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SCIENTIFIC SUBSTANTIATION AND DEVELOPMENT OF GRAPE PRODUCTION TECHNOLOGY ELEMENTS IN THE AGRO-ECOLOGICAL CONDITIONS OF THE ATU GAGAUZIA

411.07 - VITICULTURE

Summary of the Doctoral Habilitate Thesis in Agricultural Sciences

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The defense will take place on **27.12.2024** at **11.00**, during the session of the Public Defense Commission for the Doctor Habilitat Thesis within the Scientific-Practical Institute of Horticulture and Food Technologies, MD-2070, Republic of Moldova, Chișinău mun., Codru, Vierul Street, 59, Room 206.

The Doctor Habilitat thesis and summary can be consulted at the Library of the Scientific-Practical Institute of Horticulture and Food Technologies and on the ANACEC website http://www.anacec.md.

The summary was sent on 26.11.2024.

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CONTENTS

CONCEPTUAL FRAMEWORK OF THE RESEARCH

Relevance and Significance of the Issue. The strategic priority for the development of the viticulture and winemaking sector in the Republic of Moldova is the comprehensive modernization of the industry, focusing on expanding the area of high-yield vineyards, optimizing the varietal composition, and implementing advanced agronomic practices [17]; Improving the efficiency of grape production is a complex challenge that has been the focus of numerous studies by both domestic researchers such as: I. Mikhaylyuk [64], N. Perstnev [32], M. Rapcea [73], M. Cuharschi [18, 19], S. Ungureanu, V. Cebanu [41, 42] and others. Foreign scientists such as: A. Calo [3], R. Boidron [1], V. Borsellino [2] and others.

One of the key directions in the modernization of the viticulture and winemaking sector in the Republic of Moldova is the introduction of high-yielding grape clones of European selection [39]. In recent years, this strategy has arnered significant scientific and production interest. As a result, since 1998, certified virus-free clones of classic European varieties, such as Cabernet Sauvignon, Merlot, the Pinot group, Chardonnay, Sauvignon, and Riesling, have been actively incorporated into the assortment [20]. Preliminary studies conducted by Moldovan Researchers M. Cuharschii, S. Ungureanu, N. Taran, B. Gaina, A. Botnarenco and others [56, 15, 21, 54, 55] suggest the recommendation to implement these clones in the Republic of Moldova. According to these researchers, the adoption of these clones can significantly increase both the yield and the quality of the final products in the viticulture and winemaking sector of the republic.

An important aspect of the development strategy for the viticulture and winemaking sector is the rational use of the country's natural resources [13] which will increase the efficiency of winemaking production [14]. Environmental factors significantly impact the development and production of grapes [35]. Climatic conditions, soil characteristics, and terrain play a key role in the successful growth of grapevines [34]. For this reason, scientists have repeatedly studied the relationship between grape yield, the quality of the harvested crop, and the climatic conditions specific to vineyard locations [28]. This issue remains a relevant subject of research in many grape-growing and winemaking countries worldwide [44]. Climate change has a significant impact on the physiological growth processes of grapevines, leading to changes in their development dynamics, yield, and product quality [26]. To ensure the sustainability of viticulture, it is essential to implement innovative approaches and adapt cultivation technologies aimed at minimizing the negative consequences of climate change [24]. The change in climate affects many characteristics of grapevines from yield through quality [4].

Identifying the patterns of physiological adaptation of grapevines to specific environmental conditions enables effective management of growth, development, and fruiting processes [12]. This understanding is critically important, given that the best productive potential of clones is often realized in the regions where they were developed. When introduced to new growing conditions, clones can significantly alter their properties, and these changes can be either positive or negative [23]. This fact highlights the necessity of thoroughly studying the response of newly introduced clones in new growing conditions.

The growth, development, and productivity formation of grapevine clones under specific ecological and technological cultivation conditions in the Republic of Moldova, including the ATU Gagauzia, have yet to be sufficiently studied. This is particularly important now, as many new varieties and clones have emerged, and understanding their behavior in specific ecological niches is essential for thoroughly and effectively utilizing them to enhance vine productivity and the quality of the final product [9].

For the further advancement of the viticulture industry, the establishment of vineyards using planting material that ensures high vine survival rates, robust growth, high yields, and longevity is of great importance [31]. Long-term research conducted by L. Kolesnik [53], A. Mishurenko [65], V. Nikolenko [67], E. Podgorny [72], A. Mishurenko, E. Podgorny [66], N. Guzun [49], L. Maltabar [58], I. Gromakovskiy [48], Eifert Jozsef, Eifert Jozsefny [78], 70N. Perstnev [70, 71], A. Derendovskaia [50], S. Tedesco [40] and others, it has been established that the variability of grapevines is manifested in changes in biometric, biochemical, anatomical, and other growth and development indicators of grafted plants in the nursery. At the same time, most authors, while identifying signs of different quality in canes, cuttings and saplings, did not research to clarify its influence on the different quality hubs of vines, the productivity of plantations, yield quality, and other indicators after the establishment and operation of vineyards.

Research Goal and Objectives

The Goal of the Research: to determine the potential of introduced grape clones and develop agricultural techniques aimed at enhancing the viability and productivity of vineyards under the agro-ecological conditions of the ATU Gagauzia, thereby improving the sustainability and economic efficiency of viticulture in the region.

The Objectives of the Research:

- conduct an analysis of the meteorological conditions in the ATU Gagauzia;
- identify the specific features of the state and development of viticulture in the ATU Gagauzia;
- evaluate the meteorological conditions in the ATU Gagauzia;
- identify the specific features of the viticulture industry in the southern region of the Republic of Moldova;
- to study the influence of the quality of rootstock and scion cuttings on the processes of regeneration, growth, and development of grafted plants in the

nursery, as well as the output of grafted grape vines from the nursery and their shoot and root system development;

- to determine the characteristics of grafted grape vine's survival, obtained from different quality rootstock and scion cuttings;
- to analyse the changes in shoot growth parameters and leaf surface of plants derived from different quality planting materials;
- to analyse the prolonged effects of the different quality planting materials on the yield of grapevines and the quality of the products;
- to develop and improve technological practices aimed at increasing the productivity of grape plantations in the conditions of ATU Gagauzia, using the example of the SC "Tomai-Vinex" enterprise.

Scientific Hypothesis. The development and implementation of an optimal management strategy for ampelocenoses, based on considering the quality of planting material, the characteristics of grape varieties and clones, and the survival rate of saplings obtained from scion and rootstock cuttings of different quality, can create favorable conditions for enhancing the adaptive capacity of the vines, fully realizing the plants' potential productivity, and contributing to the economic sustainability of the industry and the region.

Methodology of Scientific Research. The research methods are based on a review of scientific and technical literature, a systematic approach to problem formulation, the development of objectives, tasks, and research programs. The methodology of the work is based on field and laboratory studies related to the production of grafted planting material; conducting experiments and observations on the annual growth of the shoots, the concentration of plastid pigments, the development of the leaf area index, shoot productivity, yield, and the quality of the grape harvest; mathematical processing of experimental data using correlation analysis, one-way and two-way ANOVA with post-hoc Tukey’s HSD test to evaluate the mean values of variants and their grouping by the Tukey method at a 95% confidence level. The work was carried out in accordance with standard and specialized research methodologies.

Scientific Novelty of the Obtained Results. The scientific novelty of research lies in the development of a modern conceptual approach to managing the productivity of grapevine plantations in the Southern region of the Republic of Moldova. For the first time, the potential and reserves for increasing the yield of grape plants in ATU Gagauzia have been identified and calculated. These can be achieved through the utilization of high-quality planting material of modern European clone varieties. New data on the adaptive capacity of the R5 clone of Cabernet Sauvignon and 348 clone of Merlot in ampelocenoses in the Southern region of the Republic of Moldova vineyards have been obtained. The limiting environmental factors that reduce the parameters of photosynthetic activity and productivity of the plants have been identified. Monitoring the growth and development characteristics of shoots, and leaf surfaces, and establishing their correlation with the productivity of the plantations can serve as a basis for obtaining high-quality grape products. The analysis of indicators of economic efficiency of grape production allowed us to identify the real dynamics of the industry's efficiency using the example of SC "Tomai-Vinex" SA. The dependence of the profitability of grape production and sales on the use of diverse clone varieties and different qualities of vines has been established due to the variability in the quality of the grafted saplings used for planting.

Scientific Problem. To enhance the economic efficiency of modern viticulture, there is a need to transition the industry to more intensive, cost-effective, energy- and resource-saving technologies that ensure high yields and product quality. Our research has revealed that the quality of cuttings used for grafting significantly influences the quality and adaptive characteristics of grapevines after planting in a permanent location. The data obtained contribute to identifying the most effective methods for producing grafted planting material, thereby enhancing the quality and adaptation of grapevines to the environment. The studies have uncovered important aspects of the relationship between physiological parameters of introduced grape clones, such as vine growth, assimilative surface, and productivity, and their adaptation to changing environmental conditions. This allows for a better understanding of how the studied grape clones respond to various environmental factors and optimizing the conditions for their cultivation.

Theoretical Significance lies in identifying important aspects and technological peculiarities of the growth, development, and adaptation of introduced clones R5 Cabernet Sauvignon and clone 348 Merlot, which influence the quality and productivity of grape plantations in the agro-ecological conditions of the ATU Gagauzia. The obtained data allow for a deeper understanding of the physiological and adaptive characteristics of the investigated clones, their response to various environmental factors, and optimizing the conditions of their cultivation. This opens the way for the development of more efficient methods for producing grafted planting material, contributing to the improvement of quality and adaptation of introduced clones to the agro-ecological conditions of the ATU Gagauzia. The research results enable the development of management strategies aimed at enhancing the resilience of grape plants to stressful conditions such as drought or extremely high temperatures, ultimately contributing to the increased economic efficiency of viticulture both in the Autonomous and in the Republic of Moldova as a whole.

Practical Significance. The obtained scientific data make a significant contribution to the development and improvement of ampelocenosis models characterized by a high coefficient of photosynthetically active radiation, in studying the correspondence of biological and varietal characteristics of grapevines to the ecological conditions of their cultivation zone, and to cultivation methods. The results of experimental research represent significant practical and economic interest, contain innovative elements, and contribute to the implementation of industrial technologies in viticulture. They allow recommending the use of uniform grafted saplings of the studied clones for planting in the conditions of the Southern zone of viticulture of the Republic of Moldova (ATU Gagauzia), obtained by using for grafting the 1st and 2nd cuttings from the base of the rootstock cane, scion cuttings with tendrils, and pre-stratification treatment of grafted cuttings with a solution of Calovit.

Approbation of Research Results. The materials of the Thesis were presented and discussed at the following events: 5th International Congress on Engineering and Life Science, (Pitesti, Romania, 2024); 4th International Conference on Food, Agriculture and Animal Sciences, ICOFAAS 2023, (Sivas, Turkey, 2023, online); 4th International Congress on Engineering and Life Science, (Comrat, Moldova, 2023); International Scientific Symposium: Modern Trends in the Agricultural Higher Education, (UTM, Chisinau, Moldova, 2023); VI International Scientific-Practical online-offline Conference "Biotechnology: Achievements and Development Prospects", (Pinsk, Republic of Belarus, 2023); IX National Scientific and Practical Conference “Problems and Challenges of Regional Economy in the Conditions of Globalization”, (CSU, Comrat, Moldova, 2023); International Scientific and Practical Conference "Science, Education, Culture" (CSU, Comrat, Moldova, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024); International Scientific Symposium „Agriculture and Food Industry - Achievements and Perspectives”, (UTM, Chisinau, Moldova, 2022); 5th International Agriculture Congress, UTAK 2022, (Turkey, 2022); 4th Internanional Agriculture Congress, UTAK 2021, Online, 2021); International Congress on Applied Sciences-II. AL-FARABI, (Baku, Azerbaijan, 2021, online); London International Conference, London, United Kingdom, (UKEY, 2021, online); Innovative Development within the Smart Specialization of the Region: Challenges and Prospects, Innovation Week in CSU, (CSU, Comrat, Moldova, 2020); 3rd International Agriculture Congress (Tunis, Online, 2020,); 1st International Symposium on Agriculture and Food in Turkish world (Izmir, Turkey, 2019); 2nd Internanional Agriculture Congress (Ayas, Ankara, Turkey, 2019); International Tairov Readings, V.E. Tairov Research and Development Institute. V.E. Tairov (Odessa, Ukraine, 2019); V National Scientific and Practical Conference “Problems and Challenges of Regional Economy in the Conditions of Globalization” (CSU, Comrat, 2019); International Symposium: Horticulture. Agronomy "85 years of the Faculty of Agronomy - Achievements and Perspectives" (SAUM, Chisinau, Moldova, 2018); 1st Internanional Agriculture Congress (Chisinau/Comrat, Moldova, 2018); X International Conference “Geology in School and University: Earth Sciences and Civilization” (St. Petersburg, Russia, 2017); Scientific and Practical

Conference “Modern Achievements of Science and Ways of Innovative Ascent of the Economy of the Region, Country”, (CSU, Comrat, 2017); III National Scientific and Practical Conference “Problems and Challenges of Regional Economy in the Conditions of Globalization” (CSU, Comrat, 2017).

Publications on the subject of the Thesis: The main materials of the thesis have been published in 73 Scientific Papers, including: 1 Monograph, 1 article in Journals from Web of Science and SCOPUS databases, 2 articles in Journals of other databases accepted by ANACEC, 10 articles in recognized foreign Journals, 1 article in Journals of the National Register of Category B, 12 articles in International Scientific Conferences abroad, 27 articles in International Scientific Conferences in Moldova, 2 articles of Republican Scientific Conferences with international participation, 12 abstracts in International Scientific Conferences abroad, 5 abstracts in International Scientific Conferences in Moldova.

The structure and volume of the Thesis: The Thesis consists of 213 pages of the main text and includes the following: Introduction, 8 Chapters, Conclusions, Recommendations for Production, and Bibliography. It contains 66 tables and 45 figures, along with 12 appendixes. The bibliography comprises 342 sources.

THESIS CONTENT

1. TECHNOLOGICAL FEATURES OF GRAFTED PLANTING STOCK PRODUCTION AND THEIR IMPACT ON THE PRODUCTIVITY OF VINEYARDS

The Chapter summarizes the literature on the key technological features of grafted grapevine seedling production. It is shown that modern technologies for growing grafted grapevines must be based on the high quality of the initial material used for propagation, as this directly affects the vines survival rate, longevity, and productivity of future vineyards. Special attention is given to the need for developing elements of the cultivation technology for grapevine clones, including the R5 clone of Cabernet Sauvignon and the 348 clone of Merlot, from the production of grafted planting material to full fruit-bearing, considering the different quality of cuttings, saplings, and vines.

2. MATERIALS AND METHODS

The experimental vineyards are located in the southern part of the Republic of Moldova, in the ATU Gagauzia, at the SC "Tomai-Vinex" SA farm. Experimental plot No. 1 (experimental scheme I and II) covers an area of 1.11 ha, with the following coordinates: 46.157727, 28.791652. Experimental plot No. 2 (experimental scheme III and IV) is located at coordinates 46.1542651, 28.8011721.

The objects of the research were: rootstock cuttings of BxR Kober 5BB and RxR 101-14, prior to grafting; grafted cuttings from bench grafting during their stratification, hardening, and growth in the nursery, as well as saplings after being dug out from the nursery; young, entering the fruiting stage grape plantations of the R5 clone of Cabernet Sauvignon variety; fruiting vineyards of the R5 clone of Cabernet Sauvignon variety; vineyards of the R5 clone of Cabernet Sauvignon and the 348 clone of Merlot variety with hanging and vertical shoot position training systems.

The R5 clone of the Cabernet Sauvignon variety was obtained through individual clonal selection at San Michele all'Adige (Trento), Italy in 1969 [10]. Merlot clone 348 was bred in 1975 in Gironde (Bordeaux) France by the INRA research institute [11].

Experimental Designs

Experimental Scheme I aimed to study the influence of the positioning of rootstock cuttings along the length of the stock cane on regeneration processes, the growth of grafts in the nursery, the emergence of grafted saplings from the nursery, their survival rate, growth, development, and productivity of vines.

Canes were collected from rootstock mother-grapevines at SC "Tomai-Vinex" SA in the autumn of 2003 in the mother grape plantations of the phylloxera-resistant varieties BxR Kober 5BB and RxR 101-14. The collected canes were stored in the cellar under a plastic cover. Before grafting, cuttings (from 1st to 5th) were taken from the prepared rootstock canes, starting from the base to the top along the length of the cane. By group: 1st cuttings from the base of the rootstock cane - experimental group 1 (EG 1); 2nd cuttings from the base - experimental group 2 (EG 2); 3rd cuttings from the base - experimental group 3 (EG); 4th cuttings from the base - experimental group 4 (EG 4); 5th cuttings from the base - experimental group 5 (EG 5); the control group consisted of cuttings without grouping – the production variant.

Experimental Scheme I	
Experimental Variants:	
Clone R5 Cabernet Sauvignon Grafting onto Rootstock Cuttings, from the Base of the Stock Cane	
Stock Variety	*Positioning of Cuttings Along the Length of the Stock Cane*
BxR Kober 5BB	1. Control Group (CG) – without grouping (the production variant) 2. Experimental Group 1 (EG 1) – 1st cutting (0-50 cm) 3. Experimental Group 2 (EG 2) – 2nd cutting (50-100 cm) 4. Experimental Group 3 (EG 3) – 3rd cutting (100-150 cm) 5. Experimental Group 4 (EG 4) – 4th cutting (150-200 cm) 6. Experimental Group 5 (EG 5) – 5th cutting (200-250 cm)
RxR 101-14	1. Control Group (CG) – without grouping (the production variant) 2. Experimental Group 1 (EG 1) – 1st cutting (0-50 cm) 3. Experimental Group 2 (EG 2) – 2nd cutting (50-100 cm) 4. Experimental Group 3 (EG 3) – 3rd cutting (100-150 cm) 5. Experimental Group 4 (EG 4) – 4th cutting (150-200 cm) 6. Experimental Group 5 (EG 5) – 5th cutting (200-250 cm)

Experimental Scheme II - to study the influence of the quality variation of scion cuttings and the treatment of grafted cuttings with Calovit on the processes of regeneration, grafted saplings' emergence from the nursery, and their viability at the permanent place.

The scion canes of the clone R5 Cabernet Sauvignon variety were collected from autumn on the scion mother grapevines in the zone of 4-12 buds. Cutting one-bud scion cuttings were divided into two groups: with tendrils (developed diaphragm) and without tendrils (insufficiently developed diaphragm).

Experimental Scheme II
Clone R5 Cabernet Sauvignon onto BxR Kober 5BB
Experimental Variants:
1. Experimental Group 1 – Without tendrils H_2O
2. Experimental Group 2 – With tendrils H_2O
3. Experimental Group 3 – Without tendrils Calovit
4. Experimental Group 4 – With tendrils Calovit

Each of these scion cutting groups was grafted onto rootstock cuttings of the BxR Kober 5BB variety. One part of the grafted cuttings served as a control, while the second part underwent pre-stratification treatment with a Calovit solution. The treatment was carried out as follows: the apical part of the grafted cuttings was dipped 5-7 cm in the 1,5% Calovit solution for 1-2 seconds. The control group was dipped in water.

Calovit is a chemical plant growth regulator (originating from Romania). It is a transparent colourless liquid with a density of 0.975 and a pH range of 5.0-5.5. The preparation is used to stimulate the union during the grafting of grapevines. It is recommended to use 1.5% Calovit solution to treat the apical part of grafted cuttings [43].

Grafting (Scheme I, and II) was performed at the same time - mid-March (2004), using a mechanized method with the help of the UPV-1 device. The formation of the grafting components was done with an omega-shaped knife, creating a tongue on the rootstock and a corresponding groove on the scion. In each experimental variant, 500-700 grafts were performed, depending on the experimental schemes. The grafted cuttings were stratified in boxes filled with sawdust in a general heating area. After stratification and hardening, the grafted cuttings were planted in the nursery. After digging out the saplings from the nursery, storage, their preplanting preparation, an experimental plot of vine plantations was established in 2005, according to the experimental schemes. The experimental plot was used for long-term studies of growth, development and productivity of grapevines.

Experimental Scheme III aimed to study the features of growth, development, and productivity of clone R5 of the Cabernet-Sauvignon variety and clone 348 of the Merlot variety, depending on the shoot management system of the grapevines.

In 2013-2014, a reconstruction of the grapevine plantations, planted in 2006 with a spacing of 2.5x1.35 m, was carried out. The reconstruction of the 8-year-old fruiting vineyards included changes to the type of support structures, vine training and trellis system. A comparative assessment of the condition of the grapevine plantations was carried out depending on the shoot training system. The growth parameters of the shoots and leaf area, the photosynthetic activity of the leaves, and the productivity of the vines were studied.

Experimental Scheme IV – long-term monitoring of growth, development, and productivity of the R5 clone Cabernet-Sauvignon and 348 clone Merlot grapevines under changing agroecological conditions of ATU Gagauzia.

Methods

The characterization of soil conditions was based on data provided in the vineyard planting project [33].

The analysis of meteorological conditions for the research years was conducted using data from the Agro-Industrial Complex of ATU Gagauzia. The monthly precipitation was calculated in millimetres, and the annual precipitation totals for each year of the study were also calculated in millimetres. The average monthly air temperature values for each year of the study were calculated in degrees Celsius, and the average annual air temperature for each year of the study was determined. The sum of active temperatures was calculated for each year of the study [25].

During the research, the following were conducted: determination of raw and absolutely dry biomass of the cuttings; the content of soluble sugars [47, 63]; the starch content was determined using the calorimetric method [51]; accounting for callus formation at the site of graft union [53]; the dynamics of shoot growth in the grafted plants in the nursery [61]; the output of first-grade grafted saplings from the nursery, the survival rate of grafted saplings [60]; the dimensions of annual and mature shoot growth [62]; growth and development of leaf area [62]; plastid pigments' concentration (chlorophylls a, b, and carotenoids), were calculated using the formula of Wintermans and De Mots [75]; chlorophyll index (chlorophyll a/chlorophyll b), pigment index (chlorophyll a+b/carotenoids), chlorophyll index were calculated [77]; superficial chlorophyll content in the leaf, Leaf Area Index (LAI) [57]; the accumulation of absolutely dry leaf biomass [45]; the Specific Leaf Weight (SLW) [75]; determination of Vine Productivity Parameters [74]; Shoot Productivity [46]; fruit yield per vine and harvest quality [74]; the mass concentration of sugars and titratable acidity [36].

Statistical data analysis was performed using correlation analysis, as well as one-way and two-way ANOVA. Calculations were conducted in Microsoft Excel 2016 and Minitab 17 [27].

Economic efficiency, yield growth potential, and the calculation of potential grape yield indicators were carried out according to the methodology of D. Parmakli [68].

3. THE STATE AND DEVELOPMENT OF THE VITICULTURE SECTOR IN ATU GAGAUZIA

The grape and wine-growing territory of the Republic of Moldova has been divided into Regions, Centers, and Districts [29]. Four grape and wine-growing regions have been identified: Southern, Central, Southeastern, and Northern; there are 22 grapes and wine-growing centers, with 7 in the Southern region, 10 in the Central region, 2 in the Southeastern region, and 3 in the Northern region, each with specified settlements belonging to them.

Fig. 3.1. Delimitation Map of the Grape and Wine Regions of the Republic of Moldova

Geographical areas for wine production with protected geographical indication (PGI) have been designated. Regions with protected geographical indication (PGI) include "Valul lui Traian," "Ștefan-Vodă," and "Codru"(fig. 3.1) [30]. The region with Protected Geographical Indication "Valul lui Traian" includes 5 districts: Leova, Cantemir, Cahul, Taraclia, and Gagauzia Autonomous Territorial Unit (ATU Gagauzia)

3.1. Specific Features of the Conditions in ATU Gagauzia

Soil characteristics UTA Gagauzia. The territory of ATU Gagauzia is located in the Budjak steppe, which forms part of the Southern Moldavian Plateau. The region's terrain is predominantly steppe, interspersed with small elevations. The total area of Gagauzia is 1,848 km², accounting for 6.1% of the territory of the Republic of Moldova. Agricultural land covers 150,000 hectares, of which 65,400 hectares consist of calcareous chernozems, and 63,400 hectares are represented by typical low-humus chernozems [38].

Meteorological conditions. The climate of ATU Gagauzia has been influenced by global changes in recent decades, which is accompanied by an increase in climate risks, including frequent and prolonged droughts [37].

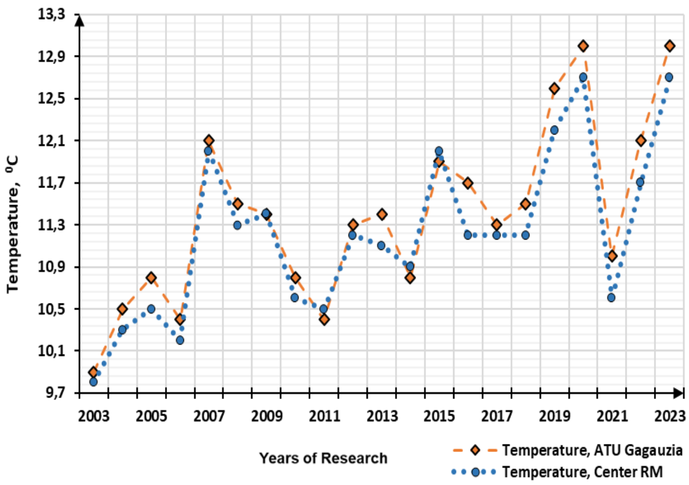


Fig. 3.2. The Dynamics of Average Annual Temperature Values by Regions of the Republic of Moldova

To identify differences in meteorological conditions, a comparative analysis of climatic indicators for the southern (ATU Gagauzia) and central (Chisinau) regions of the Republic of Moldova was conducted for the period 2003–2023 (fig. 3.2). Microclimatic differences typical for ATU Gagauzia were revealed, including significantly lower precipitation compared to the central region, higher air temperatures, and a greater sum of active temperatures, with particularly noticeable differences in recent years (2019-2023).

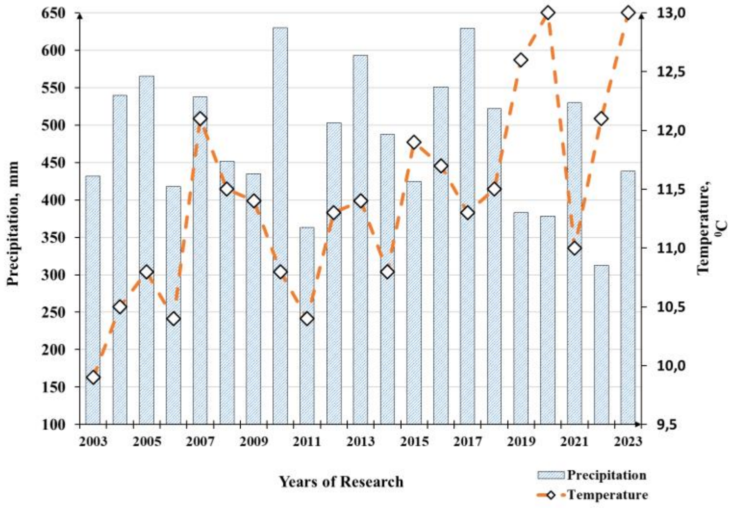
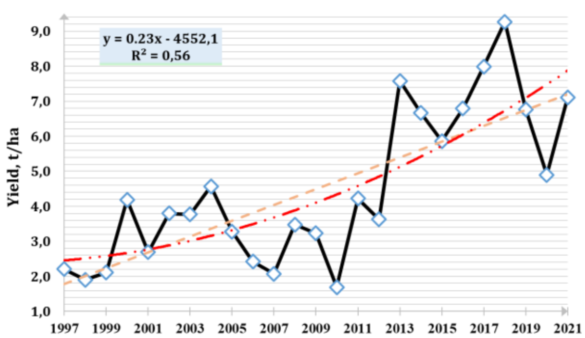


Fig. 3.3. Dynamics of Annual Precipitation Amounts and Air Temperature in UTA Gagauzia

It was noted that in the ATU Gagauzia, temperatures of 10°C and higher are maintained for 179-187 days, which is significantly longer than in other parts of the Republic of Moldova. The sum of active temperatures is 3300°C. The average annual precipitation is 350-370 mm. In recent years, there has been an increase in the average annual temperatures and a decrease in precipitation in ATU Gagauzia (Fig. 3.3). The distribution of rainfall during the vegetative and dormant periods of the grapevine has also changed. Vine plants experienced a moisture deficit during critical growth and development periods, which negatively affected growth processes, development, and grapevine productivity.

3.1. Peculiarities of the Development of the Viticulture Sector under the Conditions of ATU Gagauzia

We conducted an analysis of changes in the area, gross harvest, and yield of grape plantations in the agricultural sector of ATU Gagauzia from 1997 to 2021, covering the past 25 years [68]. According to the trend equation (y = -513.68x + 1,041.15), a decreasing trend in the fruit-bearing area of grape plantations in ATU Gagauzia from 1997 to 2021 has been observed, with an average annual decrease of 513.68 hectares



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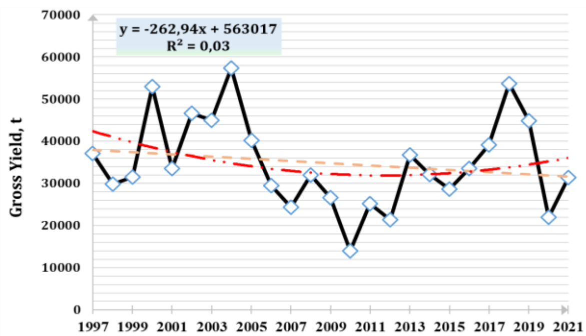

b

Fig. 3.4. a) Dynamics of Grapevine Plantations Yield; b) Dynamics of Gross Grape Yield. ATU Gagauzia, 1997-2021.

An analysis of the dynamics of grape cultivation over the past 25 years (1997-2021) shows a noticeable increase in grape yield. As indicated by the trend equation, the average annual increase in grape productivity amounts to 0.23 tons per hectare (fig. 3.4 a). On average, over the analyzed period, the total grape harvest in ATU Gagauzia amounts to 30,743.1 tons per year. It is noteworthy that as grape yield increases, there is a tendency for a decrease in the total grape harvest by 262.94 tons per year, which is associated with a reduction in the cultivated area for grapevines (fig. 3.4 b).

The established potential yield level for ATU Gagauzia is 7.95 tons per hectare. The obtained data indicates that the potential grape yield exceeds the actual yield by 45%, which represents a possible reserve for increasing the productivity of grape plantations. The growth reserves for yield can reach 2.47 tons per hectare for ATU Gagauzia.

We conducted an analysis of the condition of the grape plantations in SC "Tomai-Vinex" SA, which showed that the reduction in the area due to the uprooting of old vineyards is accompanied by an increase in the yield of the main grape varieties. It has been observed that from 2001 to 2021, there is an increase in grape yield by 0.51 tons per year ($y=0.51x+22.33$). Notably, there has been a significant increase in productivity over the past six years, despite the unfavourable weather and climatic conditions in 2020. The grape yield reached 17.4 tons per hectare in 2017 and 17.3 tons per hectare in 2018, which is higher than the previous years of vineyard operation.

4. BIOLOGICAL AND TECHNOLOGICAL FEATURES OF GRAFTED VINE SAPLINGS PRODUCTION

4.1. The Processes of Regeneration, Output, and Quality of Grafted Saplings Depending on the Quality of the Stock Material

Before grafting, cuttings (from the 1st to the 5th) were prepared separately from the base to the top of the rootstock canes BxR Kober 5BB and RxR 101-14 varieties, onto which scion cuttings of the R5 clone Cabernet Sauvignon variety were grafted. The control group consisted of grafted cuttings without being divided into groups.

It was established that before grafting, the mean diameter of cuttings, for the variety RxR 101-14, from the base of the cane is 8.12-7.81 mm EG 1, EG 2 (1$_{st}$-2nd), from the middle zone of the cane is 7.78-7.44 mm EG 3- EG 4 (3rd-4th), and from the top zone is 7.05 mm EG 5 (5th); for the variety BxR Kober 5BB, it is 8.70-8.27 mm, 7.98-7.76 mm and 6.89 mm, respectively. The mass of 100 cuttings, 0-35 cm in length (from 1st to 5th), decreases from 1.96 kg to 1.31 kg for the RxR 101-14 rootstock variety; for BxR Kober 5BB, it decreases from 1.82 kg to 1.13 kg. The cuttings from the base and middle parts of the cane (1st-3rd) have the highest biomass, regardless of the rootstock variety. This pattern is also observed in the changes in the dry biomass of the cuttings [8].

Along with the mass of cuttings, important indicators of the quality of the cane are the total carbohydrate content (in dry matter) and the carbohydrate reserves in 100 pieces of cuttings, which are necessary for the bipolar regeneration of grafted cuttings during their stratification and hardening period. The carbohydrate content in the investigated cuttings of all variants, except the 5th cutting of BxR Kober 5BB, exceeds 100g/100 pieces of cuttings (fig. 4.1).

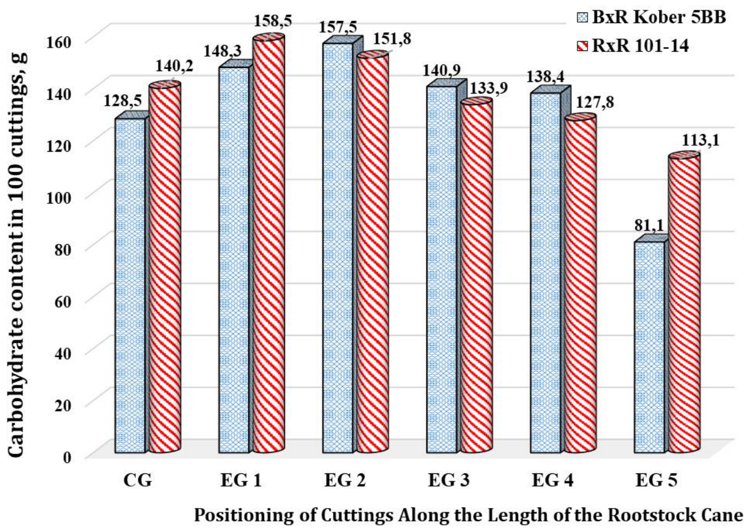

Fig. 4.1. The Carbohydrate Content in 100 pieces of Rootstock Cuttings, Depending on Their Layout Along the Length of the Stock Cane, 2004.

So, in the case of the RxR 101-14 variety, the carbohydrate content varies from 158.5±2.2 g to 113.1±1.8 g, and for the BxR Kober 5BB variety, it ranges from 148.3±2.1 g to 81.1±1.7 g (from the 1st to the 5th cuttings), with higher values in the basal-cane and mid-cane region and lower in the top-cane. In the control groups (GC), the carbohydrate reserves in the cuttings vary depending on the variety and amount to 140.2±2.0 g (RxR 101-14) and 128.5±1.8 g (BxR Kober 5BB), corresponding to the 3rd and 4th cuttings.

We have determined that the rootstock variety and the position of cuttings along the stock-cane length significantly influence the grafted sapling output from the nursery. Thus, for the grafted components of clone R5 Cabernet Sauvignon onto RxR 101-14, the output of saplings varies from 49.4% EG 1 (1st cutting) to 28.4% EG 5 (5th cutting) (from the number of grafts made). When grafting clone R5 Cabernet Sauvignon onto BxR Kober 5BB, the grafted saplings output increases when using cuttings from the base-cane and middle-cane zones EG 1, EG 2, EG 3 (1st to 3rd cuttings) and decreases when using cuttings from the top-cane zone EG 4, EG 5 (4th and 5th cuttings).

We have established that there is a strong correlation (r=0.98±0.1) between the carbohydrate content in 100 rootstock cuttings and the output of grafted saplings from the nursery. According to the obtained data, carbohydrate content in the range of 150-160 g per 100 cuttings ensures an output of high-quality grafted vine saplings from the nursery within the range of 50-60% (fig. 4.2). When grafting on cuttings taken from the base to the top rootstock cane (from 1st to 5th), there is a consistent decrease in the size of the vine saplings growth and the main shoot. The indicators of matured growth, the diameter at the base of the main shoot, total growth volume, matured growth volume, total root count, as well as the number of roots with a diameter > 2mm, all show a decrease.

Thus, the output of vine saplings from the nursery of clone R5 Cabernet Sauvignon onto BxR Kober 5BB and clone R5 Cabernet Sauvignon onto RxR 101-14 is dependent on the position of cuttings along the stock-cane length. Grafting on cuttings from the base-cane zone EG 1, EG 2 (1^{st} to 2^{nd}) significantly increases the output of saplings, their shoot development, and root system compared to grafting on cuttings from the top-cane zone EG 5 (5^{th}).

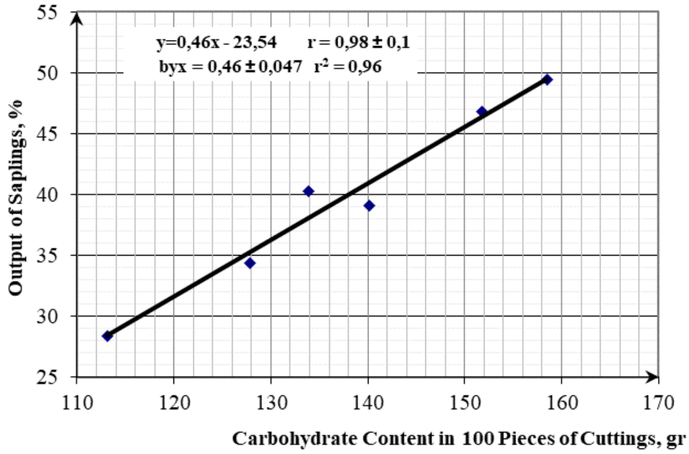

Fig. 4.2. Relationship Between Carbohydrate Content in 100 Pieces of Cuttings BxR Kober 5BB and Output of Grafted Saplings from a Nursery, 2004г

Our research findings are consistent with the data from L. Kolesnik [53], L. Maltabar [58], A. Mishurenko [65], who note that the most productive cuttings within a single cane are those taken from the middle and base parts of the rootstock cane. Cuttings from the top part, even if they meet the standard requirements and mature normally, exhibit lower survival rates and output saplings of somewhat inferior quality compared to cuttings from the base-cane or middle-cane zones.

4.2. The Impact of the Quality of Scion Material and Treatment of Grafted Cuttings with Calovit on the Processes of Regeneration and the Output of Grafted Saplings from the Nursery

We have determined that in bench grafting carried out by a mechanized method using an Omega-wedge, the regeneration processes do not proceed uniformly. The quality of scionwood cuttings (with or without tendrils) as well as treatment with a solution of calovit significantly influence these processes. It has been established that by the end of stratification in control variants (H_2O), the number of grafted cuttings with a circular callus on the scion is 70.0% and 78.6% on the rootstock and 90.0% and 100.0% respectively, significantly higher in the scions with tendrils variant. The application of calovit enhances the callus-forming ability of the grafted components. Active differentiation of xylem vessels occurs in the callus. The number of grafted cuttings with vessels in the callus particularly increases when grafting scions with tendrils, and in the calovit variant, it reaches 100.0%. It has been established that Calovit treatment, in addition to enhancing callus formation, leads to the inhibition of budbreaks and shoot growth. In the control variants (H_2O), the percentage of grafted cuttings with unopened eyes is 67.6% and 52.9%, while with calovit treatment, it increases to 85.3% and 60.0%. It is characteristic that the inhibition of budbreaks is more pronounced in variants without tendril scions. On the bottom of the rootstock cuttings in the control variants, root primordia and callus are formed, while calovit treatment induces the formation of root primordia and small roots.

We have determined that the survival rate of grafted cuttings in the nursery under control variants is 62.6% and 63.1%, and it is not influenced by the quality of the scion cuttings used in the experiment. When treated with Calovit, the survival rate increases by 8.8% and 19.6%, reaching 71.4% (scion without tendrils) and 82.7% (scion with tendrils), which is presumably attributed to active regeneration of root primordia at the bottom of the rootstock. We have determined that the growth processes of grafted vine saplings in the nursery vary among different experimental variants. For instance, during the period of active shoot growth, the total length of growth for one sapling in the control variants ranges from 173.0 to 194.3 cm, the growth volume ranges from 23.05 to 25.68 cm^3, and the Leaf Surface Area ranges from 36.4 to 39.7 dm^2. A certain regularity is observed, associated with the fact that when using cuttings with tendril, the sapling output increases by 6.5-5.7%. It is noteworthy that with calovit treatment in the without-tendriled graft variant, the vine output remains at the control level (35.1 and 36.8%). At the same time, with calovit treatment grafted cuttings with tendrils, the sapling output increases by 4.0-4.9% (LSD_{05} = 0.90 and 0.88%).

Table 4.1. The Output of Sapling from a Nursery and Their Quality Depending on Different Quality of Scion Cuttings and Treatment with Calovit. Clone R5 Cabernet Sauvignon onto BxR Kober 5BB, 2004.

Variants	The output of saplings from the number of grafted cutting, %		Saplings' Growth Length, cm		Saplings' Growth Volume, cm^3		Number of roots, pcs		
	made	planted in the nursery	total	ma-tured	total	ma-tured	>2 mm	to 2 mm	total
without tendrils H_2O	35.3±1.2	37.2±1.2	65.9±1.9	35.0±0.4	5.6±0.1	4.4±0.1	5	4	9
weith tendrils H_2O	41.8±1.2	42.9±1.2	72.4±1.9	41.4±0.4	7.2±0.2	6.6±0.1	5	4	9
without tendrils Calovit	35.1±1.1	36.8±1.2	75.4±1.9	50.0±0.5	8.5±0.2	7.1±0.2	5	4	9
with tendrils Calovit	46.7±1.2	46.9±1.3	94.2±2.0	50.6±0.5	9.2±0.2	7.9±0.2	6	3	9
LSD_{05}	*0.90*	*0.88*							

The grafting vine sapling of the researched variants are characterized by varying shoot growth and root system development (tab. 4.1). For instance, when grafting a scion with tendrils, compared to without tendrils an increase in the length and volume of both the total and mature growth of the grafted vine saplings. Treatment of grafted cuttings with tendril scion with calovit leads to an increase in the growth parameters of grape saplings: the length of sapling growth is 94.2 cm, the main shoot - 50.6 cm; the total volume of growth - 9.2 cm^3, matured - 7.9 cm^3; the total number of roots - 9 pieces, including 6 pieces with diameter > 2 mm. These measurements significantly surpass the growth and root system sizes of saplings from other variants.

Treating grafted cuttings with calovit on the background of hormone-containing paraffin of the Actygref type yields more pronounced positive outcomes, particularly when utilizing high-quality grafting material (scion cuttings with a tendril), which can be capable of withstanding the complex hormonal demands during the regeneration period.

5. PRODUCTIVITY OF VINEYARDS DEPENDING ON THE QUALITY OF PLANTING MATERIAL

5.1. Survival Grafted Saplings, Growth, and Development of Young Vines

5.1.1. The Impact of Rootstock Quality

The grape-grafted saplings of clone R5 Cabernet Sauvignon onto BxR Kobber 5BB and onto RxR 101-14, after being dug up from the nursery, stored in cellars, were planted in their permanent location according to the experimental plots in 2005. At the end of the growing season, the saplings' survival rates were recorded, and the Annual Growth developed on young vines.

The survival rate of saplings of Cabernet-Sauvignon Cl R5 onto RxR 101-14 ranges from 100.0% to 89.5%, and onto BxR Kobber 5BB – from 97.4% to 85.5%. By the end of the first growing season, the total length of shoot growth in the vines, the length of the main shoot, the dimensions of matured growth of the main shoot, the diameter at the base of the main shoot, and the total volume of shoot growth were 1.1–1.4 times greater than the growth parameters of the vines in the control variant and 2.6 times greater than the growth parameters of vines grafted onto cuttings from the top-cane rootstock zone.

It has been determined that vines grown from saplings obtained by using 1-2 cuttings for grafting, in the third year after planting, are characterized by more vigorous development of annual shoots and the accumulation of perennial wood, which is important for the formation of the vine's shape. Thus, on vines characterised by vigorous growth (vigorous vines) were trained to have well-developed two trunks and two cordons. On vines with moderate growth (medium vines), one to two trunks and one developed cordon were successfully formed. On vines with the weakest growth (weak vines), only one trunk was formed. We have determined that the distribution of vines among these groups varies in different experimental variants (fig. 5.1). In the control group (CG), the number of vigorous vines for the clone R5 Cabernet Sauvignon onto the BxR 5BB and onto RxR 101-14 rootstocks is 34.9% and 37.6%, respectively, while the number of medium vines is 47.6% and

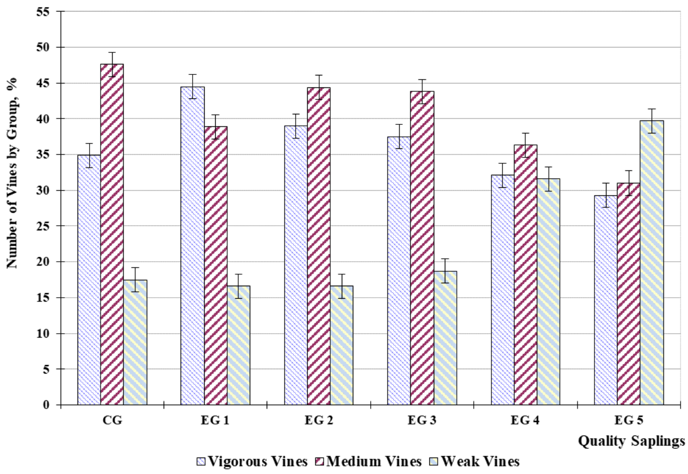

Fig. 5.1. The Impact of Different Quality Saplings on the Degree of Young Vines Development, 2007

41.6%, and weak vines constitute 17.5% and 20.8%, respectively. It is notable that when grafting onto cuttings from the base-cane of the stock 1st-2nd cuttings (EG 1, EG 2), the number of vigorous vines increases by 1.7–2.1 times and the number of weak vines decreases [6].

It has been established by us that in the third year after planting, the number of developed annual shoots on young vines of the R5 Cabernet Sauvignon clone varies, depending on the experimental variants, from 12.3±0.3 to 21.2±0.4 shoots per vine (onto BxR Kober 5BB) and from 11.0±0.2 to 15.6±0.4 shoots per vine (onto RxR 101-14). The percentage of fruitful shoots ranges from 63.4% to 81.0% for BxR Kober 5BB and from 71.9% to 77.3% for grafting onto RxR 101-14, increasing when using cuttings from the base of the stock cane EG 1 – EG 3 (1st-3rd cuttings).

The coefficients of fruiting and fruitfulness vary slightly, and no specific dependence of changes in these indicators on the location of rootstock cuttings along the length of the cane has been established. The third year of planting in the control variants, the number of grape clusters for clone R5 Cabernet-Sauvignon onto BxR Kober 5BB is 18.8 clusters per vine and onto RxR 101-14 is 15.5 clusters per vine. It is noteworthy that when using cuttings from the base of the stock cane to the top (from 1st to 5th cuttings) for grafting, the number of clusters decreases. The mean cluster weight varies slightly, ranging from 85 to 91 grams (onto BxR Kober 5BB) and from 82 to 96 grams (onto RxR 101-14).

The yield of vines in the third year of vegetation of Cl R5 Cabernet Sauvignon onto BxR Kober 5BB in the control variant is 1.69 kg/vine. When grafted with cuttings from the base of the stock cane (1st and 2nd cuttings) it increases compared to the control by 18.3-14.8%. When grafted onto cuttings from the middle and top zones of the stock cane, the yield is at the control level or decreases. The mass concentration of sugars in the control variant is 224 g/dm³, with titratable acidity at 6.9 g/dm³. When grafted with cuttings from the base and middle zones of the stock cane, these indicators increase by 11-26 g/dm³ and 0.5-0.6 g/dm³, respectively. The yield of the young grapevines in the control variant clone R5 Cabernet Sauvignon grafted onto RxR 101-14 is 1.38 kg. When using cuttings from the base and middle of the stock canes EG 1-EG 3 (1st-3rd cuttings) for grafting, the yield increases by 21.5-7.8%, respectively. A decrease in yield of 10.1-19.7%, compared to the control, is observed when using cuttings from the top zone of the stock cane EG 4 – EG 5 (4th-5th cuttings) for grafting. The mass concentration of sugars and titratable acidity in the grape berries changes insignificantly and amounts to 230-250 g/dm^3 and 6.2-7.0 g/dm^3.

In the fourth year after planting, 60-80% of the vines of this clone were fully formed. On average, each of them developed 35-38 shoots and 42.9-57.9 clusters (tab. 5.1). Compared to the third year, the number of clusters increased 2.7-3.1 times, depending on the experimental variants. At the same time, the average cluster weight decreased by 1.6-1.7 times, reaching 53-59 gram for the clone R5 Cabernet Sauvignon grafted onto BxR Kober 5BB and 50-58 g onto RxR 101-14.

Table 5.1. Yield Indicators and Harvest Quality of Young Vines Depending on the Quality of Saplings. Fourth Year of Planting, 2008.

Variants	No. of Clusters pcs./vine	Weight of Clusters, g	Yield		Mass concentration, g/dm³	
			kg/vine	% to controll	sugars	titratable acids
Cl R5 Cabernet Sauvignon onto BxR Kober 5BB						
CG	50.9±0.26	57±2.1	2.90±0.04	100	185±2	6.5±0.03
EG 1	57.9±0.32	59±2.2	3.42±0.04	117.9	190±2	6.4±0.03
EG 2	57.0±0.45	54±2.2	3.08±0.04	106.3	194±3	6.5±0.03
EG 3	56.1±0.24	53±2.1	2.97±0.03	102.4	180±2	6.5±0.03
EG 4	50.9±0.22	55±2.1	2.80±0.03	96.6	180±2	6.6±0.03
EG 5	42.9±0.21	58±2.2	2.49±0.03	85.9	172±2	6.7±0.03
LSD_{05}			*0.10*			
Cl R5 Cabernet Sauvignon onto RxR 101-14						
CG	46.1±0.08	55±2.2	2.53±0.04	100	202±3	6.3±0.01
EG 1	53.0±0.20	58±2.2	3.07±0.04	121.4	189±2	6.4±0.02
EG 2	51.9±0.20	55±2.2	2.86±0.04	113.1	200±3	6.2±0.01
EG 3	47.9±0.14	54±2.1	2.59±0.04	102.4	205±3	6.4±0.02
EG 4	45.1±0.11	52±2.1	2.34±0.03	92.5	192±2	6.3±0.02
EG 5	45.0±0.18	50±2.1	2.25±0.03	88.9	214±3	6.2±0.01
LSD_{05}			*0.20*			

The yield grapevines of clone R5 Cabernet Sauvignon onto BxR Kober 5BB is 2.49-3.42 kg per vine, when grafted onto RxR 101-14, it amounts to 2.25-3.07 kg per vine. There is a significant increase in yield in cases of grafting from the base and middle of the stock cane EG 1 – EG 3 (1st to 3rd cuttings). It should be noted that the mass concentration of sugars increases with grafting onto RxR 101-14 (189-214 g/dm^3) compared to grafting onto BxR Kober 5BB (180-194 g/dm^3), while the acidity of the berry juice, regardless of the rootstock, remains at a level of 6.2-6.6 g/dm^3.

The influence of the different quality of rootstock cuttings along the length of the stock cane is manifested during the stages of stratification, nursery cultivation of vines, and after their planting in the permanent location. Moreover, a strong correlation exists between stock cutting quality parameters, the success rate of grafted vines emerging from the nursery, their quality, survival upon transplantation, and the growth of young grapevines [8].

It has been that the growth and development of clone R5 Cabernet Sauvignon grapevines, their entry into fruiting, and productivity are influenced by the rootstock variety as well as the different quality of the planting stock. For this clone, the onset of fruiting in the vines is observed in the third to fourth year after planting, during the period of shape-establishment. In the fourth year, the plantation yield of clone R5 Cabernet Sauvignon onto BxR Kober 5BB depending on the experimental variations ranges from 6.04 to 8.29 ton per hectare; onto RxR 101-14 - from 5.45 to 7.44 ton per hectare, and significantly increases when planting vines obtained using cuttings from the base-cane and middle-cane of the stock (1^{st}-3^{rd} cuttings).

We believe that to ensure high output and quality of grafted vines from the nursery, a hundred per cent survival rate upon plantation to their permanent location, as well as vigorous development of young vines and their early entry into fruiting period, it is advisable to use rootstock cuttings taken from the first two metres of the stock cane from the base for grafting.

5.1.2. The Impact of Scion Quality and Calovit

It has been established that the survival rate of vines with a tendrilless scion is 93.4%, and with a tendril - 96.1%. The use of scion with tendrils and subsequent pre-stratification treatment with a solution of calovit leads to increased regeneration processes, increased output of well-developed grafted vines with vigorous growth and root systems, as well as increased their survival rate in a permanent location.

It has been determined that vines grown from saplings obtained by using 1-2 cuttings for grafting, in the third year after planting, are characterized by more vigorous development of annual shoots and the accumulation of perennial wood, which is important for the formation of the vine's shape. In the third year after pruning, the number of vigorous vines (with two trunks and two well-developed arms) was 57.9%, medium-strength vines (with one or two trunks and one developed arm) accounted for 31.6%, and weak vines (with only a trunk) made up 10.5%. As a result, in the four-year-old vines after pruning in this variant, the formation of shape parts on many vines was completed. The number of fully formed vines was 72.2%.

Clone R5 Cabernet-Sauvignon was found onto BxR Kober 5BB in the three-year-old vines, the number of formed annual shoots varies, depending on the variants of the experiment, from 11.2 to 15.8 shoot/vine, including fruiting shoots, from 8.8 to 13.8 shoot/vine. The percentage of fruiting shoots varies from 78.6 to 87.3 and increases when using planting material obtained by grafting with tendrils scion cuttings. In control variants, the number of flower clusters changes insignificantly and makes 16.8 - 18.4 pieces/vine. It should be noted that the number of flower clusters increases 1.3-1.5 times in the variants scion with tendrils compared to the without tendrils, especially when calovit solution is used. The coefficients of fruiting and fruitfulness capacity when using scion with tendrils are somewhat higher than those when using without tendrils, apparently, due to a higher percentage of fruiting shoots and a greater number of flower clusters on them. A similar pattern is observed in the fourth year after planting, which is characteristic of this clone.

The formation of grape clusters occurs following the same pattern as that of the actual flower clusters. For instance, in the third year of vegetation, the number of flower clusters ranges from 13.5 to 21.6 per vine, significantly increasing in variants of the scion with tendrils and treatment with calovit solution. The mean clusters weight changes slightly, ranging from 94±2.2 grams to 105±2.3 grams. The yield of young vine in the control variant of scion without tendrils is 1,27±0.02 kg, whereas in the variant of scion with tendrils, it is 1,75±0.02 kg. In the variants utilizing the calovit solution, the yield predictably increases: for scions without tendrils to 1,48±0.02, and for scions with tendrils to 2,03±0.03 kg. The mass concentration of sugars and titratable acids in grape berries changes slightly and amounts to 238±2-243±2 g/dm³, and 6,7±0.03-7,3±0.03 g/dm³, respectively.

It has been determined that by the four-year-old vines, a mean of 41.8±0.2 to 49.7±0.3 cluster per vine had developed on the studied vines (tab. 5.2). Compared to the three-year-old vines, the number of clusters increased by 2.3 to 3.1 times, depending on the experimental variants. However, the mean cluster weight decreased by 1.4 to 1.5 times. Thus, in 2008, compared to 2007, meteorological conditions during the berry growth period (August) were less favorable due to insufficient precipitation (9 mm).

Table 5.2. Yield Indicators and Harvest Quality of Young Vines Depending on the Quality of Saplings. Cl R5 Cabernet Sauvignon onto BxR Kober 5BB. Fourth Year of Planting, 2008.

Variants	No. of Clusters pcs./vine	Weight of Clusters, g	Fruit Yield, kg/vine	Mass concentration, g/dm³	
				sugars	titratable acids
without tendrils H_2O	41.8±0.2	64±2.2	2.68±0.03	189±2	6.9±0.02
with tendrils H_2O	47.1±0.3	69±2.2	3.25±0.04	180±2	6.9±0.02
without tendrils Calovit	44.6±0.2	67±2.3	2.99±0.04	184±2	6.8±0.02
with tendrils Calovit	49.7±0.3	72±2.3	3.58±0.04	201±3	6.5±0.02
LSD₀₅	*2.54*	*2.84*	*0.21*		

The fruit yield of vine in the control variants ranges from 2.68±0.03 to 3.25±0.04 kg/vine or 64.9 to 78.8 centner per hectare. When using calovit solution, it increases to 2.99±0.04 to 3.58±0.04 kg/vine, particularly in the variant scion with tendrils. At the same time, the sugar concentration in the berry juice decreased by 42 g/dm³ compared to 2007.

It was determined that during the period when the vines of the R5 clone of the Cabernet Sauvignon variety enter the fruiting stage, there is a consistent increase in the number of shoots and vine productivity, along with a slight decrease in shoot productivity. Thus, in the three-year-old vines, the mean number of shoots is 11.2-15.8 pieces per vine, yield ranges from 1.27 to 2.03 kg per vine, and shoot productivity is 113.4-128.5 g per shoot. In the four-year-old vines, these indicators are, respectively, 30.2-32.8 shoots per vine; 2.68-3.58 kg per vine; and 88.7-109.1 g per shoot. In the variant’s scion with tendrils, and particularly with the application of calovit solution, these indicators notably increase [7].

Thus, the impact of the different quality of scion cuttings manifests at the stages of stratification, vine growth in the nursery, and after planting them in a permanent place. In this regard, a strict correlation is observed between the parameters of scion cuttings quality, the output of grafted saplings from the nursery, their quality, the survival rate at the permanent location, and the growth of young vines.

5.2. Growth and Productivity of Fruiting Vineyards

5.2.1. Analysis of the After-effect of Different Quality Planting Stock by Rootstock Attributes

Shoot Growth and Development. using planting stock of different quality (based on the length of the stock cane) leads to the development of vines with uneven growth strength in the initial years after planting [9].

During the period of full fruiting (2015-2021), the average shoot load of the vines is established based on the vigour of the vines and varies from year to year. When grown onto the BxR Kober 5BB, the number of developed shoots ranges from 46.5 to 40.1 per vine; onto RxR 101-14, it ranges from 43.5 to 39.2 per vine. In specific years (2019-2020) characterized by extreme meteorological conditions (drought), there is a reduction in the shoot load of the vines.

The growth of shoots depends on the different quality of the vines and the rootstock onto which they are grafted. By the end of the vegetative period, the average length, depending on the year of study, ranges from 113.5 to 172.5 cm (BxR Kober 5BB); 105.9 to 161.2 cm (RxR 101-14). This variation in the average length of shoots can be explained, on one hand, by the non-uniformity of the vines according to the experimental variants, and on the other hand, by a combination of unfavourable meteorological conditions - reduced precipitation and increased average monthly temperatures (soil-air drought) - observed in certain years (2019-2021).

In favourable meteorological conditions in the years 2017-2018, by the end of the vegetation period, for the R5 of Cabernet Sauvignon onto Kober 5BB, the average length of the shoots is 172.8 cm – EG 1, 160.1 cm – EG 2, and 151.6 cm – EG 3; the length of the annual shoot growth is 80.4, 72.5, and 65.6 cm per vine; the volume of the annual shoot growth is 5.7, 4.9, and 4.4 dm^3 per vine, respectively (tab. 5.3). On vines grown from saplings obtained using rootstock cuttings from the top zone of the rootstock cane – EG 4, EG 5, the growth parameters of shoots decrease: the length of annual shoot growth decreases by 1.3-1.5 times, and the volume of annual shoot growth decreases by 1.5-1.6 times. A similar pattern is observed for the R5 clone of Cabernet Sauvignon onto RxR 101-14 rootstock. In unfavourable meteorological conditions during the years 2019-2021, high average daily temperatures during the summer period and a lack of moisture led to a significant reduction in the annual shoot growth of the vines. For instance, in the anomalous year of 2020, the average length of shoots for the R5 clone of Cabernet Sauvignon onto BxR Kober 5BB ranges from 51.8 to 71.8 cm, the length of annual shoot growth ranges from 12.3 to 28.2 m per vine, and the volume of annual shoot growth ranges from 0.3 to 0.7 dm^3 per vine. Onto RxR 101-14, the average length of shoots decreases to 49.8-69.0 cm, the length of annual shoot growth ranges from 11.2 to 20.4 m per vine, and the volume of annual shoot growth ranges from 0.3 to 0.5 dm^3 per vine.

Table 5.3. Annual Growth Volume Parameters Depending on the Different Quality of Vines. Cl R5 Cabernet Sauvignon onto BxR Kober 5BB.

cm^3 per shoot

Variants	2015	2016	2017	2018	2019	2020	2021	Mean
CG	67.3±0.9 klm	72.9±1.3 ijk	101.2±1.4 c	81.0±1.0 gh	66.2±1.0 lm	16.2±0.2 uv	30.2±0.3 qr	62.1±3.3 C
EG 1	75.1±0.8 ij	82.6±1.2 g	122.4±1.8 a	98.6±1.4 cd	82.0±1.3 gh	19.0±0.4 tu	36.1±0.6 p	73.7±4.0 A
EG 2	73.6±1.1 ij	76.5±1.5 hi	108.7±1.4 b	90.0±1.2 ef	71.2±1.0 i-l	16.9±0.4 uv	32.0±0.7 pq	67.0±3.6 B
EG 3	67.1±1.0 lm	73.3±1.1 ij	100.7±1.4 c	82.6±1.2 g	66.9±1.1 lm	16.8±0.4 uv	31.8±0.7 pq	62.7±3.3 C
EG 4	62.6±1.0 mno	69.7±1.1 jkl	93.9±1.5 de	75.0±1.0 ij	62.2±0.9 mno	13.6±0.4 uv	25.4±0.7 rs	57.5±3.2 D
EG 5	58.8±1.1 no	63.0±1.1 mn	86.3±1.5 fg	70.5±1.1 jkl	57.0±0.9 o	12.3±0.3 v	23.2±0.6 st	53.0±2.9 E
Mean	67.4±0.8 D	73.0±0.9 C	102.2±1.6 A	83.0±1.3 B	67.6±1.1 D	15.8±0.3 F	29.8±0.6 E	62.7±1.4

ANOVA

$F_{Variants}$ 4993.3* F_{Years} 336.6*** $F_{Variants*Years}$ 11.9*****

dm^3 per vine

Variants	2015	2016	2017	2018	2019	2020	2021	Mean
CG	2.72 ± 0.02 i	2.99 ± 0.02 h	4.47 ± 0.03 c	3.49 ± 0.03 ef	2.73 ± 0.03 i	0.51 ± 0.01 qr	1.13 ± 0.02 o	2.58 ± 0.15 C
EG 1	3.26 ± 0.04 g	3.63 ± 0.03 e	5.69 ± 0.04 a	4.38 ± 0.04 c	3.59 ± 0.04 ef	0.67 ± 0.01 pq	1.52 ± 0.02 n	3.25 ± 0.19 A
EG 2	3.06 ± 0.04 h	3.25 ± 0.04 g	4.92 ± 0.06 b	3.89 ± 0.04 d	2.91 ± 0.03 h	0.58 ± 0.01 q	1.28 ± 0.02 o	2.84 ± 0.17 B
EG 3	2.68 ± 0.02 i	3.06 ± 0.03 h	4.36 ± 0.05 c	3.46 ± 0.04 f	2.63 ± 0.04 ij	0.52 ± 0.01 q	1.16 ± 0.03 o	2.55 ± 0.15 C
EG 4	2.47 ± 0.02 j	2.74 ± 0.03 i	3.92 ± 0.04 d	2.68 ± 0.03 i	2.17 ± 0.02 kl	0.34 ± 0.01 rs	0.79 ± 0.02 p	2.16 ± 0.14 D
EG 5	2.22 ± 0.02 k	2.00 ± 0.02 l	3.45 ± 0.04 f	2.30 ± 0.04 k	1.81 ± 0.02 m	0.29 ± 0.01 s	0.66 ± 0.02 pq	1.82 ± 0.12 E
Mean	2.74 ± 0.05 D	2.94 ± 0.07 C	4.47 ± 0.09 A	3.37 ± 0.09 B	2.64 ± 0.07 E	0.48 ± 0.02 G	1.09 ± 0.04 F	2.53±0.07

ANOVA

$F_{Variants}$ 1856.1* F_{Years} 11521.3*** $F_{Variants*Years}$ 66.7*****

m^3 per hectare

Variants	2015	2016	2017	2018	2019	2020	2021	Mean
CG	6.60±0.05 i	7.24±0.05 h	10.82±0.07 c	8.46±0.08 ef	6.63±0.07 i	1.24±0.04 qr	2.74±0.05 o	6.25±0.37 C
EG 1	7.90±0.09 g	8.80±0.06 e	13.80±0.11 a	10.61±0.09 c	8.69±0.10 ef	1.62±0.03 pq	3.67±0.05 n	7.87±0.46 A
EG 2	7.41±0.10 h	7.86±0.09 g	11.92±0.14 b	9.44±0.10 d	7.06±0.08 h	1.40±0.04 q	3.11±0.04 o	6.88±0.40 B
EG 3	6.50±0.06 i	7.41±0.08 h	10.56±0.13 c	8.39±0.09 f	6.37±0.09 ij	1.25±0.03 q	2.81±0.07 o	6.18±0.36 C
EG 4	5.98±0.06 j	6.64±0.08 i	9.51±0.09 d	6.50±0.07 i	5.24±0.05 kl	0.83±0.03 rs	1.92±0.04 p	5.23±0.33 D
EG 5	5.39±0.05 k	4.85±0.04 l	8.35±0.10 f	5.56±0.09 k	4.39±0.04 m	0.70±0.03 s	1.60±0.04 pq	4.41±0.29 E
Mean	6.63±0.11 D	7.13±0.16 C	10.83±0.23 A	8.16±0.22 B	6.40±0.18 E	1.17±0.04 G	2.64±0.09 F	6.14±0.16

ANOVA

$F_{Variants}$ 1861.6* F_{Years} 11552.3*** $F_{Variants*Years}$ 66.9*****

*Ns: not significant, *: significant at p≤0.1, **: significant at p≤0.01, ***: significant at p≤0.001*

The data obtained by us are consistent with the materials presented in the monograph by K. Stoev [76], which confirms that the maximum shoot growth is determined by meteorological conditions, primarily the temperature factor. The relationship is so close that any increase or decrease in temperature corresponds to an almost proportional increase or decrease in growth intensity.

Growth and Development of Leaf Surface Area. It has been determined that the Leaf Blade Area during the years of the research does not depend on the experimental variants but varies from year to year. A mean, depending on the year of the research, it ranges from 84.1±1.1 cm^2/leaf to 144.8±0.7 cm^2/leaf. Changes of data on Leaf Blade development is related to inadequate meteorological conditions during the years of research.

In favourable years (2017-2018), the Leaf Blade Area in the control variant measures 138.6±0.4-144.6±0.4 cm^2/leaf (BxR Kober 5BB) and 131.6±3.2-141.0±2.6 cm^2/leaf (RxR 101-14). In the subsequent years, there is a consistent decrease in Leaf Blade Area, which is attributed to reduced precipitation and elevated average monthly air temperatures during the vegetative period. For instance, in 2020, the Leaf Blade Area decreased by 1.7-1.8 times compared to 2017-2018. The Leaf Area per vine of the R5 clone of Cabernet Sauvignon in 2017 at the end of the vegetation period in the control variant onto BxR Kober 5BB was 45,0 dm^2/shoot and 19.9 m^2/vine. Grapevines obtained from grafted vines using 1^{st}-3^{rd} cuttings from the base of the stock cane showed an increase in Leaf Area, it was 51.3 (EG 1), 47.5 (EG 2), 44.7 dm^2/shoot (EG 3) and 23.8, 21.5, 19.4 m^2/vine. On vines received using stock cuttings from the top-cane (EG 4, EG 5), a decrease in Leaf Surface Area by 1.1-1.2 times is observed. It is notable that the development of the leaf area of grapevines depends on the rootstock variety on which they are grafted. When grafted onto RxR 101-14, compared to BxR Kober 5BB in the control variant, the leaf area per shoot and per vine decreases by 1.1-1.2 times, amounting to 40.7 dm^2/shoot and 17.1 m^2/vine, respectively. A reduction in leaf area size is observed when 4^{th} and 5^{th} cuttings are used for grafting. In unfavorable years, the growth parameters of the leaf area per shoot and per vine decline sharply.

Calculations of the Leaf Area of the vineyards of the studied clone grafted onto BxR Kober 5BB and RxR 101-14, revealed variations influenced by the different quality of the vines and a complex of meteorological conditions during their growth. In favourable years (2017), the Leaf Area reaches 48.2±0.3 and 41.4±0.3 thousand of m^2/hectare in the control variants. The Leaf Area Index of the R5 clone of Cabernet Sauvignon varies depending on the different quality of the vines, growing conditions, and the year of the research. Under favourable conditions, the Leaf Area Index ranges from 3.75±0.13 to 5.78±0.09 m^2/m^2 (onto BxR Kober 5BB) and from 3.30±0.08 to 4.92±0.07 m^2/m^2 (onto RxR 101-14) (tab. 5.4, tab. 5.5). It significantly decreases under unfavourable conditions (2020-2021). Inhibition of Leaf Blade Area growth due to high

Table 5.4. Development of Leaf Surface Area Depending on the Different Quality of Vines. Cl R5 Cabernet Sauvignon onto BxR Kober 5BB.

Leaf Area, m² per vine

Variants	2015	2016	2017	2018	2019	2020	2021	Mean
CG	12.4±0.2 k-n	15.0±0.1 f-i	19.9±0.1 bc	18.3±0.1 cde	12.3±0.2 k-o	6.1±0.1 u	9.5±0.1 rs	13.4±0.5 C
EG 1	14.6±0.1 f-j	17.9±0.5 de	23.8±0.4 a	21.4±0.3 b	15.2±0.2 fgh	7.4±0.1 tu	11.7±0.5 m-q	16.0±0.6 A
EG 2	13.4±0.3 i-l	16.0±0.2 f	21.5±0.3 b	19.4±0.3 cde	13.2±0.4 j-m	6.9±0.2 tu	10.5±0.3 pqr	14.4±0.6 B
EG 3	12.1±0.2 l-p	15.4±0.4 fg	19.4±0.3 cd	17.7±0.5 e	12.2±0.2 k-p	5.9±0.2 u	9.2±0.2 rs	13.1±0.5 C
EG 4	11.3±0.3 n-q	13.7±0.3 h-k	17.8±0.3 de	14.3±0.3 g-j	10.3±0.2 qr	4.3±0.3 v	7.1±0.3 tu	11.2±0.5 D
EG 5	10.2±0.3 qr	10.7±0.3 o-r	15.5±0.5 fg	12.3±0.6 k-o	8.5±0.3 st	3.9±0.2 v	6.3±0.3 u	9.6±0.4 E
Mean	12.3±0.2 D	14.8±0.3 C	19.7±0.4 A	17.2±0.4 B	11.9±0.3 D	5.7±0.2 F	9.0±0.3 E	13.0±0.2

ANOVA

$\mathbf{F}_{Variants}$ **392.0***** $\mathbf{F}_{Years}$ **1476.4***** $\mathbf{F}_{Variants*Years}$ **6.6*****

Leaf Area, thousands of m2 per hectare

Variants	2015	2016	2017	2018	2019	2020	2021	Mean
CG	30.2±0.4 klm	36.4±0.2 fg	48.2±0.3 c	44.3±0.3 d	29.8±0.4 lmn	14.7±0.2 vw	23.1±0.3 rs	32.4±1.3 C
EG 1	35.4±0.4 fgh	43.3±0.3 d	57.8±0.3 a	51.9±0.3 b	36.9±0.4 efg	18.1±0.3 u	28.3±0.2 mno	38.8±1.5 A
EG 2	32.4±0.3 ijk	38.9±0.3 e	52.1±0.4 b	47.1±0.8 c	32.1±0.3 jkl	16.7±0.2 uvw	25.3±0.3 pqr	35.0±1.4 B
EG 3	29.3±0.4 mn	37.4±0.4 ef	47.0±0.5 c	43.0±0.6 d	29.5±0.4 mn	14.4±0.3 w	22.3±0.4 st	31.8±1.3 C
EG 4	27.4±0.8 nop	33.2±0.3 hij	43.1±0.3 d	34.7±0.6 ghi	25.0±0.5 qr	10.4±0.4 x	17.1±0.3 uv	27.3±1.2 D
EG 5	24.7±0.6 qrs	25.9±0.6 opq	37.6±0.4 ef	29.8±0.8 lm	20.6±0.7 t	9.6±0.5 x	15.3±0.4 vw	23.4±1.1 E
Mean	29.9±0.5 D	35.9±0.7 C	47.6±0.8 A	41.8±1.0 B	29.0±0.7 E	14.0±0.4 G	21.9±0.6 F	31.4±0.6

ANOVA

$\mathbf{F}_{Variants}$ **1097.1***** $\mathbf{F}_{Years}$ **4128.1***** $\mathbf{F}_{Variants*Years}$ **18.4*****

Leaf Area Index, m²/m²

Variants	2015	2016	2017	2018	2019	2020	2021	Mean
CG	3.01±0.06 k-n	3.64±0.04 f-i	4.82±0.03 bc	4.44±0.03 cde	2.98±0.06 k-o	1.48±0.02 u	2.30±0.02 rs	3.24±0.13 C
EG 1	3.54±0.03 f-j	4.35±0.12 de	5.78±0.09 a	5.20±0.08 b	3.67±0.05 fgh	1.81±0.03 tu	2.83±0.13 m-q	3.88±0.16 A
EG 2	3.24±0.07 i-l	3.87±0.06 f	5.20±0.07 b	4.70±0.08 cde	3.19±0.09 j-m	1.67±0.04 tu	2.55±0.08 pqr	3.49±0.14 B
EG 3	2.92±0.05 l-p	3.74±0.09 fg	4.71±0.07 cd	4.30±0.11 e	2.96±0.05 k-p	1.44±0.05 u	2.23±0.04 rs	3.18±0.13 C
EG 4	2.73±0.08 n-q	3.33±0.07 h-k	4.31±0.06 de	3.46±0.08 g-j	2.49±0.06 qr	1.03±0.06 v	1.73±0.08 tu	2.73±0.13 D
EG 5	2.46±0.07 qr	2.59±0.08 o-r	3.75±0.13 fg	2.97±0.14 k-o	2.05±0.08 st	0.95±0.06 v	1.52±0.07 u	2.33±0.11 E
Mean	2.98±0.05 D	3.58±0.08 C	4.76±0.09 A	4.18±0.10 B	2.89±0.07 D	1.39±0.04 F	2.19±0.07 E	3.14±0.06

ANOVA

$\mathbf{F}_{Variants}$ **393.0***** $\mathbf{F}_{Years}$ **1474.4***** $\mathbf{F}_{Variants*Years}$ **6.5*****

*Ns: not significant, *: significant at p≤0.1, **: significant at p≤0.01, ***: significant at p≤0.001*

Table 5.5. Development of Leaf Surface Area Depending on the Different Quality of Vines. Cl R5 Cabernet Sauvignon onto RxR 101-14.

Leaf Area, m^2 per vine

Variants	2015	2016	2017	2018	2019	2020	2021	Mean
CG	10.5±0.3 k-n	13.7±0.3 fg	17.1±0.2 bc	15.4±0.2 de	10.9±0.2 j-m	5.2±0.2 stu	8.3±0.1 q	11.6±0.5 C
EG 1	12.7±0.2 ghi	16.0±0.3 cd	20.3±0.3 a	18.4±0.4 b	13.3±0.2 gh	5.8±0.3 st	10.0±0.2 m-p	13.8±0.6 A
EG 2	11.8±0.3 ijk	13.7±0.3 fg	17.9±0.5 b	15.4±0.2 de	11.6±0.2 ijk	5.1±0.2 stu	9.0±0.2 opq	12.1±0.5 B
EG 3	10.7±0.3 j-m	12.7±0.3 ghi	16.3±0.3 cd	14.0±0.3 efg	10.4±0.3 k-o	4.8±0.1 tuv	7.8±0.2 qr	11.0±0.4 D
EG 4	9.1±0.2 n-q	11.5±0.3 i-l	15.0±0.4 def	12.0±0.4 hij	8.9±0.2 pq	3.8±0.2 uv	6.4±0.2 rs	9.5±0.4 E
EG 5	8.2±0.2 q	10.1±0.3 l-p	13.6±0.3 fg	10.9±0.2 j-m	7.9±0.2 q	3.4±0.1 v	5.8±0.2 st	8.6±0.4 F
Mean	10.5±0.2 D	13.0±0.3 C	16.7±0.3 A	14.4±0.3 B	10.5±0.2 D	4.7±0.1 F	7.9±0.2 E	11.1±0.2

ANOVA

$F_{Variants}$ 351.2* F_{Years} 1411.2*** $F_{Variants*Years}$ 5.6*****

Leaf Area, thousands of m^2 per hectare

Variants	2015	2016	2017	2018	2019	2020	2021	Mean
CG	25.5±0.4 mn	33.1±0.6 hi	41.4±0.3 cd	37.4±0.4 ef	26.4±0.3 k-n	12.5±0.4 u	20.2±0.5 qrs	28.1±1.1 C
EG 1	30.8±0.6 ij	38.8±0.6 def	49.2±0.6 a	44.7±0.8 b	32.1±0.5 hi	14.1±0.5 tu	24.2±0.5 nop	33.4±1.4 A
EG 2	28.5±0.4 jkl	33.3±0.6 hi	43.4±0.8 bc	37.3±0.6 ef	28.2±0.4 jkl	12.5±0.2 u	21.9±0.4 opq	29.3±1.2 B
EG 3	26.0±0.4 lmn	30.8±0.5 ij	39.6±0.7 de	34.0±0.5 gh	25.2±0.5 n	11.6±0.3 uv	18.9±0.3 s	26.6±1.1 D
EG 4	22.1±0.5 opq	28.0±0.5 klm	36.4±0.6 fg	29.0±0.6 jk	21.7±0.5 pqr	9.2±0.2 vw	15.5±0.5 t	23.1±1.0 E
EG 5	19.9±0.4 qrs	24.5±0.5 no	33.0±0.5 hi	26.5±0.4 k-n	19.1±0.4 rs	8.2±0.2 w	14.2±0.4 tu	20.8±0.9 F
Mean	25.5±0.5 D	31.4±0.6 C	40.5±0.7 A	34.8±0.8 B	25.5±0.6 D	11.4±0.3 F	19.2±0.5 E	26.9±0.5

ANOVA

$F_{Variants}$ 612.4* F_{Years} 2475.2*** $F_{Variants*Years}$ 9.8*****

Leaf Area Index, m^2/m^2

Variants	2015	2016	2017	2018	2019	2020	2021	Mean
CG	2.55±0.08 j-n	3.31±0.07 fg	4.14±0.03 bc	3.74±0.06 de	2.64±0.06 j-m	1.25±0.04 rst	2.02±0.05 p	2.81±0.11 C
EG 1	3.08±0.06 ghi	3.88±0.08 cd	4.92±0.07 a	4.47±0.09 b	3.21±0.07 gh	1.41±0.07 rs	2.42±0.06 mno	3.34±0.14 A
EG 2	2.85±0.08 ijk	3.33±0.07 fg	4.34±0.11 b	3.73±0.06 de	2.82±0.04 ijk	1.25±0.03 rst	2.19±0.04 op	2.93±0.12 B
EG 3	2.60±0.06 j-m	3.08±0.07 ghi	3.96±0.08 cd	3.40±0.07 efg	2.52±0.08 k-o	1.16±0.03 stu	1.89±0.04 pq	2.66±0.11 D
EG 4	2.21±0.05 nop	2.80±0.06 i-l	3.64±0.09 def	2.90±0.11 hij	2.17±0.05 op	0.92±0.04 tu	1.55±0.05 qr	2.31±0.10 E
EG 5	1.99±0.05 p	2.45±0.07 l-o	3.30±0.08 fg	2.65±0.04 j-m	1.91±0.04 p	0.82±0.02 u	1.42±0.03 rs	2.08±0.09 F
Mean	2.55±0.05 D	3.14±0.06 C	4.05±0.07 A	3.48±0.08 B	2.55±0.06 D	1.14±0.03 F	1.91±0.05 E	2.69±0.05

ANOVA

$F_{Variants}$ 347.1* F_{Years} 1398.9*** $F_{Variants*Years}$ 5.5*****

*Ns: not significant, *: significant at $p\leq0.1$, **: significant at $p\leq0.01$, ***: significant at $p\leq0.001$*

temperatures and water deficiency leads to a reduction in the Leaf Area of shoots, vines, and vineyards.

Productivity of Vineyards. The studied clone R5 of Cabernet-Sauvignon variety indicator coefficient of fruiting is 1.09-1.10 and insignificantly varies by years and variants of the experiment. The demonstrated that the cluster weight varies depending on meteorological conditions that are inadequate in the years of the research. For instance, during the favourable years of 2015-2018, the cluster weight in the control grup with grafting onto BxR Kober 5BB ranged from 97.6±0.8 g to 130.3±3.0 g and sharply decreased during adverse meteorological conditions in 2020, reducing the average cluster weight to 55.9 g. When grafted onto RxR 101-14, compared to BxR Kober 5BB, the average cluster weight decreases and is 95.4±1.9 g – 120.4±2.7 g in favourable years and also decreases in unfavourable years, 2020-2021. It is demonstrated that on grapevines grown from vines when used for grafting 1st-3rd cuttings from the base of the stock rootstock cane (EG 1, EG 2, EG 3), the average cluster weight increases by 1.1-1.2 times compared to the control variant. This effect is consistent regardless of the rootstock variety. However, the average cluster weight decreases when 4th (EG 4) and 5th (EG 5) cuttings of the stock cane are used for grafting.

Our conducted research enabled us to determine that the Shoot Productivity of the R5 clone of Cabernet Sauvignon varies depending on the rootstock variety and meteorological conditions (fig. 5.1). The Shoot Productivity of the clone R5 Cabernet Sauvignon onto BxR Kober 5 BB in the years 2015-2018, in the control variant, was 108.2±2.2 g/shoot - 137±3.0 g/shoot. On grapevines grown from grafted saplings in variants EG 1, EG 2, EG 3, the Shoot Productivity increases by 1.1-1.2 times regardless of the year of research. For instance, in 2017, the Shoot Productivity in these variants reached 152.0 g/shoot to 159.0 g/shoot. In grapevines grown from grafted vines, the use of cuttings from the top-cane zone EG 4, EG 5 (4th and 5th cuttings) either maintains the Shoot Productivity at the control level or decreases it. It is characteristic that when grafted onto RxR 101-14, compared to BxR Kober 5BB, the development of Leaf Area decreases by 1.1-1.2

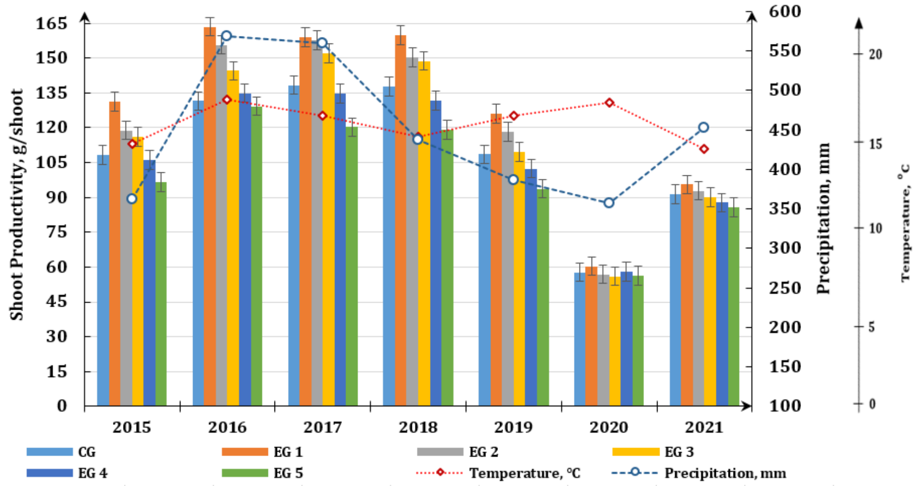

Fig. 5.1. Shoot Productivity of Grapes Depending on Different Quality of Vines and Meteorological Conditions.

Table 5.6. Vineyard Productivity Depending on the Different Quality of Vines. Cl R5 Cabernet Sauvignon onto BxR Kober 5BB.

Yield, kg per vine

Variants	2015	2016	2017	2018	2019	2020	2021	Mean
CG	4.37±0.09 n-r	5.39±0.07 jk	6.11±0.09 d-g	5.94±0.14 f-i	4.47±0.08 m-q	1.82±0.08 z	3.42±0.10 v	4.50±0.17 D
EG 1	5.71±0.14 g-j	7.18±0.14 a	7.40±0.12 a	7.10±0.16 ab	5.52±0.13 ij	2.14±0.06 yz	4.02±0.04 q-u	5.58±0.22 A
EG 2	4.93±0.09klm	6.61±0.14 bc	7.14±0.11 a	6.50±0.09 cde	4.86±0.11 lmn	1.97±0.11 z	3.70±0.11 s-v	5.11±0.21 B
EG 3	4.64±0.07m-p	6.02±0.07 e-h	6.58±0.06 cd	6.23±0.06 c-f	4.32±0.06 o-r	1.75±0.06 z	3.29±0.06 x	4.69±0.20 C
EG 4	4.18±0.07 p-s	5.30±0.09 jkl	5.61±0.08 hij	4.70±0.08 mno	3.56±0.08 uv	1.45±0.06 z	2.73±0.06 yz	3.93±0.17 E
EG 5	3.64±0.07 tuv	4.10±0.09 q-t	4.81±0.09 l-o	3.89±0.07 r-v	2.97±0.04 xy	1.33±0.05 z	2.43±0.03 yz	3.31±0.13 F
Mean	4.58±0.09 C	5.77±0.14 B	6.27±0.12 A	5.73±0.15 B	4.27±0.12 D	1.74±0.05 F	3.27±0.08 E	4.52±0.08

ANOVA

$F_{Variants}$ 576.9* F_{Years} 1925.6*** $F_{Variants*Years}$ 15.0*****

Mass Sugar Concentration, g/dm³

Variants	2015	2016	2017	2018	2019	2020	2021	Mean
CG	232±1 j-n	250±1 e-g	235±1 j-m	237±1 i-l	234±2 j-m	297±2 b	253±2 efg	248±3 BC
EG 1	224±1 no	245±2 ghi	228±2 l-o	230±2 k-o	222±2 o	281±2 d	251±2 efg	240±2 D
EG 2	226±1 mno	248±2 fgh	230±2 k-o	235±2 j-m	226±2 mno	283±1 cd	252±1 efg	243±2 D
EG 3	228±2 l-o	253±2 efg	235±2 j-m	237±2 i-l	230±2 k-o	292±2 bc	254±2 efg	247±3 C
EG 4	232±2 j-n	256±1 ef	237±2 i-l	238±2 ijk	232±2 j-n	300±2 b	256±2 ef	250±3 B
EG 5	238±2 ijk	258±2 e	240±2 hij	240±2 hij	236±2 i-l	316±2 a	258±2 e	255±3 A
Mean	230±1 D	252±1 B	234±1 C	236±1 C	230±1 D	295±2 A	254±1 B	247±1

ANOVA

$F_{Variants}$ 63.4* F_{Years} 1029.0*** $F_{Variants*Years}$ 4.3*****

Mass Concentration of Titratable Acids, g/dm³

Variants	2015	2016	2017	2018	2019	2020	2021	Mean
CG	8.3±0.03 ghi	8.9±0.08 bcd	8.9±0.04 bcd	8.0±0.05 i	6.0±0.04 n	6.0±0.04 n	8.2±0.06 ghi	7.8±0.14 DE
EG 1	8.5±0.21 efg	9.3±0.06 a	9.1±0.04 abc	8.2±0.05 ghi	6.3±0.06 klm	6.7±0.06 j	8.3±0.02 ghi	8.1±0.13 A
EG 2	8.5±0.13 efg	9.2±0.06 ab	9.0±0.04 a-d	8.1±0.06 hi	6.2±0.04 lmn	6.6±0.07 jk	8.2±0.02 ghi	8.0±0.13 AB
EG 3	8.4±0.06 fgh	9.0±0.06 a-d	8.9±0.04 bcd	8.1±0.03 hi	6.1±0.03 mn	6.5±0.04 jkl	8.2±0.03 ghi	7.9±0.13 BC
EG 4	8.3±0.06 ghi	8.9±0.05 bcd	8.8±0.04 cde	8.0±0.03 i	6.1±0.04 mn	6.4±0.04 j-m	8.1±0.02 hi	7.8±0.13 CD
EG 5	8.1±0.05 hi	8.8±0.03 cde	8.7±0.03 def	8.0±0.04 i	6.0±0.03 n	6.1±0.08 mn	8.0±0.04 i	7.7±0.13 E
Mean	8.3±0.05 C	9.0±0.03 A	8.9±0.02 B	8.1±0.02 E	6.1±0.02 G	6.4±0.04 F	8.2±0.02 D	7.9±0.05

ANOVA

$F_{Variants}$ 41.0* F_{Years} 2302.4*** $F_{Variants*Years}$ 2.3*****

*Ns: not significant, *: significant at p≤0.1, **: significant at p≤0.01, ***: significant at p≤0.001*

times, which affects the Shoot Productivity. Thus, in favourable years, in control variants, Shoot Productivity ranges from 109.7±2.4 g/shoot to 135.7±3.3 g/shoot, while in variants EG 1, EG 2, EG 3, it reaches from 137.9±3.2 to 148.6±3.6 grams per shoot. A reduction in the size of Shoot Productivity is observed in EG 4, EG 5 variants. In unfavourable years, shoot productivity decreases. It has been established that the Shoot Productivity of the studied grapevine clones hinges on meteorological conditions, which do not consistently unfold in the years of the research. It has been established that the Shoot Productivity of the studied grapevine clones hinges on meteorological conditions, which do not consistently unfold in the years of the research.

We have established that the yield of vineyards of clone R5 Cabernet Sauvignon, grown under the conditions of the ATU Gagauzia, depends on shoot productivity and varies from year to year (tab. 5.6). Thus, in the years 2015-2018, when grafting the vines onto BxR Kober 5BB, the yield in the control variant ranged from 4.09 to 5.69 kg per vine. The yield of vines grown from grafted saplings when used for grafting 1^{st}-3^{rd} cuttings increases 1.1-1.2 times and is 4.73-6.46 kg per vine, especially in favourable weather years (2017). Whereas, the yield of vines grown from grafted saplings when used for grafting cuttings from the top-cane (EG 4 and EG 5) is at the level of control or decreases. A similar pattern is observed when grafting the clone R5 of Cabernet Sauvignon onto the RxR 101-14 rootstock. Thus, a prolonged effect of the different quality of grafted saplings on the growth, development, and productivity of the grapevines and vineyards is observed.

The R5 clone of Cabernet Sauvignon is characterized by high sugar accumulation. This parameter varies from year to year and depends on the stock variety on which it is grafted. When cultivated onto Kober 5BB stock, the mass concentration of sugars changes within the range of 224 g/dm^3 to 258 g/dm^3; the mass concentration of titratable acids is within 8.0 g/dm^3 to 9.1 g/dm^3. Onto the RxR 101-14 rootstock, these values are 238 g/dm^3 to 265 g/dm^3 for sugar concentration and 7.5 g/dm^3 to 9.1 g/dm^3 for titratable acids, respectively.

In most cases, general biological patterns are manifested, which are associated with the fact that an increase in yield leads to a decrease in the mass concentration of sugars and a slight increase in titratable acids in berry juice. A characteristic feature is a significant change in the quality of the product in unfavourable meteorological years. A decrease in yield results in an increase in the mass concentration of sugars and a reduction in the level of titratable acids (in 2020), which negatively impacts grape processing.

5.2.2. Analysis of the After-effect of Different Quality Planting Stock by Scion Attributes and Calovit Treatment

Shoot Growth and Development. During the full fruiting period, the average shoot load per vine varies over the years depending on the vine's vigour and stands at 37,7±0,2 shoots per vine when grafted onto BxR Kober 5BB rootstock. However, the load decreases in unfavourable years (2019-2020). It has been determined that the growth of shoots is influenced by the different quality of vines. By the end of the vegetation period, the mean length of shoots, depending on the year of the study, ranges from 107.5±3.7 cm to 123.9±4.3 cm. In the control groups (without calovit treatment), this length varies from 55.2±2.0 cm to 135.7±2.0 cm (Scion without Tendrils) and from 64.8±1.8 cm to 159.2±2.2 cm (Scion with Tendrils). With calovit treatment, the mean shoot length increases by 1.1-1.2 times, particularly in the case of the scion with tendrils However, in unfavourable years (2019-2021), regardless of experimental variants, the average shoot length decreases.

The degree of development of Annual Growth depends on the different quality of vines, associated with the heterogeneity of planting stock. Vine growth parameters (Length and Volume of Annual Growth) vary from year to year and depend on the experimental variants. When using grafted vines of Scion without Tendrils H_2O for planting, in favourable years (2017), the length of Annual Growth of the vine reaches 56,6 m/vine și 137,2 th. m/ha; Volume of Annual Growth – 90,2 cm^3/shoot, 3,8 dm^3/vine and 9,1 m^3/ha. These parameters increase by 1.2-1.3 times when using grafted saplings of scion with tendrils (with tendril H_2O). Significant growth enhancement the Volume of Annual Growth is observed in the variant with the use of scion with tendrils and application of calovit treatment (With tendril Calovit). In unfavourable, dry years, the Volume of Annual Growth parameters of the R5 Cabernet Sauvignon sharply decreased, but the identified pattern remains consistent.

Growth and Development of Leaf Surface Area. The Area of Leaf Blades of the R5 clone of Cabernet Sauvignon onto Kober 5BB rootstock is not dependent on experimental variants during the years of research, but it varies annually. In favourable years (2017-2018), the Leaf Area amounts to 138.6±0.7 cm^2 – 144.9±0.9 cm^2. In unfavourable years (2019-2021), it significantly decreases by 1.5-1.8 times. A negative correlation between Area of Leaf Blades and average monthly positive temperatures has been identified.

Table 5.7. The Impact of Different Quality of Vines on the Leaf Area Index of Cl R5 Cabernet Sauvignon.

Years	Without tendril H_2O	With tendril H_2O	Without tendril Calovit	With tendril Calovit	Mean
2015	2.71±0.04 klm	3.18±0.06 hij	2.88±0.06 jkl	3.49±0.08 fgh	3.06±0.06 D
2016	3.03±0.06 ij	3.78±0.07 ef	3.39±0.07 gh	4.09±0.07 de	3.57±0.07 C
2017	3.55±0.05 fg	4.71±0.06 c	4.19±0.04 d	5.49±0.05 a	4.49±0.12 A
2018	3.27±0.05 ghi	4.32±0.07 d	3.77±0.07 f	5.03±0.07 b	4.10±0.11 B
2019	2.35±0.07 no	2.95±0.06 jk	2.62±0.06 lmn	3.55±0.09 fg	2.87±0.08 E
2020	1.10±0.03 s	1.45±0.03 qr	1.30±0.02 r	1.69±0.05 pq	1.38±0.04 G
2021	1.87±0.04 p	2.48±0.06 mno	2.30±0.05 o	2.71±0.10 klm	2.34±0.06 F
Mean	2.55±0.10 D	3.27±0.13 B	2.92±0.11 C	3.72±0.15 A	3.11±0.07

ANOVA

$F_{Variants}$ 483.5*** **F_{Year} 1254.5***** **$F_{Variants*Year}$ 13.9*****

*Ns: not significant, *: significant at p≤0.1, **: significant at p≤0.01, ***: significant at p≤0.001*

The Leaf Area of shoots, vines, and vineyards depends on the number of shoots (load) and the leaves developed on them. Thus, in 2017, the Leaf Area by the end of the vegetation period in the control variants amounts to 40,2±0,5 dm^2/shoot, 14,7±0,2 m^2/vine (without Tendrils, H_2O), and 47,3±0,6 cm^2/shoot, 19,4±0,2 m^2/vine (with Tendrils, H_2O). In variants using the solition of calovit, the Leaf Area of grape plants increases and amounts to 46.2 cm^2/shoot, 20.0 m^2/vine (without Tendrils, Calovit) and 56.3 cm^2/shoot, 26.3 m^2/vine (with Tendrils, Calovit). In unfavourable years (2020-2021), the Leaf Area of plants in the studied variants decreased by 1.8-2.5 times, which affected the productivity of the vineyards. Similar regularity is observed by us in other experimental variants and points to the dependence of Leaf Area development on meteorological conditions that do not develop adequately.

Calculations of the Leaf Area Index of the R5 clone of Cabernet Sauvignon vineyards also demonstrated their variation depending on the different quality of vines and the complex meteorological conditions during their growth (tab. 5.7). In favourable years (2017), the Leaf Area Index of the vineyards amounts to 3.55±0.05 m^2/m^2 (Scion without Tendrils, H_2O) and 4.71±0.06 m^2/m^2 (Scion with Tendrils, H_2O). With the application of solution Calovit the Leaf Area Index of the vineyards increases by 1.1-1.2 times.

Productivity of Vineyards. During the period of full fruiting (2015-2021), the number of clusters ranges from 42.0±0.4 to 43.4±0.3 clusters per vine in favourable years (2015-2018). In unfavourable years (2020-2021), this count decreases by 1.3-1.4 times. At the same time, it was found that the average weight of the clusters changes depending on both meteorological conditions and experimental variants. Thus, in 2017-2018, the average cluster weight was 128.8±1.7 g – 132.4±1.8 g; a decrease in average cluster weight was observed starting from 2019, with the average weight in 2020 being 55.0±0.8 g (a decrease of 2.0-2.5 times). It was shown that in the variants (with Tendril), the growth parameters of the clusters increased by 1.1-1.2 times; in the (with Tendril Calovit) variant, the average cluster weight increased to 110.3±3.6 g.

The yield of vineyards of the R5 clone of Cabernet Sauvignon varies depending on the different quality of the vines, observed in the variants using grafted saplings of the scion with and without tendrils and application of solution Calovit (tab. 5.8). The highest vine yields are observed in 2017. Thus, in 2017, the yield in control variants amounted to 4.80±0.11 kg per vine (Scion without Tendrils, H_2O); 5.98±0.12 kg per vine (Scion with Tendrils, H_2O). It is characteristic that in the variant (Scion with Tendrils, Calovit), the yield of vines and grapevine plantation increases by 1.3 times compared to the control and amounts to 5.73±0.12 kg per vine. In unfavourable years (2020-2021), irrespective of the experimental variants, the yield decreases.

The mass concentration of sugars and titratable acids varies from year to year and depends on experimental variants. It changes within the range of 233±1 g/dm^3 to 296±2 g/dm^3 for mass concentration of sugars and 6.03±0.02 g/dm^3 to 8.55±0.01 g/dm^3 for mass concentration of titratable acids.

Table 5.8. The Impact of Different Quality of Vines on the Yield Indicators of Cl R5 Cabernet Sauvignon.

Years	Without tendril H_2O	With tendril H_2O	Without tendril Calovit	With tendril Calovit	Mean
		Fruit Yield per Vine, kg/vine			
2015	3.93±0.05 ijk	4.34±0.13 ghi	4.09±0.09 hij	4.79±0.13 efg	4.29±0.07 C
2016	4.74±0.09 fg	5.45±0.08 d	5.24±0.11 de	5.97±0.13 bc	5.35±0.09 B
2017	4.80±0.11 efg	5.98±0.12 bc	5.47±0.13 d	6.65±0.08 a	5.73±0.12 A
2018	4.57±0.10 gh	5.65±0.10 cd	5.17±0.07 def	6.29±0.13 ab	5.42±0.11 B
2019	3.74±0.04 jkl	4.12±0.10 hij	3.96±0.06 ijk	4.37±0.10 ghi	4.05±0.05 D
2020	1.52±0.06 o	1.84±0.06 no	1.73±0.06 no	2.08±0.05 n	1.79±0.04 F
2021	2.89±0.07 m	3.56±0.09 kl	3.39±0.09 l	3.93±0.07 ijk	3.44±0.07 E
Mean	3.74±0.14 D	4.42±0.17 B	4.15±0.15 C	4.87±0.18 A	4.29±0.08
ANOVA					
$F_{Variants}$ 180.2* F_{Year} 880.8*** $F_{Variants*Year}$ 5.6*** **					
		Mass Sugar Concentration, g/dm³			
2015	238±2 ijk	232±1 jkl	238±2 ijk	230±1 kl	235±1 D
2016	231±2 kl	223±2 lm	231±2 kl	220±2 m	226±1 E
2017	251±2 d-g	243±2 f-i	250±2 d-h	242±2 ghi	247±1 C
2018	249±1 d-h	241±2 hij	248±1 e-h	241±1 hij	245±1 C
2019	235±2 ijk	232±1 jkl	235±1 ijk	230±1 kl	233±1 D
2020	308±2 a	295±2 b	297±2 b	282±2 c	296±2 A
2021	258±2 d	252±1 def	256±2 de	251±1 d-g	254±1 B
Mean	253±3 A	245±3 B	251±3 A	242±2 C	248±1
ANOVA					
$F_{Variants}$ 160.3* F_{Year} 249.3*** $F_{Variants*Year}$ 1.7* **					
		Mass Concentration of Titratable Acids, g/dm³			
2015	7.70±0.03 i	8.00±0.03 fg	7.90±0.06 gh	7.80±0.05 hi	7.85±0.03 E
2016	8.00±0.02 fg	8.20±0.03 de	8.10±0.03 ef	8.30±0.05 cd	8.15±0.02 C
2017	8.50±0.03 ab	8.60±0.02 a	8.50±0.03 ab	8.60±0.02 a	8.55±0.01 A
2018	8.00±0.02 fg	8.10±0.03 ef	8.00±0.03 fg	8.10±0.03 ef	8.05±0.02 D
2019	6.00±0.02 j	6.10±0.03 j	6.00±0.05 j	6.00±0.05 j	6.03±0.02 F
2020	6.10±0.02 j	6.00±0.05 j	6.10±0.03 j	6.00±0.02 j	6.05±0.02 F
2021	8.20±0.03 de	8.40±0.03 bc	8.20±0.03 de	8.40±0.06 bc	8.30±0.03 B
Mean	7.50±0.11 B	7.63±0.12 A	7.54±0.12 B	7.60±0.13 A	7.57±0.06
ANOVA					
$F_{Variants}$ 17.8* F_{Years} 3501.3*** $F_{Variants*Years}$ 4.6*** **					

*Ns: not significant, *: significant at p≤0.1, **: significant at p≤0.01, ***: significant at p≤0.001*

Typically, an increase in yield leads to a decrease in the mass concentration of sugars. In unfavourable meteorological conditions, there is a reduction in yield, which increases the mass concentration of sugars and decreases the level of titratable acids (2020).

Therefore, the after-effect of different quality in grafted vines on the growth and productivity of R5 clone Cabernet Sauvignon vineyards during the period of full fruiting is observed. A strong direct correlation has been established between the shoot growth, leaf surface area, and grape vineyard productivity (r=0.98). In the variants (Scion with Tendrils, H_2O; Scion with Tendrils, Calovit), there is a significant increase in the parameters of shoot growth, assimilation area surface, and vine productivity.

6. GROWTH, DEVELOPMENT, AND PRODUCTIVITY OF CLONES DEPENDING ON THE SHOOT TRAINING SYSTEM OF GRAPE VINES

6.1. Comparative Assessment of the Condition of Vineyard Plantations in the First Year of Reconstruction

Shoot and Leaf Growth. Studies were conducted to determine the number of shoots, their average length, and to calculate the length of annual growth before and after the reconstruction of the grapevine plantations, which included a change in the shoot training system. It was established that under identical soil-climatic and agronomic conditions, the development of annual growth of the vines depends on the biological characteristics of the clones and changes throughout the stages of vegetation.

Parameters of Photosynthetic Activity. The reconstruction of grapevine plantations leads to changes in the spatial arrangement of the shoots and the development of the assimilation surface of the plants. An increase in shoot length and the number of leaves per shoot by 1.3-1.4 times is observed. The leaf area per shoot, per vine, and across the plantation increases by 1.8-1.9 times. The leaf index parameters increase by 1.5-1.9 times during the berry ripening period. The content of plastid pigments in the leaves of the studied clones depends on the spatial arrangement of the shoots before and after the vineyard reconstruction.

Table 6.1. Content of Plastid Pigments in the Leaves of Grape Plants, milligrams per gram of absolute dry matter, 2013.

Clone	Recon.	ch.a	ch.b	ch.a+ ch.b	caroten.	ch.a/ch.b	ch.a+ ch.b/ caroten.
Cl R5	before	5.579±0.06	3.167±0.04	8.746±0.10	1.619±0.02	1.8/1	5.4/1
	after	7.144±0.08	4.169±0.05	11.313±0.11	1.966±0.02	1.6/1	5.8/1
Cl 348	before	5.489±0.06	3.115±0.04	8.604±0.10	1.610±0.02	1.8/1	5.3/1
	after	7.441±0.08	4.266±0.05	11.707±0.11	2.461±0.03	1.7/1	4.8/1
LSD₀₅		*0.25*	*0.19*	*0.38*	*0.09*		

During the stage fruit set, in the leaves of the clone R5 Cabernet Sauvignon and clone 348 Merlot, before reconstruction (with hanging shoot positioning system) the content of plastid pigments varies insignificantly (tab. 6.1). The concentration of chlorophyll a is 5.579 and 5.489, chlorophyll b is 3.167 and 3.115, chlorophyll a+b is 8.746 and 8.604, and carotenoids are 1.619 and 1.610 mg/g of absolute dry matter, respectively. At the same time, after reconstruction (with vertical shoot positioning system), the content of chlorophylls increases by 1.3-1.4 times, and carotenoids increase by 1.2-1.5 times.

The analysis of photosynthetic activity in grapevine leaves showed that for the investigated clones, after vineyard reconstruction, there is an increase in Leaf Surface Area by 1.6-1.7 times during the fruit set growth stage and by 1.5-2.5 times during the maturity stage. The content of chlorophyll also increases by 1.5-2.3 and 1.5-3.2 times, respectively, with an increase in the surface content of chlorophyll. Leaf biomass accumulates, with an increase in its content by 7.44-14.61 and 11.26-42.11 grams of leaves per shoot. It was established that the correlation coefficients between the Chlorophyll Content and the Leaf Surface Area per shoot are r=0.92, and between Chlorophyll Content and Shoot Productivity, the correlation coefficient is r=0.92. These findings indicate a connection between Leaf Surface Development, Chlorophyll Content, Organic Substance Formation, and Grapevine Plant Productivity.

Productivity of Vineyards. It has been established that the average number of clusters in the clone R5 of Cabernet Sauvignon variety varies from 39.8 to 40.2 clusters per vine, while in the clone 348 of Merlot variety, it is 34.7 clusters per vine before reconstruction and increases to 37.1 clusters per vine after reconstruction. It has been established that the average number of clusters in the studied clones increases by 0.8-2.4 per vine after the reconstruction. The cluster weight varies in clone R5 Cabernet Sauvignon from 72.1 g to 98.5 g and in clone 348 Merlot from 95.1 g to 135.5 g, respectively. It has been established that the yield of clone R5 of Cabernet Sauvignon is 8.47-11.68 tons per hectare, while for clone 348 of Merlot, it is 9.73-14.83 tons per hectare and increases after the reconstruction of the vineyards by 1.1-1.3 times. There is some decrease in the mass concentration of sugars in the variant with vertical shoot positioning, regardless of the clone. The mass concentration of titratable acids changes insignificantly and varies from 9.1 g/dm^3 to 9.4 g/dm^3, staying within the technological requirements imposed on this group of clones.

6.2. Assessment of the Condition of Vineyard Plantations in the Second Year After Reconstruction

Shoot and Leaf Growth. At the post-reconstruction stage (2014), the number of shoots for clone R5 Cabernet Sauvignon ranges from 29.1 to 30.3 shoots per vine, and for clone 348 of Merlot, it ranges from 27.1 to 28.3 shoots per vine. The mean length of the shoots during the stage of shoot growth is 127.3 cm for clone R5 Cabernet Sauvignon and 141.2 cm for clone 348 Merlot. During the stage of cane ripening, their length increases to 145.8 cm and 162.7 cm, respectively. The total length of the vine's growth by the end of the vegetation period is 44.2 meters per vine for clone R5 Cabernet Sauvignon and 46.0 meters per vine for clone 348 Merlot. The volume of Annual Growth for clone R5 Cabernet Sauvignon is 2.2 dm^3 per vine, while for clone 348 Merlot, it increases to 2.6 dm^3 per vine. Therefore, clone 348 of Merlot is characterized by more active growth and the ability to accumulate biomass.

Parameters of Photosynthetic Activity. The Leaf Blade Area increases, regardless of the growth stages, in clone 348 of the Merlot variety compared to clone R5 of the Cabernet Sauvignon variety, which leads to an increase in the size of the Leaf Surface of the shoots and vines by 1.3-1.4 times. During the intensive berry growth stage on the reconstructed plantations, the concentration of chlorophyll a in the leaves of clone R5 of the Cabernet Sauvignon variety is 7.298; chlorophyll b – 4.134; the total chlorophyll a+b – 11.432; and carotenoids – 1.501 mg/g of absolute dry biomass. In clone 348 of the Merlot variety, the concentration of assimilatory pigments increases by 1.1-1.2 times compared to clone R5 of the Cabernet Sauvignon variety. At the same time, the chlorophyll index (chlorophyll a/ chlorophyll b) increases, and the pigment index (chlorophyll a+b/carotenoids) decreases. In subsequent stages, the level of chlorophylls decreases, but the level of carotenoids increases, especially in clone 348 of the Merlot variety. A strong correlation was observed between photosynthetic activity indicators and shoot productivity (cluster weight/shoot). The chlorophyll index, which characterizes the accumulation of chlorophyll per unit leaf area of grapevine plantations (in g/m², kg/ha), is high and amounts to 2.2 g/m² and 21.9 kg/ha (clone R5 Cabernet Sauvignon); 2.9 g/m² and 28.6 kg/ha (clone 348 Merlot).

Productivity of Vineyards. Enhanced photosynthetic activity of the investigated grapevine clones leads to an increase in their productivity. It has been determined that for clone R5 of the Cabernet Sauvignon variety, the mean number of clusters is 36.3 per vine with a mean weight of 121.8 grams; the yield is 4.42 kilograms per vine. The sugar content is 226 g/dm^3, and titratable acidity is 8.3 g/dm^3. For clone 348 of the Merlot variety, these indicators are higher and amount to a mean cluster weight of 167.5 grams, a yield of 5.66 kilograms per vine. The sugar content is 228 g/dm^3, and titratable acidity is 8.2 g/dm^3.

The reconstruction of grapevine plantations, associated with changes in the the shoot training system, leads to changes in the Phytometric Indicators of the Vine Canopy, an increase in the Growth Parameters of Shoots and the Assimilation Surface, and an enhancement of Leaf Photosynthetic Activity, which ultimately contributes to the increased Productivity of the studied clones.

7. MONITORING OF THE GROWTH, DEVELOPMENT AND PRODUCTIVITY OF GRAPEVINE CLONES

7.1. Shoot Growth and Development

Long-term monitoring of the growth of fruit-bearing vine plantations showed that the clone R5 Cabernet Sauvignon, a mean, forms 29.7±0.3 shoots per vine, while the clone 348 Merlot forms 25.7±0.3 shoots per vine. At the same time, the shoot length was higher in the clone 348 Merlot, reaching 146.0±4.9 cm. The length of the Annual Growth for the clone R5 Cabernet Sauvignon was 39.6±1.7 m/vine, and for the clone Cl 348 Merlot, it was 38.5±1.6 m/vine. The Volume of Annual Growth for the clone R5 Cabernet Sauvignon was 2.16±0.12 m³/vine, and for the clone 348 Merlot, it was 2.43±0.14 m³/vine. It was noted that the highest values of these parameters were recorded in 2017.

It was found that the development of the Volume of Annual Growth is strongly influenced by the genetic characteristics of the clones and the meteorological conditions during the years of research.

7.2. Growth and Development of Leaf Area

The number of leaves per shoot in the studied grapevine clones varies depending on the clone and the conditions of the study years. The highest number of leaves was observed in 2017: 35.4±0.8 leaves per shoot (clone R5 Cabernet Sauvignon) and 31.2±0.7 leaves per shoot (clone 348 Merlot), indicating favorable conditions for grapevine growth during this period. In 2018, the number of leaves was also above average: 34.8±0.7 leaves per shoot (clone R5 Cabernet Sauvignon) and 30.7±0.7 leaves per shoot (clone 348 Merlot). However, in 2019 and 2020, a decrease in the number of leaves was observed. In 2020, the number of leaves was 24.3±0.4 leaves per shoot for the clone R5 Cabernet Sauvignon and 22.8±0.4 leaves per shoot for the clone 348 Merlot.

Table 7.1. Monitoring the Development of Leaf Area Parameters of Grapevine Clones.

Years	Leaf Area, m^2/vine			LAI, m^2/m^2		
	Cl R5	**Cl 348**	**Mean**	**Cl R5**	**Cl 348**	**Mean**
2015	10.8±0.3 fg	11.4±0.3 f	11.1±0.2 C	3.18±0.10 f	3.36±0.09 ef	3.27±0.07 D
2016	13.5±0.4 de	15.1±0.4 cd	14.3±0.3 B	3.98±0.11 de	4.45±0.13 cd	4.21±0.10 C
2017	17.0±0.5 abc	18.6±0.7 a	17.8±0.5 A	5.01±0.15 bc	5.50±0.19 a	5.25±0.13 A
2018	15.9±0.5 bc	17.4±0.6 ab	16.7±0.4 A	4.68±0.14 c	5.14±0.17 ab	4.91±0.12 B
2019	11.1±0.4 f	11.7±0.5 ef	11.4±0.3 C	3.26±0.11 f	3.44±0.13 ef	3.35±0.09 D
2020	5.2±0.2 i	5.8±0.2 i	5.5±0.2 E	1.54±0.07 h	1.70±0.06 h	1.62±0.05 F
2021	8.3±0.3 h	8.9±0.2 gh	8.6±0.2 D	2.45±0.08 g	2.61±0.05 g	2.53±0.05 E
Mean	11.7±0.5 B	12.7±0.54A	12.2±0.4	3.44±0.14 B	3.74±0.16 A	3.59±0.11
ANOVA						
F_{Clone} 31.5*** F_{Year} 260.5*** $F_{Clone*Year}$ 2.8*				F_{Clone} 31.4*** F_{Year} 260.4*** $F_{Clone*Year}$ 2.81*		

*Ns: not significant, *: significant at p≤0.1, **: significant at p≤0.01, ***: significant at p≤0.001*

The Leaf Area was 38.5±1.4 dm² per shoot for clone R5 Cabernet Sauvignon and 48.2±1.6 dm² per shoot for clone 348 Merlot. The Leaf Surface Area was 11.7±0.5 m² per vine, 34.5±1.6 thousand m² per hectare, with a Leaf Area Index of 3.44±0.14 m²/m² for clone R5 Cabernet Sauvignon, and 12.7±0.54 m² per vine, 37.5±1.4 thousand m² per hectare, with a Leaf Area Index of 3.74±0.16 m²/m² for clone 348 Merlot (tab. 7.1). The maximum values for Leaf Surface growth parameters were observed in 2017, reaching 18.6±0.7 m² per vine, 55.0±1.5 thousand m² per hectare, and a Leaf Area Index of 5.50±0.19 m²/m² for clone 348 Merlot, and 17.0±0.5 m² per vine, 50.1±2.5 thousand m² per hectare, and a Leaf Area Index of 5.01±0.15 m²/m² for clone R5 Cabernet Sauvignon. The lowest values were recorded in 2020.

Thus, the unstable meteorological conditions in ATU Gagauzia have a significant impact on the development of the Leaf Surface Area in vineyards of clone R5 Cabernet Sauvignon and clone 348 Merlot. Years with favorable conditions promoted more active Leaf Area growth, whereas periods with less favorable conditions, such as 2019 and 2020 (characterized by reduced precipitation and increased summer temperatures), negatively affected the Leaf Area development of grapevines.

7.3. Productivity of Vineyards

The mean number of clusters was 36.6±0.4 clusters per vine for clone R5 Cabernet Sauvignon and 33.1±0.4 clusters per vine for clone 348 Merlot. The highest number of clusters was recorded in 2017, with 38.9±0.1 clusters per vine for clone R5 Cabernet Sauvignon and 36.1±0.1 clusters per vine for clone 348 Merlot, indicating favorable conditions for grape yield development that year. However, a significant decrease in the number of clusters was observed in 2020, dropping to 29.5±0.2 clusters per vine for clone R5 Cabernet Sauvignon and 26.2±0.1 clusters per vine for clone 348 Merlot. Moderate decreases in this indicator were also observed in 2019 and 2021.

It was found that clone R5 Cabernet Sauvignon produces a higher number of clusters compared to clone 348 Merlot, whereas an inverse relationship is observed regarding cluster weight. The mean cluster weight for clone R5 Cabernet Sauvignon was 103.2±3.0 g, while for clone 348 Merlot, it was 142.0±4.1 g. The highest cluster weights were recorded in 2017: 130.5±1.8 g for clone R5 Cabernet Sauvignon and 179.5±1.6 g for Cl 348 Merlot, which is 1.4 times greater than that of clone R5 Cabernet Sauvignon.

Table 7.2. Monitoring the Dynamics of Yield Parameters of Grapevine Clones.

Years	Yield, kg per vine			Yield, tons per hectare		
	Cl R5	**Cl 348**	**Mean**	**Cl R5**	**Cl 348**	**Mean**
2015	3.76±0.11 d	4.49±0.08 c	4.13±0.11 C	11.1±0.20 f	13.3±0.15 e	12.2±0.28 C
2016	4.83±0.09 bc	6.13±0.06 a	5.48±0.16 B	14.3±0.28 cd	18.1±0.17 b	16.2±0.47 B
2017	5.08±0.10 b	6.48±0.11 a	5.78±0.18 A	15.0±0.26 c	19.1±0.20 a	17.1±0.50 A
2018	4.85±0.07 bc	6.17±0.09 a	5.51±0.16 B	14.3±0.28 cd	18.2±0.20 ab	16.3±0.48 B
2019	3.70±0.09 d	4.61±0.07 c	4.15±0.12 C	10.9±0.23 f	13.6±0.16 de	12.3±0.34 C
2020	1.65±0.06 f	2.01±0.05 f	1.83±0.05 E	4.9±0.08 i	5.9±0.15 h	5.4.±0.15 E
2021	3.08±0.10 e	3.72±0.06 d	3.40±0.09 D	9.1±0.14 g	11.0±0.20 f	10.0±0.25 D
Mean	3.85±0.14 B	4.80±0.18A	4.33±0.12	11.4±0.41 B	14.2±0.53 A	12.8±0.36
ANOVA						
F_{Clone} 470.8*** F_{Year} 598.1*** $F_{Clone*Year}$ 11.8***				F_{Clone} 616.3*** F_{Year} 784.9*** $F_{Clone*Year}$ 16.7***		

*Ns: not significant, *: significant at p≤0.1, **: significant at p≤0.01, ***: significant at p≤0.001*

Changes in cluster weight over the research years influenced the yield of the investigated vine clones. A mean, during the research period, the yield per vine for clone R5 Cabernet Sauvignon was 3.85±0.14 kg/vine, while for clone 348 Merlot, it was 4.80±0.18 kg/vine (tab. 7.2). The highest vine yield was observed in 2017: 5.08±0.10 kg/vine for clone R5 Cabernet Sauvignon and 6.48±0.11 kg/vine for clone 348 Merlot. The highest vineyard yield was also recorded in 2017: 14.98±0.26 t/ha for clone R5 Cabernet Sauvignon and 19.12±0.20 t/ha for clone 348 Merlot. High yields were also recorded in 2016 and 2018, indicating favorable productivity during these years. However, a significant decline in yield was observed in 2020. That year, vineyard yields of the studied clones dropped sharply to 4.86±0.08 t/ha for clone R5 Cabernet Sauvignon and 5.94±0.15 t/ha for clone 348 Merlot, directly linked to unfavorable weather conditions. In 2021, vineyard yields began to recover following the drought; however, they did not reach the average values observed over the research period.

Analysis of the relationship between Leaf Area and fruit yield per vine for the grapevine clones studied in the conditions of the ATU Gagauzia are presented that each additional square meter of Leaf Area (x) leads to an increase in fruit yield (y) of 3.2 kg per vine for clone R5 Cabernet Sauvignon ($y=3,2x+0,53$). For clone 348 Merlot an increase in leaf area per each additional square meter results in an increase in yield of 2.73 kg per vine ($y=2,73x+0,28$) (fig. 7.1). The correlation coefficients, r=0.97±0.1 (clone R5 Cabernet Sauvignon) and r=0.98±0.1 (clone 348 Merlot), indicate a strong linear relationship between Leaf Area and fruit yield per vine for the clones under study. The high coefficients of determination, $r^2=0.94$ (clone R5 Cabernet Sauvignon) and $r^2=0.96$ (clone 348 Merlot) suggest that 94% and 96% of the variation in vine yield, respectively, is explained by changes in Leaf Area, confirming the model's good explanatory power. Additionally, the standard error of the estimate ($b_{yx}=3.2\pm0.4$ and $b_{yx}=2.73\pm0.04$) indicates the stability of the slope estimate for the regression line.

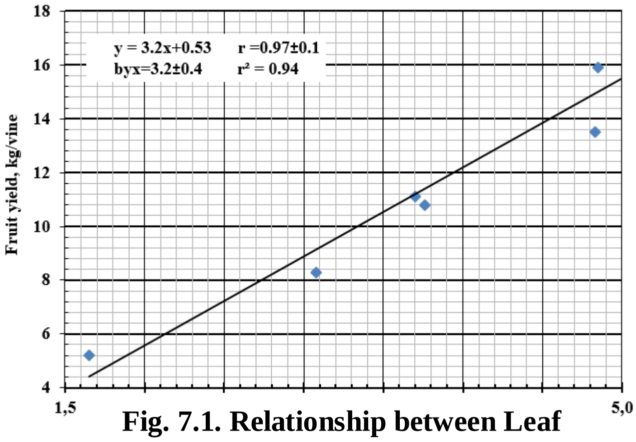

Fig. 7.1. Relationship between Leaf Area and Yield of Grapevine Clones

The analysis of sugar mass concentration and titratable acidity in grape berry juice from the studied clones from 2015 to 2021 has revealed interesting trends. The highest sugar mass concentration was recorded in 2020, reaching 281±3 g/dm^3 (clone R5 Cabernet Sauvignon) and 290±2 g/dm^3 (clone 348 Merlot), with similarly elevated values observed in 2016 and 2021. The mean sugar mass concentration over the entire period was 245±2 g/dm^3 for the clone R5 Cabernet Sauvignon and 250±2 g/dm^3 for the clone 348 Merlot. Statistically significant differences in sugar mass concentration were identified depending on the experimental variants and the year of the research. The mean titratable acid concentration over the research period was 7.8±0.10 g/dm^3. Notably, an increase in titratable acidity to 8.2±0.06 g/dm^3 was observed in 2018, while a significant decrease to 6.1±0.05 g/dm^3 and 6.0±0.08 g/dm^3 was recorded in 2019 and 2020, respectively.

The Shoot Productivity of the clone R5 Cabernet Sauvignon varies from 68.7±2.5 g/shoot to 160.8±3.4 g/shoot, while the clone 348 Merlot ranges from 98.7±2.2 g/shoot to 230.7±4.6 g/shoot (fig. 7.2). The wide variation in shoot productivity is influenced by growing conditions. In years with favorable meteorological conditions (2016-2018), shoot productivity reached 154.5±3.2 g/shoot, 160.8±3.4 g/shoot, and 154.4±2.4 g/shoot for the clone R5 Cabernet

Sauvignon and 222.0±2.6 g/shoot, 230.7±4.6 g/shoot, and 222.2±4.2 g/shoot for the clone 348 Merlot. During these years, vineyard yields were 14.25-14.98 t/ha (clone R5 Cabernet Sauvignon) and 18.08-19.12 t/ha (clone 348 Merlot). In the subsequent years, there has been a significant change in weather conditions, characterized by decreased precipitation and increased monthly temperatures. In most cases, there was a soil-air drought. Under these unfavourable conditions, the shoot productivity of the studied clones decreased by 2.2-2.3 times and the harvest decreases to 4.86-5.94 t/ha (in 2020). A direct correlation was established between shoot productivity and the amount of precipitation, while an inverse correlation was found between shoot productivity and monthly temperature means.

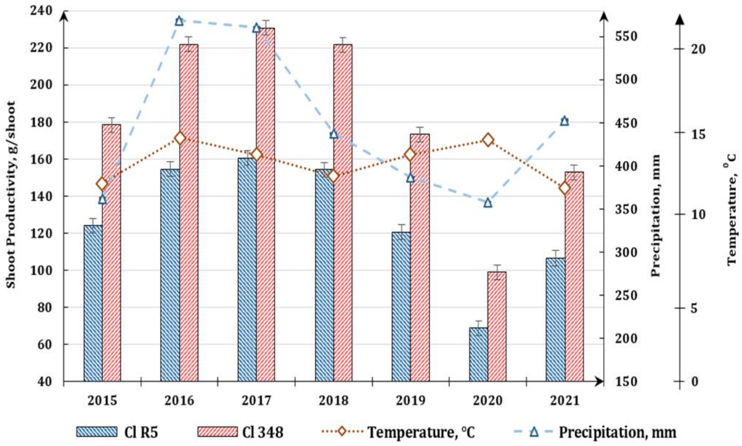

Fig. 7.2. Dynamics of Shoot Productivity in Studied Clones Depending on Meteorological Conditions

Therefore, the productivity of the vineyard for clone R5 of Cabernet Sauvignon and clone 348 of Merlot in the ATU Gagauzia is influenced by the agroecological conditions of their cultivation. The dependence of shoot growth, photosynthetic activity, and the productivity of vines on meteorological conditions leads to changes in the morpho-anatomical and physiological growth parameters of shoots and leaf areas, affecting their photosynthetic activity. In certain years (2019-2021), there is a depression in growth processes and photosynthetic activity in plants, resulting in reduced grapevine plantation productivity.

8. ECONOMIC EFFICIENCY OF GRAPE PRODUCTION IN SC «TOMAI-VINEX» SA

8.1. Analysis of the Economic Efficiency of Grape Production Depending on the Different Quality of Vines

An analysis of economic indicators characterizing the economic efficiency of grape production has allowed us to identify the real dynamics of the efficiency level in this sector, using the example of SC "Tomai-Vinex" SA. As a result, we have a proven relationship between the economic efficiency of grape production and marketing and the employed grapevine clones and different quality of vines, stemming from different quality of the planting stock used for vineyard establishment. The analysis of economic efficiency was conducted over the last seven-year period of grapevine cultivation (2015-2021).

In the control variants from 2015 to 2018, when grafted onto Kober 5BB rootstock, vineyard yield ranged from 10.59 to 14.40 t/ha. When using 1st-3rd cuttings from the base of the rootstock cane for grafting, the yield increased to 15.96 to 17.93 tons per hectare, especially in favourable meteorological conditions, as seen in the year 2017. When using cuttings from the top-cane of rootstock (EG 4 and EG 5), the yield of the vines remained at the control level or decreased. Thus, the prolonged effect of the variability of grafted saplings on the growth, development, and productivity of vineyards is observed, which is reflected in the economic efficiency indicators. At a grape selling price of 5100 lei per ton in the control variant, the revenue from product sales amounted to 75,531 lei. With production and sales costs of 37,814.5 lei per hectare, the profit amounted to 37,716.5 lei per hectare, and the level of profitability was 99.7%. When grafting the base of the rootstock cane (EG 1, EG 2, EG 3), the profitability level increases to 133.2%, 126.8%, and 112.3%, respectively. However, when grafting with cuttings from the top zone of the cane rootstock (EG 4 and EG 5), the profitability level decreases by 1.2 to 1.6 times compared to the control variant.

In 2018, due to the low selling price of the product (4200 lei per ton) and increased costs, the profitability level in the control variant was 57.4%, which decreased by 1.7 times compared to 2017. The decrease in profitability levels was also observed in other experimental variants, but the previously identified pattern of increased profit and profitability levels vines when using grafted vines from the top zone of the stock cane for grafting remained consistent. In the subsequent years (2019-2021), due to unfavourable meteorological conditions (soil-air drought), there was a decrease in grape yield, profit from product sales, and profitability levels regardless of the experimental options. In 2020, negative indicators of economic efficiency (profit, profitability) were observed for all experimental options. However, in 2021, there was an increase in grape yield, and with the increased selling price (8000 lei per ton), profits and profitability will increase, reaching 24,165 lei per hectare and 57.2% (CG); 35,112.5 lei per hectare and 81.9% (CG 1); 29,223.5 lei per hectare and 68.7% (CG 3). A similar pattern in economic efficiency indicators is observed when operating the vineyards of clone R5 of the Cabernet Sauvignon grown onto the RxR 101-14 rootstock.

The grape yield of clone R5 of the Cabernet Sauvignon variety also varies depending on the different quality of the vines, which is observed in the variants using scion materials with and without tendrils. For instance, in 2017, the yield in the control variants was 12.35 tons per hectare (without tendrils, H_2O) and 14.49 tons per hectare (with tendrils, H_2O), with profitability levels of 71.6% and 96.2%, respectively. In variants using scion material with tendrils, there is a significant increase in the parameters of vineyard productivity, profit, and profitability, especially when using a calovit solution. In this variant, profitability increases by 1.3

times. In unfavourable years (2019-2021), regardless of the experimental variants, a decrease in yield, profit, and profitability is observed. In some years (2020), the indicators of economic efficiency acquire negative values.

Consequently, the analysis of economic efficiency parameters in the production of clone R5 of Cabernet Sauvignon shows the dependence of these indicators on the one hand on the quality of the rootstock and scion materials and on the other hand on meteorological conditions that do not adequately develop during the years of the research. Long-term research conducted by us has shown that using grafted saplings obtained from the first meter from the base of the rootstock cane and scion with tendrils increases the productivity and profitability of grapevine plantations.

8.2. Economic Efficiency of Grapevine Clones Production under the Conditions of SC «Tomai-Vinex» SA

We have established that in favourable years, the studied clones demonstrate good yield performance, reaching 14.0-15.0 tons per hectare (for clone R5 Cabernet Sauvignon) and 18.0-19.0 tons per hectare (for clone 348 Merlot) (Table 8.1). They are characterized by high sugar accumulation, sufficient for producing high-quality red table wines. With such productivity indicators, the level of profitability reaches 101.9% and 145.0%, respectively.

Table 8.1. Economic Efficiency of Grapevine Clones Production

Clone	Year	**Yield, tons per hectare**	**Price of 1 ton of productio n, lei**	**Revenue from product sales, lei**	**Production and sales costs, lei**	**Profit, lei (P)**	**Profitabilit y level, % (Pr)**
Cl R5	2015	11.09	4500	49905	34990.5	14914.5	42.6
	2016	14.25	4700	66975	37512.5	29462.5	78.5
	2017	14.98	5100	76398	37891.0	38507.0	101.6
	2018	14.3	4200	60060	37835.0	22225.0	58.7
	2019	10.93	4600	50278	37918.5	12359.5	32.6
	2020	4.86	5800	28188	36187.0	-7999.0	-22.1
	2021	9.08	8000	72640	39086.0	33554.0	85.8
Cl 348	2015	13.26	4500	59670	35967.0	23703.0	65.9
	2016	18.08	4700	84976	39236.0	45740.0	116.6
	2017	19.12	5100	97512	39754.0	57758.0	145.3
	2018	18.21	4200	76482	39594.5	36887.5	93.2
	2019	13.6	4600	62560	39120.0	23440.0	59.9
	2020	5.94	5800	34452	36673.0	-2221.0	-6.1
	2021	10.98	8000	87840	39941.0	47899.0	119.9

According to data from M. Cuharschii [56], M. Cuharschii, V. Ciobanu [15], M. Cuharsci, N. Taran, B. Gaina [21], M. Cuharschii, S. Ungureanu, A. Botnarenco [22], European grapevine clones are characterized by high biological and economic productivity, which is confirmed by our research conducted in the agroclimatic conditions of the ATU Gagauzia. The consistency and coherence of our research findings confirm the reliability and validity of the presented data, indicating their broader applicability in similar agricultural contexts.

However, in unfavourable years (2019-2021) due to harsh meteorological conditions (soil-air drought), the productivity of vineyards sharply declines. In 2020, despite the increase in purchase prices for the sold grape production, the level of profitability decreased sharply and acquired negative values.

GENERAL CONCLUSIONS

1. Analysis of the development indicators of the viticulture industry of the ATU Gagauzia, which is part of the grape and wine region with the protected geographical indication "Valul lui Traian", conducted over the past 25 years showed that the fruit-bearing area of vineyards decreases annually by an average of 500 hectares, while the gross grape harvest decreases by an average of 270 tons/year. The reserve for growth in the yield of vineyards of the Autonomy is about 2.5 tons/ha.
2. For the first time in the conditions of ATU Gagauzia, a prolonged effect of the quality of cuttings and grafted vines on the growth and development of grapevines in their permanent place has been established. In the case of the R5 clone of the Cabernet Sauvignon variety grown at SC "Tomai-Vinex" SA, the fruiting period begins in the fourth year after planting and depends on the rootstock variety. When grafted onto RxR 101-14 in the control variants, the yield is 1.38 kg per vine, and onto BxR Kober 5BB, it is 1.69 kg per vine. An increase in yield of 7.8-21.5% was observed when cuttings from the base and middle zones of the rootstock canes were used for grafting, compared to the control variants
3. It was found that during the full fruiting period (2015-2021), the mean Shoot Load, Growth, and Development of Annual Growth in clone R5 Cabernet Sauvignon vines depend on agroecological conditions and vary by year. In favorable meteorological years (2017), when grown on BxR Kober 5BB rootstock, the number of developed shoots ranged from 40.1 to 46.5 per vine, and the Volume of Annual Growth ranged from 4.4 to 5.7 dm^3 per vine, depending on the experimental variant. These indicators increased in variants using cuttings taken from the base of the rootstock canes (1^{st} and 2^{nd} cutting). A similar trend was also observed in clone R5 Cabernet Sauvignon grafted onto RxR101-14 rootstock.
4. It has been established that by the end of the vegetation period, the Leaf Surface Area of the clone R5 Cabernet Sauvignon onto BxR Kober 5BB in the control variant (2017) amounts to 48.2 dm^2 per shoot and 21.3 m^2 per vine. When using cuttings from the base of the rootstock canes for grafting, the Leaf Surface Area of the plants increases by 1.1-1.2 times and noticeably decreases when using cuttings from the top zone of the rootstock canes. When grafted onto RxR 101-14, there is

some reduction in the size of the Leaf Surface Area, but the observed pattern among the experimental variants remains consistent;

5. A strong direct correlation has been identified between Leaf Surface Area Development and Shoots' Productivity. The correlation coefficients are high, ranging from r=0.96 to 0.98. Interestingly, when grafted onto RxR 101-14, compared to BxR Kober 5BB, Leaf Surface Area and Shoot Productivity indicators decrease by 1.1-1.2 times. Shoot productivity in the control variants amounts to 109.7-135.7 g per shoot, and when using 1^{st}-3^{rd} cuttings from the base of the rootstock canes, it increases to 114.0-148.6 g per shoot;
6. For the first time, it was determined that the yield of clone R5 Cabernet Sauvignon depends on the Shoot Load of the vines, Shoot Productivity, and meteorological conditions of the year. In the control variants (2015-2018), when grafted onto BxR Kober 5BB, the yield ranged from 4.09 to 5.69 kg per vine. It increases by 1.1-1.2 times when using 1^{st}-2^{nd} cuttings from the base of the rootstock cane. The sugar content varies within the range of 224 g/dm^3 to 258 g/dm^3 (BxR Kober 5BB) and 238 g/dm^3 to 265 g/dm^3 (RxR 101-14), with titratable acidity of 8.0 g/dm^3 to 9.1 g/dm^3 and 7.5 g/dm^3 to 9.1 g/dm^3, respectively;
7. Changes in the training system and canopy management of grapevines from a hanging shoot positioning to a vertical shoot positioning system contribute to an increase in Leaf Surface Parameters and its Photosynthetic Activity. In favourable years, the Leaf Area Index reaches 5.5 m²/m², Chlorophyll Content is 9.7 g/vine, the Chlorophyll Index is 2.87 g/m², and Shoot Productivity is 160.6 g/shoot for clone R5 Cabernet Sauvignon and 230.8 g/shoot for clone 348 Merlot, which is 1.3-1.4 times higher than in non-reconstructed plantations.
8. The monitoring of the productivity of the studied clones (2015-2021) conducted in the conditions of the SC "Tomai-Vinex" SA has shown that they are characterized by high yield and product quality. In favourable years (2017), the yield of the clone R5 Cabernet Sauvignon reaches 15.0 ton per hectare with a sugar mass concentration of 235 g/dm^3 and titratable acidity of 8.9 g/dm^3; the clone 348 Merlot yields up to 19.1 ton per hectare with a sugar mass concentration and titratable acidity of 238 g/dm^3 and 8.8 g/dm^3, respectively. In unfavourable years (2019-2020), the productivity of the vineyards decreased by 1.4-2.8 times. A negative correlation coefficient has been established between the productivity of grapevine plantations and the amount of annual precipitation (r=0.81);
9. The analysis of the economic efficiency parameters of grape production for clone R5 Cabernet Sauvignon revealed their dependence on the quality of scion and rootstock materials, as well as on meteorological conditions, which were unfavorable during 2019-2021. In favorable meteorological years, profit and profitability levels increase, reaching 57,656.0 lei/ha and 145.0%, respectively.

RECOMMENDATIONS FOR PRODUCTION

1. To enhance the survival rate of of grafted saplings in permanent locations and establish high-yielding and profitable grape plantations, it is essential to use high-quality planting material obtained by:
   - utilizing rootstock cuttings collected from the first two metres of the base of the stock canes (1st, 2nd, and 3rd cuttings) for grafting;
   - grafting scion cuttings with tendrils, followed by pre-stratification treatment of the apical part of the grafted cuttings with a growth stimulant such as Calovit.
2. Long-term studies conducted at SC "Tomai-Vinex" SA suggest planting clone R5 Cabernet Sauvignon variety and clone 348 Merlot variety grafted onto the Kober 5BB rootstock. These combinations are characterized by high agronomic and biological productivity as well as excellent product quality.
3. To achieve a high-quality and full grape harvest from clone R5 Cabernet Sauvignon and clone 348 Merlot under the conditions of ATU Gagauzia, with dense planting (2.5 m x 1.35 m), it is recommended to use a vertical shoot positioning system.

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1.1. single-author monographs

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2. Articles in scientific journals

2.1. in journals in Web of Science and SCOPUS databases

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5. Materials Presented at Invention Exhibitions

1. **INFOINVENT 2023**. BRONZE MEDAL. *Section II: Innovation and Technology Transfer Projects. Research Projects. Monographs*. II.C.32. Growth and Productivity of Vine Plantations Depending on the Quality of Planting Material.

6. Projects

1. **13.824.14.184T.** Technology for Optimizing Grape Production in SC " Tomai-Vinex" SA". Project of the Agency for Innovation and Technological Transfer of the Academy of Sciences of Moldova (2013);
2. **196T 26.09.2014**. Reconstruction and Modernization of the Production of Clone Vine Varieties under the Conditions of SC" Tomai-Vinex" SA. Project of the Agency for Innovation and Technological Transfer of the Academy of Sciences of Moldova (2014);
3. **205T 26.05.20162016**. Implementation of Innovative Technology for Saving Energy Resources in the Production of Wines with PGI and PDO. Project of the Agency for Innovation and Technological Transfer of the Academy of Sciences of Moldova (2016)**;**
4. **19.00208.1908.16.** Development and Implementation of Modern Technologies for the Production of Grapes in the Agro-Ecological Conditions of the ATU Gagauzia. Postdoctoral Programs (2019-2020).

ANNOTATION

Cara S. **“Scientific Substantiation and Development of Grape Production Technology Elements in the Agro-Ecological Conditions of the ATU Gagauzia”**. Thesis Doctor Habilitate in Agricultural Sciences. Chisinau, 2024. The thesis structure: introduction, 8 chapters, general conclusions, practical recommendations, bibliography – 342 sources of information, 12 annexes, 213 basic text pages, 66 tables, 45 figures. Research results have been published in more than 73 scientific papers, including 1 monograph.

Key words: Clone, Cuttings, Grapes, Harvest, Productivity, Quality, Regeneration, Rootstock, Scion, Vines.

Domain of study: 06.01.08 – Viticulture.

The aim of research: to determine the potential of introduced grape clones and develop agricultural techniques aimed at enhancing the viability and productivity of vineyards under the agro-ecological conditions of the ATU Gagauzia, thereby improving the sustainability and economic efficiency of viticulture in the region.

Scientific novelty of work. It consists in the creation of a modern conceptual approach to the management of the productivity of vine plantations in the Southern viticulture zone of the Republic of Moldova. For the first time, the potential was identified and the reserve for increasing the yield of grape vines in the ATU Gagauzia was calculated. Monitoring the characteristics of the Growth and Development of Shoots, Leaf Surface and Establishing their correlation with the Productivity of Plantations can be the basis for obtaining High Quality Grape Products.

Theoretical significance lies in identifying important aspects and technological peculiarities of the growth, development, and adaptation of introduced clones R5 Cabernet Sauvignon and 348 Merlot, which influence the quality and productivity of grape plantations in the agro-ecological conditions of the ATU Gagauzia.

The applicative value of the research. The scientific data obtained make a significant contribution to the development and improvement of ampelocenosis models characterized by a high coefficient of photosynthetically active radiation, in studying the correspondence of biological and varietal characteristics of grapevines to the ecological conditions of their cultivation zone, and to cultivation methods.

The implementation of scientific results. The results of the research were implemented in the cultivation of grafted grapevine planting material and its planting in a permanent place, the production of grape variety clones in SC "Tomai-Vinex" SA in 2004-2021.

ADNOTARE

Cara S. "**Argumentarea științifică și elaborarea elementelor tehnologiei de producere a strugurilor în condițiile agro-ecologice ale UTA Găgăuzia".** Teza de doctor habilitat în științe agricole, Chişinău, 2024. Structura tezei: introducere, 8 capitole, concluzii generale, recomandări practice, bibliografie - 342 surse de informare, 12 anexe, 213 pagini de text de bază, 66 tabele, 45 figuri. Rezultatele cercetărilor sunt publicate în peste 73 lucrări științifice, inclusiv o monografie.

Cuvintele cheie: Viţa de vie, Clona, Portaltoi, Altoi, Productivitate, Calitate, Regenerare, Viţe, Butaşi, Recolta.

Domeniul de studiu: 411.07 – Viticultură.

Scopul cercetărilor: determinarea potențialului clonelor de viță de vie de introducție și elaborarea procedeelor tehnologice de sporire a viabilității și productivității plantațiilor viticole în condițiile agroecologice ale UTA Gagauzia, în scopul sporirii sustenabilității și eficienței economice a viticulturii în regiune.

Noutatea ştiinţifică a lucrării. Constă în crearea unei abordări conceptuale moderne a managementului productivității plantațiilor de viță de vie din zona de viticultura de sud a Republicii Moldova. Pentru prima dată a fost identificat potențialul și s-a calculat rezerva pentru creșterea randamentului plantelor de vița de vie în UTA Găgăuzia. Monitorizarea caracteristicilor de creștere și dezvoltare a lăstarilor, a suprafeței frunzelor și stabilirea corelației acestora cu productivitatea plantațiilor poate sta la baza obținerii unor produse din vița de vie de calitate superioară.

Semnificaţa teoretică constă în identificarea aspectelor importante și a caracteristicilor tehnologice ale creșterii, dezvoltării și adaptării clonelor introduse R5 Cabernet Sauvignon și a clonului 348 Merlot, care influențează calitatea și productivitatea plantațiilor de viță de vie în condițiile agro-ecologice ale UTA Găgăuzia.

Valoarea aplicativă a lucrării. Datele științifice obținute aduc o contribuție semnificativă la dezvoltarea și îmbunătățirea modelelor agroecosistemelor viticole, care prezintă un coeficient ridicat de eficiență a radiației fotosintetice active, în studierea compatibilității caracteristicilor biologice și de soi ale plantei de viță de vie cu condițiile ecologice din zona lor de cultivare și practicilor culturale.

Implementarea rezultatelor ştiinţifice. Rezultatele cercetărilor au fost implementate la cultivarea viţelor vița de vie, plantarea viţelor vița de vie la locul permanent, producerea clonelor de vița de vie în SC „Tomai-Vinex” SA în perioada 2004-2021.

АННОТАЦИЯ

Кара С. **«Научное обоснование и разработка элементов технологии производства винограда в агроэкологических условиях АТО Гагаузия»**. Диссертации на соискание ученой степени доктора хабилитат сельскохозяйственных наук, Кишинев, 2022. Структура диссертации: введение, 8 глав, выводы, рекомендации производству, библиография – 342 источников, 12 приложений, 213 страниц основного текста, 66 таблиц, 45 рисунков. Результаты исследований опубликованы в 73 научных работах, включая 1 монографию.

Ключевые слова: Виноград, Клон, Подвой, Привой, Продуктивность, Разнокачественность, Регенерация, Саженцы, Черенки, Урожайность.

Специальность: 411.07 – Виноградарство.

Цель исследований: определить потенциал интродуцированных клонов винограда и разработать технологические приемы увеличения жизнеспособности и продуктивности виноградных насаждений в агроэкологических условиях АТО Гагаузия, для повышения устойчивости и экономической эффективности виноградарства региона.

Научная новизна и оригинальность. Заключается в создании современного концептуального подхода к управлению продуктивностью виноградных насаждений в Южной зоне виноградарства Республики Молдова. Впервые выявлен потенциал и рассчитан резерв повышения урожайности растений винограда в АТО Гагаузия. Мониторинг особенностей роста и развития побегов, листовой поверхности и установление их корреляционной связи с продуктивностью насаждений может явиться основой для получения виноградной продукции высокого качества.

Теоретическая значимость заключается в выявлении важных аспектов и технологических особенностей роста, развития и адаптации интродуцированных клонов R5 Каберне-Совиньон и 348 Мерло, которые оказывают влияние на качество и продуктивность виноградных насаждений в агроэкологических условиях АТО Гагаузия.

Практическая оценка работы. Полученные научные данные вносят значительный вклад в разработку и совершенствование моделей ампелоценозов, обладающих высоким коэффициентом полезного действия фотосинтетически активной радиации, в изучение соответствия биологических и сортовых особенностей виноградного растения экологическим условиям зоны их возделывания и способам культуры.

Внедрение в производство. Результаты исследований внедрены при выращивании привитых саженцев винограда, посадке саженцев винограда на постоянное место, производстве клонов винограда в SC «Tomai-Vinex» SA в 2004-2021 гг.

CARA SERGHEI

SCIENTIFIC SUBSTANTIATION AND DEVELOPMENT OF GRAPE PRODUCTION TECHNOLOGY ELEMENTS IN THE AGRO-ECOLOGICAL CONDITIONS OF THE ATU GAGAUZIA

411.07 - VITICULTURE

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