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ВЕСТНИК

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РЕСПУБЛИКИ КАЗАХСТАН

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INFLUENCE OF VARIOUS SUBSTRATES ON PRODUCTIVITY AND ECONOMICAL EFFICIENCY OF CULTIVATION OF TOMATOES BY THE METHOD OF LOW-VOLUME HYDROPONICS

Abstract. Currently, low-volume hydroponics is the most intensive system for vegetable plant cultivation in a greenhouse, the effective use of which largely depends on the selection of a substrate. The wide variety of substrates used for this technology suggests that when cultivating tomatoes in different regions, substrates from local raw materials can be used, making it possible to preserve all the positive properties of low-volume hydroponics and to get a high yield of tomatoes.

This paper presents the results of a study on cultivating Lilos F1 tomatoes hybrid using substrates of peat (control option) and sawdust (SD) and rice husk (RH) in various ratios (SD 100%; RH 100%; SD: RH 50:50; SD: RH 75:25 and SD: RH 25:75). It was found that the highest tomato yield was received when growing tomatoes using a peat substrate (25.54 kg/m^2) and in ratios SD: RH 75:25 and SD: RH 50:50 (27.70 and 24.57 kg/m^2). The calculation of the economical efficiency of tomato cultivation showed that the level of production profitability was determined not so much by the yield as by the cost of the substrate, therefore the most effective was the use of composite substrates SD: RH 75:25 and SD: RH 50:50, which ensured the production profitability of 14.7% and 14.0%. The obtained results confirmed the expediency of using substrates from sawdust and rice husk to increase the efficiency of low-volume cultivation of tomatoes in regional conditions. It has been established that the use of substrates based on sawdust and rice husk for low-volume cultivation allows preserving all the positive properties of the technology and to get a rich yield of high-quality tomato fruits.

The cost-effectiveness analysis of low-volume tomato cultivation using various substrates showed that the level of production profitability was influenced not so much by the yield as by the cost of the substrate. Since the region lacks natural reserves of organic substrates, when peat is used as a substrate, it has to be purchased from the CIS countries, which significantly affects the cost of production. The use of waste products from processing industries such as sawdust and rice husk as substrates, on the contrary, allows you to reduce this cost item in the cost of production and thereby increase the production profitability.

The ground for doing research: Source of funding - grant of the Ministry of Education and Science of the Republic of Kazakhstan AP08956053 «Improving the production efficiency of greenhouse production in the Aral Sea region through the introduction of adapted innovative technology for low-volume tomato cultivation».

Keywords: hydroponics, tomato, substrate, sawdust, rice husk, yield, profitability.

Introduction. In the past decade, the technology of low-volume cultivation of vegetables, using either an inert organic or inorganic substrate by feeding nutrient solutions through a drip irrigation system, has received the wide speeding in the world. This technology makes it possible to significantly increase the production cost-effectiveness, both by increasing yields and by significantly saving resources. The use

of low-volume technology can essentially reduce the water and fertilizer consumption, improve the ecology due to the controlled drainage flow and the rejection of chemical plant protection from pests and diseases. At the same time, ecological cleanliness, high taste, and excellent presentation of products are achieved, this allows you to cultivate vegetables of the "Premium" class - the highest category of quality and environmental safety. [1].

Currently, low-volume hydroponics is the most intensive system for cultivating vegetable plants in a greenhouse, effectively using all resources to maximize yields and the most intensive form of agricultural enterprises for commercial production of greenhouse vegetables [2, 3]. Also, it is an ideal way to cultivate vegetables in regions with arid climates, marginal soils, and a lack of irrigation water. [4].

The successful low-volume cultivation of plants largely depends on the selection of the substrate and its constituent components. It is difficult to choose a substrate that can be considered the most versatile, guaranteeing the success of cultivation and high quality of planting material. Currently, about two dozen substrates used for vegetable crop cultivation in greenhouse conditions have been tested: organic (peat, coconut fiber, tree bark, and sawdust, etc.) and inorganic (mineral wool, perlite, vermiculite, zeolite, etc.). Each substrate has its specific physical and chemical properties that should be considered when choosing for successful cropping. In addition to properties, when choosing a substrate, they also pay attention to its availability, price, economic efficiency, period of use, and the possibility of recovery. [5, 6].

The wide variety of substrates used in this technology suggests that substrates made from local raw materials can be used when cultivating greenhouse tomatoes in different regions.

Today, a certain amount of experience has been accumulated in the use of sawdust as a substrate for low-volume tomato cultivation [7, 8], and in some Central Asian republics of the CIS, rice husk substrates are being actively tested [9, 10]. The use of a substrate based on these materials makes it possible to preserve all the positive properties of low-volume hydroponics and get a high yield of high-quality and environmentally friendly tomatoes. But for a wider introduction of these materials, it is necessary to develop application technology for specific culture and regional conditions.

The basis for performing the research work. The ground for doing research: Source of funding - grant of the Ministry of Education and Science of the Republic of Kazakhstan AP08956053 «Improving the production efficiency of greenhouse production in the Aral Sea region through the introduction of adapted innovative technology for low-volume tomato cultivation».

Materials and methods of research. Experimental studies were carried out based on the greenhouse facilities at the Korkyt Ata University using generally accepted techniques for greenhouse vegetable cultivation [11-13].

The indeterminate hybrid Lilos F1 was chosen for testing, which has shown good results in terms of yield in previous studies conducted in the conditions of this region. The hybrid was cultivated under conditions of an extended culture with a seed sowing date on August 1 and planting in a substrate on September 15 using the following substrates: peat (control), sawdust (SD), rice husk (RH), SD: RH 50:50, SD: RH 75:25, SD: RH 25:75. The experiment was repeated three times, the planting was randomized.

The prepared substrates were put in 30 liters volume plastic bags and placed on racks in the greenhouse. Tomato seedlings were grown in pots with 10 cm diameter with a peat substrate, normalized by acidity (pH 5.5-6.0), and containing the required amount of macro- and microelements. In the 4 leaves stage, the seedlings were placed in a greenhouse, and in the stage of 8-9 leaves, they were combined with the substrate, previously moistened through a drip irrigation system with a balanced nutrient solution with E.C - 3.0-3.5 until full saturation. The plant population is 2.3 pcs/m^2, the formation of plants into one stem with lowering and laying on a rack.

For watering and feeding of the plants, a hydroponics solution of the following composition was used: (in ppm): before fructification 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 fructification N -200, P -55, K -300, Ca -200, Mg -55, Fe -3.0, Cu -0.50, Mo -0.12, Mn -0.12, Zn -0.20, B -0.90, with EC concentration - 1.2 - 2.7 mS/cm, pH - 5.5 - 6.5. The hydroponics solution was fed through the drip irrigation system every hour from 7.00 to 17.00 so that the volume of the drainage solution per day was at least 30%.

Counting the tomato yield was performed at each harvest 2-3 times a week. Mathematical processing of the yield data was carried out by the analysis-of-variance method [14, 15] using the Excel program in the Microsoft Windows operating system.

Results. Of all the stages of growth and development of tomato plants, the type of substrate could only affect the onset of the fructification phase, since the same substrate (peat with perlite) was applied for growing seedlings in all options and the plants were planted in different substrates in the flowering phase of the first raceme. Phenological observations showed that the fructification of the Lilos F1 hybrid began 2 days earlier when cultivated on a peat substrate and a composite substrate with a predominance of sawdust (SD: RH = 75:25). When cultivated on a one-component rice husk substrate the plants began to bear fruits at the latest (figure 1).

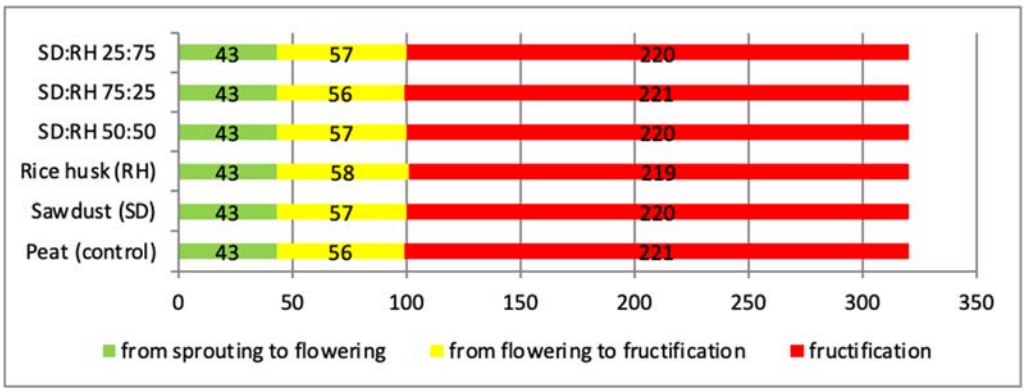

Figure 1 – Growth and development of tomato plants Lilos F1 on various substrates in an extended cycle

Analysis of the results of the fruit yield of the Lilos F1 hybrid (table 1) showed that the greatest early and total yield were formed when grown on peat substrate and using composite substrate SD: RH 75:25 (table 1).

The values of the early yield in these options were 2.18 and 2.15 kg/m2, respectively, determined by the time of the beginning of fructification, since the plants that grew on these substrates began to bear fruit 2 days earlier.

Table 1 – Productivity of tomatoes cultivated using various substrates

Substrate	Yield						Number of fruits from one plant	Weight of 1 fruit, g
	Early		Total		Standard			
	kg/m^2	% to control	kg/m^2	% to control	kg/m^2	% to total		
Peat (control)	2.18	100	25.54	100	24.82	97.2	105	105.8
Sawdust (SD)	2.12	97.2	24.45	95.7	23.67	96.8	103	103.2
Rice husk (RH)	2.08	95.4	24.03	94.1	23.21	96.6	101	103.4
SD:RH 50:50	2.13	97.7	24.54	96.1	23.8	97.0	102	104.6
SD:RH 75:25	2.15	98.6	24.70	96.7	24.05	97.4	102	105.3
SD:RH 25:75	2.11	96.8	24.31	95.2	23.53	96.8	102	103.6
LSD 05			1.09 kgr/m^2; 4.4%					

As the biometrics of the yield showed, its value was determined by two indicators: the number of formed fruits and their weight. The highest total crop yield of tomato fruits of 25.54 kg/m^2 was obtained when cultivated on peat substrate (control), where the largest number of fruits was 105 with the greatest weight 105.8 g. On composite substrates SD: RH 75:25; 50:50 and 25:75, the number of formed fruits was the same 112, and the crop yield was determined by their weight 105.3 g; 104.6 g and 103.6 g respectively. So the highest crop yield was obtained using the substrate SD: RH 75:25 - 24.70 kg/m^2. On one-component substrates of sawdust and rice husk, the fruits had the smallest weight, which showed their smallest yield of all options, 24.45 and 24.03 kg/m^2, respectively.

Analysis of variance confirmed the reliability of the results (Ff > F05 = 24.12 > 3.59) and insignificant differences in the productivity of tomato plants grown on composite substrates SD: RH 75:25 and SD: RH 50:50 in comparison with the control option.

It has been established that the use of substrates based on sawdust and rice husks for low-volume cultivation allows preserving all the positive properties of the technology and get a high yield of high-quality tomato fruits.

The cost-effectiveness analysis of low-volume tomato cultivation on various substrates showed that the level of production profitability was influenced not so much by the crop yield as by the cost of the substrate. Since the region does not have natural reserves of organic substrates, when using peat as a substrate, it has to be imported from the CIS countries, which significantly affects the cost of production. The use of waste products from processing industries such as sawdust and rice husk, on the contrary, allows to reduce this cost item in the prime cost of production and thereby increase the production profitability (figure 2).

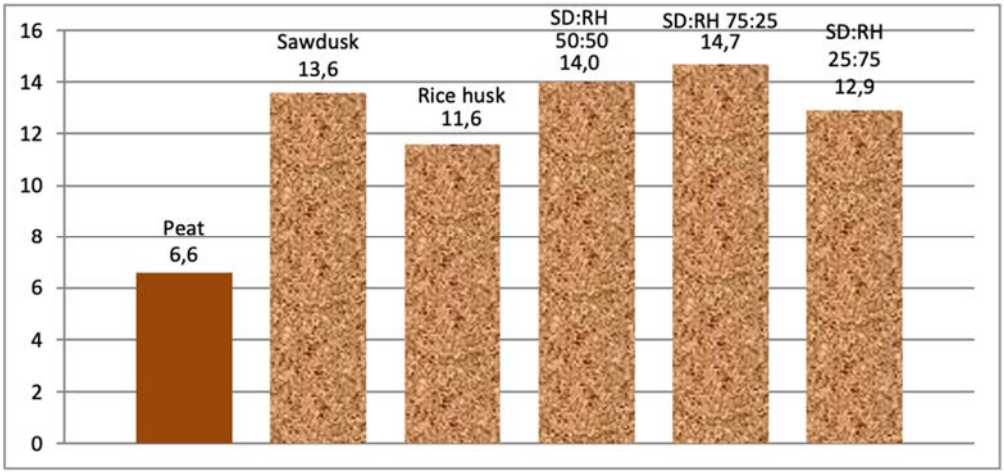

Figure 2 – Profitability of cultivation of tomatoes on various substrates.

The application of cheap substrates based on sawdust and rice hulls provided more profit than using peat substrates. Its value determined the crop yield of the obtained products, therefore, the most effective from an economic point of view were composite substrates SD: RH 75:25 and SD: RH 50:50, which ensured the profitability of production of 14.7% and 14.0%, respectively.

Conclusion. The obtained results confirmed the rationale of using cheap substrates from sawdust and rice husk for low-volume cultivation of tomatoes, as an alternative to expensive substrates. As a result of the research, it was found that the addition of substrates based on sawdust and rice husks for low-volume cultivation gives possibilities to preserve all the positive properties of the technology and get a rich yield of high-quality tomato fruits, which guarantees profit and production profitability. The results will contribute to the wider introduction of technology for cultivating tomatoes in greenhouses in the region.

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ҚЫЗАНАҚТЫ АЗ КӨЛЕМДІ ГИДРОПОНИКА ӘДІСІМЕН ӨСІРУДІҢ ӨНІМДІЛІГІ ЖӘНЕ ЭКОНОМИКАЛЫҚ ТИІМДІЛІГІНЕ ӘРТҮРЛІ СУБСТРАТТАРДЫҢ ӘСЕРІ

Аннотация. Бүгінгі таңда аз көлемді гидропоника-жылыжайда көкөніс өсімдіктерін өсірудің ең қарқынды жүйесі, оны тиімді пайдалану көбінесе субстратты таңдауға байланысты. Бұл технологияда қолданылатын субстраттардың алуан түрлілігі әртүрлі аймақтарда қызанақ өсіру кезінде жергілікті шикізаттың субстраттарын қолдануға болатынын болжайды, бұл аз көлемді гидропониканың барлық оң қасиеттерін сақтауға және қызанақтың жоғары өнімділігін алуға мүмкіндік береді.

Тәжіриебелік зерттеулер Қорқыт Ата атындағы Қызылорда университетінің жылыжай шаруашылығы базасында қорғалған топырақты көкөніс өсіруге арналған жалпы қабылданған әдістемелерді пайдалана отырып жүргізілді. Сынақтарды жүргізу үшін индетерминантты гибрид Lilos F1 таңдалды, ол осы аймақта жүргізілген алдыңғы зерттеулерде өнімділік бойынша жақсы нәтижелер көрсетті. Гибрид 1 тамызда ұзартылған дақыл жағдайында тұқым себу мерзімімен және 15 қыркүйекте субстратқа көшіру арқылы келесі субстраттарда өсірілді: жертезек (бақылау), ағаш жоңқалары (АЖ), күріш қауызы (КҚ), АЖ : КҚ 50:50, АЖ : КҚ 75:25, АЖ : КҚ 25:75. Тәжірибенің қайталануы - үш рет, орналасуы көрсетілген.

Фенологиялық бақылаулар көрсеткендей, lilos F1 гибридінің жемісі жертезек субстратында және ағаш жоңқалары басым болатын композициялық субстратта өсірілгенде 2 күн бұрын пайда болды (АЖ : КҚ = =75:25). Кейінірек күріш қабығының бір компонентті субстратында өсірілген кезде бүкіл өсімдіктер өз жемісін бере бастады.

Аз мөлшерде өсіру үшін ағаш жоңқалары мен күріш қауызына негізделген субстраттарды қолдану технологияның барлық жағымды қасиеттерін сақтап, сапалы қызанақ жемістерінен жоғары өнім алуға мүмкіндік беретіні анықталды.

Қаржыландыру көзі Қазақстан Республикасының Білім және ғылым министрлігінің гранты AP08956053 «Шағын көлемді қызанақ өсіру үшін бейімделген инновациялық технологияны қолдану негізінде Арал өңірінде жылыжай өндірісінің тиімділігін арттыру».

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ВЛИЯНИЕ РАЗЛИЧНЫХ СУБСТРАТОВ НА ПРОДУКТИВНОСТЬ И ЭКОНОМИЧЕСКУЮ ЭФФЕКТИВНОСТЬ ВЫРАЩИВАНИЯ ТОМАТОВ МЕТОДОМ МАЛООБЪЕМНОЙ ГИДРОПОНИКИ

Аннотация. На сегодняшний день малообъемная гидропоника – это наиболее интенсивная система культивирования овощных растений в теплице, эффективное использование которой во многом зависит от подбора субстрата. Большое разнообразие субстратов, применяемых для этой технологии, предполагает, что при выращивании томатов в разных регионах могут использоваться субстраты из местного сырья, позволяющие сохранить все положительные свойства малообъемной гидропоники и получать высокий урожай томатов.

Экспериментальные исследования выполнялись на базе тепличного хозяйства КУ им. Коркыт Ата с использованием общепринятых методик для овощеводства защищенного грунта. Для проведения испытаний был выбран индетерминантный гибрид Lilos F1, который показал хорошие результаты по урожайности в предыдущих исследованиях, проводимых в условиях данного региона. Гибрид выращивали в условиях продленной культуры со сроком посева семян 1 августа и высадкой в субстрат 15 сентября на следующих субстратах: торф (контроль), древесные опилки (ДО), рисовая шелуха (РШ), ДО:РШ 50:50, ДО:РШ 75:25, ДО:РШ 25:75. Повторность опыта - трехкратная, размещение рендомизированное.

Фенологические наблюдения показали, что плодоношение гибрида Lilos F1 наступало на 2 дня раньше при выращивании на торфяном субстрате и на композиционном субстрате с преобладанием древесных опилок (ДО:РШ = 75:25). Позднее всего растения начинали плодоносить при выращивании на однокомпонентном субстрате из рисовой шелухи.

Анализ результатов урожайности плодов гибрида Lilos F1 (таблица 1) показал, что наибольший ранний и общий урожай формировался при выращивании на торфяном субстрате и на композиционном субстрате ДО:РШ 75:25. Величина раннего урожая в этих вариантах составляла соответственно 2,18 и 2,15 кг/м^2 определялась сроком начала плодоношения, поскольку растения, которые расли на этих субстратах начинали плодоносить на 2 дня раньше.

Установлено, что использование субстратов на основе древесных опилок и рисовой шелухи для малообъемного выращивания позволяет сохранить все положительные свойства технологии и получать высокий урожай качественных плодов томатов.

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Ключевые слова: гидропоника, томат, субстрат, древесные опилки, рисовая шелуха, урожайность, рентабельность.

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