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ABSTRACT

of the dissertation for the degree of Doctor of Sciences

**INTENSIVE AGROTECHNOLOGICAL PROCESSING OF
FRUITS IN THE NORTH-EAST REGION OF AZERBAIJAN**

Specialty: **3103.08-Fruit growing and viticulture**

Field of science: **Agrarian sciences**

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Ganja - 2021

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GENERAL DESCRIPTION OF THE RESEARCH

Relevance and degree of completion of the topic. Currently, extensive research is being conducted worldwide on the effective placement and intensive development of fruit plants with different bioecological characteristics in the local environment. As our country is on the path of a market economy, varieties and rootstocks are of greater importance. Because the variety, along with market qualities, is also a key element in the intensification of horticulture, rootstocks have a direct impact on increasing the density of crops and the period of commodity production. This problem is especially urgent due to the growing population density in the world and our country, the widespread use of arable lands in the plains under residential, industrial, and road constructions, use of various agricultural crops as a product of daily consumption. In this regard, the special role of "genotype-environment" components in the formation of fruit production stands out. To address all these issues, the main goal of our research is to re-examine the potential of the region's orchards, to place the cultivars under appropriate conditions, to select the most suitable rootstock-variety combinations, and to study the factors influencing their potential.

Until recent years, agro-technical measures applied in orchards were based only on certain observations and considerations. The solution of issues related to the planting superintensive orchards from foreign varieties and rootstocks, technological care to uncover potential opportunities, the scientifically sound research based on local conditions, application, as well as accelerated fruiting and increasing potential productivity period are the urgent problems of the day.

Given that currently the average productivity of orchards is 65.7 cwt/ha, and in modern horticultural practice, orchards with productivity lower than 200 centners can not be considered profitable, so the structure of orchards should be changed, technologies developed following local conditions.

Fruit growing in the north-eastern region of Azerbaijan has an ancient history, accounting for up to 50% of fruit production in the country. One of the urgent problems of the day is to ensure the development of regional fruit growing on an innovative basis, as well as to meet the growing demand for environmentally friendly products, to provide high-quality products that can enter the world market.

The purpose and tasks of the research. Given the great role of the region in fruit production for the country, the main goal is to develop a scientific basis and practical recommendations for the cultivation of local and introduced fruit and vegetable varieties, rootstocks, and species based on modern, innovative technologies. In this regard, the study of the following issues is included in the research program as a task.

1. Analysis of the modern period based on the history of fruit growing in the region;

2. Analysis of the current status of fruit groups;

3. Development of advanced stalk production technology;

4. Plants belonging to the group of pome and stone fruits grown in large areas - traditional and new types of varieties, rootstocks, planting schemes, food fields, and canopy forms;

5. Non-traditional and new fruit crops for the region - varieties, rootstocks, planting schemes, nutrient fields, and canopy forms.

Main points presented to the defense of the dissertation:

- The sown area of fruit and berry crops existing in the republic, productivity, and production were determined and on this basis, the degree of satisfaction of the population's demand for fresh fruit was analyzed;

- When new orchards were planted in the region, the scheme of placement of orchards in micro-zones depending on rootstock-variety combinations was given;

- Propagation of clonal seedlings, compliance of rootstock-variety combinations, advantages of modern stalk growing technology were presented;

- Economic and biological features of pome and stone fruit plants grown in large areas of the region were studied;
- Economic and biological characteristics of almond and hazelnut plants, which are non-traditional and new fruit crops for the region, were studied;
- Depending on the rootstock-variety combinations, the nutrient areas of fruit plants were determined and optimal planting schemes were given accordingly.

Scientific novelty of the research. For the first time in our country, scientific and practical bases for the development of fruit growing with innovative technologies have been developed.

Practical significance of the research. To provide an abundance of products in the domestic market and open the way to foreign markets by revealing the potential of fruit plants through the application of new types of gardens and technologies.

Approbation and application of the work. The results of the research were presented and approved at the Final scientific conferences of the research work of ASAU and Research Institute of Fruit and Tea Growing in 2012-2016, International Scientific Conference dedicated to the 75th anniversary of CBG, ANAS (2009), Scientific-practical conference "Problems of food security on the basis of enrichment and improvement of agrarian science" dedicated to the 100th anniversary of A.S. Narimanov, held at Azerbaijan Research Institute of Horticulture and Subtropical Plants, International Scientific-Practical Conference "Modern Agrarian Science: Actual Problems and Prospects of Development in the Context of Globalization" dedicated to the 85th anniversary of ASAU (2014), International scientific-methodical conference on "Introduction, conservation and biodiversity of fruit plants", Dagestan (Makhachkala) in 2014, International All-Russian Scientific-Practical Conference "Problems of Horticulture and Prospects for Sustainable Development", Dagestan (Makhachkala) in 2015, International Scientific-Practical Conference in Michurinsk (2015), International Scientific-Practical Conference on "Selection of Viticulture, Vegetable and Subtropical Fruit Plants and Application

of Innovative Technologies" held in Derbent (2016), International Scientific-Practical Conference on "Innovative Development of Agrarian Science and Education: World Experience and Modern Priorities" dedicated to the proclamation of 2015 as the "Year of Agriculture" in the Republic of Azerbaijan, held at ASAU (2015).

The results of the research are widely used in nursery farms and super-intensive type orchards located in the Guba-Khachmaz region.

Name of the organization where the dissertation was performed: The dissertation was performed at the Azerbaijan State Agrarian University.

Total volume of the dissertation in characters with an indication of the separate volumes of the structural units. The dissertation consists of an introduction, five chapters, conclusions, a list of 281 references, and appendices. Of these sources, 135 are in Azerbaijani and 146 in foreign languages. The dissertation contains 84 tables and 20 figures. In the structure of the dissertation, the title part and the table of contents are 6 pages with 16,130 characters, the introduction is 4 pages with 8,792 characters, the first chapter is 78 pages with 147,983 characters, the second chapter is 19 pages with 30,254 characters, the third chapter is 127 pages with 21,5521 characters, the fourth chapter is 24 pages with 42,638 characters, the fifth chapter is 19 pages with 36,895 characters, conclusions contain 6 pages with 13,460 characters, recommendations for producers is one page with 1,656 characters and the reference list contains 31 pages with 56,434 characters.

The total text of the dissertation (excluding figures, tables, graphs, appendices, and reference list) is 208 pages of computer typing or 431,591 characters.

CONTENT OF THE WORK

The introduction substantiates the relevance of the research, the purpose, scientific innovations of the work, and the practical significance of the results obtained.

Chapter I. Degree of the problem study. This chapter presents the description and analysis of the history and current state of development of fruit growing in the country and the region, the share of fruit and vegetable groups in existing orchards (arable land, orchard productivity, and production). literature data on main properties of the traditional (apple, pear, sweet cherry, plum) and new (hazelnut, almond) fruit plants for the production of marketable products in the region, traditional and new types of rootstocks, planting schemes, nutrient fields, canopy forms [4,9,13,16,17].

Chapter II. Research conditions, material, program, and methodology.

Research conditions. The soil and climatic conditions in the Guba-Khachmaz region, where the study was conducted in 2012-2016, were analyzed and it was considered to be completely suitable for the cultivation of the studied fruit crops.

Research material. Economical and biological properties of some previously and newly introduced varieties of four traditional fruit species (apples, pears, cherries, plums) on different rootstocks, planting schemes, and garden types as well as the new and non – traditional hazelnut and almond plants in the production of marketable products in the North-Eastern region of the country were studied. The rootstocks M-9, MM-106, wild forest apple, and apple varieties such as Gala, Jonagored, Golden Reinders, Granny Smith, Aydared, Red Winter, Fuji, Simirenko reneti, Golden Delicious x 972, Jonagold; pear rootstocks BA-29, wild forest pear, pear varieties Conference, White Williams, Red Williams, Forelle, Guyot, Kure, Talgar gyozele, Meshe gyozele; sweet cherry rootstocks Maxima-14, wild sweet cherry, sweet cherry varieties Belge, Burlat, Summit, Kordia, Regina, Kel ureyi, Sari Dragana and Napoleon; MIR-29C and wild cherry-plum rootstocks and Angelina, Black Amber, Fortune, President, Stanley, Anna Shpet, Khurmayi Vengerka, and Italian Vengerkasi varieties of the plum plant, the most promising rootstocks and varieties of hazelnuts and almonds grown in the zone and recently introduced were taken as research material.

Research program. The research program includes the following issues:

1. Selection of rootstocks and varieties for the studied species, development of advanced stalk production technology;
2. Study of height, productivity, commodity, and economic indicators of fruit plants by rootstock-variety combinations;
3. Determination of economic efficiency of production.

The following indicators were studied during the solution of the mentioned issues:

1. Phenological phases by species;
2. Biometric indicators by species;
3. Annual productivity and productivity every two years by species;
4. Net photosynthesis rate;
5. Commodity quality indicators of fruits;
6. Exposure to diseases and pests by species;
7. Farming and economic indicators by species.

Research methodology. The issues raised were mainly studied based on generally accepted methods of gardening.

Issues related to diseases and pests were resolved by the methods of A.E. Chumakov; Titov D.A; Popkovoy K.V., Shmigli V.A., Net photosynthesis rate (NPR) was determined by the "ringing" method proposed by A.S. Ovsyanikov.

Economic efficiency indicators were studied using the methodology proposed by P.V. Dubrova, experimental research materials were developed by the methods of mathematical analysis of B.A. Dospekhov and S.V. Frolova.

Chapter III. Technology of cultivation of traditional and new fruit crops.

3.1. Production technology of the planting material (stalk).

Cultivation of rootstocks. One of the main conditions for the intensification of horticulture is the small size of the canopy of fruit plants and the small projection area. To achieve this, first of all, the rootstocks must be selected correctly.

Besides, a standard type of rootstocks cannot be used in all cases and the selection of rootstocks should be based on climatic conditions of the region [1].

Stalk cultivation technology. In the cultivation of stalks, new and advanced technologies were applied in the nursery areas of the Research Institute of Fruit and Tea Growing and Guba Regional Agrarian Science and Innovation Center. The main essence of this technology is to increase the yield of stalks from a unit area using the hill planting method, improve the quality and reduce the cost price of stalks.

Examination of the budding capacity in summer revealed sharp differences in all fruit plants depending on the rootstocks. The budding capacity of wild forest apple was 81.9%, while on clonal rootstock, this parameter ranged between 87.7% and 93.7%. Pajam-1 (88.0%) was the best among rootstocks. In the pear plant, the budding capacity of seedling rootstocks was lower compared to vegetative rootstocks. In BA-29 and OHF-333 rootstocks, the budding capacity was in the range of 85.0-87.0%, whereas, the budding capacity of wild forest pear and Jir Nadiri seedling rootstocks amounted to only 76.7-79.3%.

However, in sweet cherry plants, the budding capacity was lower compared to all other fruit species (70.8-76.8%) and slightly higher compared to vegetative rootstocks.

In plum and peach plants, the budding percentage on clonal rootstocks was also high. The highest budding percentage was found for varieties on the MIR-29C rootstock.

Studies have shown that there is no significant difference between varieties in terms of grafting capacity on the same rootstock [2,6].

3.2. Fruit production technology.

Traditional fruit plants. The results of the study of apple, pear, sweet cherry, and plum plants, old and newly introduced varieties, which are important in the production of marketable fruits in the region and, as well as rootstocks that can meet the requirements of modern horticulture are presented.

Apple plant. Apple plant is considered the main fruit plant in the region [5].

Vegetation period. Numerous observations in different areas of the region have shown that apple varieties grown in the region, regardless of the rootstocks, are developing normally in the micro-zones. The existing soil and climatic conditions in the region are suitable for every phase of the annual development period of the apple plant.

Growth characteristics of trees. The main advantage of modern intensive orchards is the production of high-quality and stable crops per hectare of land. Intensive type orchards should be high-yielding, suitable for the soil and climatic conditions of the region, yielding high-quality products, resistant to diseases and pests, which fruit and give a commodity product quickly due to the small size of the canopy.

Our research showed that the morphometric characteristics of apple varieties differ significantly depending on the rootstock. The morphometric characteristics of apple varieties grown on clonal rootstocks, including both the volume of the canopy (CV), the projection area of the canopy (CPA), and the cross-sectional area of the trunk (CSA), were significantly reduced compared to the apple varieties grown on the seedling rootstocks. Thus, the morphometric dimensions of the apple plant grown on vegetative rootstocks were smaller than those grown on the seedling rootstocks. The height of the apple trees grown on wild forest apple was 3.76-4.32 m (on average 4.01 m), 3.57-3.9 m (on average 3.75 m) on the MM-106 rootstock, and 3.26-3.45 m, on the M-9 rootstock (on average 3.38 m). As can be seen, there is not much difference between varieties on the same rootstock. However, in all varieties, the height of the trees varied depending on the rootstocks. At the same time, the effect of the rootstock on the diameter of the trunk was more pronounced. Thus, the diameter of the trunk was 14.68-16.54 cm (on average 15.42 cm) in apple varieties grown on seedling rootstocks, it decreased by 3.21 cm on average in varieties cultivated on the MM-106 rootstock, and amounted to 11.12 -13.12 cm (on average 12.21

cm), it decreased by 5.38 cm in varieties grown on the M-9 rootstock and amounted to 6.14-8.26 cm (on average 6.83 cm).

This decrease was also detected in the diameter of the canopy. Thus, the volume of the canopy, the projection area of the canopy, and the cross-sectional area of the trunk were reduced. The largest canopy volume (on average 19.91 m³) had varieties grown on wild forest apple. The largest canopy volume (23.95 m³) was observed in Granny Smith and the smallest canopy volume (17.46 m³) in Golden Delicious x 972. Another largest canopy was observed in the varieties grown on the MM-106 rootstock (on average 13.02 m³). The Jonagold variety was found to have the largest (14.85 m³) and the Gala variety the smallest (10.8 m³) canopy volume. This parameter was also lower in apple varieties cultivated on the M-9 rootstock compared to those cultivated on other rootstocks. Among the apple varieties grown on M-9, the Jonagored variety (4.32 m³) had the largest, and the Gala variety (3.21 m³) had the smallest canopy volume. In general, the canopy volume in the varieties grown on the M-9 rootstock was found to be smaller by 3.71 m³ on average.

Certain differences were also found in the projection area of the canopy. Thus, the Granny Smith variety cultivated on wild forest apple had the largest projection area of the canopy (12.51 m²) and this parameter for Simirenko reneti variety differed slightly (12.33 m²). The Fuji variety on the same rootstock had a relatively compact (10.59 m²) projection area compared to these varieties. Other varieties cultivated on wild forest apple, on the other hand, had an intermediate projection area of the canopy, on average, 11.3 m².

The largest canopy projection area (9.27 m²) was found in the Jonagold variety cultivated on the MM-106 rootstock, and the smallest (6.76 m²) in the Gala variety. In other varieties, this parameter averaged 7.96 m².

The projection area of the canopy in apple varieties grown on the M-9 rootstock was found to be 3-4 fold smaller compared to that of varieties grown on other rootstocks. The projection area of the canopy was 2.19-2.74 m² (on average 2.43 m²) for the varieties grown on the short M-9 rootstock. The largest projection area (2.74

m²) of the canopy was observed in the Jonagored variety and the smallest (2.19 m²) in the Gala variety.

The studies showed that the largest cross-sectional area of the trunk (187.0 cm²), as in other cases, had varieties cultivated on seedling rootstocks. Apple varieties grown on the MM-106 (117.43 cm²) rootstock were ranked second, and apple varieties grown on the M-9 (36.9 cm²) rootstock were ranked third [3,7,8,10,19].

Vegetative growth and leaf surface. Our observations showed that apple varieties grown on vegetative rootstocks had less height growth and leaf surface than apple varieties grown on seedling rootstocks. However, the canopy size and the leaf area per hectare were larger in the clonal rootstocks. This allows increasing the leaf surface per field unit and providing the biological basis of the product. The average length of shoots cultivated on wild forest apple was 77.0-128.0 cm (on average 106.71 cm), in varieties grown on the MM-106 rootstock - 67.0-115.0 cm (on average 91.71 cm), and in the varieties cultivated on the M-9 rootstock - 58.0-90.0 cm (on average 72.14 cm).

The total number and length of shoots per tree differed sharply depending on the rootstock. Thus, this indicator averaged 85.7 and 92.59 m in apple varieties grown on seedling rootstocks, 71.0 and 66.16 m in varieties grown on the MM-106 rootstock, 53.3 and 39.28m in the varieties grown on the M-9 rootstock.

It has also been found that the rootstocks have a direct effect on the leaf surface. Thus, the leaf surface of varieties grown on clonal rootstocks was much larger than that of varieties grown on seedling rootstocks. In other words, while the average surface area was 29.3 cm² in varieties cultivated on the surface of wild forest apple, this parameter was 34.0 cm² in varieties grown on the MM-106 rootstock and 38.7 cm² in varieties grown on the M-9 rootstock. However, the leaf area in varieties cultivated on wild forest apple varied in the range of 26.6-49.3 m² which is much higher than that of the varieties cultivated on the MM-106 and M-9 rootstocks (12.5 -19.2 m²). Jonagored and Fuji varieties (49.3 m², 40.3 m², respectively), grown on wild forest apple, and the same varieties grown on the MM-106

rootstock (40.3 m², 37, 8 m², respectively), Golden Reinders and Jonagored varieties (21.8 m², 20.5 m², respectively) grown on the M-9 rootstock had the greatest leaf surface area. Whereas, the smallest leaf surface area was observed in Granny Smith and Jonagold varieties grown on wild forest apple (26.6 m², 29.8 m², respectively), Simirenko reneti and Jonagold varieties, grown on the MM-106 rootstock (25.2 m², 25.7 m², respectively), Aйдared and Gala varieties (17.1 m², 18.0 m², respectively) grown on the M-9 rootstock.

Fruit growth dynamics. The intensive period of fruit growth occurs from May 31 to June 6. In this period, fruits of varieties can accumulate 10.43% additional mass on average. Then the growth of the fruit begins to slow down until maturity though to a lesser extent. When approaching maturity, this parameter decreases sharply and averages 1.71% for varieties.

Useful fruiting. The indicator, such as useful fruiting, i.e. the amount of fruit formed from the total number of flowers on the tree can be affected by many factors. Our observations and analysis of the region have shown that the flowering capacity of trees, as well as the characteristics of the shedding of flowers and other elements, vary greatly depending on the rootstocks. This confirms the high impact potential of the rootstocks. As a result, the useful fruiting of trees increases (Figure 1). As seen in the figure, in all varieties of apples grown on clonal rootstocks, the percentage of useful fruiting is higher than in those grown on seedling rootstocks [22].

Productivity coefficient. Based on this parameter, which is calculated based on the ratio of the product formed on the tree to the various morphometric indicators, the optimal position scheme of trees in the garden is determined. The results of our research (Table 1) showed that among the varieties grown on wild forest apple, the largest canopy volume was observed in Golden Delicious x 972 (2.58 kg / m³), the smallest in Granny Smith and Jonagored (1.79 kg/m³ and 1.8 kg /m³, respectively). The same indicator had intermediate values in other varieties.

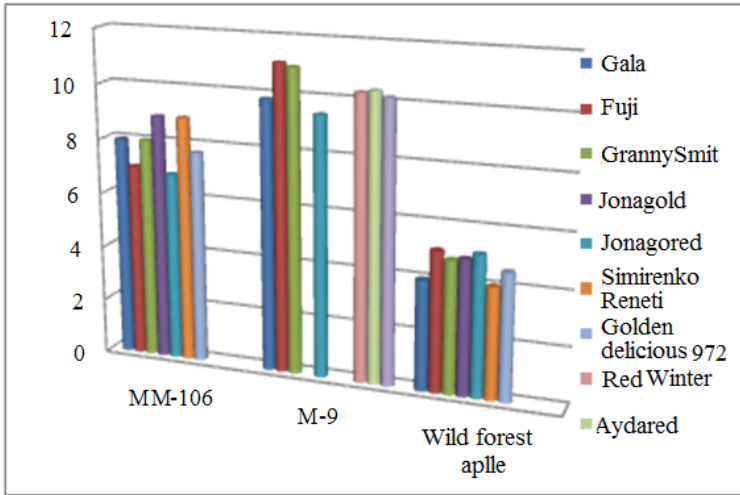


Figure1. Useful fruiting capabilities of trees.

Among the varieties grown on the MM-106 rootstock, Golden Delicious x 972 ($4.18 \text{ kg} / \text{m}^3$) was ranked first for the amount of product per canopy volume. It was followed by the Gala, Granny Smith, and Fuji varieties (more than 3 kg) and then the varieties Simirenko reneti, Jonagored, and Jonagold, which yielded less than 3 kg ($2.71\text{-}2.95 \text{ kg}$) per 1m^3 of canopy volume. In varieties cultivated on the M-9 rootstock, this indicator was significantly greater, and the highest values were observed in Fuji, Gala, and Golden Reinders ($8.8\text{-}9.07 \text{ kg}/\text{m}^3$), and the lowest in Jonagored ($4.96 \text{ kg} / \text{m}^3$). The remaining varieties were in the middle position ($7.09\text{-} 7.97 \text{ kg} / \text{m}^3$).

Thus, the yield per 1m^3 of the canopy was on average 2.07 kg in the varieties grown on seedling rootstocks, while on the varieties grown on the MM-106 rootstock it increased by an average of 1.25 kg and amounted to 3.32 kg . In the varieties cultivated on the M-9 rootstock, this parameter increased by 4.35 kg on average and was equal to 7.67 kg .

When comparing productivity per the canopy projection surface, the lowest yields were observed in the varieties grown on wild forest apple, and the highest in the varieties grown on the M-9 rootstock.

Table 1. Productivity of apple varieties in different rootstock-variety combinations

Rootstocks	Varieties	Coefficient of productivity, kg			
		Per 1 m ³ of canopy volume	Per 1 m ² of canopy projection area	Per 10 cm ² of trunk cross-sectional area	Per 1m ² of leaf surface area
Wild forest apple	Gala	2.24	3.91	2.46	1.08
	Jonagored	1.8	3.15	1.82	0.7
	Granny Smit	1.79	3.42	1.99	1.61
	Fuji	2.1	3.78	2.3	0.99
	Simirenko reneti	2.03	3.55	2.57	1.16
	Golden delicious x972	2.58	4.22	2.25	1.23
	Jonagold	1.95	3.35	2.01	1.28
	Average	2.07	3.63	2.2	1.15
M - 9	Gala	8.8	12.9	9.06	1.57
	Jonagored	4.96	7.83	4.00	1.05
	Golden reinders	8.47	13.26	7.78	1.48
	Granny Smit	7.97	12.14	8.32	1.53
	Aydared	7.09	10.87	7.99	1.51
	Red Winter	7.33	11.19	8.92	1.4
	Fuji	9.07	13.74	9.61	1.76
	Average	7.67	11.7	7.95	1.47
MM-106	Gala	3.67	5.87	4.09	1.5
	Jonagored	2.89	4.74	3.49	0.89
	Granny Smit	3.12	5.32	3.35	1.36
	Fuji	3.69	6.11	4.14	1.25
	Simirenko reneti	2.95	5.01	3.64	1.65
	Golden delicious x 972	4.18	6.43	3.72	1.46
	Jonagold	2.71	4.35	3.15	1.57
	Average	3.32	5.4	3.65	1.38
	LSD ₀₅	0.97	1.38	1.22	0.18

The yield per 1 m² of the canopy projection surface averaged 3.63 kg in varieties grown on wild forest apple, 5.4 kg on average in varieties grown on the MM-106 rootstock, and this parameter significantly increased reaching 11.7 kg in varieties grown on the M-9 rootstock. In this case, the variety feature also manifests itself. The most productive variety on wild forest apple was Golden delicious x972 (4.22 kg/m²) and the most productive variety on the MM-106

rootstock was also Golden delicious x972 (6.43 kg/m²), while on the M-9 rootstock the highest productivity had the Fuji variety (13.74 kg/m²). The same pattern was observed in the parameters such as the product per trunk cross-sectional area and leaf surface area [12,14].

Yielding every two years. The rootstock and varietal properties of apples are factors directly affecting productivity every two years. Although the high level and stable production were obtained in varieties grown on all three studied rootstocks, the productivity index every two years was significantly lower in varieties cultivated on the MM-106 and M-9 rootstocks compared to those grown on seedling rootstocks (18.96%) which amounted to 7.52 and 5.62%, respectively [22].

Net photosynthesis rate. One of the main factors affecting the potential productivity in plants is the net photosynthesis rate. Our research has shown that the accumulation of assimilation products in leaves varies considerably depending on the varieties and rootstocks (Table 2).

As seen in the table, the photosynthetic activity of leaves in apple varieties grown on clonal rootstocks is higher than in varieties grown on seedling rootstocks, so they can collect more assimilation products in a unit area [21].

Commodity quality of fruits. Our research has shown that the type of rootstock has a direct effect on the quantity and quality of fruit in apple varieties.

In terms of commodity yield, the first-grade product was more observed in the varieties cultivated on the M-9 (11.6%) and MM-106 (9.57%) rootstocks compared to the varieties grown on wild forest apple (7.09%). The II and III grade products intended for sale in the fresh state were also observed in varieties grown on clonal rootstocks, and the IV and V grade products intended for processing were observed in varieties grown on wild forest apple (42.3%). Based on the chemical composition, the newly introduced apple varieties conceded the local Cirhaci variety, even though they are predominant over previously introduced apple varieties [35].

Table 2. Net photosynthesis rate at various rootstock-variety combinations

Rootstock	Varieties	Growth, g	A leaf surface area, cm ²	Total leaf surface area, cm ²	Duration, days	PP, m ² /day	NPR, g-m ² /day	Δ PP, m ² /day	LSPP kg/m ²
Wild forest apple	Gala	50.2	18.32	714.48	109	7.79	6.45	24.8	3.14
	Jonagored	104.28	24.9	1444.2	109	15.74	6.63	24.13	6.52
	Granny Smith	85.87	23.1	1178.1	109	12.84	6.69	23.92	5.37
	Fuji	41.4	18.4	570.4	109	6.22	6.45	24.81	2.51
	Simirenko reneti	40.41	18.3	549.0	109	5.99	6.75	23.71	2.53
	Golden delicious x972	98.61	22.3	1383.6	109	15.07	6.55	24.43	6.17
	Jonagold	48.31	20.1	643.2	109	7.01	6.82	23.46	2.99
	Average	67.01	20.77	926.0	109	10.09	6.62	24.18	4.18
	Gala	55.22	18.0	666	105	6.99	7.9	21.52	3.25
	Jonagored	114.71	23.9	1386.2	105	14.56	7.88	21.58	6.75
M-9	Golden reiners	111.54	19.8	1366.2	105	14.35	7.77	21.88	6.56
	Granny Smith	64.48	18.7	822.8	105	8.64	7.46	22.79	3.79
	Aydared	98.78	20.0	1220.0	105	12.81	7.71	22.05	5.81
	Red Winter	49.72	20.3	588.7	105	6.18	8.05	21.12	2.93
	Fuji	89.98	22.3	1070.4	105	11.24	8.0	21.25	5.29
	Average	83.49	20.43	1017.2	105	10.68	7.82	21.74	4.91
	Gala	123.6	21.2	1632.4	105	17.14	7.21	22.19	7.73
	Jonagored	97.12	20.4	1264.8	105	13.28	7.31	22.57	5.88
	Granny Smith	83.83	18.7	1103.3	105	11.59	7.23	22.82	5.08
	Fuji	117.67	19.2	1574.4	105	16.33	7.12	23.18	7.13
MM-106	Simirenko reneti	85.24	19.5	1111.5	105	11.67	7.31	22.57	5.17
	Golden delicious x 972	136.61	22.11	1724.58	105	18.11	7.54	21.88	8.28
	Jonagold	127.95	23.16	1690.7	105	17.75	7.2	22.92	7.75
	Average	110.29	20.61	1443.1	105	15.15	7.27	22.59	6.72

Pear plant. After apples, pears have a special place among pome fruits and are of great economic importance.

Vegetation period. The onset, duration, and end of the phenological phases in the pear plant are influenced more by varietal characteristics and natural conditions than by the rootstock.

Tree growth characteristics. The results of our study on different rootstock-variety combinations of pear plants show that all morphometric indicators of trees are smaller in varieties grown on the BA-29 rootstock compared to those grown on the seedling rootstocks. This allows increasing the number of plants and productivity per unit area.

The height of the pear varieties grown on wild forest pear was 3.75 m for the Kure variety, 3.89 m for the Talgar gyozele variety, 3.69 m for the White Williams variety, and 3.97 m for the Meshe gyozele variety. This parameter in varieties cultivated on the BA-29 rootstock did not differ sharply and amounted to 3.32 m in the Conference variety, 3.38 m in the White Williams and Forelle varieties, and 3.29 m in the Red Williams and Guyot varieties. The average height of trees grown on wild forest pear was 3.83 m, and that of the varieties grown on the BA-29 rootstock was found to be 3.33m, which was less by 0.5 m.

Although there is not a sharp difference in the height of the trees depending on the rootstocks, a big difference was observed in other biometric indicators of the plant. Thus, the diameter of the trunk of the White Williams variety was 14.48 cm when grown on wild forest pears, while the diameter of the trunk of the same variety was reduced by 8.08 cm and amounted to 6.4 cm when grown on the BA-29 rootstock. This indicator changed significantly in other varieties depending on the rootstock, as a result of which the diameter of the trunk decreased by an average of 14.9 cm in varieties grown on wild forest pear, and by 8.42 cm (to 6.48 cm) in varieties grown on the BA-29 rootstock.

The analysis of the results revealed that the rootstocks had a significant effect on the diameter of the canopy of trees. As a result, the 8-9 fold difference occurred between the volume of the canopy

and its projection area. In this case, the canopy volume in the Kure variety grown on wild forest pear was 25.66 m³, in the Talgar gyozele variety-24.72 m³, in the White Williams variety-21.52 m³, in the Meshe gyozele variety-24.39 m³. When using the clonal rootstock BA-29, this parameter was 2.76 m³ for the Conference variety, 3.04 m³ for the White Williams variety, 2.15 m³ for the Red Williams variety, 2.48 m³ for the Forelle variety, and 2.42 m³ for the Guyot variety.

Thus, the size of the canopy was almost the same in different pear varieties grown on the same rootstock. However, there was a big difference depending on the rootstock. Thus, the average volume of the canopy in the varieties grown on wild forest pears was 24.07 m³, and in the varieties grown on the BA-29 rootstock, it significantly decreased (by 21.5 m³) and amounted to 2.57 m³. At the same time, the projection area of the canopy, which is one of the main indicators in determining the orchard planting scheme, also varied significantly depending on the rootstock. Thus, this parameter was 15.72 m² in the Kure variety, 14.4 m² in the Talgar gyozele variety, 13.35 m² in the White Williams variety, and 13.96 m² in the Meshe gyozele variety grown on wild forest pear. In the varieties grown on BA-29, the projection area of the canopy was significantly reduced and amounted to 1.9 m² for the Conference variety, 2.04 m² for the White Williams variety, 1.5 m² for the Red Williams variety, 1.66 m² for the Forelle variety, and 1.71 m² for the Guyot variety.

As can be seen above, the canopy projection area differs little between varieties cultivated on the same rootstock. However, there is a significant difference in the projection area of the canopy, depending on the rootstocks. Thus, while the average projection area of the canopy was 14.36 m² in varieties grown on wild forest pear, 1.76 m² was recorded in varieties grown on the BA-29 rootstock.

We detected also a significant effect of the rootstocks on the trunk cross-sectional area. This indicator averaged 175.82 cm² in pear varieties grown on seedling rootstocks and 32.97 cm² on the BA-29 rootstock.

The results of our research on different rootstock-variety combinations of pears show that all the morphometric characteristics of pear varieties are smaller when grown on the BA-29 rootstock compared to plants grown on seedling rootstocks. This allows increasing the number of plants and productivity per unit area [20].

Vegetative growth and leaf surface area. The rootstocks were found to affect markedly not only plant growth but also the leaf surface. Although pear varieties grown on vegetative rootstocks have less vegetative growth and leaf surface compared to those grown on seedling rootstocks, plants grown on the clonal rootstocks predominate in leaf surface per hectare. Thus, the number of shoots per pear tree in varieties grown on wild forest pear was in the range of 52-74 (on average 65.3), and in varieties cultivated on the BA-29 rootstock, it ranged between 18 and 44 (on average 35). In this case, no significant difference was observed in varieties grown on the same rootstock. The difference was observed only in the Red Williams variety grown on the BA-29 rootstock and in this case, the lowest number of shoots per tree (18) was registered.

Moreover, the heights of shoots were different depending on the rootstocks and the plant height significantly changed. Thus, in varieties grown on wild forest pear, the total height growth was 36.5 m, whereas, in varieties grown on the BA-29 rootstock, a significant decrease (by 24.3 m) occurred and this parameter was equal to 12.2.m. In this case, the Red Williams variety differed sharply from other varieties with weak growth. Thus, the total height of the Red Williams variety was 3.96 m, which showed that it tended to grow weakly on the same rootstock, compared to other varieties. According to our results, the rootstocks affect not only the plant growth but also have a significant effect on the leaf surface. Thus, in the pear varieties grown on seedling rootstocks, the average surface area per leaf was 27.8 cm², while in the varieties grown on the BA-29 rootstock, this parameter was slightly higher 29.1 cm².

Besides, the total number of leaves per tree decreased (3787 against 13,236, on average), which resulted in a lower level of the total leaf surface of the tree. The total leaf surface per tree was 34.15-

37.65 m² in pear varieties grown on wild forest pear, and 4.94-15.1 m² in varieties grown on the BA-29 rootstock.

As can be seen, the studied pear varieties grown on the same rootstock do not differ much in this indicator except the Girmiizi Williams variety with the least leaf surface of 4.94 m². In this case, the rootstocks manifest themselves causing a change in the leaf surface per tree. Thus, while the total leaf surface was 36.51 m² in pear varieties cultivated on wild forest apple, it was significantly reduced (by 25.19 m²) in the varieties grown on the BA-29 rootstock and amounted to 11.32 m².

As can be seen, pear varieties grown on vegetative rootstocks have less vegetative growth and leaf surface than those grown on seedling rootstocks. However, clonal rootstocks predominate in the leaf area per hectare.

Useful fruiting. Depending on the rootstock, the flowering capacity of the trees, as well as the nature of the shedding of flowers and other elements, is quite different (Figure 2).

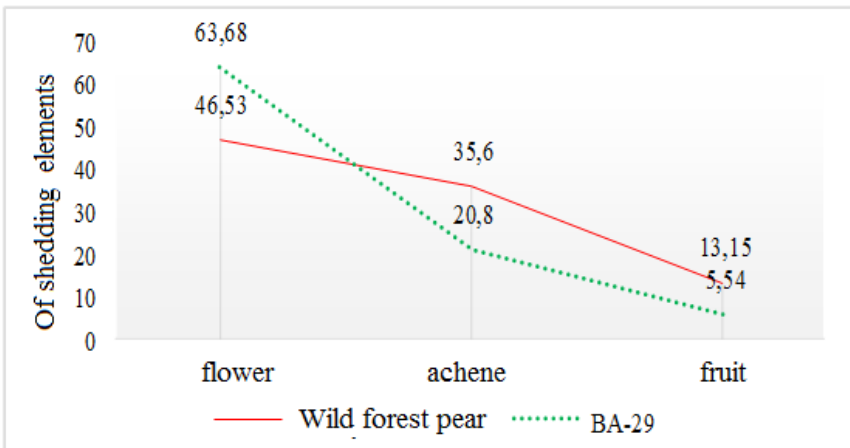


Figure 2. Shedding dynamics of fruit elements depending on rootstocks.

As can be seen in the figure, more flower shedding occurs in the varieties grown on vegetative rootstocks (on average 63.68%), and more shedding of achene (35.6%) and fruit (13.15%) is observed in

the varieties grown on seedling rootstocks than those grown on clonal rootstocks.

Undoubtedly, a lot of shedding during the flowering period reduces the loss of nutrients by preventing subsequent shedding. This allows the nutrients to be preserved for next year's flower buds. Thus, the amount of fruit formed in pear varieties can increase or decrease, despite the loss of fruit elements, depending on the rootstocks [33].

Coefficient of productivity. Productivity is an important biological and economic indicator of the variety and is the basis of its existence. Only sufficiently productive varieties are of economic importance and can gain a sustainable life. In our study, the biometric parameters and the leaf surface of the pear plant were significantly lower in the varieties grown on the vegetative rootstocks (Table 3).

Thus, the average yield per 1 m³ of the canopy was 1.87 kg, the yield per 1 m² of canopy projection was 3.13 kg, the yield per 10 cm² of the trunk cross-sectional area was 2.68 kg, and the yield per 1 m² of the leaf surface was 1.23 kg in the varieties grown on seedling rootstocks, whereas these indicators increased sharply in the varieties grown on the BA-29 rootstocks and amounted to 7.17 kg, 10.43 kg, 5.58 kg, 1.95 kg, respectively [20].

The above-mentioned confirms that the pear varieties, grown on the short clonal rootstocks, fully correspond to the spirit of modern intensive horticulture and have a wide range of applications in the region.

Production every two years. The study of the changes in the productivity in pear varieties depending on the rootstocks showed the effect of the rootstocks, especially in varieties grown on wild forest pear. In this regard, they are included in the index of relatively stable production and medium-degree production every year.

In general, the average productivity index for every two years was 29.68% in the varieties grown on seedling rootstocks, while this indicator decreased sharply in the varieties cultivated on the BA-29 rootstock and was 10.77% on average over the years. It is clear that pear varieties grown on the clonal rootstocks give a high stable yield every year [33].

Table 3. Productivity indices of pear varieties at different rootstock-variety combinations

Rootstock	Varieties	Harvest per tree, kg	Canopy volume, m ³	Canopy projection area, m ²	Trunk cross-sectional area, cm ²	Leaf surface area per tree, m ²	Coefficient of productivity, kg			
							Per 1m ³ of canopy volume	Per 1m ² of projection area	Per 10 m ² of trunk cross-sectional area	Per 1m ² of leaf surface area
1	2		4	5	6	7	8	9	10	11
	Kure	43.00	25.66	15.72	188.11	37.1	1.68	2.74	2.29	1.16
Wild forest pear	Talgar gyozele	47.14	24.72	14.4	129.02	37.14	1.91	3.27	3.65	1.27
	Summer Williams	50.44	21.52	13.35	164.59	34.15	2.34	3.78	3.07	1.48
	Meshe gyozele	37.98	24.39	13.96	221.56	37.65	1.56	2.72	1.71	1.01
	Average	44.64	24.07	14.36	175.82	36.51	1.87	3.13	2.68	1.23
	Conference	18.08	2.76	1.9	34.09	13.77	6.55	9.52	5.3	1.31
	White Williams	24.14	3.04	2.04	32.15	15.1	7.94	11.83	7.51	1.6
	Red Williams	21.88	2.15	1.5	31.95	4.94	10.18	14.59	6.85	4.43
	Forelle	12.96	2.48	1.66	34.4	12.12	5.23	7.81	3.77	1.07
	Guyot	14.34	2.42	1.71	32.25	10.67	5.93	8.39	4.45	1.35
	Average	18.28	2.57	1.76	32.97	11.32	7.17	10.43	5.58	1.95
	LSD ₀₅	3.70					2.83	3.91	1.34	2.22

Commodity quality of fruits. Quantitative indicators of fruits are higher in pear varieties grown on clonal rootstocks than in those grown on seedling rootstocks. In this case, the commodity indices of fruits are rising. Regarding chemical composition, the local variety, Jir Nadiri, surpasses the newly introduced pear varieties in many respects. Latifa, a selection variety of the Research Institute of Fruit and Tea Growing, surpasses other varieties in the amount of vitamin C. This is one of the factors confirming the importance of the local varieties [23].

Sweet cherry plant. The selection of rootstock-seedling combinations that meet the principles of intensification of the sweet cherry plant, one of the valuable fruit plants having a large cultivation area in the republic, and the study of its economic and biological characteristics are some of the important issues [32].

Vegetation period. The duration of the vegetation period of the sweet cherry plant was found to be 222-235 days, depending on the variety, and no significant difference was observed.

Plant growth characteristics. It was found that the biometric parameters of the sweet cherry plant were strongly influenced by rootstock-variety combinations (Table 4).

As seen in the table, sweet cherry varieties propagated on seedling rootstocks have larger morphometric dimensions than varieties grown on clonal rootstocks [27].

Vegetative growth and leaf surface. To ensure normal conditions for the plant, it is necessary to know the characteristics of its growth and development and apply the appropriate type of technological operation.

In the sweet cherry plant, vegetative growth and leaf surface vary sharply depending on the rootstock-variety combinations.

Contrary to other studied fruit plants, the number and length of shoots, total height growth, the leaf number per shoot, total leaf surface area were significantly lower in the varieties grown on seedling rootstocks compared to those grown on the Maxima -14 clonal rootstock.

Table 4. Biometric indices of various rootstock-variety combinations of the sweet cherry plant

Rootstocks	Varieties	Tree height, m	Trunk height, m	Trunk diameter, cm	Canopy diameter, m		Canopy volume, m ³	Canopy projection area, m ²	Trunk cross-sectional area, cm ²
					d ₁	d ₂			
Wild Sweet Cherry	Kel ureyi	5.17	65	36.0	4.97	5.36	63.13	26.64	1017.36
	Sary Drogana	4.96	67	31.92	4.76	4.98	53.27	23.71	799.83
	Napoleon	5.40	64	32.68	4.85	5.26	63.68	25.51	838.37
	Average	5.18	65.3	33.5	4.86	5.2	60.03	25.29	885.19
Maxima - 14	Belge	3.49	60	19.16	3.78	3.94	22.54	14.89	288.18
	Burlat	3.57	62	22.1	3.58	3.84	21.26	13.75	383.4
	Summit	3.46	65	21.47	3.67	3.94	21.3	14.46	361.85
	Kordia	3.44	62	20.45	3.6	4.07	22.1	14.94	328.29
	Regina	3.72	58	24.32	3.77	3.98	24.69	15.01	464.3
	Average	3.54	61.4	21.5	3.69	3.95	22.38	14.61	365.2

Thus, there are 95 shoots in varieties grown on wild sweet cherry, whereas, 139 shoots were observed in varieties grown on the Maxima-14 rootstocks. Besides, the total height growth of the tree was very low due to the small average length of the shoots in the varieties grown on the seedling rootstocks. As the number and surface area of the leaves, in this case, are large, they are provided with better capacity.

The limited canopy volume allows cultivating more plants per unit field area, resulting in a much larger leaf area per hectare. Thus, the leaf surface area per hectare in varieties grown on the Maxima-14 rootstock was 1.6 fold larger than that of varieties grown on seedling rootstocks. In other words, while the average leaf area per hectare in varieties grown on the seedling rootstocks was 26,904.9 m², this parameter in varieties grown on the Maxima-14 rootstock was 43,720 m². This is one of the main factors influencing the increase in productivity per hectare.

Useful fruiting. Our research has shown that in sweet cherry varieties, as in other fruit plants, only a small part of the total flowers

have the ability to bear useful fruit. However, in this case, the capabilities of rootstocks come to the fore (Figure 3).

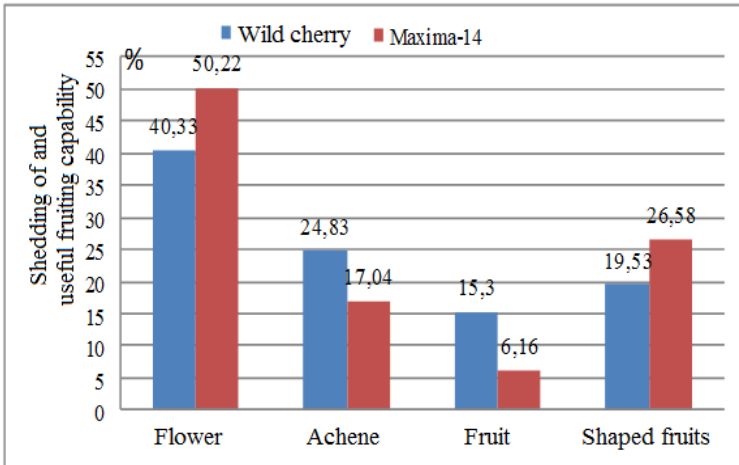


Figure 3. Shedding of fruit elements of sweet cherry varieties and useful fruiting capability depending on rootstocks.

As seen in Figure 3, while an average of 19.53% of the flowers bloomed in varieties grown on wild sweet cherry turned into mature fruit, this parameter increased by 7.05% and amounted to 26.58% in sweet cherry varieties grown on the Maxima-14 rootstock.

Coefficient of productivity. As with other fruit crops, the productivity of the sweet cherry plant can vary depending on many factors, especially the rootstock-variety combinations. This issue has been confirmed by our research.

The productivity per tree was much higher (by 10 kg) in the varieties grown on wild cherry than the varieties grown on the Maxima-14 rootstocks. However, due to the small morphometric characteristics of trees grown on the Maxima-14 rootstocks, the yield per unit area, or in other words, the productivity coefficient is much higher. This is one of the important indicators in the practice of fruit growing, and one of the conditions that allows determining the planting schemes in the garden, as well as nutrient areas and farm productivity.

Commodity quality of fruits. The mass of one fruit in the newly introduced varieties Belge, Burlat, Summit, Kordia, Regina was 8.5-11.5 g, whereas, in the previously introduced varieties Kel Ureyi, Sary Drogana, and Napoleon it amounted to 5.7-6.7 g. The soluble dry matter, total sugars, acidity, and vitamin C in the fruit content changed little depending on the variety. The highest vitamin C content was detected in the Kel ureyi (4.57 mg%) and Belge (3.17 mg%) varieties [30].

Although the chemical composition of the newly introduced sweet cherry varieties does not differ significantly from the previously introduced ones, the average mass of one fruit in these varieties is higher, fruits are tolerant to long-term storage and transportation, their peels are brighter, which is also considered to be superiority.

Plum plant. Being one of the main stone fruit crops in the region, it has a great commodity potential.

Vegetation period. Some factors affect the vegetation phases of the plum plant. The most important factor is the climatic conditions of the area where the plant is grown. Thus, the vegetation period changes depending on the climate indices. There were no significant differences in the course of phenological phases in the orchards planted with plum varieties in the Guba and Gusar regions due to similar conditions of these terrains. In this case, the duration of the vegetation period was 229-243 days, depending on the conditions of cultivation and varieties.

Tree growth characteristics. Our research has shown that the biometric and productivity indices of the plum trees differ significantly depending on the characteristics of the rootstock and variety. Thus, in the plum varieties grown on seedling rootstocks, the average volume of the canopy was 35.82m³, while in the varieties grown on clonal rootstocks it was much lower and amounted to 14.34 m³. Besides, the projection area of the canopy was much smaller on the vegetative rootstock. Thus, this parameter was 17.7 6 m² in varieties on seedling rootstocks, and 9.45m² in varieties on the MIR-29 rootstock. This decrease was also observed in the cross-

sectional area of the trunk and on the leaf surface area. These reductions, as we have noted for other crops, are considered positive because they allow increasing the number of plants per unit of the field area. It is of great importance for the economy because it results in increasing productivity [25].

Vegetative growth and leaf surface. The number of leaves on a shoot, the size of a leaf, and the number of leaves on a skeletal branch also vary in the plum plant depending on the rootstock-variety combinations. The canopy shapes of the studied plum varieties also vary depending on rootstocks. This ultimately affects the total leaf area on the tree. In this regard, although the leaf surface area of different varieties grown on the same rootstock did not differ sharply, the effect of the rootstock on this indicator was obvious. The average leaf area per tree was 52.9 m² in plum varieties grown on seedling rootstock, while this parameter was 29.63 m² on average in varieties cultivated on clonal rootstocks. However, due to the great number of varieties per unit of the field area, the total leaf area was higher than that of the varieties grown on seedling rootstocks, which led to increases in the photosynthetic potential and productivity.

Useful fruiting. Depending on the rootstock-variety combinations, some shedding occurs during flowering and fruiting, as well as before the fruit formation in the plum tree. During the natural shedding of the formed flowers, the effect of the rootstock is manifested (Figure 4).

In the cherry varieties grown on wild sweet cherry, on average, 42.83% of the flowers shed, while 51.68% of the flowers formed on the varieties grown on the MIR-29 rootstock shed. Shortly afterward, the process of achene and fruit shedding took place. In this case, on the contrary, the amount of shed elements was less in the varieties grown on clonal rootstocks, compared to that in varieties grown on wild cherry. As seen in the figure, in the varieties grown on seedling varieties, relatively fewer (21.9%) fruit remains in comparison with clonal rootstocks (28.5%).

Coefficient of productivity. Some factors are known to affect morphometric and productivity indices of fruit plants. The results of

the research performed in the Guba-Khachmaz region showed that rootstock-variety combinations had significant effects on productivity and morphometric indices of the sweet cherry plant (Table 5).

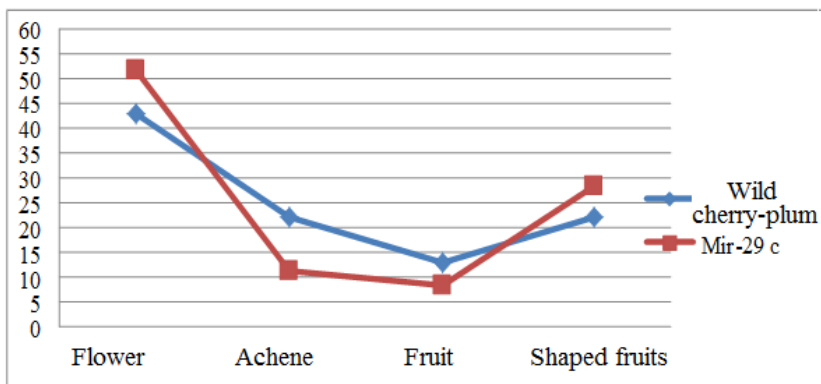


Figure 4. Useful fruiting in plum varieties depending on the rootstock.

Thus, the higher productivity of plum varieties grown on clonal rootstocks and lower morphometric indices compared to those grown on seedling rootstocks lead to the increase in productivity coefficient in all cases. Thus, the yield per 1 m³ of canopy volume was on average 1.84 kg in the varieties on the seedling rootstock, while on the varieties grown on the MIR-29 rootstock it increased by an average of 2.58 kg reaching 4.42 kg. This increase was also observed in the projection area of the canopy. While the yield per canopy projection area was 3.79 kg on average in varieties grown on seedling rootstocks, this parameter averaged 6.7 kg in varieties grown on the MIR-29 rootstocks. The yield per m² of leaf area was 2-fold greater in the varieties grown on clonal rootstocks than in the varieties grown on the seedling rootstocks. Thus, it is clear that in the varieties of plums grown on vegetative rootstocks, due to the high capacity of the leaves, fewer leaves are needed to form more production.

Table 5. Productivity indices of sweet cherry varieties at various rootstock-variety combinations

Rootstocks	Varieties	Coefficient of productivity, kg			
		Per 1 m ³ of canopy volume	Per 1 m ² of canopy projection area	Per 10 sm ² of trunk cross-sectional area	Per 1 m ² of leaf area
Wild cherry-plum	Anna Shpet	1.66	3.26	3.2	1.12
	Khurmayi Vengerka	1.68	3.45	2.79	1.20
	Italian Vengerkasi	2.17	4.66	3.62	1.40
	Average	1.84	3.79	3.2	1.24
Mir-29	Angelena	4.39	6.56	6.28	2.03
	Black Amber	3.92	5.81	6.00	2.13
	Fortune	5.07	7.62	7.31	2.09
	President	5.16	7.90	7.74	3.11
	Stanley	3.57	5.62	5.16	1.63
	Average	4.42	6.7	6.5	2.2
	LSD ₀₅	0.85	1.18	0.80	0.33

Commodity quality of fruits. In terms of the amount of soluble dry matter among the studied plum varieties, the President variety is ranked first (19.5%), the Italian Vengerkasi and Stanley varieties are ranked second (16.4% - 16.6%, respectively), followed by Anna Shpet, Khurmayi Vengerka, Angelena, Black Amber (13.0%-15.0%). The least soluble dry matter (11.2%) was found in the Fortune variety. The President and Stanley varieties (10.12%-11.3%) are ranked first in terms of the content of total sugar accumulated in the fruit. In other varieties, this parameter ranged between 6.81% and 8.86%. The acidity and vitamin C content in the fruits varied to some extent depending on the variety. In this case, the highest acidity (2.34%) was observed in the variety Anna Shpet, and the highest vitamin C content was observed in the Khurmayi Vengerka and Italian Vengerkasi varieties (3.87%). The least acidity in the fruit was found in the President and Stanley varieties (0.52-0.55 %), the Angelena and Stanley varieties were distinguished by the least

vitamin C content (1.94%). The content of tannins and dyes in fruits was detected on average between 0.15% and 0.2% [32].

Non-traditional and new fruit plants. These are horticultural crops (hazelnuts) limitedly cultivated by amateurs only in the backyards and plants not cultivated in the region until recent years (almonds), contrary to fruit crops grown in the region for the production of marketable products [28].

Hazelnut plant. In our country, hazelnut varieties created as a result of long-term selection, as well as imported varieties are widely cultivated. These varieties are mainly grown in the Sheki-Zagatala region and partly in the Guba-Khachmaz region [15,18].

Plant growth characteristics. Our research revealed that the morphometric characteristics of the hazelnut plant did not differ significantly between varieties.

Thus, the height of the shrub was 3.8 m in the Ata-Baba and Galib varieties, and 3.7 m in the Sachagli variety. There were some differences in the diameter of the canopy, which was reflected in the size and the projection area of the canopy. In this case, the largest (73.6 m³) canopy volume was detected in the Galib variety, the smaller (6.8 m³) canopy volume was in the Sachagli (66.8 m³) variety, and the smallest (62.3 m³) canopy volume was found in the Ata-Baba variety. The same pattern was observed in the projection area of the canopy. Thus, according to this indicator, the Galib variety was ranked first (19.27 m²), and the Sachagli variety had a slightly smaller (by 1.51 m²) canopy projection (17.76 m²). The smallest (16.38 m²) canopy projection had the Ata-Baba variety. As can be seen, morphometric dimensions of the local Ata-Baba and Sachagli varieties and the Galib variety, a selection variety of the Research Institute of Fruit and Tea Growing do not differ significantly.

Coefficient of productivity. Our observations and evaluations have shown that the yield and coefficient of productivity of hazelnut plants grown in the region for commodity production vary significantly depending on the varieties. Thus, the highest productivity per shrub was recorded in the Ata-Baba variety (6.3 kg),

followed by the Sachagli variety (5.8 kg), which productivity was lower by 0.5 kg, and the Galib variety (4.7 kg). Since the product harvested from the shrubs was somewhat different, the biometric indicators of the shrubs were also different, as a result, the productivity coefficient differed significantly in the product per 1 m² of canopy projection. Thus, the product per 1 m² of canopy projection was highest in the Ata-Baba variety (0.39 kg / m²) and lowest in the Galib variety (0.24 kg / m²). The Sachagli variety was ranked (0.33 kg/m²) second by this indicator.

Almond plant. Almond plant, which is one of the most important plants in the world and our country, has historically been widely cultivated in Absheron and partly in Shirvan. In our research, we tested the almond plant as a new plant in the North-East of the country in order to expand its cultivation area, given that it is grown in limited areas.

Tree growth characteristics. Studies have shown that the biometric characteristics of almond plants do not differ significantly depending on the variety. Thus, the height of the tree was in the range of 3.23 -3.28 m (on average 3.26 m) and the canopy diameter was 2.9 m-3.5 m. There was no significant difference in other biometric indicators of the varieties. The average volume of the canopy, the projection area of the canopy, and the cross-sectional area of the trunk were 14.27 m³, 10.15 m², and 86.4 cm², respectively. It is clear that the morphometric characteristics of the almond plant do not differ sharply depending on the variety.

Coefficient of productivity. According to our research materials, the productivity of almond plants is 2935 kg per hectare, which is much higher than the average productivity of almond orchards in the country. The main effective factor is considered to be the late flowering of the newly introduced varieties and their cultivation on the new type, vegetative rootstocks.

Thus, if the variety, area, and rootstocks are chosen properly, the productivity of the almond plants in this region can be higher compared to that of plants grown in the traditional cultivation areas of the almond plant-Absheron, and Shirvan [29].

Chapter IV. Widespread fruit diseases, pests in the region, and integrated control measures against them.

It is important to manage orchards with science-based technologies, as well as to study diseases and pests to protect the crop. Irregular spraying or insufficient preventive measures due to the lack of financial resources also contributes to the enrichment of the species composition of various plant pests and diseases, leading to an increase in the aggressiveness of species that have not been considered harmful previously. This requires a further detailed study of some harmful organisms.

As a result of our research, it was found that due to the large morphometric dimensions of the canopy in fruit varieties grown on seedling rootstocks, the penetration of pesticides into the canopy during spraying against diseases and pests and thereby the effectiveness of chemical control was reduced. Therefore, the damage caused by diseases and pests increased. Thus, the damage caused by diseases and pests to the studied fruit plants was higher in varieties grown on seedling rootstocks than in those grown on clonal rootstocks [16, 31].

Chapter V. Agricultural indicators and economic efficiency of fruit plants in the region.

The results of each study are evaluated based on economic efficiency. The level of economic productivity of the canopy varies as biometric parameters of the canopy are different depending on the rootstock and varieties.

The studies have revealed that nutrient areas calculated on the average diameter of the canopy do not differ sharply in varieties grown on the same rootstock but they can change depending on the rootstock. Therefore, the more nutrient field is required for the varieties grown on seedling rootstocks compared to varieties grown on the clonal rootstocks. Accordingly, the number of plants per hectare varies, and the number of plants grown on the clonal rootstocks is higher. This leads to an increase in farm productivity, resulting in increasing farm economic indicators (Table 6).

Table 6. Economic efficiency of fruit plants depending on various rootstock-variety combinations (on average)

Plants	Rootstocks	The number of plants per ha	Productivity, cwt/ha	Expenditure, manats	Cost of 1 centner of product	Selling value of 1 centner product	Gross income, manats	Net income, manats	Profitability, %
Apple	Wild forest apple	607.0	247.87	3019.69	12.26	24.41	6049.25	3029.57	100.06
	M-9	2120.0	598.92	5997.31	10.23	48.4	28985.77	22988.45	381.14
	MM-106	827.0	352.56	4493.83	12.91	31.91	11146.37	6652.54	147.54
Pear	Wild forest pear	495	221.15	2252.88	10.32	32.0	7082.45	4829.57	212.73
	BA-29	2896	526.1	4815.26	9.5	50.0	25368.26	20553.0	425.48
Sweet cherry	Wild sweet cherry	301	112.14	2745.6	24.6	133.3	14734.4	11988.8	439.42
	Maxima -14	487	132.46	3889.56	30.2	234.0	31059.14	27169.58	688.12
Plum	Wild cherry-plum	420	275.58	2502.3	9.19	21.7	5911.7	3409.4	135.97
	Mir-29 C	703	444.22	4076.8	9.28	42.8	18993.8	14917.8	363.98
Hazelnut		403	22.8	1254.7	55.9	220.0	5017.5	3762.8	296.9
Almond	CF-677	663	29.26	4255.0	145.8	650.0	17553.0	13298.0	312.2

It has been found that more funds are spent on the production per hectare in the plants on the clonal rootstocks than in the plants on the seedling rootstocks.

Although the fund spent per hectare for varieties grown on clonal rootstocks is high, gross and net income also increase significantly due to the increase in yield per hectare and the increase in the selling price of the product. This, in turn, leads to an increase in the level of profitability [11,24,26,34].

Conclusions

The development of fruit growing in the North-Eastern region of Azerbaijan based on innovative technologies has been studied using scientific and practical methods and the following conclusions have been made:

1. The North-Eastern region of Azerbaijan is an ancient fruit-growing region, which accounts for 29% of the country's total fruit production and over 50% of the production of stone fruits. The diverse soil and climatic conditions of the North-East region are also favorable for the cultivation of other groups of fruit crops (stone fruits, fruits with shells, as well as some representatives of subtropical fruit plants).

2. The selection of vegetatively propagated (clonal) rootstocks and the identification of appropriate rootstock-variety combinations are important factors in the cultivation of stalks. They are much better than seedling rootstocks. Thus, the fruiting percentage of apple varieties grown on seedling rootstocks is 71.4%, whereas the same parameter of the varieties grown on the clonal rootstocks ranges between 75.7 and 88.0%. This indicator is the same in other fruit plants, 70.7% and 81.0% in pear varieties; 65.2% and 71.2% in sweet cherry varieties; 80.5% and 87.8% in plum varieties; 77.3% and 86.0% in peach varieties, respectively.

3. In the studied varieties, the vegetation period is more influenced by environmental conditions and varietal characteristics than by the rootstock. In the mountainous region of Gusar, fruit

plants have shorter vegetation periods than in the foothills (Guba) and the plains (Shabran). The vegetation period of the apple plant is 230 days, 223 days, and 235 days on average, in the Guba, Gusar, and Shabran regions, respectively. In pear varieties the vegetation period is 226 days in the Gusar region, 240 days in the Guba region, in sweet cherry varieties 230 days in the Gusar region, 231 days in the Guba region, in plum varieties 235 days in the Gusar region, and 239 days in the Guba region.

4. All biometric indicators of fruit plants grown on clonal rootstocks differ from those grown on seedling rootstocks. This can be considered a positive development, as the small volume and the small projection area of the canopy are the main conditions for the intensive development of horticulture. By reducing the projection area of the canopy, it is possible to increase the number of plants per unit field area and productivity. Although the canopy volume decreases, the leaf surface area (photosynthetic potential-PP) provided by physiologically active radiation (PAR) predominates inside the canopy, but due to the good lighting of the canopy inside, the life cycle of the fruit branches also increases. Besides, it facilitates the application of technical maintenance work.

5. In all fruit plants, vegetative growth and leaf surface change dramatically due to the effect of the rootstock. In this case, plants grown on vegetative rootstocks have less vegetative growth and leaf surface than plants grown on seedling rootstocks. However, canopy volume and leaf area per hectare are higher in plants grown on clonal rootstocks. If we take into account that up to 4% of PAR on the Earth's surface is spent on photosynthesis, then the biological productivity (equivalent to 4,000 calories) is 18 tons per hectare based on 1 kg dry matter. When converted into agricultural products, this value can be 50 tons. In other words, the productivity varies depending on the normal condition of the leaves. In our study, leaf area per hectare in most fruit and vegetable varieties (excluding plum varieties) grown on clonal rootstocks is higher compared to varieties grown on seedling rootstocks.

6. The fruiting percentage is higher in plants grown on clonal rootstocks compared to those grown on seedling rootstocks. The trees grown on the clonal rootstocks are released from the fruit elements at an early stage of flowering, which reduces the loss of nutrients, creates favorable conditions for the formation of future crops, and eliminates the risk of yielding every two years. The number of fruit formed on different varieties grown on the same rootstock does not differ significantly. However, this is directly influenced by the rootstocks. Thus, while 4.65% of the flowers bloomed in the apple varieties grown on the seedling rootstock turned into ripe fruit, 7.91% of the flowers in the varieties grown on the MM-106 rootstock, and 10.31% of the flowers in the varieties grown on the M-9 rootstock turned into ripe fruit. The same patterns are observed in the other fruit plants studied. When grown on the seedling rootstocks, 4.73% of the bloomed flowers and on the BA-29 rootstock, 9.98% of the bloomed flowers of the pear plant can turn into ripe fruit. In the sweet cherry varieties grown on seedling rootstock-19.53% and on the Maxima-14 rootstock-26.58% and in the plum varieties grown on the seedling rootstocks-21.9% and on the MIR-29 rootstock-28.5% of the bloomed flowers can turn into ripe fruit. This parameter confirms the superiority of clonal rootstocks.

7. The process of photosynthesis is one of the main factors influencing the formation of the product. The effect of a rootstock is more pronounced in the net productivity of photosynthesis (NPP), and varieties grown on clonal rootstocks can yield more while having less leaf surface. NPP is highest in varieties grown on M-9 (on average 7.82 g-m²/day), and relatively low (on average 6.62 g-m²/day) in varieties grown on the seedling rootstocks. In this case, the varieties grown on the MM-106 rootstock, being at the middle position, have an average NPP of 7.27 g-m²/day.

8. In apple varieties grown on clonal rootstocks, the intensity of leaf assimilation is higher than in varieties grown on seedling rootstocks, so they accumulate more assimilation products per unit area of the leaf. In this case, less leaf surface is required for the

production of one kilogram of product, which indicates the suitability of the variety, rootstock, and growing conditions. Thus, varieties grown on clonal rootstocks can yield more while having less leaf surface. This physiological basis can be considered as a key factor in increasing the productivity of orchards, as well as opening up the potential of cultivated plants.

9. Yielding every two years is one of the negative factors affecting the efficiency of orchards. From this point of view, the studied apple varieties grown on all three rootstocks have a high stable yield. However, some varieties grown on wild forest apple have a certain tendency to yielding every two years, and in this regard, every year, they are included in the index of relatively stable yields. In general, while the productivity index for every two years is 18.96% on average in the varieties grown on seedling rootstocks, this indicator for varieties grown on MM-106 decreases sharply and amounts to 7.52%, and in the varieties grown on M-9, it decreases more and is equal to 5.62%. Pear varieties, grown on wild forest pear, also have a certain tendency to yield every two years, and in this regard, they have been included in the index of relatively stable yields every year and medium yields every two years. In general, the average productivity index (every two years) of pear varieties grown on seedling rootstocks is 29.68% and on varieties grown on the BA-29 rootstock, it is averaged to 10.77%, so they are included in the group of high stable yields every year.

10. Productivity coefficient, being one of the most important indicators for the economy, has a major impact on the definition and regulation of farm productivity. It has been found that the coefficient of productivity in varieties grown on clonal rootstocks is higher than in varieties grown on seedling rootstocks. The high productivity coefficient, being one of the main indicators of intensification, has a direct impact on the growth of both quantitative and qualitative indicators of the product per unit area.

11. The type of rootstock also has a direct effect on the quantity and quality of fruits. From this point of view, the varieties grown on vegetatively propagated (clonal) rootstocks have higher indices.

Commodity product intended for sale in fresh condition has a greater advantage over varieties grown on clonal rootstocks. The product intended for the canning industry can be obtained mostly from varieties grown on seedling rootstocks. From this point of view, the varieties grown on clonal rootstocks can be considered more suitable for storage and fresh use, while those grown on seedling rootstocks are more appropriate for the canning industry. In terms of chemical composition, newly introduced varieties concede local varieties by many indices, although they are superior to previously introduced varieties. Thus, among apple varieties, the Cirhaci variety exceeds the introduced varieties both in terms of sugar content (total sugar content 13.98%) and the vitamin C content (by 3.17 mg%).

The local, folk selection variety of pear, Jir Nadiri is superior by many indices of chemical composition, and Latifa, a selection variety from the Research Institute of Fruit and Tea Growing, is superior to the newly introduced pear varieties in terms of vitamin C.

12. Due to the large morphometric dimensions of the canopy in fruit varieties grown on seedling rootstocks, lighting is reduced inside the canopy, and humidity increases leading to decreasing penetration of pesticides into the canopy during spraying against diseases and pests. Thus, the effectiveness of chemical control is reduced. As a result, the chances of spreading diseases increase and their development intensifies. In superintensive orchards, due to the limited canopy of trees, the damage caused by diseases and pests is reduced.

13. Productivity is one of the main economic indicators of the plant, and it is directly affected by technological maintenance, as well as the characteristics of the rootstock and variety. In fruit crops grown on vegetative rootstocks, the yield per unit area is 2-2.5 fold greater than in plants grown on seedling rootstocks. While the farm productivity is 247.87 cwt/ha in the apple varieties grown on the seedling rootstocks, this parameter amounts to 352.56 cwt/ha in the apple varieties grown on the MM-106 rootstock, and 598.92 cwt/ha on the M-9 rootstocks. This indicator has been also evaluated in other fruit crops under study. While the average productivity of pear

varieties grown on seedling rootstocks is 221.15 cwt/ha, in pear varieties cultivated on the BA-29 clonal rootstocks it is 526.1 cwt/ha. The productivity of sweet cherry varieties grown on seedling rootstocks is 112.14 cwt/ha, in varieties cultivated on the Maxima-14 clonal rootstocks-132.46 cwt/ha. In the case of the plum trees, this parameter amounts to 275.58 cwt/ha in varieties grown on seedling rootstocks and 444.22 cwt/ha in those grown on the MIR-29C clonal rootstock.

14. Among the varieties of hazelnuts, which are not considered to be traditional crops in the region, but whose planting area has been expanded in recent years, the Ata-Baba variety is distinguished by its higher productivity. While the productivity of this variety is 27.53 cwt/ha, the productivity of the Sachagli variety is 23.27 cwt/ha, and that of the Galib variety is much lower - 17.62 cwt/ha.

15. The almond plant, which is being cultivated as a new plant in the Guba-Khachmaz region, despite growing in limited areas, does not concede the traditional varieties grown in the Absheron and Shirvan regions, in all qualitative and quantitative indicators. Moreover, it can surpass them in terms of productivity if the cultivation area, the variety, and rootstock are chosen properly. The productivity of the Feraduel variety of almond plant under observation is 27.52 cwt/ha, and that for the Quara variety-30.99 cwt/ha. Due to its late flowering, the Quara variety is not exposed to spring frosts and produces a regular crop every year. This proves the suitability of this variety for cultivation in the region.

16. The final indicator of the suitability of each species and variety under cultivated conditions depends on its economic efficiency. It has been found that the agrobiological characteristics of fruit plants are strongly influenced by the rootstock-variety combinations, which, in turn, determines their high productivity and economic indices. Although the fund spent per hectare for varieties grown on clonal rootstocks is high, gross and net income also increases significantly due to the increase in yield per hectare and the increase in the selling price of the product. As a result, it leads to an increase in profitability. The level of profitability is 100.06% in apple

varieties grown on seedling rootstocks, and 147.54% in apple varieties grown on the MM-106 clonal rootstocks, and 381.14% in the apple varieties grown on the M-9 clonal rootstocks. This indicator amounts to 212.73% and 425.48% in pear varieties, 439.42% and 688.12% in sweet cherry varieties, 135.97% and 363.98% in plum varieties, respectively.

Recommendations for producers

1. Taking into account the role of fruit nursery in the development of fruit growing, new modern farms should be established following the soil and climatic conditions of the region. Given the crucial importance of rootstocks in the cultivation of planting material that meets the requirements of the standard, preference should be given to the production of clonal rootstocks.

2. The area of apple, pear, sweet cherry, and plum orchards in the Guba-Khachmaz region should be expanded, giving preference to the establishment of super-intensive orchards.

3. The nutrient area of the trees by varieties should be chosen according to the soil and climatic conditions, rootstock-variety combinations, considering the parameters of agro-techniques to be applied.

4. When new orchards are established in the region, it is recommended to plant autumn varieties grafted onto seedlings in the mountainous part, winter varieties grafted onto medium-sized clonal rootstocks in the foothills, and summer varieties grafted onto small-sized clonal rootstocks in the plains.

5. The area of hazelnut and almond orchards in the region should be expanded, and it is recommended to use advanced cultivation technologies and high-yielding varieties.

6. When preparing design and estimate documents for planting new gardens, it is advisable to give preference to local folk selection varieties of vegetative rootstocks.

7. Farmers and individual owners can benefit from the scientific innovations arising from the dissertation by using the numerous

recommendations, booklets, and other resources developed by the Guba Regional Agrarian Science and Innovation Center, as well as the Research Institute of Fruit and Tea Growing.

List of published scientific works on the topic of the dissertation:

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The defense of the dissertation will be held on «25» June 2021 at 11⁰⁰ at the meeting of the one-time Dissertation council BED 2.18 operating at the Azerbaijan State Agrarian University.

Address: Az 2000, Republic of Azerbaijan, Ganja city, Ataturk Avenue, 450.

Dissertation is accessible at the library of the Azerbaijan State Agrarian University

Electronic versions of the dissertation and its abstract are available on the official website of the Azerbaijan State Agrarian University

Abstract was sent to the required addresses on «25» May 2021.

Signed for printing: 21.05.2021
Paper format: (210x297) 1\4
Volume: 79829 characters
Number of hard copies: 30