

LIST OF PERFORMERS

|  |  |  |
| --- | --- | --- |
| Supervisor of the Research work,  Candidate of Pedagogical Sciences, Associate Professor |  | Sauytbaeva G. Z.  (section 1.1, conclusion) |
|  |  |  |
| Performers: |  |  |
|  |  |  |
| NCJSC Korkyt Ata KU |  |  |
| Specialist |  | Dyamurshayeva G.E.  (section 1.2) |
|  |  |  |
| GTI «Аkmeshit» |  |  |
| Senior Researcher, PhD in agriculture |  | Kudiyarov R.I.  (introduction, section 2.2) |
| Research Associate, Master in agriculture |  | Dyamurshayeva E.B.  (section 2.1) |
| Specialist |  | Nurpeisova A.A.  (section 2.3) |
|  | | |

**REPORT**

The report contains 1 book, 52 pages, 91 sources of literature, a 10 figure, and 11 tables.

Keywords: protected soil, small-volume hydroponics, substrate, drip irrigation, tomato.

The objects of the study were: small-volume hydroponics technology, drip irrigation system, substrate and hybrid of tomatoes Lilos F1.

The purpose of the research: conducting tests on the application of an adapted technology for small-volume tomato cultivation and determining its environmental and economic efficiency.

The methodological basis of the research is to conduct semi-production experiments using generally accepted methods in protected soil vegetable growing, phenological and biometric observations, organoleptic and biochemical analysis of quality indicators and environmental safety of the tomato crop, calculation of the economic efficiency of the technology according to the main indicators: cost, sales revenue, profit and profitability.

The research results showed that the use of small-volume tomato cultivation technology adapted to regional conditions contributed to an increase in crop productivity by 20.7% and the yield of standard products by 2.4%. The total tomato yield of the Lilos F1 hybrid was 28.16 kg/m2, the yield of standard products was 99.2%. In terms of quality and environmental safety, the resulting crop fully met the requirements of GOST.

The use of a hybrid adapted taking into account regional characteristics and varietal characteristics of the grown hybrid has significantly increased the profitability of production to 54.4%, which is 20.3% higher in the previously used technology.

The applied technology allowed to increase the realization of the productivity potential of the Lilos F1 hybrid by 9.4% to 78.2%. For further successful application of small-volume tomato cultivation technology, it is necessary to test promising tomato hybrids that are able to fully realize their biological potential in the conditions of the region.

The developed technology is proposed for implementation in existing and newly created farm greenhouses of the PreAral Sea region.

Scope of application: Vegetable growing of protected soil.

**РЕФЕРАТ**

Отчет 1 книга, 52 страницы, 91 источник литературы, 10 рисунков, 11 таблиц.

ЗАЩИЩЕННЫЙ ГРУНТ, МАЛООБЪЕМНАЯ ГИДРОПОНИКА, СУБСТРАТ, КАПЕЛЬНОЕ ОРОШЕНИЕ, ТОМАТ.

Объекты исследования: технология малообъемной гидропоники, система капельного орошения, субстрат и гибрид томатов Lilos F1.

Цель исследований: проведение испытаний по применению адаптированной технологии малообъемного выращивания томата и определение ее экологической и экономической эффективности.

Методологическая основа исследований заключается в проведении полупроизводственных опытов с использованием общепринятых методик в овощеводстве защищенного грунта, фенологических и биометрических наблюдений, органолептического и биохимического анализа показателей качества и экологической безопасности урожая томатов, расчета экономической эффективности технологии по основным показателям: себестоимости, выручке от реализации, прибыли и рентабельности.

Результаты исследований показали, что применение адаптированной для региональных условий технологии малообъемного выращивания томатов способствовала увеличению продуктивности культуры - на 20,7% и выходу стандартной продукции - на 2,4%. Общий урожай томатов гибрида Lilos F1 составил 28,16 кг/м2, выход стандартной продукции 99,2%. По показателям качества и экологической безопасности полученный урожай полностью соответствовал требованиям ГОСТа.

Применение адаптированной с учетом региональных особенностей и сортовых особенностей выращиваемого гибрида позволило значительно повысить рентабельности производства до 54,4%, что на 20,3% выше в ранее применяемой технологии.

Применяемая технология позволила на 9,4%, увеличить реализацию потенциала продуктивности гибрида Lilos F1 до78,2%. Для дальнейшего успешного применения технологии малообъемного выращивания томатов необходимо проведение испытаний перспективных гибридов томатов, которые в условиях региона способны полностью реализовать свой биологический потенциал.

Разработанная технология предлагается для внедрения в существующих и вновь создаваемых фермерских тепличных хозяйствах Приаральского региона.

Область применения: Овощеводство защищенного грунта.

**CONTENT**

|  |  |  |
| --- | --- | --- |
|  |  | Стр. |
| INTRODUCTION……………………………………………………………………. | | 8 |
| THE MAIN PART OF THE RESEARCH REPORT……………………………… | | 12 |
| 1 CONDITIONS, MATERIAL AND METHODOLOGY OF RESEARCH……… | | 12 |
| 1.1 Place and conditions of experimental research……………………………… | | 12 |
| 1.2 Objects and methods of research……………………………………………… | | 15 |
| 2 RESEARCH RESULTS.......................................................................................... | | 24 |
| 2.1 The influence of the adapted technology of low-volume cultivation on the  growth and development of tomatoes........................................................................ | | 24 |
| 2.2 Assessment of the quality and environmental safety of tomato fruits………… | | 27 |
| 2.3 Economic efficiency of the application of the adapted technology of low-  volume tomato cultivation......................................................................................... | | 29 |
| CONCLUSION………………………………………………………………………. | | 33 |
| LIST OF SOURCES USED…………………………………………………………... | | 34 |
| APPENDIX A - CALENDAR PLAN……………………………………………….. | | 41 |
| APPENDIX B -List of works on the project……………………………………… | | 45 |
| APPENDIX C - Technological map of low-volume cultivation of Lilos F1 tomato in extended circulation…………………………………………………………… | | 46 |
| APPENDIX D - Calculation of costs for various complete sets of automated drip irrigation and fertigation systems…………………………………………………….. | | 51 |
|  |  |  |

TERMS AND DEFINITIONS

The following terms with the corresponding definitions are used   
 in the given report:

VEGETATIVE PHASE - the phase of plant growth from the germination of seeds to the formation of generative organs

GENERATIVE PHASE - the fruiting phase

HYBRID - an organism obtained as a result of crossing of heterogeneous ones in the genetic relation of parental forms: species, rocks, lines, etc

DRAINAGE SOLUTION - a solution withdrawn from a plate or a bag with a substrate

PROTECTED SOIL - specially equipped land plots and structures for improving the natural or creating an artificial microclimate for off-season growing of seedlings, vegetable and flower crops

DRIP IRRIGATION - such an irrigation organization when water and nutrient solutions are fed directly to the zone of plant roots ensuring a constant moistening of the root system.

CROP ROTATION - alternation of vegetable crops grown in cultivation facilities (greenhouse, hot frame, tropical house or insulated soil) within one year

SMALL-VOLUME HYDROPONICS is a method of growing vegetable and other crops on various substrates that have no nutritional value and require relatively frequent (or constant drip) watering with a working solution of mineral salts prepared according to the needs of the plant

NUTRIENT SOLUTION - an aqueous solution of substances necessary for the plant life and growth

SUBSTRATE - a material of mineral or synthetic origin used as a medium for the development of the root system of plants

FERTIGATION - is a method of applying liquid fertilizers or pesticides, simultaneously with the implementation of irrigation (irrigation)

ELECTRICAL CONDUCTIVITY - the most important indicator by which the concentration of salts in irrigation water and drainage solution is determined

ECONOMIC EFFICIENCY - is a value determined by the ratio of the profitability of production to the total costs and resources used

LIST OF ABBREVIATIONS AND DESIGNATIONS

The following designations and abbreviations are used in this report:

Ff:A-E - brown spotting of tomato leaves (cladosporiosis)

Va:0/Vd:0 - verticilli wilt

F1 - hybrid

pH - acidity

ppm - mg/ml

ToMV:0-2 - tomato mosaic

TSWV - spotted tomato wilt

Sbl/Sl/ Ss - gray leaf spot

For - fusarium rot of the root neck and roots

Fol:0,1 - fusarium wilt

EC - electrical conductivity

Ma/Mi/Mj - southern gall nematode

**INTRODUCTION**

Vegetables occupy an important place in the structure of human nutrition. Their regular use has a positive effect on health, performance and life expectancy.

Tomato is one of the most common vegetable crops in the world. In the total volume of vegetable production, tomatoes occupy the first place among vegetable crops, and in protected soil this crop occupies the second place in terms of area, after cucumber [1].

As the experience of developed countries shows, a tangible change in the economic efficiency of tomato production in protected soil can only give a significant increase in plant yield while reducing costs per unit of output. This requires the introduction of the latest scientific and technical developments, modernization of greenhouse structures, improvement of technological processes of production, as well as the use of high-yielding, resistant to major diseases varieties adapted to new technologies [2-7].

Small-volume hydroponics technology is a modern plant growing system that uses either an inert organic or inorganic substrate by feeding with nutrient solutions. Perhaps this is the most intensive cultivation system that effectively uses all resources to maximize crop yields, and the most intensive form of agricultural enterprises for the commercial production of greenhouse vegetables [3,4,6,8,9].

Recently, this technology has become increasingly widespread in the global greenhouse production, and these technologies are also being adopted by producers of greenhouse products in the UIS countries.

The main reason for such a wide spread of this technology was the high economic efficiency obtained both due to increased productivity and due to significant resource savings.

When using low-volume technology, the consumption of water and fertilizers is optimized, since each plant is supplied with a precisely verified amount of nutrient solution, the fight against plant diseases and pests is also facilitated, plant care is simplified, nutrition is optimized, and some labor-intensive processes can be automated. This allows you to reduce labor costs, improve the quality of fruits and get a higher yield compared to the soil method [10-15].

One of the main advantages of low-volume hydroponics technology is the possibility of automating the drip irrigation regime, which gives an undoubted effect in increasing productivity and improving working conditions. The automated drip irrigation system is designed to independently supply a nutrient solution of a given concentration at a given time and in the required amount directly to the root zone of each plant, thanks to which it is possible not only to significantly reduce the consumption of water and water fertilizers, but also to achieve really impressive results in increasing yields. With strict compliance with sanitation measures, this technology allows you to abandon the use of chemical means of protection against pests and diseases and thus improve the quality and biological purity of vegetable products [12,16-19].

The technology of small-volume hydroponics allows for more opportunities for irrigation and maturation management. In artificial substrates, plants are continuously supplied with a sufficient amount of all the nutrients they need in an easily accessible form from the very first days, which allows them to significantly activate physiological processes, root plant growth (up to 20-50%) and the beginning of fruiting, get larger and aligned fruits, which ensures a high level of standard production. At the same time, ecological purity, high taste qualities and excellent presentation of products are achieved. This technology allows you to grow vegetables of the "Premium" class (the highest category of quality and environmental friendliness) [14,20-26].

The introduction of drip irrigation into the irrigation system, a small-volume technology allows saving water and is an ideal way to grow vegetable crops in regions with arid climate, low-fertile soils and a shortage of water for irrigation [12,27].

Successful cultivation of plants in a low-volume way largely depends on the selection of the substrate and its constituent components. When choosing a substrate, attention is paid not only to its quality, but also to its economic efficiency, price, availability, and the period of its use in low-volume hydroponics. In addition, the characteristics of the substrates themselves should be taken into account, since the physical, chemical and biological characteristics of the substrates should be correlated with water and fertilizers, the needs of plants and climatic conditions. The knowledge and personal preferences of specialists also play a certain role [28-37].

The most used substrates for small-volume cultivation are peat moss [38-42], mineral wool [43-45] and coconut [46-51].

However, recently, the use of processing waste for low-volume cultivation of vegetables, such as sawdust and rice hulls, has become increasingly interesting, especially in those regions where there are no natural organic substrates [52-61].

The scientific novelty of the project is to create a prototype of an innovative small-volume technology for growing tomatoes on substrates made of sawdust and rice hulls, adapted to climatic factors and production conditions, with the aim of further implementation in the farms of the region.

The aim of the project - is to create a production sample of an innovative small-volume technology for growing tomatoes, adapted to the natural and climatic conditions of the region, providing an increase in the economic and environmental efficiency of greenhouse production.

To achieve this goal, the following tasks were set:

1. Analytical review of scientific achievements in the field of greenhouse technology to justify the effectiveness of the progressive technology that ensures high stable yield of environmentally safe products of high quality in conditions of protected ground in the PreAral Sea area.

2. Development of a flow process chat for growing tomato in an extended crop based on the results of previously performed research work in the light of the production characteristics for carrying out pilot production tests and efficient implementation of the technology (compiling a crop combination and determining the timing of seeding and planting seedlings; selection of the most productive hybrids of cucumbers and tomatoes adapted to the natural and climatic conditions of the protected ground of the PreAral Sea area; choice of substrate composition; compiling of irrigation and plant nutrition programs; development of a highly efficient environmentally friendly plant protection system.

3. Conducting pilot production tests for small-volume cultivation of tomatoes in an extended crop to improve the technology taking into account the factors operating in the production conditions.

4. Development and installation of an automated drip irrigation system in order to create an optimal regime of irrigation and plant nutrition for the formation of highly productive plants and the efficient use of water and fertilizers.

5. Assessment of product quality in order to determine its environmental efficiency.

6. Calculation of costs for technology in order to determine its economic efficiency.

7. Coverage of the project results and protection of intellectual property through the publication of scientific articles, including 1 (one) in a peer-reviewed scientific publication included in Q1, Q2, Q4, based on Web of Science and (or) having CiteScore percentages in the Scopus of at least 35 (thirty-five).

During the research period, the following interim reports were prepared:

1. Improving the production efficiency of greenhouse production in the Aral Sea region by the application of adapted innovative technology for small-volume tomato cultivation. Inv. No. 0220RK01828.

**THE MAIN PART OF THE RESEARCH REPORT**

**1 Conditions, material and methodology of research**

**1.1 Place and conditions of experimental research**

Experimental research on the project was carried out on the basis of a greenhouse farm of the Korkyt Ata Kyzylorda University in a greenhouse with an area of 270 m2, commissioned in 2004 as part of the Kazakhstan-Kyrgyzstan-Canada international project "Program for promoting vocational education in agriculture, technology transfer, applied research programs in industry and the relationship with trade and industry" and is a modern protected ground structure.

A special feature of the this greenhouse is a 2-layer plastic coating, between which air is pumped with the help of a compressor. The temperature regime in the greenhouse is maintained with the help of a stationary boiler system running on gas fuel. The use of such a coating and a stationary boiler room allows you to maintain an optimal temperature regime in cold (up to-35-400C) and windy winters. In addition, the greenhouse is equipped with an active ventilation system and devices for monitoring microclimatic parameters.

The climate of the the PreAral Sea region is characterized as sharply continental with hot, dry, long summers and cold, short, snow-free winters. The continentality of the climate is manifested in large fluctuations of metereological elements, in their daily, monthly and annual course. The summer is hot and long. There are no sharp differences in temperatures during this period. The average temperature in July is 36-390C, the absolute maximum is 44-480C. In winter, the difference in temperatures between the north and south of the region is noticeable, so the average temperature of the coldest month is January 35-360C. The openness to the north allows cold air masses to freely enter the territory of the region and cause sharp cold spells, especially in winter. The absolute minimum air temperature reaches-420C.

Aridity is one of the distinctive features of the region's climate. There is very little precipitation. Their average annual amount does not exceed 100-190 mm and is distributed unevenly across the seasons of the year: 60% of all precipitation falls in the winter-spring period.

The entire territory of the region is characterized by frequent and strong winds, mainly from the north-east direction. Their average annual speed ranges from 3.1 to 6.0 m/s.

Strong winds in winter at low temperatures blow away a slight snow cover from the elevated parts of the terrain, which causes deep freezing of the soil. Dust storms are observed in the summer.

The PreAral Sea region belongs to the YII light zone, the light resources of which are characterized by a fairly high influx of integrated optical radiation in the autumn and winter months. The amount of headlights penetrating into greenhouses in December - January is 2370-3450 cal/cm. And this, according to scientists, allows you to grow vegetables in a protected ground in the VII-th light zone all year round [62,63].

In conditions of protected soil, tomatoes can be grown in 3 turns: winter-spring (from December to July), extended (from December to November), summer-autumn (from June to December), of which the most popular when using low - volume hydroponics is extended. However, growing tomatoes in regional conditions in the summer is very problematic due to very hot (air temperature above 450C) and dry (air humidity below 10%) weather and is possible only in conditions of artificial cooling used in Israeli greenhouses. In addition, during this period, fresh tomatoes in large quantities come from the open ground at a much lower price.

Therefore, for growing tomatoes in winter greenhouses of the Aral Sea region, in previous studies, an extended period was developed with the beginning of culture - the second half of July and the end-June-July, depending on the temperature regime during this period (Figure 1).

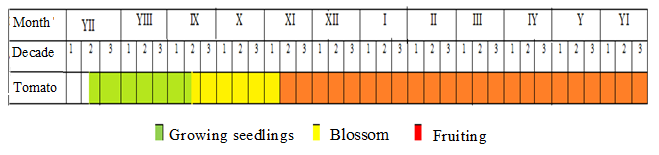


Figure 1- Prolonged turnover of tomato in winter greenhouses of the PreAral Sea region

In order to determine the optimal timing of sowing seeds, planting seedlings in the greenhouse, as well as to control and ensure the operation of technological equipment to maintain optimal microclimatic parameters in the greenhouse, monitoring of climatic conditions was carried out (table 1 )

Table 1 - Climatic indicators of the Kyzylorda region

| Month | July | August | September | October | November | December | January | February | March | April | May | June |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Daytime temperatures | | | | | | | | | | | | |
| Average temperature (°C) | 36,4 | 32,0 | 24,0 | 16,0 | 2.2 | -8,0 | -5,0 | 2,0 | 7,0 | 22,0 | 32,0 | 35,0 |
| Maximum temperature (°C) | 42,0 | 37,0 | 36,0 | 23,0 | 13 | -1,0 | 7,0 | 14,0 | 2,0 | 38,0 | 43,0 | 42,0 |
| Minimum temperature (°C) | 31,0 | 25,0 | 17,0 | 5,0 | -6,0 | -14,0 | -13,0 | -14,0 | -6,0 | 9,0 | 22,0 | 38,0 |
| Night temperatures | | | | | | | | | | | | |
| Average temperature (°C) | 23,0 | 20,0 | 12,0 | 5,0 | 2.2 | -14,0 | -11,0 | -5,0 | 0,0 | 10,0 | 18,0 | 21,0 |
| Maximum temperature (°C) | 28,0 | 25,0 | 21,0 | 11,0 | 13 | -5,0 | -1,0 | 3,0 | 14,0 | 19,0 | 26,0 | 27,0 |
| Minimum temperature (°C) | 20,0 | 16,0 | 6,0 | -3 | -6,0 | -21,0 | -20,0 | -18,0 | -12,0 | 1,0 | 9,0 | 15,0 |
| The number of cloudy, cloudy and clear days | | | | | | | | | | | | |
| Cloudy days |  | 0 | 0 | 0 | 3 | 1 | 4 | 2 | 1 | 0 | 0 | 0 |
| Cloud services |  | 9 | 10 | 6 | 11 | 8 | 6 | 17 | 15 | 12 | 10 | 7 |
| Clear |  | 22 | 20 | 12 | 16 | 22 | 21 | 9 | 15 | 18 | 21 | 23 |

Due to the fact that the air temperature in the second half of July 2020 was very hot 31-42°C – during the day and 20-28°C - at night, seed sowing was carried out not on July 15, as it was earlier, but on August 1 – a period that, according to the results of previous studies, also showed good results when cultivating tomatoes under extended culture conditions.

The length of daylight and clear sunny weather during the growing of seedlings allowed growing seedlings without the use of additional illumination.

Seedlings were planted in the greenhouse on September 15, when the outdoor air temperature was 18-22°C, which allowed maintaining an optimal temperature regime in the greenhouse during this period.

Starting from September 20, the air temperature at night dropped to 8-11 and to maintain the optimal temperature at night (18°C), heating was connected in the greenhouse, from October 20, heating was also used during the daytime in cloudy weather. The winter period was characterized by clear and sunny weather, which made it possible not to use heating to maintain the necessary temperature regime during the daytime. The heating season ended in mid-April. Starting from the middle of May, there was a sharp increase in outdoor air temperature, so shading nets were used in the greenhouse. The tomato culture was completed in June.

**2.2 Objects and methods of research**

The research included the consistent conduct of laboratory, semi-production and production experiments using generally accepted methodological recommendations for conducting experiments with vegetable crops in greenhouses [64-68].

One of the main factors determining the system of cultivation and production efficiency is the choice of a variety (hybrid), the productivity of which is closely related to its genetic characteristics. The genotype should provide a sufficient degree of reliability and protection from the adverse effects of biotic and abiotic environmental factors, which together determine the desired level of productivity [69,70].

Since currently all the production of vegetable crops in the grenhouses of Kazakhstan is based on the cultivation of hybrids of foreign selection, an indeterminate early hybrid Lilos F1 (Riik Zwaan, the Netherlands) was selected for research, which showed high and stable productivity results in previously conducted experimental studies (24.45-24.67 kg/m2) [71-73].

This hybrid is high-yielding, ideally binds fruits weighing 150-160 g and that do not grow smaller throughout the season, even in stressful conditions. The plant is open, perfectly balanced, which facilitates care, with a strong root system. Thanks to the good growth force, it ties many fruits of excellent quality on all brushes. The fruits are rounded, homogeneous, the surface is shiny without a green spot around the peduncle, bright red, dense, well stored and transported. Both the lower and upper hands are strong, with a short axis, they do not break. The hybrid has resistance to diseases: Tobacco mosaic virus (ToMv/F1-5), Fusarium wilt (Fol:0,1), Fusarium rot of tops and roots (For), Verticillately fading (Va), Gallic nematodes (Mi).

Sample to compare the efficacy of adapted technology of small-volume cultivation of tomato were the technology of growing the hybrid Lilos F1on the substrate of wood sawdust used previously.

In the adapted technology, a composite substrate made of wood sawdust and rice hulls with a ratio of components and 75:25 was used for growing the hybrid Lilos F1 under prolonged turnover conditions, when growing on which this hybrid showed the highest yield in previous tests (24.7 kg/m2) [74].

According to the results of previous studies, other technological elements were also changed: the period of sowing and planting [75], the density of plant placement in the greenhouse [76], the composition and concentration of the nutrient solution, the method of plant formation, and others. The technological parameters of the previously used and adapted technology of small-volume cultivation of tomatoes are shown in Table 2.

Table 2-Technological parameters of small-volume cultivation of tomatoes

|  |  |  |
| --- | --- | --- |
| Parameters | Technology used earlier | Adapted technology |
| Data of sowing seeds | July,15 | August,1 |
| Substrate | Wood sawdust | Wood sawdust and rice hulls with a ratio of 75:25 |
| Density of plant placement, pcs/m2 | 2,3 | 2,5 |
| The composition of the nutrient solution, ppm | Before fruiting: N - 107, P- 114, K - 114, Ca - 38, Mg - 20, Fe – 0,25, Cu - 0,018, Mo - 0,004, Mn - 0,15, Zn - 0,012, B - 0,034;  During the fruiting period: N - 200, P- 55, K - 300, Ca - 200, Mg - 55, Fe - 3,0, Cu - 0,5, Mo - 0,12, Mn - 0,125, Zn - 0,2, B - 0,9 | |
| Nutrient solution concentration (EC) | 1,7-3,0 | 0,7-2,7 |
| pH of the nutrient solution | 5,5-6,0 | |
| Method formation of plant | In one stem with stacking on racks | |

For experimental studies, a technological map for growing Lilos F1 tomatoes in small-volume hydroponic modules on substrates of wood sawdust and rice hull under prolonger turnover conditions was developed, including the entire complex of technological operations with a description of their features and conditions of execution (Appendix С).

All the agricultural equipment of the experiment was carried out in accordance with this technological map.

According to the technological requirements, tomato seedlings were grown with a pick: on August 1, the seeds were sown in cassettes with a peat substrate, and 14 days after the emergence of seedlings, the plants were dived into pots ∅ 10 cm (Figure 2). For growing seedlings, we used the peat substrate Agrobalt-N, normalized by pH 5.5 acidity and containing the necessary amount of macro- and microelements.

|  |  |
| --- | --- |
| подросшая рассада томатов в пластиковой кассете | SAM_0834 |

Figure 2-Growing tomato seedlings

During the period of growing seedlings, the necessary regime of microclimate was maintained in accordance with the stages of plant development (Table 3).

Table 3 - Parameters of the microclimate of tomato cultivation in the seedling period

|  |  |  |
| --- | --- | --- |
| Period | Temperature,0С | Humidity % |
| After sowing | 25 | 90 |
| 1-3 days after germination | 22-23 | 70-75 |
| Before the dive of seedlings | 65-70 |
| During the dive of seedlings | 20 | 70-75 |
| After the dive of seedlings | 19-20 | 65-70 |
| 3 days before planting | 17 | 65-70 |

Seedlings were grown without additional illumination and, in order to create optimal lighting conditions, the density of standing plants was constantly changed: аfter the dive of seedlings - 28 plants per 1 m2; on the 5th week - 20; on the 6th - 15; - on the 7th - 14; on the 8th - 12. Solutions of complex fertilizers N-P-K: 10-52-10 and 14-11-25, calcium nitrate and sodium humate (EC 1.5-5.0) were used for fertilizing seedlings. Preventive treatment of seedlings with 1% solution of Gaucho (immidoclapirid) against pests and 0.1% solution of Pseudobacterin against the disease - root rot was also carried out.

Before planting the seedlings, the disinfected of greenhouse was carried out and a drip irrigation system was placed. The prepared substrate was placed in plastic bags with a volume of 30 liters, which were placed on racks in the greenhouse. Landing holes were cut out in the bags, into which droppers were installed. Hooks with a rope for tying up plants were placed on the trellis (Figure 3).

|  |  |  |
| --- | --- | --- |
| D:\ФОТО\Астана 2011Алмата 2012\SAM_0829.JPG | D:\ФОТО\выставки\SAM_1369.JPG | D:\ФОТО\выставки\SAM_1366.JPG |

Figure 3 - Placement of the substrate, drip irrigation system and twine for tying plants

in the greenhouse

The seedlings were placed in the greenhouse on September 15, while the pots with the substrate were not connected yet, but were placed on bags next to the holes and connected to the drip irrigation system and tied to a vertical twine.

The seedlings were placed in the greenhouse on September 15, while the pots with the substrate were not yet connected, but were placed on bags next to the planting holes and connected to the drip irrigation system, and tied to a vertical twine.

Before planting the seedlings, the bags with the substrate were moistened with a drip irrigation system with a nutrient solution (ЕC-3,0-3,5) until full saturation. Then, 2 drainage holes were made on the side of the bag facing the track. In the phase of the beginning of flowering of the 2nd brush, the plants were moved to the substrate. The temperature and humidity conditions in the greenhouse were maintained in accordance with the technological requirements for each phase of plant growth and development (Table 4). For this purpose, constant ventilation and humidification of the tracks were carried out, shading nets were used on hot days (Figure 4).

Table 4 - Conditions of temperature and humidity when growing tomatoes in a greenhouse

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Period of vegetation | Temperature,0С | | | | Humidity % |
| Day | | | Night |
| In sunny weather | | In cloudy weather |
| After placing the seedlings in the greenhouse for 3 days | 18-20 | | | 16-18 | 60-65 |
| Before fruiting period | 20-22 | 19-20 | | 15-17 |
| During the fruiting period | 24-26 | 20-22 | | 17-18 | 65-70 |



Figure 4 - Application of shading nets and humidification of paths to maintain optimal conditions of temperature and humidity

For plant nutrition, a nutrient solution was used, fully balanced in terms of nutrition elements and differentiated in accordance with the stage of plant development (Table 5).

Table 5 - Composition of the nutrient mixture for growing tomatoes on a substrate, ppm

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Period of vegetation | N | P | K | Ca | Mg | Fe | Cu | Mo | Mn | Zn | B |
| Before fruiting period | 107 | 114 | 114 | 38 | 20 | 0,25 | 0,018 | 0,004 | 0,15 | 0,012 | 0,034 |
| During the fruiting period | 200 | 55 | 300 | 200 | 55 | 3,00 | 0,50 | 0,12 | 0,12 | 0,20 | 0,90 |

For this purpose, a concentrated fertilizer solution was prepared in two plastic containers with a volume of 100 liters for subsequent dilution using an injector. For plant nutrition in the initial period (before fruiting), the following solution was prepared: in the first container (A), 5 kg of Kemir combi complex fertilizer with an NPK content of 10:52:10 and 2 kg of magnesium sulfate was diluted, in the second container (B) – 2 kg of calcium nitrate. From the beginning of the fruiting period, the composition of the concentrate was replaced and the following solution was prepared: capacity A – 7.5 kg of Kemir combi complex fertilizer with an NPK content of 20:20:20 and 4 kg of magnesium sulfate, capacity B-5 kg of calcium nitrate and 5 kg of potassium nitrate.

The concentration of the nutrient solution was determined by electrical conductivity depending on the phase of plant development from 1.7 to 2.7; pH-5.5-6.0.

Watering and fertilizing of plants was carried out by drip method every hour from 7.00 to 17.00 so that a certain percentage of the nutrient solution was withdrawn from the substrate through drainage with each watering (Table 6).

Table 6 - Drainage volume in each irrigation time period

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Time | 7.00 | 9.00 | 10.00 | 11.00 | 12.00 | 13.00 | 15.00 | 17.00 |
| Amount of drainage, % | 0 | 3 | 6 | 12 | 30 | 25 | 25 | 10 |

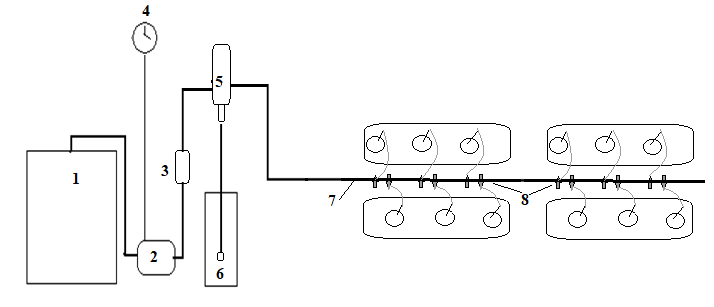
At the beginning of each week, the nutrient regime of plants was monitored by measuring the volume and concentration of nutrient solution and drainage (according to the EU) at each watering period. Daily monitoring was carried out by measuring the volumes and EC of drainage and nutrient solution for the entire day. Based on the measurements, adjustments were made: on the injector-to change the concentration of the nutrient solution and on the timer – to increase or decrease the volume of irrigation.

The formation of tomato plants was carried out in one stem with the removal of all the lateral branches ("stepsons"), as they arise. Immediately after the seedlings were placed in the greenhouse, the plants were tied to a trellis located at a height of 2 m with a hook and synthetic twine, and as the plants grew, the stem was attached to the guide thread with clips. To improve air circulation in the surface area and prevent the development of infection, the lower leaves were gradually removed (Figure 5).



Figure 5 - Formation of tomato plants and pruning of leaves.

For irrigation and fertigation of tomato plants, a scheme of an automated irrigation system was developed (Figure 6), the selection and installation of equipment was carried out, and the costs of the proposed system were calculated (Appendix D).



1-water tank, 2-pump, 3-filter, 4-timer, 5- fertilizer injector,

6-fertilizer container, 7-drip lines, 8-droppers

Figure 6 - Diagram of an automated drip irrigation system for farms

During the experiment, phenological and biometric observations, registration of the main parameters of the microclimate, monitoring of irrigation and plant nutrition regimes, accounting for yield and product quality were carried out.

The phenological observations necessary to assess the influence of agrotechnical techniques and environmental factors on the growth, development and productivity of plants were carried out in accordance with the generally accepted method of physiological observations, according to which the dates of sowing, emergence of seedlings, planting dates of seedlings, the beginning of flowering and fruiting were noted. The beginning of each phase was noted when it was observed in 10% of plants, and the mass beginning when this phase was observed in 75% of plants.

Biometric measurements were carried out in accordance with the phases of development on 10 stationary plants in each of the 6 rows: the height of the bookmark of the first brush, the number of fruits in the brush, the weight of the fruits were determined. In addition, biometric observations carried out throughout the growing season, including regular counting of the number of leaves and brushes on the plant, are necessary for the formation of plants in order to ensure their balanced development, adhering to the ratios: in the autumn-winter period of leaves -15 and brushes - 5-6, in spring-summer 18 and 6-7, respectively.

The plant nutrition regime was monitored by measuring the volume and concentration of nutrient solution and drainage (in accordance with the EU) at the beginning of each week during each watering period and daily by measuring the volume and concentration of drainage and nutrient solution throughout the day. Based on the measurements, adjustments were made: on the injector - to change the concentration of the nutrient solution and on the timer – to increase or decrease the volume of irrigation (Figure 6).

|  |  |
| --- | --- |
| https://i.mycdn.me/i?r=AyH4iRPQ2q0otWIFepML2LxRWQv426E7BQXf4Ztz0417EQ | https://i.mycdn.me/i?r=AyH4iRPQ2q0otWIFepML2LxRqoK7c_41DA68ZRQAQgNS1w |

Figure 6-Adjusting the operation of the injector and the watering timer

Harvesting was carried out 2-3 times a week, when the tomatoes reached a brown and pink degree of maturity. The quality of the grown products was evaluated according to the following indicators: organoleptic assessment (GOST 1725-85) [77], dry matter content (GOST ISO 2173-2013) [78], total sugar content (GOST 8756.13-87) [79], titrated acidity (GOST ISO 750-2013) [80], ascorbic acid concentration (GOST 24556-89) [81] and nitrate ion content (GOST 29270-95) [82].

**2 Research results**

**2.1 The influence of the adapted technology of low-volume cultivation on the growth and development of tomatoes**

Obtaining a high yield of tomatoes in protected soil conditions depends on the ecological and technological adaptability of the hybrid being grown, which is determined by its biological characteristics: precocity, plant growth strength, fruit size and quality, overall productivity [83-87].

The results of phenological observations showed that when sowing Lilos F1 tomato seeds on August 1, the first shoots appeared on August 5, the flowering of the plants came on September 16, and maturation - on November 10.

Due to the fact that the temperature conditions of the region in the period from mid-July to mid-August are extremely high and cultivation without artificial cooling becomes impossible, in the adapted technology, the term for sowing seeds and planting seedlings in the greenhouse was shifted 2 weeks later: from July 15 to August 1 and from September 1 to September 15, respectively, which allowed avoiding the severe stress of high temperatures.

As a result of phenological observations, it was found that the use of the technology of growing the tomato hybrid Lilos F1 adapted to the natural and climatic conditions of the region contributed to the intensification of the processes of plant growth and development. Flowering of plants occurred 41 days after germination (September 6), fruiting 56 days after flowering (November 10), which is 4 and 6 days earlier, respectively, than in previous studies. The duration of the period from germination to fruiting was 97 days and was 10 days shorter than in previous tests. As a result, at a later date of the beginning of tomato cultivation (by 15 days) and the simultaneous completion of the culture, the duration of the fruiting period of the tomato hybrid Lilos F1 was reduced by only 5 days (Figure 8).

Biometric observations revealed that the intensification of the growth and development processes of Lilos F1 tomato plants contributed to an earlier laying of the 1st brush-after the 8th leaf, compared to previous tests, in which the formation of the first brush began, as a rule, after the 9th leaf, as well as the formation of more fruits on the first 3 inflorescences (9.6) compared to 8 in previous studies.

.

A - adapted technology, B-previously used technology

Figure 8-Growth and development of Lilos F1 tomato plants under low-volume

cultivation under extended culture conditions

The analysis of the dynamics of crop intake presented in Figure 9 shows that the general trend of crop formation during the growing season remained: the smallest harvest was obtained in February and March, since its formation occurred during the period with the shortest duration of daylight and the lowest intensity of solar radiation (December, January), the largest - from April to June, when light ceased to be a limiting factor.

months

kg/m2

Figure 9 - Dynamics of the tomato harvest of the hybrid Lilos F1

in extended culture

Since the start date of tomato cultivation was shifted 2 weeks later in the adapted technology, the harvest of tomatoes of the Lilos F1 hybrid began not in October, as usual, but in the first decade of November. However, later terms of sowing and planting allowed to avoid temperature stress, which strongly inhibits the growth and development of the plant and to obtain a higher yield of early products-by 0.33 kg/m2 (from 2.12 kg/m2 to 2.45 kg/m2).

The results of the conducted studies confirm that the weight and quantity of fruits are quantitative components that determine the yield and depend on both genetic factors and environmental facts [20-24].

The performance indicators of the adapted technology of low-volume cultivation of the Lilos F1 tomato hybrid in an extended culture are shown in Table 7.

Table7 - Performance indicators of the adapted technology of low-volume cultivation of the tomato hybrid Lilos F1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Bookmark  1st brush | Number of fruits  on the first 3 brushes | Yield, kg/m2 | | | Number of fruits  from 1 plant | Weight  1 fetus, g |
| Early | General | Standard |
| Previously used technology (control) | after  the 9th sheet | 8,0 | 2,12 | 24,45 | 96,8 | 103 | 103,2 |
| Adapted technology | after  the 8th sheet | 9,6 | 2,45 | 28,16 | 99,2 | 96 | 117,3 |
| in % to control | - | 120,0 | 115,6 | 115,20 | 102,5 | 93,2 | 113,7 |

Since, when using the adapted technology, the fruiting period of the Lilos F1 tomato hybrid was shorter by 5 days, a smaller number of fruits formed on the plants - an average of 96, which is 7 fruits less than in previous tests. However, the formed fruits were larger, and the average weight of 1 fruit was 14.1 g higher and amounted to 117.3 g. The formation of larger fruits increased the yield of standard products from 96.8% to 99.2 % (table).

The total yield of the Lilos F1 tomato hybrid when using the adapted technology was 28.16 kg/m2, which is 3.71 kg/m2 more than in previous tests (24.45 kg/m2).

Thus, the use of technology adapted to regional conditions and varietal characteristics of the Lilos F1 hybrid allowed 78.2% to realize the productivity potential of this hybrid, which is 9.4% more than in previous studies (68.8%).

**2.2 Assessment of the quality and environmental safety of tomato fruits**

Modern industrial production of vegetables in a greenhouse puts forward exceptional requirements for the quality of cultivated varieties and hybrids. Along with the main criterion for the production of tomatoes in a greenhouse - the harvest, such factors as appearance, taste, as well as environmental safety are of great importance.

In the Republic of Kazakhstan, the quality of protected ground tomato fruits is controlled by GOST 1725-85-Fresh tomatoes. Technical conditions, according to which the following parameters will be evaluated: appearance, smell and taste, the presence of various damages and the size of the fruit.

Organoleptic analysis of the quality of the harvest of Lilos F1 tomato fruits, collected in November, showed full compliance with the requirements of GOST.

In appearance, all the fruits were fresh, whole, clean, healthy, dense, red, pink and brown degrees of maturity, without any damage and pubescent formations, with a peduncle, had a pleasant smell and taste characteristic of this hybrid. The degree of maturity of the fruits: red, pink and blank.

The size of the fruits according to the smallest transverse diameter was from 4.9 to 7.6 cm, which exceeds the permissible requirements of the standard for round-shaped fruits (at least 4.0 cm). The content of fruits with a diameter of less than 4.0 cm was 0.8% (according to the standard of the GOST is not more than 5.0) and the yield of standard products was 99.2 %.

The hardness of the fruit is a very important indicator for the sale of products, so with such hardness indicators, the fruits can be harvested at later stages of maturity and have a better taste at the same time. The hardness of the grown fruits of tomato fruits, evaluated on a scale from 1 to 10, was very good and amounted to 8.9-9.3.

Important criteria for high-quality tomatoes are taste and aroma. The aroma and nutritional value of tomato fruits is determined by the content of dry matter, vitamin C and acidity in them. A higher content of sugar and organic acid improves the quality of tomatoes, and the typical flavor of the fruit depends on the ratio between sugar and acid [88.89].

The results of the biochemical analysis of tomato fruits, shown in Table 8, show that the application of the adapted technology managed to preserve the high bite qualities of the fruits of this hybrid, and even improve them in some periods of the season.

High biochemical indicators of fruit quality were determined mainly by the concentration of the nutrient solution, which constantly increased during the growing season. This is confirmed by the opinion of researchers who claim that the content of dry matter, soluble solids, volatile compounds, minerals, carotene and vitamin C in fresh fruits increases with increasing salinity [ 89-91].

Table 8-Biochemical composition of the fruits of the hybrid Lilos F1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Month | Dry matter,  % | Total sugar, % | Ascorbic acid,  mg/100 g | Titrated acid,  % | (NO3-),  mg/kg |
| Adapted technology | | | | | |
| XI | 6,05 | 2,87 | 15,38 | 0,54 | 95,3 |
| XII | 5,98 | 2,73 | 15,22 | 0,54 | 98,1 |
| I | 5,95 | 2,70 | 15,21 | 0,55 | 98,7 |
| II | 5,89 | 2,67 | 15,06 | 0,57 | 103,4 |
| III | 5,97 | 2,79 | 15,22 | 0,54 | 94,0 |
| IY | 6,07 | 2,91 | 15,39 | 0,53 | 89,2 |
| Y | 6,19 | 2,96 | 15,47 | 0,53 | 84,6 |
| YI | 6,21 | 2,97 | 15,46 | 0,53 | 84,7 |
| Previously used technology (control) | | | | | |
|  | 6,02 | 2,91 | 15,38 | 0,59 | 84,6 |

The main indicators of environmental safety of products are the content of nitrate ions and pesticides.

When assessing the levels of nitrate content in vegetable products, they are guided by the standards approved by the Ministry of Health of the Republic of Kazakhstan, according to which the maximum permissible concentration of nitrate in tomatoes of protected soil is 300 mg/kg.

The results of laboratory tests showed that the content of nitrate ions in the grown products ranged from 85.1 to 103.4 mg/kg.

The results of the analysis to determine the content of nitrate ions allowed not only to control the ecological purity of the grown products, but also served as the basis for the operational adjustment of the nutritional regime. This made it possible to ensure the level of nitrate content in fruits significantly below the maximum permissible concentration during the entire growing season.

The analysis for the residual amount of pesticides was not carried out, since chemical protection agents were not used during the growing season of plants.

**2.3 Economic efficiency of the application of the adapted technology of low-volume tomato cultivation**

The priority direction that determines the efficiency of the production of vegetables of closed soil in modern conditions is an active energy and resource-saving policy of enterprises based on the use of intensive technologies.

Growing vegetables in protected soil has specific features due to the fact that it is necessary to create a favorable temperature regime and other microclimatic conditions for growing plants during the off-season. This requires relatively high costs per unit area, but at the same time significantly increases the output of products per unit area.

The economic efficiency of the technology application was evaluated by the following indicators: cultivation costs (cost price), revenue from the sale of finished products in accordance with seasonal sales prices, profit and profitability of production.

The costs (in current year prices) for growing tomatoes by the method of low-volume hydroponics in an extended turnover using the improved technology amounted to 12048.71 tg/m2 and were 186.89 tg/m2 more than in previous studies (Table 9).

The cost analysis showed that the increase in costs was mainly due to an increase in the density of standing plants in the adapted technology, which required more consumption of water, fertilizers, seeds, individual elements of the drip irrigation system and consumables.

With the terms of sowing and planting tomatoes of the adapted technology, the duration of the period of cultivation of plants in the greenhouse was reduced by 2 weeks and this allowed to reduce the cost of electricity used for active ventilation and pumping equipment of the drip irrigation system by 74.10 tg/m2.

Table 9 - Structure of costs for growing tomatoes in a greenhouse (at 1 m2)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Cost items | Previously used technology | | Adapted technology | |
| tenge | % | tenge | % |
| Depreciation charges | 1868,77 | 15,75 | 1868,77 | 15,51 |
| Salary with deductions | 1027,78 | 8,66 | 1027,78 | 8,53 |
| Heating (gas) | 2927,59 | 24,68 | 2927,59 | 24,30 |
| Electric power | 2297,69 | 19,37 | 2223,59 | 18,46 |
| Water | 146,92 | 1,24 | 156,67 | 1,30 |
| Fertilizers | 1316,16 | 11,10 | 1403,54 | 11,65 |
| Seeds | 78,94 | 0,67 | 85,80 | 0,71 |
| Drip irrigation system | 1961,51 | 16,54 | 2104,65 | 17,47 |
| Consumables | 159,45 | 1,34 | 173,31 | 1,44 |
| Temperature and humidity recording devices | 77,01 | 0,65 | 77,01 | 0,64 |
| Total | 11861,82 | 100,00 | 12048,71 | 100,00 |

When growing tomatoes in an extended culture, the vegetation period of plants is significantly extended. Therefore, when analyzing the efficiency of greenhouse production, it is necessary to take into account that the speed of the production process will be different in different periods of the growing season.

Due to the fact that the collection and sale of greenhouse tomatoes are stretched over time, and the selling prices during the fruiting period vary significantly, to assess the economic efficiency of the technology of growing tomatoes in an extended turnover, the revenue from the sale of finished products was calculated based on the results of productivity in dynamics and in accordance with seasonal selling prices (table 10, Figure 10).

Economic calculations have shown that the determining indicator of the efficiency of tomato production technology in a greenhouse is not only high yield, but also such factors, but also the dynamics of product receipt and the best productivity indicators during the period when the selling price is the highest.

Table 10 - Revenue from the sale of tomatoes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Месяцы | Цена, тг | Previously used technology | | Adapted technology | |
| Yield,  kg/m2 | Amount of sales, tenge | Yield,  kg/m2 | Amount of sales, tenge |
| X | 350,00 | 0,36 | 126,00 |  |  |
| XI | 470,00 | 1,76 | 872,00 | 2,45 | 1151,50 |
| XII | 680,00 | 3,56 | 2420,80 | 2,81 | 1910,80 |
| I | 820,00 | 2,53 | 2074,60 | 3,78 | 3099,60 |
| II | 800,00 | 1,61 | 1288,00 | 1,82 | 1456,00 |
| III | 780,00 | 1,49 | 1162,20 | 1,63 | 1271,40 |
| IY | 710,00 | 3,94 | 2797,40 | 5,73 | 4068,30 |
| Y | 620,00 | 4,75 | 2945,00 | 5,23 | 3242,60 |
| YI | 510,00 | 4,45 | 2269,50 | 4,71 | 2402,10 |
| Итого |  | 24,45 | 15910,70 | 28,16 | 18602,30 |

In previous studies, products began to arrive at the end of October during the period with the lowest selling price, since products from the open ground still continued to arrive on the market.

1. 2-

1 –previously used technology, 2-adapted technologies

Figure 10 - Dynamics of crop receipts (A) and the amount of product sales (B)

During the entire generative period, with the exception of December, the output of products and the amount of its sales were higher when using the adapted technology. This was due to the timing of the start of cultivation, as a result of which the maximum yield in the autumn-winter period in the previously used technology fell in December, and when using the adapted technology - in January.

Calculations of economic efficiency indicators show that the use of an adapted low-volume technology for growing tomatoes in conditions of extended culture requires additional costs, but at the same time they provide an increase in crop productivity and production profit. As the calculations show, an increase in costs by 1.6% allowed for a 20.7% increase in tomato productivity and a 61.9% higher profit (Table 11).

Table 11 - Indicators of economic efficiency of low-volume tomato growing technology

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Technology | Total cost price,  tg /m2 | Total sales of  products,  tg /m2 | Profit,  tg/ m2 | Profitability,  % |
| Previously used technology (control) | 11861,82 | 15910,70 | 4048,80 | 34,1 |
| Adapted technology | 12048,71 | 18602,30 | 6553,59 | 54,4 |
| in % to control | 186,89 | 2691,60 | 2504,79 | 20,3 |
| Previously used technology (control) | 1,6 | - | 61,9 | - |

The use of a hybrid adapted to regional characteristics and varietal characteristics of the grown hybrid has significantly increased the profitability of production to 54.4%, which is 20.3% higher than the efficiency of the previously used technology.

**CONCLUSION**

To conduct tests on the application of innovative technology of low-volume tomato cultivation in order to increase the efficiency of greenhouse production, the following were developed:

- technological map of growing crops in conditions of extended turnover, reflecting the technological aspects optimal for regional climatic conditions,

- scheme of automated drip irrigation system optimized for the production conditions of small farms.

Production tests were carried out on the application of this technology for growing the Lilos F1 tomato hybrid, as a result of which it was established:

- the applied technology contributed to the intensification of plant growth and development processes, which allowed to increase the yield of early products by 0.33 kg/m2, which amounted to 2.45 kg/m2 and by 3.71 kg/m2 to increase the total yield, which amounted to 28.16 kg/m2.

Tests of quality indicators and environmental safety of products were carried out, the results of which showed full compliance with the requirements of compliance with the requirements of GOST. The high content of dry substances in the grown fruits - 5.89-621%, sugar- 2.67-2.97% and ascorbic acid 15.16-15.47 mg /100g determined their pleasant aroma and excellent taste, and the content of nitrate ions from 85.1 to 103.4 mg/kg at a maximum concentration of 300 mg/kg determined their environmental safety.

The use of a hybrid adapted taking into account regional characteristics and varietal characteristics of the grown hybrid has significantly increased the profitability of production to 54.4%, which is 20.3% higher in the previously used technology.

The applied technology allowed to increase the realization of the productivity potential of the Lilos F1 hybrid by 9.4% to 78.2%. For further successful application of small-volume tomato cultivation technology, it is necessary to test promising tomato hybrids that are able to fully realize their biological potential in the conditions of the region.

The developed technology is proposed for implementation in existing and newly created farm greenhouses of the PreAral Sea region.

LIST OF SOURCES USED

1 Dimitriev V. L., Kosarev E. V. Cultivation of tomatoes of the closed ground on low-volume hydroponics in comparison with traditional // Modern problems of science and education. - 2015. - № 2-1. - URL: http://www.science-education.ru /ru/article /view? id=20964 (accessed: 07.11.2020). [Russian ]

2 Zhulamanov A. Zh. A brief analysis of the greenhouse market of Kazakhstan / / "Kazakstannyn zhylyzhailar kauymdastygy". - 2008. - No. 11. - P. 1-2. [Russian ]

3 Koshman K. K. Analysis of the market of vegetables of the closed ground [Electronic resource] // Greenhouses.kz: website. - URL: http://greenhouses.kz/articles.php (date of reference: 07.11.2020). [Russian ]

4 Chazova I. Yu. Assessment of the effectiveness of intensive technologies of vegetable growing of closed soil: abstract. ... Candidate of Economic Sciences: 08.00.05/IGSA. - Izhevsk, 2009. - P. 3. [Russian ]

5 Artamonova L. P. Improving the economic efficiency of the production of vegetables of closed soil: abstract. ... Candidate of Economic Sciences: 08.05.00/IGSA. - Izhevsk, 1998. - P. 2-4. [Russian ]

6 Lutsenko E. V. Prospects for growing tomatoes in closed ground using low-volume hydroponics technology / / Scientific Journal of KubGAU.- 2005. - No. 10. - URL: https://cyberleninka.ru/article/n/perspektivy-vyraschivaniya-tomatov-na-zakrytom-grunte-po-tehnologii-maloobemnoy-gidroponiki (accessed: 07.11.2020). [Russian ]

7 Dyamurshayeva E. B., Toktamysov A.M., Kudiyarov R. I., Urazbayev N. Zh., Sauytbaeva G. Z., Dyamurshayeva G. E. Promising tomato hybrids for low-volume cultivation in winter greenhouses of the Aral Sea region // Modern problems of science and education. - 2015. - No. 2(Part 1).- URL: http://www.science-education.ru/122-21343 (accessed: 07.11.2020). [Russian ]

8 Dorais M., Papadopoulos A., Gosselin A. Greenhouse tomato fruit quality // Horticultural Reviews.- 2001.-Vol.26.- P.239-319. [English]

9 Jensen M. Food production in greenhouses. In: Plant Production in Closed Ecosystems // The International Symposium on Plant Production in Closed Ecosystems. Kluwer, Dordrecht (The Netherlands), 1997.-P.1-14. [English]

10 Bioponics [Electronic resource] National Scientific Portal of the Republic of Kazakhstan. Nauka.kz: website.- URL: <https://nauka.kz/page.php?page_id=16&lang> =1&news\_id=2832 (accessed: 07.11.2020). [Russian ]

11 Kim A. Hydroponics in Russia. A brief overview [Electronic resource] / / CJSC "United Technologies Ltd": website.- URL:http://www.u-t.ru/technology2.htm (accessed: 07.11.2020). [English]

12 Greenhouse economy advanced Israeli technologies [Electronic resource] / / ALECON. CO.: website. - URL: http://alecon.co.il/article/greenhouse-israeli-technology.htm (accessed: 07.11.2020). [Russian ]

13 Lutsenko N. E. Prospects for growing tomatoes in closed ground using low-volume hydroponics technology. - Krasnodar: KubGAU, 2002. - P. 2. [Russian ]

14 Benton Jones Jr. Growing Tomatoes Anytime in the Tomato Plant Culture In the Field, Greenhouse, and Home Garden [Hardcover], 1998.- URL: http://www. Greenhouse catalog.com/greenhouse-tomatoes (дата обращения: 15.10.2020). [English]

15 Bentley M. Industrial Hydroponics. Per. from English-M.: Kolos, 1965. - P. 6-7.

16 Low-volume cultivation of crops [Electronic resource] / / Promgidroponika.<url>: website. - URL: https://www. promgidroponica.ru/vsjo-o-gidroponike / maloobemn\_virash\_kultur (accessed: 07.11.2020). [Russian ]

17 Pfanenstil V. I. Adaptation of drip irrigation technology and equipment to the conditions of winter greenhouses in Western Siberia: diss ... candidate of Agricultural Sciences: 05.20.21/ASAU. - Barnaul, 2004. - P. 3. [Russian ]

18 Gullino M.L., Garibaldi A. Influence of soilless cultivation on soilborne diseases //Acta Horticulturae.- 1994.- Vol.361.- Р.341-353. [English]

19 Louvet J. The relationship between substrates and plant diseases// Acta Horticulturae.- 1982.- Vol.126.- Р.147-152. [English]

22 Kostylev E. A. Tomato cultivation by the method of low-volume hydroponic technology on mineral injection [Electronic resource] // Greenhouses.<url>: website. –URL:http://tovtry.info/post\_1205469736.html (date of application: 07.11.2020). [Russian ]

21 Barabash O. Yu., Kravchenko V. Modern vegetable growing of closed and open ground: a practical guide. - Kiev: PP "Ruta".- 2012. - 347 p. [Russian ]

22 Greenhouse vegetable growing on low-volume hydroponics. - M. Agropromizdat, 1988. - 136 p. [Russian ]

23 Reed D.W. Water media and nutrition for greenhouse crops / In: Reed DW (ed.) Growing media: Types and physical chemical properties.- Batavia, Ill.: Ball Publishing; 1996.- P. 93-122. [English]

24 Massantini F, Favilli R, Magnani G, Oggiano N. Soilless culture-biotechnology for high quality vegetables // Soilless Culture.- 1988.- Vol.4(2).- Р. 27-40. [English]

25 Gruda N. Do soilless culture systems have an influence on product quality of vegetables //Journal of Applied Botany and Food Quality.- 2009.- Vol.82.-Р.141 – 147. [English]

26 Riviere L.M., Caron J. Research on substrates: State of the art and need for the coming 10 years // Acta Horticulturae.- 2001.- Vol.548.- Р.29-41. [English]

27 Olle M., Nagouajio M., Simos A. Vegetable quality and productivity as influenced by growing medium: A Review.- Zemdirbyste Agriculture.- 2012.- Vol.99(4).-P. 399-408. [English]

28 Borisov V. A. Substrates for growing tomatoes in low-volume culture / / "Gavrishch".- 2004. - No. 5. - P. 31-33. [Russian ]

29 Kuropatina N. D. Substrates for greenhouse farms quality and efficiency / / "We are born".- 2011. - No. 1. - P. 37-39. [Russian ]

30 Safonov.V. Types of substrates for vegetables in protected soil/ / " International scientific journal "Innovative science".- 2015. - No. 7. - P. 38-41. [Russian ]

31 Greenhouse practicum / / Digest of the magazine World of greenhouses.- Moscow, 2019.-203 p. [Russian ]

32 Tolmacheva O. A. Substrates for low-volume technology of growing plants in greenhouses [Electronic resource] / / Primitive greenhouses and technologies: website. - URL: http://www.fito-system.ru/node/300 (accessed: 30.10.2020). [Russian ]

33 Physical properties of substrates [Electronic resource] / / Gudroponika. com: website.- URL: https://gidroponika.com/content/view/82/98/ (accessed: 30.09.2020). [Russian ]

34 Fedyunkin D. K. Growing vegetables on artificial soil / / "Potatoes and vegetables".- 1989. - No. 1. - P. 44. [Russian ]

35 Yagovkin V. V. Organic substrates for low-volume cultivation of tomatoes and cucumbers in the North-Eastern region of Russia: Autoref. dis. kend. S.-x. nauk. 06.01.06/ VNIIO RASKHN-Moscow, 2007. - P. 2-3. [Russian ]

# 36 Costa J.M. The role of substrates in propagation, Horticultural Production Chains Group// Wageningen University.- by Netherlands: FlowerTECH. – 2003. – Vol. 6. № 7.-P.22-27.

37 Kuropatina N. D. Substrates for greenhouse farms quality and efficiency / / "Gavrish".- 2011. - No. 1. - P. 37-39. [Russian ]

38 Kravtsova G. M. The use of peat as a substrate for a low-volume method of growing vegetables in a greenhouse / / "Gavrish".- 1998. - No. 2. - P. 5-9. [Russian ]

39 Loebl D. O., Savinova N. I., Guskova G. N. Tomato cultivation by a low-volume method on peat substrates //The technology of growing vegetables in protected ground structures. - Moscow, 1999. - P. 17-19. [Russian ]

40 Nollendorf V. F. Peat as a nutrient substrate for greenhouse crops. - Riga: Zinatne, 1983. - P. 9-15. [Russian ]

41 Stolyarenko S. B. Features of nutrient substrates based on top sphagnum peat [Electronic resource]// Greenhouses.ru: website. - URL: http://www.greenhouses.ru/substrates-torf (date of reference: 30.10.2020). [Russian ]

42 Kuznetsova L. M. 1987. The use of peat in protected soil. Peat in agriculture of the Non-Chernozem zone: Handbook / Comp. V. N. Efimov. - L.: Agropromizdat, 1987. - P. 109-112. [Russian ]

43 Gerasimovich L. S. et al. Low-volume technology of tomato cultivation on mineral substrates. - Minsk, 2004. - 43 p. [Russian ]

44 Osvetsimsky V. Mineral wool in greenhouse production / / Vegetable growing. - 2012. - No. 12. - URL: <http://www.ovoschevodstvo.com/journal/browse/201012/> (дата обращения: 30.09.2020). [Russian ]

45 Kurenin A. Growing e tomato on mineral wool [Electronic resource] // Gudroponika.su: website.- URL: <https://www.gidroponika.su/gidroponika-teorija.html/vyrashhivanie-tomatov/137-vyraschivanie-tomata-na-mineralnoj-vate.html> (accessed: 09.11.2020). [Russian ]

46 Devochkina N. L. Features of low-volume cultivation of vegetable plants on coconut substrates / / "Gavrish". -2008. - No. 3. - P. 27-29. [Russian ]

47 Coconut fiber [Electronic resource] // Gidroponika.com: website. - URL: http://www.gidroponika.com/content/view/656/98 /#axzz3Hji87jl3 (accessed: 30.10.2020). [Russian ]

48 Coconut substrate [Electronic resource] Hydroponics.rf: website.- URL: https://www.promgidroponica.ru/vsjo-o-gidroponike/kokosovyjsubstrat (accessed: 30.09.2020). [Russian ]

49 Belich I. Coconut substrate advantages and disadvantages of using / / URL: https://www.botanichka.ru/article/kokosovyiy-substrat-preimushhestva-i-nedostatki-ispolzovaniya/ (date of reference: 30.09.2020). [Russian ]

50 Bulekova N. M. Problems of growing cucumbers on a coconut substrate in the conditions of the Vysokovsky Agricultural Farm.- Kostroma, 2009. - pp. 32-33.51 Tips for Growing Tomatoes Using Coir [Electronic resource] // Coir.com.: website.- <URL:https://coir.com/growing-medium/tips-for-growing-tomatoes-using-coir/> [Russian ]

51 Tips for Growing Tomatoes Using Coir [Электронный ресурс] // Coir.com.: сайт.- <URL:https://coir.com/growing-medium/tips-for-growing-tomatoes-using-coir/> [English]

52 Belyaeva M. V. Ecological aspects of the use of zeolites, tuffs and industrial waste in vegetable growing of protected soil: abstract. ... Candidate of Agricultural Sciences: 03.00.16 / OGAU. - Orel, 2001. - P. 5-8.[Russian ]

53 Dyamurshchaeva E. B., Kudiyarov R. I. et al. Growing tomatoes on sawdust in a low-volume version / / International Scientific Research Journal.- 2015. - No. 4 (35) Part 1. - pp. 112-114. [Russian ]

54 Utility model. 031403 RK. A method of growing tomatoes on sawdust in a low-volume version/ Dyamurshayeva E. B. et al.; applicant and patent holder Kyzylorda State University named after Korkyt Ata. - publ. 15. 08. 2016, Bul. No. 9. [Russian ]

55 Kusainov G. K. Petrov E. P., The influence of organo-mineral substrates on tomato yield in conditions of low-volume hydroponics / / Izvestiya NAS RK.- 2014. - No. 2. - p. 27-33. [Russian ]

56 Dorais M., Menard C., Begin E. Risk of phytotoxicity of sawdust substrate for greenhouse vegetables // Acta Horticulturae.- 2007.- Vol.761.- Р.589-594. [English]

57 Gruda N., Schnitzler W.H. Suitability of wood fiber substrates for production of vegetable transplants. I. Physical properties of wood fiber substrates // Scientia Horticulturae.- 2004.- Vol.100a.- Р.309-322. [English]

58 Gruda N., Schnitzler W.H. Suitability of wood fiber substrates for production of vegetable transplants. II. The effect of wood fiber substrates and their volume weights on the growth of tomato transplants//Scientia Horticulturae.- 2004.- Vol.100b.- P.333-340. [English]

# 59 Dyamurshayeva E.B., Kudiyarov R.I., Urazbayev N.Zh.,Dyamurshayeva G.E.Efficiency of use of the rice peel and wood sawdust as the substratum for cultivation of tomatoes // Papers of the International Research Journal. – Екатеринбург, 2017.- Вып.02 (56) Ч.2. - P. 63-66. [Russian ]

60 Volkov E. Ya., Lutsenkova K. K. Rice husk-a substrate for growing tomatoes //Proceedings of the Institute of NTI and Propaganda of the State Planning Committee of the USSR. The series "Chemization of agricultural production".- Tashkent, 1971. - P. 6. [Russian ]

61 Utility model. 031402 RK. A method of growing tomatoes on rice husks in a low-volume version/ Dyamurshayeva E. B. et al.; applicant and patent holder Kyzylorda State University named after Korkyt Ata .- publ. 15. 08. 2016, Bul. No. 9. [Russian ]

62 Bryzgalov V. A. Features of growing cucumbers, tomatoes in winter block greenhouses in the conditions of the 7 light zone / Handbook of vegetable growing. - L.: Kolos, 1982. - P. 300-304. [Russian ]

63 Vashchenko S. F. et al. Recommendations for the cultivation of vegetables in winter greenhouses. - M., 1970. - 27 p. [Russian ]

64 Great V. F. experimental Methods in the vegetable and melon growing. - M.: Agropromizdat, 1992.-33p. [Russian ]

65 Great V. F. Methods of physiological research in the vegetables and melons. - Moscow: VASKHNIL, 1970. P. 24-131. [Russian ]

66 Nabatova T. A. Features of the experiment with vegetable crops in greenhouses.- M., 1975.- 17 p. [Russian ]

67 Litvinova S. S. Methodology of field experience in vegetable growing. - M.: RASKH, 2011. -636 p. [Russian ]

68 Dospekhov B. A. Methodology of field experience with the basics of statistical processing of research results. - M., 2011. - 250 p. [Russian ]

69 Bakulina V. A. Variety-the basis of technology / / Potatoes and vegetables. -1988. - No. 1. - P. 14-20. [Russian ]

70 Tarakanov G. I. Variety - the main link of technology // The world of greenhouses. – 1997. - №.6. - P. 8-10. [Russian ]

71 Dyamurshayeva E. B., Kudiyarov R. I., Sauytbaeva G. Z., Dyamurshayeva G. E., etc. Promising tomato hybrids for low-volume cultivation in winter greenhouses of the Aral Sea region // Modern problems of science and education. – 2015. – № 2.- URL: <http://www.science-education.ru/122-21343> [Russian ]

72 Dyamurshayeva E.B., Kudiyarov R.I., Dyamurshayeva G.E. et al. Efficiency of use of the rice peel and wood sawdust as the substratum for cultivation of tomatoes // Papers of the International Research Journal. – Ekaterinburg, 2017.- P.63-66 (AGRIS) <http://research-journal.org/wp-content/uploads/2017/02/02-2-56.pdf> [Russian ]

73 Dyamurshayeva E.B., Kudiyarov R.I., Bobrenko I.A., Sauytbayeva G.Z., Dyamurshayeva G.E. et al. Variety trial on tomato hybrids in greenhouse conditions of the Prearal Area of Kazakhstan// OnLine Journal of Biological Sciences. 2017.- Vol.17, Issue 2.- Р.26-34.-**DOI:** 10.3844/ojbsci.2017.26.34. -URL: [http://thescipub.com/PDF/ ofsp.11143.pdf](http://thescipub.com/PDF/%20ofsp.11143.pdf) [Russian ]

74 Kudiyarov R. I., Dyamurshayeva E. B., Sauytbayeva G. Z., Dyamurshayeva G. E. et al.. Influence of various substrates on productivity and economical efficiency of cultivation of tomatoes by the method of low-volume hydroponics // Bulletin of national academy of sciences of the Republic of Kazakhstan.– Almaty. -2021– Vol. 2.- Р.6-11. [Russian ]

75 Dyamurshayeva E. B., Kudiyarov R. I., Sauytbaeva G. Z., Dyamurshayeva G. E. The influence of different planting dates on tomato yield in the conditions of protected soil of the Kazakhstan Aral Sea region // Modern problems of science and education. - 2015. - No. 2. - URL: http://www.science-education.ru/122-21321 (date of reference: 18.08.2015). [Russian ]

76 Dyamurshayeva E. B., Kudiyarov R. I., Dyamurshayeva G. E. Agroeconomical justification of technological methods of growing tomatoes in greenhouses of the Aral Sea region / / Collection of proceedings of the XX International.scientific and practical conf."Trends and innovations of modern science". - Krasnodar: "A Priori", 2017. - P. 62. [Russian ]

77 GOST 1725-85. Fresh tomatoes. Technical conditions. [Russian ]

78 GOST ISO 2173-2013. Fruit and vegetable products. A refractometric method for determining the content of soluble solids. [Russian ]

79 GOST 8756.13-87. Fruit and vegetable products. Methods for determining sugar. [Russian ]

80 GOST ISO 750-2013. Fruit and vegetable products. Determination of titrated acidity. [Russian ]

81 GOST 24556-89. Fruit and vegetable processing products. Methods for determining vitamin C. [Russian ]

82 GOST 29270-95. Fruit and vegetable products. Methods for determining nitrates. [Russian ]

83 Dhaliwal M.S. et al. Genetics of yield and its components in tomato. Ann. Biol.- Vol.4.-1998.- P.75-80. [English]

84 Zdravković, J., Pavlović N.V., Girek Z. and Cvikić A.D. Generation mean analysis of yield components and yield in tomato (Lycopersicon esculentum Mill.). Pak. J. Bot.- 2011.- Vol. 43.-2011.- P. 1575-1580. [English]

85 Hussain S.I.et al. Yield potential of some exotic and local tomato cultivars grown for summer roduction. Pak.J.Biol.Sci.- 2001.-Vol.4.- P.1215-1216.- DOI: 10.3923/pjbs.2001.1215. 1216. [English]

86 Singh, T. et al. Performance of tomato (Solanum lycopersicum L.) hybrids for growth, yield and quality inside polyhouse under mid hill condition of uttarakhand. Am. J. Drug Discovery Dev.- 2014.-Vol.4.- P. 202-209. - DOI: 10.3923/ajdd.2014.202.209. [English]

87 Rajasekar M. T. et al. Influence of weather and growing environment on vegetable growth and yield. J.Horticulture Forestry.- 2013.-Vol.5.- P.160-167. [English]

88 Vesseur W.P. Tomato tasting and consumer attitude. Acta Horticulturae.-1990.- Vol.259.- P. 83-89.- DOI: 10.17660/ActaHortic.1990.259.7. [English]

89 Davies J.N., Hobson G.E. The constituents of tomato fruit-the influence of environment, nutrition and genotype. CRC Critical Rev. Food Sci. Nut.-1981.- Vol. 15.- P. 205-280.- DOI: 10.1080/10408398109527317. [English]

90 Tuzel J.H., Tuzel Y., Sul A. et. a1. Effects of EC level of the nutrient solution on yield and fruit quality of tomatoes. Acta Horticulturae.-2001.-Vol.559.-P.587-592. - DOI: 10.17660/ActaHortic.2001.559.86. [English]

91 Dorais M. R. et al. Improving tomato fruit quality by increasing salinity: Effects on ion uptake, growth and yield. Acta Horticulturae.-2000.-Vol. 511.-P. 1109-1100. - DOI: 10.17660/ActaHortic.2000.511.21. [English]

APPENDIX A

**CALENDAR PLAN**

1. **National Joint Stock Company Korkyt Ata Kyzylorda University**

1.1 By priority: "Sustainable development of the agro-industrial complex and the safety of agricultural products".

1.2 By sub-priority: Intensive agriculture and crop production

1.3 On the topic of the project: AP08956053 "Improving the production efficiency of greenhouse production in the Aral Sea region through the introduction of adapted innovative technology for small-volume tomato cultivation".

1.4 The total amount of the project is 5,000,000 (five million) tenge 00 tiyn, including by year, for the performance of works according to paragraph 3:

- for 2020-in the amount of 3,000,000 (three million) tenge 00 tiyn;

- for 2021 - in the amount of 2,000,000 (two million) tenge 00 tiyn.

**2. Characteristics of scientific and technical products according to qualification criteria and economic indicators**

2.1 Direction of work: the project is to create a sample of a low-volume technology for growing tomatoes on substrates made of sawdust and rice husk with an automated plant nutrition system developed on the basis of a systematic approach taking into account the natural and climatic conditions of the region and recommended in the future for small farms. The introduction of this technology will allow greenhouse farms in the region to increase the efficiency of production of high-quality greenhouse products, reduce labor and money costs per unit of production, increase its competitiveness. In general, the project is aimed at the development and intensification of greenhouse production in the region, and its implementation will contribute to the solution of the main goal of the state food security program - the replacement of imported vegetables with domestic products.

2.2 Scope of application: Vegetable growing of protected soil.

2.3 Final result:

- for 2020: An experiment will be launched to create an example of an improved low-volume technology for growing tomatoes on substrates made of sawdust and rice husk, developed on the basis of a systematic approach taking into account the natural and climatic conditions of the region and the specifics of the enterprise conditions, and an automated drip irrigation system for small farms has been developed and tested. A technological map will be drawn up with an indication of the dates of tomato cultivation and a description of the procedure for carrying out technological operations for their cultivation, recommended tomato hybrids, irrigation and plant nutrition programs, etc. The results of the research will be published in the form of an article.

- for 2021: The economic and environmental efficiency of the adapted technology of low-volume tomato cultivation on substrates made of sawdust and rice husk with the use of an automated drip irrigation system will be determined. Based on the conducted tests, recommendations will be made for the introduction of improved tomato technology in greenhouse farms in the region. The results of scientific research will be published in national and foreign journals, including 1 (one) in a peer-reviewed scientific publication included in Q1, Q2, Q3, Q4 in the Web of Science database and (or) having a CiteScore percentile in the Scopus database of at least 35 (thirty-five).

2.4 Patentability: yes

2.5 Scientific and technical level (novelty): the Scientific novelty consists in the construction of a prototype of an innovative low-volume technology of growing vegetables on substrates from sawdust and rice husk, adapted to climatic factors and production conditions, with the aim of further implementation in the farms of the region

2.6 Use of scientific and technical products is: Farm greenhouses in the region.

2.7 The type of use of the result of scientific and (or) scientific and technical activities: The introduction of improved innovative technology in greenhouse farms in the region.

**3. The name of the works, the terms of their implementation and the results**

**the beginning of the window**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Code of task, of stage | The name of the work under the Contract and the main stages of its implementation | Completion  date | | The expected result | |
| start | end |
| 2020 | | | | | |
| 1 | Analytical review of scientific achievements in the field of greenhouse technologies | October | December | | The analysis of scientific achievements in the field of greenhouse technologies will be carried out in order to justify the effectiveness of the proposed technology |
| 2 | Development of a technological map based on the results of previously performed research works, taking into account production characteristics | October | December | | The technological map will be compiled indicating the technological operations of tomato cultivation and the timing of their implementation, the plant nutrition program, microclimate parameters, etc. |
| 3 | Conducting pilot production tests for small-volume tomato cultivation | October | December | | The following will be carried out: monitoring of climatic conditions and microclimate, phenological and biometric observations, analysis of the dynamics of crop intake |
| 4 | Installation and testing of the automated drip irrigation system | October | December | | A scheme will be developed, equipment selection and installation of an automated drip irrigation system will be carried out, as well as monitoring of nutrient and drainage solutions according to the EU and pH for adjustment in irrigation and nutrition modes |
| 5 | Determination of the environmental efficiency of the technology | November | December | | Preparation for the determination of product quality indicators |
| 6 | Determining the economic efficiency of the technology | October | December | | Technology costs will be accounted for |
| 7 | Project results coverage and intellectual property protection | November | December | | Preparation of scientific articles for publication |
| 2021 | | | | | |
| 1 | Conducting pilot production tests for small-volume tomato cultivation | January | September | | The following will be carried out: monitoring of climatic conditions and microclimate, phenological and biometric observations, analysis of the dynamics of crop intake |
| 2 | Installation and testing of the automated drip irrigation system | January | September | | The nutrient and drainage solutions will be monitored according to the EU and pH, and adjustments will be made to the irrigation and nutrition regimes |
| 3 | Determination of the environmental efficiency of the technology | January | September | | Product quality indicators will be determined and the environmental efficiency of the technology will be determined |
| 4 | Determining the economic efficiency of the technology | January | September | | Accounting of technology costs and calculation of economic efficiency will be carried out |
| 5 | Project results coverage and intellectual property protection | January | August | | Publication of scientific articles, including 1 (one) in a peer-reviewed scientific publication included in Q1, Q2, Q3, Q4 in the Web of Science database and (or) having a CiteScore percentile in the Scopus database of at least 35 (thirty-five), or being in print in these publications, as well as 1 (one) in a peer-reviewed foreign or domestic publication with a non-zero impact factor (recommended by CQAFES), or obtaining 1 (one) security document |

|  |  |
| --- | --- |
| From the Customer:  Chairman  SI "Committee of Science of the Ministry of Education and Science of RK \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Kurmangalieva Zh. D.  P.S. | From the Executor:  Acting Chairman of the Board-Rector  NCJSC Korkyt Ata Kyzylorda University  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Karimova B. S. M. P.  Familiarized with:  Scientific Director of the project  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Sauytbaeva G. Z. |

APPENDIX B

**List of works on the project**

1 Improving the technology of growing tomatoes in low-volume hydroponics in the conditions of the Aral Sea region / / Collection of proceedings of the International Interuniversity Congress "Higher School-scientific research".- Moscow.- 2020- P.266-270, [Russian ]

2 Kudiyarov R. I., Dyamurshayeva E. B., Sauytbayeva G. Z., Dyamurshayeva G. E., Tuleubayev Zh., Ziyaeva G. K. Influence of various substrates on productivity and economical efficiency of cultivation of tomatoes by the method of low-volume hydroponics // Bulletin of national academy of sciences of the Republic of Kazakhstan.– Almaty. - Vol. 2. -2021. - P. 6-11. Indexing in the Web of Science (Impact Factor 3.533, Quartile in category Q2, CiteScore 5.5, Percentile - 47). Recommended by COXON MES RK, IF KazBC - 0,264. - ISSN 1991-3494. [English]

3 Sauytbaeva G. Z., Dyamurshayeva G. E. Kudiyarov R. I., Dyamurshayeva E. B. The use of Encarsia formosa for biological control of Trialeurodes vaporariorum on tomatoes from in greenhouses of the Aral region / / Collection of proceedings of the IY Scientific and Practical Conference "Biotechnology: a look into the future".- Stavropol, 2021. - p. 132-134. [Russian ]

4 Dyamurshayeva G. E., Dyamurshayeva E. B., Sauytbaeva G. Z., Kudiyarov R. I. Influence of substrates from sawdust and rice husk on the yield of tomatoes l,ilos F1// Mosolovsky readings: materials of the international scientific and practical conference "Topical issues of improving the technology of production and processing of agricultural products".- Yoshkar-Ola, 2021. - Issue XXIII. - P. 30-34. [Russian ]

5 Kudiyarov R. I., Dyamurshayeva E. B., Sauytbaeva G. Z., Dyamurshayeva G. E. The effectiveness of the adapted low-volume technology for growing tomatoes in greenhouses of the Aral Sea region // Bulletin of the KU im.Korkyt Ata.- Kyzylorda.- No. 3. -2021. - P.16-24. Recommended by COXON MES RK, IF KazBC-0.032. - ISSN 1607-2782. [Russian ]

APPENDIX C

**Table - Technological map of low-volume cultivation of Lilos F1 tomato in extended circulation**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Сроки культиви-рования томата в условиях продлен-ного оборота | Посев семя – 1 августа  Пикировка рассады 15 августа  Высадка рассады в теплицу – 15 сентября | | | | | | |
| Гибрид |  | | Томат Lilos F1- это индетерминантный, ранний, высокоурожайный гибрид компании Rijk Zwaan (Нидерланды), который идеально завязывает плоды массой 150-160 г и которые не мельчают в течение всего сезона даже в стрессовых условиях. Растение открытое, идеально сбалансированное, что облегчает уход, сильная корневая система. Благодаря хорошей силе роста завязывает много плодов отличного качества на всех кистях. Плоды округлые, однородные, поверхность блестящая без зелёного пятна вокруг плодоножки,ярко-красные, плотные, хорошо хранятся и транспортируются. Как нижние, так и верхние кисти сильные, с короткой осью, не заламываются. Устойчивость к болезням: ToMv/F1-5/ Fol:0,1/For /Va/Mi. | | | | |
| Субстрат | Древесные опилки: рисовая шелуха в соотношении 75:25 | | | | | | |
| Выращивание рассады | Рассаду томатов выращивают с пикировкой: сначала семена высевают в ящики или кассеты с торфяной смесью , а через 12-14 суток после появления всходов растения томатов пикируют в горшки 0,6-0,8 л с торфяной смесью (рекомендуется использовать готовый торфяной субстрат Агробалт –Н). По мере роста рассаду необходимо расставлять для лучшего использования света: после пикировки на 1 м2 должно находиться 28 растений; на 5-ой неделе - 20; на 6-ой- 15; - на 7-ой – 14; на 8-ой – 12. | | | | | | |
| Микроклимат, удобрение и полив при выращивании рассады | Параметры | После  посева | | 1-12 день после всходов | 13 день (пикировка) | 14день -до высадки | за 3 дня до высадки |
| Температура воздуха, 0С | 25 | | 22-23 | 20 | 19-20 | 17 |
| Досвечивание, часов |  | | 1-3 день-  24, затем- 18 | 16 | 12 | |
| Температура субстрата, 0С | 18-20 | | | | | |
| Влажность воздуха, % | 70-75 | | 65-70 | 70-75 | 65-70 | |
| Удобрения и полив | Полив чистой водой или раствором кальциевой селитрой 0,05-0,1% | | | Раствор кальциевой селитры,  ЕС 1,0 мС | Раствор кальциевой селитры и комплексного удобрения N14P11K25,  ЕС 1,5-2,5 мС | Раствор кальциевой селитры и комплексного удобрения N14P11K25,  ЕС 3 -5 мС |

Continuation of the APPLICATION C table

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Микроклимат, удобрение и полив при выращивании рассады | Влажность субстрата, % | Перед поливом – 65, после полива – 85 | | |
| Обогащение помещения углекислым газом | Регулярное проветривание помещения | | |
| Профилактические мероприятия при выращивании рассады | Для защиты растений от корневых гнилей полив рассады после всходов и перед расстановкой 0,1% раствором фунгицида (Псевдобактерин, Фитоспарин, Превикур). Против вредителей за три дня до посадки обрабатка 1% раствором инсектицидом (Конфидор, Гаучо, Энжио и др). | | | |
| Подготовка теплицы к посадке | Перед высадкой рассады помещение, конструкции и покрытие тщательно моют и дезинфицируют 3% раствором гипохорида (из расчета 10м3 на 1 га). После обработки теплицу герметично закрывают, выдерживают на 1 сутки, после чего хорошо проветривают. Затем размещают систему капельного орошения. Подготовленный субстрат помещают в полиэтиленовые мешки объемом 30л, заносят в теплицу и размещают на стеллажах, вырезают в них посадочные лунки,а затем увлажняют с помощью системы капельного орошения питательным раствором (Е.С - 3,0-3,5) до полного насыщения. После этого на самой длинной, обращенной к дорожке стороне мешка, как можно ближе к нижней поверхности, делают по 2 небольшие отверстия, через которые будет вытекать избыток воды. На шпалере размещают крючки с веревкой для подвязывания растений. | | | |
| Высадка рассады | За сутки до высадки полив рассады следует прекратить. Рассаду выставляют в теплицу через 45 после посева. При этом горшки пока не соединяют с субстратом, а ставят на мешки рядом с отверстиями и подсоединяют к системе капельного полива и подвязывают растения к вертикальному шпагату. Во время цветения 2-й кисти растения соединяют с субстратом. Плотность посадки гибридов томатов составляет крупноплодных - 2,1 растений на 1 м2, среднеплодных – 2,3 растений на 1 м2. | | | |
| Микроклимат при выращивании томата в  теплице | Параметр | После выставления рассады в теплицу | До плодоношения | После плодоношения |
| Температура 0С | В течение 3- дней  Днем – 18-20 0С  Ночью -16- 18 0С  Затем увеличивать на 10С в день до оптимальной | Днем  - солнечный 20-220С  - пасмурный 19-200С  Ночью – 15-170С | Днем  - солнечный 24-260С  - пасмурный 20-220С  Ночью – 17-180С |
| Влажность, % | 60-65 | | 65-70 |
| Обогащение углекислым газом | Регулярное проветривание помещения | | |

Continuation of the APPLICATION C table

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Программа полива и питания  растений томата | До плодоношения | Ppm | | | | | | | | | | | | | | | | | |
| N | P | | K | | Ca | Mg | | | Fe | Cu | Mo | | Mn | | Zn | | B |
| 107 | 114 | | 114 | | 38 | 20 | | | 0,25 | 0,018 | 0,004 | | 0,15 | | 0,012 | | 0,034 |
| Концентрат  для инжектора при разведении 1: 100 | | | | | Комплексное удобрение  10-52-10 | | Сульфат магния | | | Нитрат кальция | | | | Нитрат калия | | | |
| Емкость 1 | | | | | 50 г/л | | 20г/л | | |  | | | |  | | | |
| Емкость 2 | | | | |  | |  | | | 20 г/л | | | |  | | | |
| В период  плодоношения | Ppm | | | | | | | | | | | | | | | | | |
| N | P | | K | | Ca | Mg | | | Fe | Cu | Mo | | Mn | | Zn | | B |
| 200 | 55 | | 300 | | 200 | 55 | | | 3,00 | 0,50 | 0,12 | | 0,12 | | 0,20 | | 0,90 |
| Концентрат для инжектора при разведении 1: 100 | | | | Комплексное удобрение  20-20-20 | | Сульфат магния | | | | Нитрат кальция | | | | Нитрат калия | | | |
| Емкость 1 | | | | 75 г/л | | 40 г/л | | | |  | | | |  | | | |
| Емкость 2 | | | |  | |  | | | | 50 г/л | | | | 50г/л | | | |
| ЕС, мС | 1,2-2,7 | | | | | | | | | | | | | | | | | |
| Время полива | 7.00 | | 9.00 | | | 10.00 | 11.00 | | 12.00 | | 13.00 | | 15.00 | | 17.00 | | 7.00 | |
| Объем дренажного раствора, % | 0 | | 3 | | | 6 | 12 | | 30 | | 25 | | 25 | | 10 | | 0 | |
| Мониторинг полива и питания растений | 1 раз в неделю | В каждый срок полива | | | | | |  | | | | | | | | | | | |
| Ежедневно | 1 раз после окончания полива  ( норма дренажа 30 %) | | | | | |

Continuation of the APPLICATION C table

|  |  |  |  |
| --- | --- | --- | --- |
| Корректировка  режима полива и питания растений | ЕС дренажного раствора должен быть несколько выше ЕС питательно раствора (примерно на 10-15%) | | |
| ЕС дренажа= ЕС питательно раствора | Процент отведения слишком велик и нутриенты проходят через субстрат, не будучи усвоенными. Необходимо уменьшить объем полива. | |
| ЕС дренажа ниже ЕС питательно раствора | Растение не получает достаточно питательных веществ из-за чрезмерного количества воды. Необходимо увеличить ЕС питательного раствора | |
| ЕС дренажа значительно выше ЕС питательно раствора | Питательные вещества накапливаются в субстрате по причине малого количества воды Необходимо либо уменьшить ЕС питательного раствора, либо увеличить объем полива. | |
| Формирование растения | Растения томатов формируют в 1 стебель с удалением всех боковых ответвлений («пасынков») в течение всего периода вегетации. Растения томата рекомендуется выращивать с приспусканием, при этом по мере роста стебель опускают вдоль стеллажа под наклоном. Раз в неделю верхушки растений следует обвивать по часовой стрелке вокруг направляющей нити. Этот прием лучше всего проводить во второй половине дня, когда растения теряют тургор и снижается вероятность надлома. Для улучшения циркуляции воздуха в приземной зоне и предотвращения развития грибковых болезней еженедельно проводят удаление листьев, при этом на растении можно оставлять до 18 листьев весной и до 24 летом. За один прием необходимо убирать не более 2-3 листьев. Листья необходимо удалять полностью, не оставляя на растениях «пеньков». Для равномерного поступления продукции высокого качества необходимо проводить нормировку плодов на каждой кисти. В первой и второй кистях следует оставлять по 4-5 плодов (цветков), а в остальных - по 5-6 плодов. За 40-50 дней до ликвидации культуры необходимо прищипнуть верхушку основного стебля. | | |
| Признаки состояния растения | Вегетативный рост | | Генеративный рос |
| Мощный стебель | | Тонкий стебель |
| Крупный и хрупкий лист | | Короткий и грубый лист |
| Крупные цветы | | Мелкие цветы |
| Кисть завязывается низко от верхушки растения | | Кисть завязывается близко от верхушки растения |
| Сильный рост боковых побегов | | Слабый рост верхушки растения |
| Сильный налив плодов | | Быстрый налив плодов |
| Растения светло-зеленые | | Растение темно-зеленые |

Continuation of the APPLICATION C table

|  |  |  |  |
| --- | --- | --- | --- |
| Способы регулирования баланса между вегетативным и генеративным развитием растения | Показатель | Вегетативный рост | Генеративный рост |
| Начало полив | Раньше | Позже |
| Окончание полива | Позже | Раньше |
| Частота и продолжительность полива | Часто и мало | Редко и много |
| Концентрация солей в растворе | Низкая | Высокая |
| Влажность грунта (субстрата) | Высокая | Низкая |
| Разница температур днем и ночью | Маленькая | Большая |
| Среднесуточная температура | Низкая | Высокая |
| Количество плодов в кисти | Мало | Много |
| Количество листьев на растении | Много | Мало |
| Сбор урожая | Сборы проводят через 2 – 3 раза в неделю, летом ежедневно. Собирают плоды в бланжевой спелости, что способствует наливу остающихся на растении плодов. | | |
| Анализ качества плодов | Требования к плодам томата регламентируются ГОСТ 1725-85 - Томаты свежие. Технические условия. | | |

APPENDIX D

**Table - Calculation of costs for various complete sets of automated drip irrigation and fertigation systems**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Название | Фото | Ед.изм. | Кол-во | Цена, тг | Сумма, тг |
| 1 | 2 | 3 | 4 | 5 | 6 |
| Емкости для воды и удобрений |  | шт. | 1 | 20 000,00 | 20 000,00 |
| Емкости для удобрений |  | шт. | 1 | 12 600,00 | 12 600,00 |
| Повержностный вихревой |  | шт. | 1 | 24 190,00 | 24 190,00 |
| Фильтр | Фильтр сетчатый | шт. | 1 | 2 640, 00 | 2 640,00 |
| Дозатор удобрений  «Dozotron» |  | шт. | 1 | 164 000,00 | 164 000,00 |
| Трубка ПЭ д 16 мм |  | м | 150 | 76,00 | 11 400,00 |
| Капельницы  Компенсированная 2 л/час |  | шт. | 360 | 55 | 19 800,00 |

Continuation of the APPLICATION D table

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 |
| Микротрубка | D:\ФОТО\проект 2010 1 транш\SAM_0425.JPG | м | 180 | 35,00 | 6 300,00 |
| Колышки (держатели микротрубки) | D:\ФОТО\проект 2010 1 транш\SAM_0425.JPG | шт. | 360 | 25,00 | 9 000,00 |
| Дырокол |  | шт. | 1 | 1 200,00 | 1 200,00 |
| Электронный таймер |  | шт. | 1 | 6 440,00 | 6 440,00 |
| ЕС-метр |  | шт. | 1 | 16 000,00 | 16 000,00 |
| рН-метр |  | шт. | 1 | 9 500,00 | 9 500,00 |
| Итого: |  |  |  |  | 303 070,00 |