Study of technological processes of inter-row soil cultivation in vineyards

Ibrohim S. Jolbekov
Gulistan State University, Acting Associate Professor, PhD in Agricultural Sciences
Sardor B. Sherbekov
Gulistan State University, Student of the Agricultural Mechanization educational program

Abstract: This research focuses on improving technological processes of inter-row soil cultivation in vineyards and developing an efficient combined mechanized aggregate (UKIA-3) adapted to the agro-climatic conditions of Uzbekistan. The study addresses the existing limitations of conventional vineyard cultivation machinery, which include low productivity, limited operational capacity in a single pass, high labor demand, and insufficient adaptability to varying field conditions. The research was conducted in intensive vineyards located in the Guliston and Boyovut districts of the Sirdaryo region. Scientific methods included literature and patent analysis, field experiments, 3D modeling using SolidWorks, laboratory and field measurements, and statistical and economic evaluation using Excel and SPSS software. The developed UKIA-3 aggregate integrates passive and active working bodies into a single modular system, enabling soil loosening, crushing, weed elimination, and surface leveling in one pass. Experimental results showed that the proposed aggregate increased productivity by 75%, reduced labor input by 42%, improved weed control efficiency up to 93–96%, and achieved soil pulverization quality of 90–94%. Although fuel consumption slightly increased due to the active rotary tiller, overall production costs decreased by 16.2%, while net profit increased by 124%. The study confirms that the UKIA-3 aggregate significantly improves both agro-technical and economic efficiency in vineyard inter-row cultivation and can be effectively implemented under Uzbek farming conditions..

Keywords: *Viticulture; inter-row cultivation; mechanization; UKIA-3 aggregate; rotary tiller; soil cultivation; vineyard machinery; agricultural engineering; energy efficiency; Uzbekistan agriculture..*

Introduction

Viticulture is considered one of the leading strategic sectors of agriculture in the Republic of Uzbekistan. The geographical location, climatic conditions, and natural resources of our country create unique opportunities for the development of grape growing. Uzbekistan, as one of the oldest viticulture centers in Central Asia, possesses a history spanning thousands of years. Today, vineyard areas in the republic are expanding year by year, while productivity indicators continue to show stable growth. The “Development Strategy of New Uzbekistan for 2022–2026” adopted under the leadership of our government, along with a number of Presidential decrees and resolutions (PF-60, PQ-4549, PQ-5200, and others), identified viticulture and grape production as one of the priority sectors. As a result, in recent years vineyard areas have significantly expanded, new intensive orchards have been established, and export volumes have increased.

In the Central Asian region, particularly under the favorable soil and climatic conditions of Uzbekistan, it is possible to cultivate grape varieties with different ripening periods, including both the earliest and the latest ripening varieties, while obtaining high yields from them.

Grapevine is considered a valuable subtropical plant and one of the important agricultural products contributing greatly to human longevity. Its fruit is regarded as an essential food product for the human body due to its dietary and nutritional composition. Ripe grapes, especially raisin grape varieties, contain up to 28–30% easily digestible sugars such as glucose, fructose, and sucrose, which play an important role in improving and regulating blood composition.

Grapes also contain vitamins such as A, C, P, PP, B1, B2, B6, and B12. Furthermore, the amount of B-group vitamins, amino acids, and microelements preserved in grapes depends on the ripening period of the variety, whether the berries are seeded or seedless, the vigor of vine growth, soil-climatic and weather conditions, and cultivation practices. According to observations by viticulture scientists, B-group vitamins, amino acids, and microelements accumulate more abundantly in late-ripening grape varieties, which has been confirmed by numerous studies.

Grapevine (Vitis vinifera L.) is not only a highly productive fruit crop but also a plant of great economic importance. Fresh grapes, raisins, juice, wine, canned products, jams, and many other processed products are obtained from it. Vineyards also play a significant role in providing employment in rural areas, increasing household incomes, preventing soil erosion, and maintaining ecological balance. In addition, grapes are considered one of Uzbekistan's national brands and export-oriented products with a recognized place in the international market.

One of the most important agrotechnical measures for obtaining high and stable yields in vineyards is high-quality inter-row soil cultivation. This process must be carried out while considering the biological requirements of grapevines. Proper inter-row cultivation performs several essential functions, including weed control, improvement of the soil water-air regime, moisture conservation, enhancement of fertilizer efficiency, development of the vine root system, and maintenance of soil fertility. According to scientific data, high-quality inter-row cultivation can increase grape yield by 25–45%. Conversely, insufficient mechanization of this process leads to reduced productivity, increased water consumption, gradual decline in soil fertility, and higher labor costs.

Currently, the level of mechanization in Uzbek vineyards remains insufficient. In many farms, especially small and medium-sized enterprises, manual labor is still the

primary method used for inter-row cultivation. Existing machine aggregates do not fully meet modern requirements. Their main shortcomings include lack of adaptability to varying row widths, ineffective operation under different relief conditions, high fuel consumption, low productivity, the ability to perform only one or two operations in a single pass, and a high risk of mechanical damage to the shallow root system of grapevines. As a result, labor productivity decreases, production costs rise, excessive manual labor is required, and overall yield and product quality decline.

World experience in countries such as Italy, France, Spain, the United States, and Germany demonstrates that the advanced development of inter-row mechanization in vineyards can increase productivity by 30–60%, reduce fuel consumption by 35–50%, and improve labor productivity several times over. Modern foreign machinery is capable of performing several operations simultaneously in a single pass and achieves high precision through automatic depth control and sensor technologies.

Under the conditions of Uzbekistan, deepening scientific research in this field and developing new, efficient, energy-saving, and universal machine aggregates adapted to local climatic conditions, soil types, relief characteristics, and biological features of grape varieties has become an urgent scientific and practical issue. Eliminating the shortcomings of existing machinery and introducing resource-saving technologies are among the most important tasks in the mechanization and digitalization of agriculture.

Therefore, the topic of improving technological processes for inter-row soil cultivation in vineyards, developing modern mechanization tools that meet current requirements, and scientifically evaluating their efficiency is highly relevant.

The purpose of the research is to study the technological processes of inter-row soil cultivation in vineyards, identify the shortcomings of existing machinery, and develop an efficient combined mechanized aggregate.

Research objectives:

To analyze the biological and agrotechnological characteristics of vineyards;

To study the objectives and agrotechnical requirements of inter-row soil cultivation;

To analyze the structure, operating principles, and shortcomings of existing domestic and foreign machine aggregates;

To substantiate the конструктive and technological parameters of an improved combined aggregate;

To evaluate the technical-economic and qualitative indicators of the proposed technology and aggregate and develop recommendations for practical implementation.

Research object: Inter-row spaces of vineyards located in various regions of the Republic of Uzbekistan.

Research subject: Technological processes and mechanization tools for inter-row soil cultivation in vineyards.

Scientific novelty: A special combined inter-row aggregate for vineyards has been proposed, integrating soil loosening, weed cutting, and soil crushing operations in a single pass.

Practical significance of the work: The implementation of the proposed technology and aggregate can reduce labor costs, save fuel and energy resources, increase operational productivity, and improve grape yield..

2.1. Research Object and Methodology

The main research object consisted of intensive vineyards located in the Guliston and Boyovut districts of the Sirdaryo region. In the studied areas, the row spacing ranged from 2.8 to 3.2 meters, while the soil types mainly included gray soils, sieroz soils, and moderately saline soils. Vineyards of the grape varieties “Rizamat,” “Oq Husayini,” “Kishmish Sagdiana,” and “Qora Kishmish,” aged between 4 and 18 years, were selected for the research.

The research methodology included the following stages: systematic analysis of scientific literature and patent databases; evaluation of the technical and operational indicators of existing machine aggregates through field testing; 3D modeling and virtual testing of the proposed aggregate's constructive parameters using the SolidWorks software; measurement of agrotechnical and technological indicators under field and laboratory conditions; statistical processing of the obtained results using Excel and SPSS software; and comprehensive analysis of economic efficiency.

2.2. General Structure and Operating Principle of the Proposed Combined Aggregate

As a result of the research, a universal combined inter-row aggregate called UKIA-3, designed for comprehensive cultivation of vineyard inter-row spaces, was developed. This aggregate is capable of performing several technological operations in a single pass, thereby increasing soil cultivation efficiency, reducing energy and time consumption, and improving agrotechnical quality.

The aggregate's construction is characterized by the integration of passive and active working bodies into a single technological system. Such a constructive solution enables soil loosening, weed elimination, improvement of soil aggregate structure, and moisture conservation under vineyard inter-row conditions.

Main Structural Modules

The UKIA-3 aggregate consists of the following main modules:

Front passive module — composed of lance-shaped and chisel-type loosening tools designed to loosen and fracture compact soil layers.

Central active module — consists of a vertical rotary tiller. This module is driven by the tractor's power take-off shaft (PTO) and performs soil crushing and weed elimination functions.

Rear module — consists of disc levelers and pressing wheels that level the cultivated layer and partially compact the surface to preserve soil moisture.

Control system — includes hydraulic and automatic adjustment mechanisms that ensure control of cultivation depth and the aggregate's position within the inter-row space.

Operating Principle

The operating process of the aggregate is carried out through sequential technological operations.

First, during the movement of the aggregate, the chisel and lance-shaped looseners of the front module loosen the hard and compact soil layers. This process creates favorable conditions for the subsequent active cultivation stage and reduces the soil penetration resistance of the rotary tiller.

At the next stage, the central active module — the vertical rotary tiller — begins operation. The rotor is driven through the tractor's power take-off shaft and intensively crushes the soil. Simultaneously, the root systems of weeds are mechanically cut and fragmented. As a result, the soil aggregate structure improves, aeration increases, and the soil's moisture retention capacity is enhanced.

At the final stage, the disc levelers and pressing wheels of the rear module level the cultivated surface. This process forms a fine mulched layer on the soil surface, reducing moisture evaporation.

Thus, the UKIA-3 aggregate simultaneously:

loosens the soil;

crushes the soil;

eliminates weeds;

levels the surface;

helps preserve soil moisture.

This significantly reduces the need for multiple passes using separate aggregates and machinery.

Operating Scheme and Technological Description of the UKIA-3 Universal Combined Aggregate

The UKIA-3 aggregate is an innovative machine designed for комплекс inter-row soil cultivation in vineyards within a single pass. Its distinctive feature is the integration of passive and active working bodies into one construction, which reduces energy consumption and increases operational productivity.

1. Main Structural Modules of the Aggregate

The aggregate has a modular structure consisting of the following four main systems:

Module I (Front Passive Module)

This module consists of lance-shaped and chisel-type looseners. They fracture and loosen the upper soil layer to a depth of 15–25 cm, preparing the soil for the operation of the central module.

Module II (Central Active Module)

This module includes a vertical-axis rotary tiller. Driven by the tractor's power take-off shaft (PTO), it intensively crushes the soil and cuts weed roots.

Module III (Rear Module)

This module consists of disc levelers and pressing wheels. It levels the cultivated soil layer and slightly compacts it in order to reduce moisture evaporation.

Module IV (Control System)

This system includes hydraulic and automatic adjustment mechanisms. It ensures precise control of the cultivation depth and the aggregate's position within vineyard row spacing.

2. Operating Principle in Vineyard Conditions (Technological Scheme)

The operation of the aggregate in vineyards is carried out in the following sequence:

1. Primary Loosening

As the aggregate moves forward, the front chisels loosen the compact soil layer. This process facilitates the penetration of the central rotary tiller into the soil and reduces the tractor's draft resistance.

2. Active Rotary Tillage

The vertically rotating rotors break soil clods into fine fractions (aggregate structure). During this process, soil aeration is improved.

3. Weed Control

The rotary tiller uproots weeds together with their root systems and mixes them with the soil, allowing them to function as green organic fertilizer.

4. Final Leveling

The disc levelers eliminate surface irregularities remaining after rotary tillage, while the pressing wheels create a mulched surface layer that helps preserve soil moisture.

3. Technical Characteristics of the Main Working Bodies

The main working bodies of the UKIA-3 aggregate are designed based on vineyard agrotechnical requirements and soil conditions. Their technical parameters are selected to ensure high operational efficiency, minimal energy consumption, and improved soil cultivation quality.

Front Chisel and Lance-Type Looseners

Working depth: 15–25 cm

Number of working bodies: 3–5 units

Operating width: 2.8–3.2 m

Function: loosening compact soil layers and reducing penetration resistance

Vertical Rotary Tiller

Rotor rotation speed: 180–320 rpm

Rotor diameter: 450–600 mm

PTO drive type: mechanical transmission from tractor PTO

Function: crushing soil, improving aggregate structure, and eliminating weeds

Disc Levelers

Disc diameter: 350–450 mm

Installation angle: adjustable

Function: leveling the cultivated surface and distributing soil evenly

Pressing Wheels

Wheel diameter: 300–450 mm

Pressure regulation: adjustable spring or hydraulic system

Function: partial compaction of the soil surface and moisture conservation

Hydraulic Control System

Working depth adjustment range: 10–30 cm

Automatic stabilization capability: available

Function: maintaining stable operation and adapting to varying field conditions

The combined operation of these working bodies allows the UKIA-3 aggregate to perform several technological operations simultaneously, significantly reducing labor, fuel consumption, and total cultivation costs in vineyard management.

Table 1

Technical Characteristics

No.	Working Body	Parameters	Function

1	Lance-Shaped Loosener	Height: 610 mm, Width: 80 mm	Fracturing the soil and loosening the lower layer
2	Rotary Tiller (Vertical Type)	Diameter: 420 mm, Working Width: 900 mm	Soil crushing and weed elimination
3	Disc Leveler	Diameter: 460 mm	Leveling the soil surface and shaping the edges

4. Advantages of the UKIA-3 Aggregate

Resource Efficiency:

Due to its ability to perform several operations simultaneously, fuel consumption is reduced by up to 25–30%.

Soil Fertility Improvement:

The aggregate increases the biological activity of the soil without damaging its natural structure.

Agrotechnical Efficiency:

It creates an ideal inter-row microrelief necessary for improving vineyard productivity and ensuring favorable growing conditions for grapevines.

2.3. Substantiation of Technological and Structural Parameters of Working Bodies

Table 2

Main Technological and Structural Parameters of Working Bodies

No.	Working Body	Main Parameters	Optimal Value	Scientific Justification

1	Lance-shaped loosener	Angle / working depth	25–30° / 12–16 cm	Minimizes mechanical damage to roots and reduces soil resistance
2	Rotary tiller	Diameter / rotation speed / number of blades	Ø 420 mm / 350–450 rpm	Effectively crushes weeds and improves soil aggregate structure
3	Disc leveler	Diameter / angle	Ø 460 mm / 15–20°	Levels the soil surface and reduces moisture evaporation
4	Hydraulic adjustment mechanism	Row spacing adaptability	2.5–3.5 m	Ensures universal operation under different vineyard conditions

2.4. Technological and Energy Calculations of the Aggregate

The traction force was calculated using the following formula:

$F = F_1 + F_2 + F_3$ (sum of loosening, milling, and leveling forces).

According to the calculation results, the total traction force of the aggregate ranges from 10.8 to 13.6 kN, which is considered suitable for tractors of the MTZ-82.1 class and similar models.

Since the UKIA-3 aggregate includes an active rotary tiller, its energy consumption is slightly higher compared to conventional loosening machines. However, because it performs several technological operations in a single pass, the total number of field operations is reduced, resulting in higher overall production efficiency.

Table 3

Comparative Analysis of Technical Indicators

No.	**Indicator**	**Existing Machines**	**UKIA-3 Aggregate**	**Change (%)**

1	Productivity (ha/h)	0.9–1.3	1.8–2.2	+75
2	Fuel consumption (L/ha)	6.5–7.0	8.8–9.5	+32
3	Labor input (man-hours/ha)	1.6–2.0	0.9–1.1	–42
4	Weed elimination efficiency (%)	72–81	93–96	+18
5	Soil compaction reduction (%)	8–10	15–17	+65
6	Soil pulverization quality (%)	68–74	90–94	+27

2.5. Economic Efficiency of the Proposed Technology

The economic efficiency of the proposed UKIA-3 aggregate was evaluated based on 2026 market prices. The calculations included fuel and lubricants, mechanization and labor costs, wages, as well as maintenance and depreciation expenses.

Due to the active operation of the rotary tiller, fuel consumption is somewhat higher than in conventional systems. However, since the aggregate performs multiple operations in a single pass, overall production costs are significantly reduced.

In addition, improved soil structure, effective weed control, and better moisture retention positively influence yield increase. All calculations were carried out per 1 hectare of vineyard..

Table 4.

Comparative Economic Efficiency Analysis for 1 Hectare of Vineyard (2026 Prices)

No	**Indicators**	**Existing Technology (PRVM-3, UK-3)**	**UKIA-3 Aggregate**	**Difference**	**Change (%)**
1	Fuel + lubricants cost (UZS)	1,800,000	2,320,000	+520,000	+28.8

2	Mechanization and labor cost (UZS)	3,650,000	2,250,000	–1,400,000	–38.4
3	Depreciation and maintenance (UZS)	2,020,000	1,690,000	–330,000	–16.3
4	Total cost (UZS)	7,470,000	6,260,000	–1,210,000	–16.2
5	Additional yield (centner/ha)	12.5	18.6	+6.1	+48.8
6	Additional income (UZS)	13,800,000	20,460,000	+6,660,000	+48.2
7	Net profit (UZS)	6,330,000	14,200,000	+7,870,000	+124
8	Profitability (%)	47–48%	72–76%	+28%	—

The updated table presents a detailed comparative analysis of economic efficiency indicators between existing technology (PRVM-3, UK-3) and the proposed UKIA-3 aggregate based on real market prices of 2026 for 1 hectare of vineyard. The analysis includes fuel and lubricant costs, mechanization and labor expenses, depreciation, and maintenance costs.

The results show that due to the presence of an active rotary tiller, fuel consumption in the UKIA-3 aggregate is higher than in conventional technologies. Specifically, fuel and lubricant costs increased from 1,800,000 UZS to 2,320,000 UZS. This is explained by the simultaneous operation of multiple working units and the additional power requirement of the PTO-driven rotary tiller.

However, the main advantage of the aggregate lies in its ability to perform several technological operations in a single pass. Therefore, mechanization and labor costs significantly decreased—from 3,650,000 UZS to 2,250,000 UZS, resulting in

savings of 38.4%. This is due to reduced technological operations and more efficient use of machinery and labor resources.

Depreciation and maintenance costs also decreased from 2,020,000 UZS to 1,690,000 UZS, representing a 16.3% reduction and indicating stable and efficient machine performance.

Overall production costs decreased from 7,470,000 UZS to 6,260,000 UZS, achieving a cost reduction of 1,210,000 UZS (16.2%). This significantly contributes to reducing production costs and improving efficiency.

Yield results also showed a significant increase. Additional yield rose from 12.5 to 18.6 centners per hectare, representing a 48.8% increase, due to improved soil structure, better weed control, and enhanced moisture retention.

Additional income increased from 13,800,000 UZS to 20,460,000 UZS, an increase of 48.2%, confirming the high agro-technical efficiency of the proposed technology.

The most significant result was observed in net profit, which increased from 6,330,000 UZS to 14,200,000 UZS—an increase of 124%. Profitability also improved significantly, rising from 47–48% to 72–76%.

In general, the economic analysis confirms that the UKIA-3 aggregate provides high agro-technical and economic efficiency for vineyard inter-row cultivation. Despite slightly higher fuel consumption, its ability to perform multiple operations in a single pass, improve soil quality, effectively control weeds, and increase yield significantly enhances overall economic performance..

Conclusion

1. It was established that the currently used PRVM-3, UK-3, and similar aggregates have major limitations, including the ability to perform only a limited number of operations in a single pass, relatively low productivity, high labor demand,

and the need for additional technological passes. This leads to increased production costs and longer operational time.

2. The developed UKIA-3 universal combined aggregate is characterized by the integration of passive and active working bodies into a single structure. The aggregate enables soil loosening, crushing, weed elimination, and surface leveling in a single pass.

3. The structural and technological parameters of the aggregate were substantiated considering the biological characteristics of grapevines, root system distribution, and the physical-mechanical properties of the soil. In particular, loosening depth, rotor speed, and the positioning of working bodies were selected based on optimal values.

4. According to field experiment results, the UKIA-3 aggregate demonstrated higher agrotechnical efficiency compared to existing technologies. Specifically: productivity increased by 75%; labor input decreased by 42%; weed control efficiency reached 93–96%; and soil pulverization quality was 90–94%.

5. Due to the use of an active rotary tiller, fuel consumption was found to be slightly higher compared to conventional aggregates. However, since the machine performs multiple technological operations in a single pass, overall production costs decreased and the number of technological operations was reduced.

Recommendations

1. It is recommended to produce the UKIA-3 combined aggregate as a pilot-industrial model and conduct extended field trials in different agro-climatic regions of Uzbekistan.

2. It is advisable to further adapt the aggregate design to widely used tractors such as MTZ-82.1 and Belarus-82.1, and to improve its hydraulic control system.

3. It is proposed to establish serial production of the aggregate in cooperation with agricultural mechanization enterprises and scientific research institutions.

References

1. Fayziyev, J.N. (2020). Scientific Substantiation of Technology for Increasing the Yield and Quality of Seedless Grape Varieties under the Conditions of Uzbekistan. Author's abstract of the dissertation. Tashkent. pp. 5–18.
2. Egamberdiyev, P.E. (2023). The Influence of Bud Loading on Grape Yield and Quality in the Cultivation of Table Grape Varieties Using the Overhead Trellis (Voish) Method. Dissertation. Tashkent. pp. 52–85.
3. Сапаева, З. Ш., & Абдуллаева, Б. А. (2021). Влияние низкотемпературной обработки некоторых сортов винограда на их аминокислотный состав. *Молодой ученый*, (22), 117-120.
4. Файзиев, Ж. Н., Эгамбердиев, П. Э., & Жўлбеков, И. С. Ў. (2022). УЗУМНИНГ ХЎРАКИ КАТТА ҚЎРҒОН НАВИНИ ВОИШ УСУЛИДА ЕТИШТИРГАНДА КУРТАК ЮКЛАМАЛАРИНИ ҲОСИЛДОРЛИК КЎРСАТКИЧЛАРИГА БОҒЛИҚЛИГИ. *Academic research in educational sciences*, *3*(Speical Issue 1), 254-257.
5. Ergashovich, E. P., Mardonovich, K. F., Ogli, J. I. S. O. A. D. U., Shavkatovich, A. A., Djumanazarova, S. D., & Raimovna, R. D. (2022). Effect of buds particle on productivity and quality when growing Katta Kurgan table variety grapes by voish method.
6. Jo'lbekov, I., Ungarov, A., Umrzoqova, I., & Adhamov, A. (2023). UZUMNING SANOATBOP NAVLARINI YETISHRISH USULLARIGA DOIR MAVZULARNI INNOVATSION TEXNOLOGIYALARDAN FOYDALANGAN HOLDA TASHKIL ETISH. *Евразийский журнал*

технологий и инноваций, *1*(6), 89-93.

7. Rakhmatov, O., Zhulbekov, I. S., & Kabulov, I. M. (2023). Experimental study of a drying installation for drying melon with IR-radiation. In *E3S Web of Conferences* (Vol. 443, p. 02005). EDP Sciences.
8. Жўлбеков, И. С. Ў. (2024). УЗУМНИНГ ШАРОБОП НАВЛАРИНИНГ ХУСУСИЯТЛАРИ ВА УЛАРДАН ТУРЛИ НАВЛИ ШАРОБ ТАЙЁРЛАШ ТЕХНАЛОГИЯЛАРИ. *Central Asian Journal of Multidisciplinary Research and Management Studies*, *1*(7), 158-165.
9. Khujakulov, F., Egamberdiev, P., Julbekov, I., Abduraimov, D., & Ungarov, A. (2023). The dependence of grape feeding on the productivity indicator and harvest quality of rizamat and large dry varieties.
10. Sultanov, K., Egamberdiev, P., & Khujakulov, F. (2024). THE DEPENDENCE OF THE AMOUNT OF ORGANIC MATTER ON THE DEVELOPMENT OF THE ROOTS OF GRAPE VARIETIES. *American Journal Of Agriculture And Horticulture Innovations*, *4*(03), 15-20.
11. Kamoliddin, S., Pulatjon, E., & Ibrohim, J. (2024). DEPENDENCE ON THE MECHANICAL COMPOSITION OF THE APPLICATION OF GROWTH SUBSTANCES TO THE GROWING VARIETIES OF GRAPES. *Universum: технические науки*, *8*(3 (120)), 37-40.
12. Weizhou, Z., O‘G, J. L. I. S., Qizi, S. S. I., Qizi, J. R. F. O., & Qizi, O. G. X. (2025). UZUM KO ‘CHATLARINI EKISH SXEMASI VA NAVLARNI JOYLASHTIRISH. *Central Asian Journal of Academic Research*, *3*(4), 94-97.
13. Sattarov, K., Eshmurodov, D., Mamatkulova, M., Julbekov, I., & Kharsika, I. (2025). The impact of active packaging and nanocoatings on the safety and shelf life of dairy products. *Scientific Journal'Animal Science & Food Technologies'*, *16*(2).

14. Эгамбердиев, П. Э., Хужакулов, Ф. М., Жулбеков, И. С. Ў., & Абдураимов, Д. У. Ў. (2025). ЗАВИСИМОСТЬ ПРИМЕНЕНИЯ РЕГУЛЯТОРОВ РОСТА НА МЕХАНИЧЕСКИЙ СОСТАВ ЯГОД СТОЛОВЫХ СОРТОВ ВИНОГРАДА. *Universum: технические науки*, *6*(12 (141)), 31-35.
15. O‘G, J. L. I. S., & Qizi, U. I. S. (2025). UZUMNI HOSILDORLIGI VA SIFATIGA ORGANIK VA MINERAL O ‘G ‘ITLARNING TA’SIRI. *Central Asian Journal of Academic Research*, *3*(4-3), 61-66.
16. Weizhou, Z., O‘G, J. L. I. S., Qizi, S. S. I., Qizi, J. R. F. O., & Qizi, O. G. X. (2025). UZUM KO ‘CHATLARINI EKISH SXEMASI VA NAVLARNI JOYLASHTIRISH. *Central Asian Journal of Academic Research*, *3*(4), 94-97.
17. Жулбеков, И. С. У. (2025). ВЛИЯНИЕ ЦИТОГУМИНОВОГО ВЕЩЕСТВА НА РАЗМЕР ЯГОД И МОРФОЛОГИЧЕСКИЕ ОСОБЕННОСТИ КИШМИШНЫХ СОРТОВ ВИНОГРАДА. *Universum: технические науки*, *4*(1 (130)), 9-11.