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STUDY OF THE EFFECT OF MINERAL AND ORGANIC SUBSTRATES ON THE GROWTH OF RICE ORYZA SATIVA L. IN HYDROPONICS

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Annotation

The influence of the composition of organic and mineral substrates on the germination and development of rice varieties "Yantar", "Favorit", "Aykerim" grown on a rack hydroponic installation was studied.

Foam glass, perlite, mineral wool (agrowool), coconut substrate, and jute rug were tested as substrates.

The influence of organic and mineral substrates turned out to be ambiguous on different varieties of rice in terms of germination and biometric characteristics. Agrowool substrates and coconut fiber substrates are the most favorable for Aykerim and Favorit varieties. Perlite and foam glass substrates are universal, all three varieties can be grown on them, but they are inferior in terms of biometric indicators. The jute substrate turned out to be less favorable for the studied rice varieties, moreover, it is completely unsuitable for the Yantar variety.

Key words: hydroponics; substrate; perlite; mineral wool; rice.

Introduction

The issues of the agrarian sector of the Republic of Kazakhstan are among the priority tasks of the economy and state policy. Among the problems associated with the cultivation of many types of crop products, the leading role is played by the environmental problems of soil degradation, the provision of water resources, the use of pesticides, and others [1]. One of the environmentally unfavorable types of crop production is rice growing, as it is excessively water-intensive, given the growing water shortage throughout Central Asia [2,3].

However, despite these problems, rice in the region has always been one of the leading crops, the production of which will grow from year to year.

Material and methods

The work was carried out at the "Center for Training Specialists for the Development of Greenhouse Farms" on the basis of the Kazakh National Agrarian Research University in Almaty.

It is possible to reduce the adverse effects of rice growing only through the search and application of the latest technologies for growing plants, in particular, the large-scale use of hydroponics. At the moment, rice is not grown anywhere in hydroponics until the final stage of vegetation, but it makes sense for the future to study the best conditions and possibilities of this technology for rice, namely: to select the most successful substrates and mineral supplements.

The purpose of the work is to study the effect of the composition of organic and mineral substrates on the germination and development of rice varieties "Yantar", "Favorit", "Aykerim" grown on a rack hydroponic installation.

To study the effect of mineral and organic substrates on the growth of rice under hydroponic conditions, the actively cultivated varieties Aykerim, Favorit and Yantar were selected. These varieties were chosen

due to the fact that they have a number of differences from each other in terms of cultivation requirements.

Rice variety "Yantar" was created by hybridization of variety ST 101 (regenerated from Krasnodar 424)/M and variety 705 (Buran). "Yantar" refers to the mid-season group with a growing season of 114-117 days. This variety is interesting in that it has good resistance to environmental stress factors [4,5].

Rice "Favorite" is the result of hybridization of varieties Amethyst and Yantar. It is also a mid-season variety and the growing season takes 110–115 days [6].

The Aykerim rice variety is domestic, which was bred by the method of individual selection during

experimental mutagenesis from the Marzhan variety. The vegetation period of this plant is 110-115 days. Variety "Aikerim" is mid-season, high-yielding, salt-tolerant [7].

For different crops in hydroponics, the correct selection of the substrate is important, since it has a different effect on the germination of plants. Often the composition of the substrate becomes variety- and even species-specific. In grain crops, foam glass, perlite, and mineral wool are often used as substrates. There are works on the use of organic substrates from coconut and jute fibers (Figure 1). In this work, a comparison was made of the germination of rice seeds on the above types of substrates.

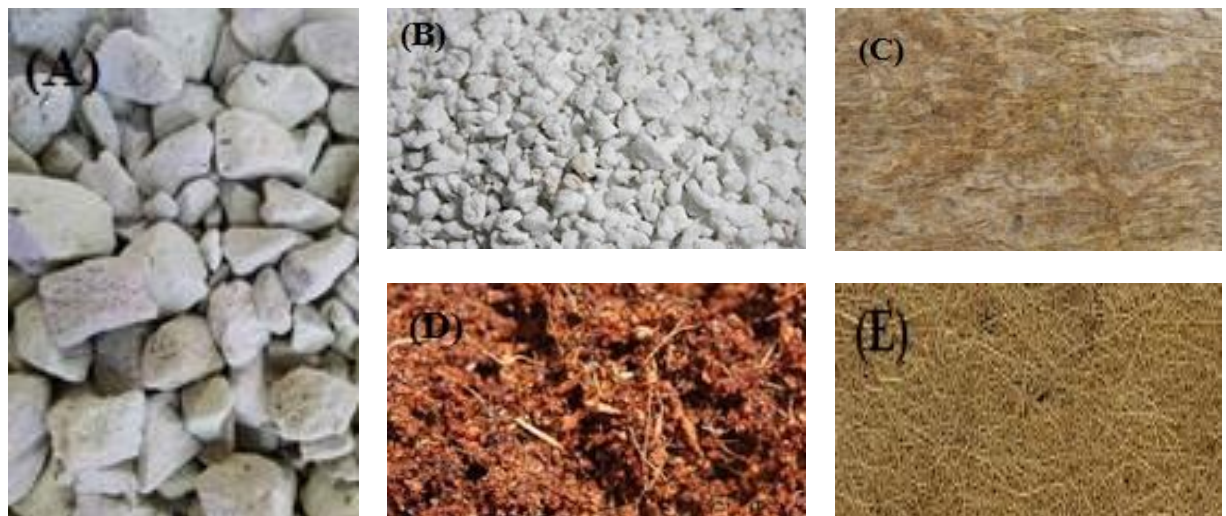


Figure 1. Substrates for hydroponically growing rice: (A) foam glass, (B) perlite, (C) agrowool, (D) coir, (E) jute rug.

The selected substrates have great advantages: the risk of the spread of soil pathogens is practically excluded, the physicochemical properties of growth substrates can be controlled within narrow limits. Such properties of substrates can ensure the

growth of healthier plants, and hence a higher yield [8,9].

Perlite "Agroperlite Permagrobusiness" (Russia) was chosen due to such features as the ability to retain oxygen, and also because of its high inertness: substrate

substances are not digestible by plants [10].

A relatively new material is the GrowPlant foam glass substrate we have chosen (made in Russia), which absorbs air and water well due to its high porosity. It has been noted that gas exchange and circulation on this substrate is very successful for many cultures [11].

Due to the low bulk density, the Ecover Grunt Green mineral wool substrate (OAO Uralasbest, Russia) 2.0 is convenient to use, which is

close to high-moor peat in terms of physical properties and is practically sterile [12]. Even with significant moisture capacity in glass wool, the high porosity allows sufficient air to be present in the root zone. Despite the content of a number of metals (iron, copper, zinc), mineral wool is basically neutral in terms of interaction with the nutrient solution.

The main physical properties of mineral substrates are presented in table (table 1).

Table 1. Basic physical properties of selected mineral substrates

Substrates	Bulk density (bulk) g/cm ³	Dry material porosity % of total volume	Water-retaining capacity, %
Perlite Agroperlite Permagrobusiness	0,30	85-90	51
Foam glass "GrowPlant"	0,23	90-95	40
Mineral wool "Ecover Grunt Green"	0,08	95-97	80

Coconut substrate "UGro" (Spain), which is dried organic fibers, was used as an organic substrate. Coconut fiber is a popular hydroponic substrate in industrial hydroponics. They are suitable for the cultivation of a large number of plants in hydroponics [13].

And also from organic substrates, we chose "Jute rug" (Russia) from jute hay soaps. Mat of natural composition, absorbs moisture 4.5 times its own weight; does not give a smell and dusting. The substrate is economical in consumption; meets all the

requirements of environmental and sanitary safety [14].

Equipment

In the course of the work, 2 types of rack hydroponic installations were used, designed by the individual order of the greenhouse facilities of KAZNAIU.

Installation No. 1 is designed for intensive plant growth, the model is a rack structure with lighting on each tier, it has a system for supplying a nutrient solution from a reservoir. Technical characteristics are presented in table (table 2).

Table 2. Technical characteristics of the hydroponic plant for intensive growth

Characteristic	indicators
Dimensions, mm	2200 x 1550 x 760
Tiers	3
Tray + hydroponic system	3
Drain system	1
bay system	1
Pump, W.	430
Tank, liter	65
Automation	light/watering
Landing area, m2	2,04

Hydroponic installation No. 2 is intended for the complete vegetation of the plant. It is a vertical structure on which PVC pipes with a diameter of 30 cm are installed, in which holes are made for pots with seedlings.

Horizontally installed pipes are connected at the ends with plastic bends. The assembled system circulates the nutrient solution supplied from the tank by means of a pump.

Results

The cleaned and thoroughly washed rice seeds were soaked in water for 8 hours. Substrate preparation was carried out according to manufacturer's instructions [10-13].

Perlite and foam glass were washed in water to remove small grains and impurities, after which pots for seedlings were filled with them.

To absorb water, the substrates (foam glass, perlite, mineral wool and coconut substrate) were placed in containers with water, the jute substrate was soaked in a phytosporin solution in order to suppress the reproduction of plant fungi and bacteria (Figure 2).



Figure 2. Substrate preparation work

Work was carried out to prepare the hydroponic installation (washing

the vessel, checking the illumination, etc.) and preparing the containers

(cleaning, filling with prepared substrates).

When choosing artificial lighting, the following features were taken into account: daylight hours, lamp intensity, radiation spectrum and its color temperature. We used fluorescent lamps as an additional source of illumination. The spectrum of fluorescent lamps varies from 2700 to 7800K, which brings it closer to natural white light. The used lamps do not heat up and therefore do not affect

the microclimate of the hydroponic plant. Cost-effectiveness and ease of use make fluorescent lamps convenient for growing rice in hydroponics [15].

As a nutrient solution for the rice plant was used the composition of the solution itself, taking into account the necessary elements for the vegetation of rice with the following dosage, is indicated in table (table 3).

Table 3. Composition of working solution No. 3

Название удобрения	Количество вещества, г/л воды
Калимагнезия ($K_2SO_4 \cdot MgSO_4$)	0,07
Сульфат магния ($MgSO_4$)	0,18
Нитрат кальция ($Ca(NO_3)_2$)	0,27
Хелат железа Fe	0,01
Нитрат Аммония (NH_4NO_3)	0,5
Акварин	0,8

Optimal climatic conditions for growing rice were created: air humidity from 55-85% (depending on the time of day), room temperature from 22-28 °C, nutrient solution temperature from 18-24 °C, photoperiod was 12 hours.

5 seeds were planted in special containers filled with substrates. of each variety in three positions (Figure 3). To create a greenhouse effect, seedlings in pots were covered with plastic bags and left to germinate.



Figure 3. Planting rice seeds

Germination of seeds in pots lasted 7 days. Seed germination by substrate types differed (Figure 4).

For intensive growth and before the appearance of the third true leaf, the seedlings were transferred to a hydroponic plant for intensive growth (Figure 4).



Figure 4. Rice seedlings in a hydroponic plant for intensive growth

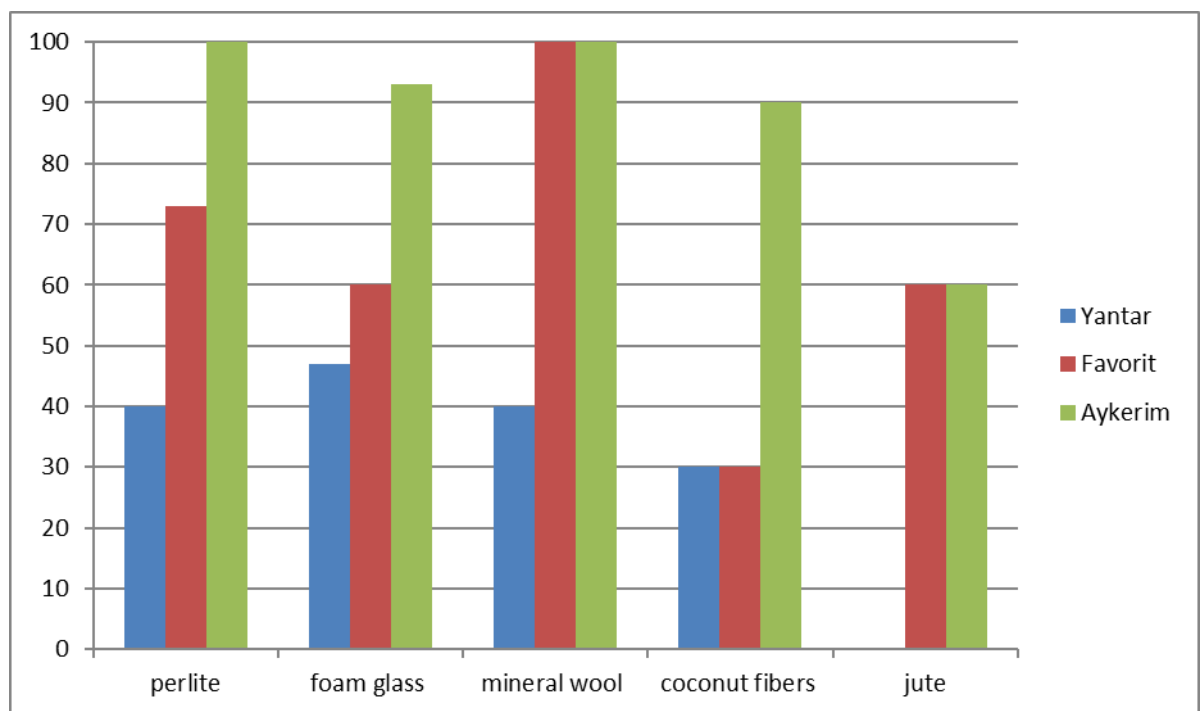


Figure 5 - Seed germination of rice varieties (%) by types of substrates at the germination-shooting phase (16th day)

Seed germination and rice growth on different types of substrate varied.

In the Yantar variety, the germination rate is low, perlite was 40% on the substrate, 47% on foam glass (grouplant), 40% on agrowool, 30% on coconut substrate, and there were no seedlings on the jute substrate (Figure 5).

For the germination of the “favorit” variety, the agrowool substrate turned out to be favorable, which amounted to 100%, also on coconut fibers - 80%, on perlite - 73%, on grow plant and on a jute substrate - 60%.

The germination of the Aykerim variety showed 100% on the substrates of perlite and mineral wool,

on growplast - 93%, on the coconut substrate the germination of this variety was low and amounted to 60%.

Of the five types of substrates for rice germination, the most unfavorable was the substrate of jute fibers. On the contrary, mineral substrates (perlite, foam glass and mineral wool) turned out to be more suitable. On organic substrates (coconut fibers and jute), this figure is low. Containers with coco substrate showed mold and were treated (sprayed) with a 2.5% hydrogen peroxide solution.

The height of the plant at the seedling phase differed by types of rice varieties (Figure 6).

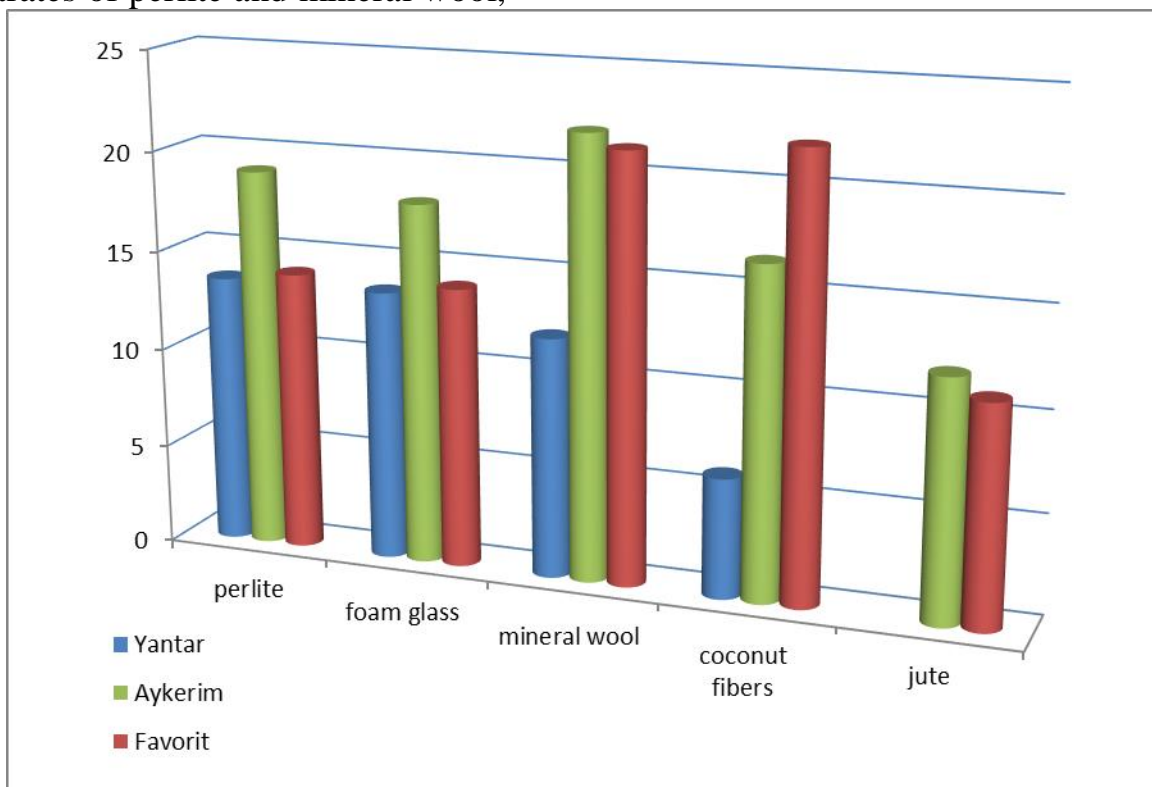


Figure 6. Biometric characteristics of plant growth of rice varieties at the seedling phase (30 days)

According to the results of the research, it was found that the types of substrates affect the growth of the

plant in different ways. The most favorable for the growth of the plant was the mineral substrate of agorvat,

where rice varieties "Aykerim" (22 cm) and "Favorit" (21.3 cm) reached up to 22 cm on the 30th day from sowing. Variety "Yantar" has grown to 12 cm on agrowool. The substrate from coconut fibers also turned out to be suitable for the growth of rice varieties: Favorit rice - 22 cm, Aykerim rice - 16.5 cm, and for the Yantar variety it was less favorable, at this stage of development its growth was only 6 cm.

Perlite and foam glass substrates affected the growth of rice varieties

Discussion

When grown hydroponically, plants use substrates for anchorage, similar to how they do in soils. But at the same time, the root system extracts nutrients and water not from the substrate, but from the solution. However, substrates must meet granulometric requirements, conditions for ensuring optimal root respiration, water-retaining features, obstacles to the growth of pathogenic bacteria and other parasites, and must also be easily washed from excess salts [14].

In this regard, the choice of optimal soils for growing rice is of particular interest, since the plant is quite capricious even in traditional farming conditions. In the scientific literature there are similar studies on grain crops, in particular on different varieties of wheat [16]. However, according to rice, no one has yet carried out the selection of different substrates for the complete vegetation of rice with the production of ripe seeds. Therefore, the results obtained by us on the selection of substrates for growing three varieties of rice

almost the same, the Yantar variety grew up to 13.5 cm on both substrates, the Aykerim rice variety reached 19 cm on perlite, and 18 cm on foam glass. On these substrates, the growth of the Favorit rice variety reached the same - 14 cm.

The jute substrate turned out to be less suitable of all types of substrates, which was shown by the following results of rice varieties: "Aykerim" - 12 cm, "Favorite" - 11 cm, and the "Yantar" variety did not grow on this substrate at all.

"Aykerim", "Favorit" and "Yantar" in hydroponics are currently unique.

We selected substrates used for other crops, but they had different effects on different varieties of rice, in particular on germination and on biometric indicators. Based on our results, the best and most versatile substrates are mineral: agrowool and perlite. However, it is still possible to continue studying the possibilities of foam glass on other varieties of rice with different nutrient media. Organic substrates (coconut substrate, jute rug) are less favorable for rice, in particular, plant damage by root system mold was more often observed here, which requires additional processing.

The development of technologies for the artificial cultivation of rice of different varieties, in our opinion, is timely, since it can form the basis of the growing industrial distribution of green technologies that are environmentally friendly, but also solve various environmental problems in the national economy [16].

Conclusion

Thus, the experiment showed the possibility of successfully growing rice varieties "Aykerim", "Favorit" and "Yantar" in a hydroponic plant under the above conditions on such substrates as foam glass, perlite, agrowool, coco substrate, jute rug.

According to the influence of organic and mineral substrates on different varieties of rice, the following can be distinguished:

1. The substrate of agrovat is most favorable for varieties "Aykerim" and "Favorite": germination rate "Aykerim" - 100%, "Favorit" - 100%, biometric characteristics - plant height at the seedling phase "Aykerim" - 22 cm, "Favorit" - 21.3cm

2. Substrate from coconut fibers gave positive results for varieties "Aykerim" and "Favorite": germination rate "Aykerim" - 90%, "Favorite" - 80%, "Yantar" - 30% - 22 cm, "Favorite" - 21.3 cm, "Amber" - 6 cm.

3. The perlite substrate affected the growth of the rice plant in different ways: the germination of "Aykerim" - 100%, "Favorite" - 100% and "Amber" - 40%, biometric characteristics - the height of the plant in the phase of seedlings "Aykerim" - 19 cm, "Favorite" - 14 cm, "Amber" - 13.5 cm.

4. Foam glass substrate: germination "Aykerim" - 93%, "Favorite" - 60% and "Amber" - 47%, the height of the plant in the seedling phase - "Aykerim" - 18 cm, "Favorite" - 14 cm, "Amber" - 13.5cm.

5. The jute substrate turned out to be less favorable for the varieties "Aykerim" and "Favorite", on this substrate the variety "Yantar" did not have seedlings: the germination rate of "Aykerim" was 60%, "Favorit" - 60%, the height of the plant at the seedling phase "Aykerim" - 12cm, "Favorite" - 11cm.

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ГИДРОПОНИКА ЖАҒДАЙЫНДА ORYZA SATIVA L. ЕКПЕ КҮРІШТІҢ ӨСУІНЕ МИНЕРАЛДЫ ЖӘНЕ ОРГАНИКАЛЫҚ СУБСТРАТТАРДЫҢ ӘСЕРІН ЗЕРТТЕУ

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Түйін

Органикалық және минералды субстраттар құрамының стеллаждық гидропоникалық қондырғыда өсірілген «Янтарь», «Фаворит», «Айкерим» күріш сорттарының өнуіне және дамуына әсері зерттелді.

Субстрат ретінде көбік шыны, перлит, минералды мақта, кокос субстраты, джут матасы сыналды.

Органикалық және минералды субстраттардың әсері өнгіштігі мен биометриялық сипаттамалары бойынша күріштің әртүрлі сорттарына біркелкі болмады. Минералды мақта субстраттары мен кокос талшықтарының субстраты «Айкерим» және «Фаворит» сорттары үшін ең қолайлы екендігін көрсетті. Перлит пен көбік шыны субстраттары әмбебап болып шықты, олар барлық үш сортты да өсіре алады, бірақ биометриялық көрсеткіштері төмен нәтиже берді. Джут субстраты күріштің зерттелген сорттары үшін шамалы қолайлы болды, сонымен қатар «Янтарь» сортына мүлдем жарамды.

Кілт сөздер: гидропоника; субстрат; перлит; минералды мақта; күріш.

**ИЗУЧЕНИЕ ВЛИЯНИЯ МИНЕРАЛЬНЫХ И ОРГАНИЧЕСКИХ
СУБСТРАТОВ НА РОСТ РИСА ПОСЕВНОГО ORYZA SATIVA L. В
УСЛОВИЯХ ГИДРОПОНИКИ**

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Аннотация

Было изучено влияние состава органических и минеральных субстратов на всхожесть и развитие сортов риса «Янтарь», «Фаворит», «Айкерим» выращенных на стеллажной гидропонной установке.

В качестве субстратов опробированы пеностекло, перлит, минеральная вата (агровата), кокосовый субстрат, джутовый коврик.

Влияние органических и минеральных субстратов оказалось неоднозначным на разные сорта риса по всхожести и биометрическим характеристикам. Субстраты агровата и субстрат из кокосовых волокон наиболее благоприятны для сортов «Айкерим» и «Фаворит». Субстраты перлит и пеностекло универсальны, на них можно вырастить все три сорта на них произрастают, но уступает по биометрическим показателям. Субстрат из джута оказался менее благоприятным для изучаемых сортов риса, причем, совершенно не подходит для сорта «Янтарь».

Ключевые слова: гидропоника; субстрат; перлит; минеральная вата; рис.