ha in 2024 and 78.6 c/ha in 2025. On the vigorous seedling rootstock, yield rose from 7.6 c/ha in 2023 to 55.6 c/ha in 2025. Although, starting in 2024, per-tree yield was highest for MM-106, the interstock, and the vigorous rootstock, the highest overall yield per hectare was recorded for M-9, which had the greatest planting density — 2,000 trees per hectare.

Our research once again confirmed that seedling density is the strongest factor influencing yield across rootstocks. Thus, apple orchards established on this basis reached their sixth year

No.	Rootstock name	Seedling density, trees/ha	2023		2024		2025		Average over 3 years		
			Yield per tree, kg	Yield, c/ha	Yield per tree, kg	Yield, c/ha	Yield per tree, kg	Yield, c/ha	Yield per tree, kg	Yield, c/ha	Additional yield, c/ha
1	M-9	2000	2.8	56	5.6	112.0	10.2	204.0	6.2	124.0	–
2	MM-106	1000	3.2	32	8.3	83.3	15.6	156.0	9.0	90.4	-33.6
3	Interstock	666	2.1	14.0	9	59.9	11.8	78.6	7.6	50.8	-73.2
4	Vigorous (seedling)	400	1.9	7.6	9.1	36.4	13.9	55.6	8.3	33.2	-90.8
	LSD05 **LSD05**		3.6 c/ha 12.2%		5.2 c/ha 7.1%		7.0 c/ha 5.7%				

Table 1. Yield of apple trees on different rootstocks ('Golden Delicious' variety, planted n 2020).

(2025), by which point a direct relationship was found between yield per unit area and seedling density for each rootstock. Thus, the studies confirmed that apple trees on dwarf and semi-dwarf rootstocks come into bearing earlier than seedlings with a strong root system.

Analysis of the data on growth vigor showed that these processes are directly related to rootstock type. In particular, in 2023 seasonal shoot growth on M-9 and MM-106 rootstocks was 48.4–56.7 cm, while on the interstock and vigorous rootstocks it was 37.2 and 46.2 cm, respectively (Table 2).

No.	Rootstock name	Annual shoot growth, cm			Canopy diameter, m			Trunk girth, cm			Trunk cross-sectional area, cm2			Yield per tree, kg			Yield per unit trunk cross-section, kg/cm2		
		2023	2024	2025	2023	2024	2025	2023	2024	2025	2023	2024	2025	2023	2024	2025	2023	2024	2025
1	M-9	48.4	77.1	48.4	1.3	1.8	2.0	14.0	21.2	23.8	16.7	35.9	45.3	2.8	5.6	10.2	0.17	0.16	0.22
2	MM-106	56.7	83.8	49.3	1.8	1.9	2.2	15.3	21.0	23.3	20.0	35.0	43.0	3.2	8.3	15.6	0.16	0.24	0.36
3	Interstock	37.2	87.3	51.7	1.7	2.0	2.1	13.8	21.9	23.8	16.3	38.2	45.3	2.1	9.0	11.8	0.20	0.24	0.26
4	Vigorous (seedling)	46.2	91.1	54.0	1.5	2.4	2.3	17.2	25.1	27.2	25.3	49.9	58.1	1.9	9.1	13.9	0.08	0.18	0.24

Table 2. Growth and development processes and yield load of apple trees on different rootstocks

However, by 2024 the highest annual shoot growth was recorded for the interstock

(87.3 cm) and vigorous (91.1 cm) rootstocks, which have strong root systems. In 2025 the same pattern by rootstock persisted for shoot growth.

In terms of canopy diameter, the vigorous rootstock (2.4 m) again showed the greatest growth in 2024, while M-9 showed the least growth (1.8 m). In 2025 as well, MM-106 and the vigorous rootstock led in canopy growth. The experiment showed that the interstock rootstock acted as a limiting factor for canopy growth: canopy size on the interstock rootstock was noticeably smaller than on the vigorous rootstock over the three years (1.7–2.0–2.1 m), and was nearly the same as MM-106.

Grafting M-9 onto the trunk of a vigorously growing wild seedling rootstock, to prepare interstock seedlings, significantly limits the growth of the resulting canopy.

Because the growth vigor of interstock seedlings is limited in this way, such seedlings can be planted more densely per unit area, making it possible to establish intensive orchards with at least 1,000 trees per hectare. The highest values for trunk girth and the corresponding cross-sectional area over 2023–2024–2025 were found, respectively, on the vigorous rootstock (17.2–25.1–27.2 cm and 25.1–49.9–58.1 cm^2).

Analysis of yield per unit of trunk cross-sectional area showed that apple trees on the interstock and MM-106 rootstocks outperformed those on the dwarf (M-9) and vigorous rootstocks.

Specifically, yield per unit cross-sectional area on the interstock rootstock over 2023–2024–2025 was 0.20–0.24–0.26 kg/cm^2, and on MM-106 it was 0.16–0.24–0.36 kg/cm^2, whereas relatively lower values were recorded on M-9 (0.17–0.16–0.22 kg/cm^2) and the vigorous rootstock (0.08–0.18–0.24 kg/cm^2).

Conclusions and Recommendations

Our research confirmed that, under low-fertility, stony-gravelly soil conditions, M-9 and MM-106 rootstocks show more rapid development and earlier entry into bearing during the early years of apple tree life compared with the vigorous and interstock rootstocks.

Given the relatively limited growth vigor of interstock seedlings, it is recommended that such seedlings be planted more densely per unit area, at a rate of at least 1,000 trees per hectare, to establish intensive orchards.

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