

Features of cultivation technology for organic pumpkin certified by JAS (Japan) in the conditions of Primorsky region

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Abstract. In the modern world, special attention is paid to rational use of natural resources and provision of the population with high-quality food. In this connection, the principles of organic farming are relevant both in our country and abroad, as they allow reducing the negative impact of agriculture on the environment. Primorsky Territory has significant potential for development of organic farming, as well as the possibility of exporting organic vegetables to the countries of the Asia-Pacific region, including Japan. Based on the results of the studies carried out, the authors found that the soil and climatic conditions of the Partizansky District of the Primorsky Territory are suitable for cultivation of pumpkins considering the requirements of the Japanese JAS standards. Compliance with the recommended agricultural practices made it possible to obtain a yield of marketable pumpkin fruits of 11.1-12.2 c/ha with high quality indicators.

1 Introduction

According to the FAO forecast, by 2050 the world's population will increase by 34 % and will amount to 9.1 billion people. In this connection, in order to provide food for the growing population, the production of agricultural products will need to be increased by 60 % [1].

In the modern world, there has been a change in paradigms and ideas about healthy food. The focus is not on volumes, gross harvests, harvest, but healthy nutrition and quality of life. Movement for the so-called "ecological vegetables" is growing, while the share of organic vegetable growing is constantly growing [2]. According to the National Organic Union of the Russian Federation, the market for organic products is one of the most dynamically developing in the world and over the past twenty years has grown more than five times (from 18 to 97 billion euros). According to forecasts by Grand View Research, the market will continue to grow at a rate of 10-12 % per year and will reach about \$212-230 billion in 2025 [3].

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A great deal of practical experience has been accumulated in the cultivation of organic crops. So, in Russia organic grain crops, soybeans, peas, potatoes and even artichoke are grown [4-6]. However, only since 2020, after the entry into force of Federal Law No. 280 "On Organic Products", this direction is regulated at the legislative level [7].

Despite the differences in the certification procedure and in the requirements for organic production in different countries, the technology of organic farming is the same, since it excludes use of synthetic agrochemicals, pesticides, hormonal preparations, and genetically modified (genetically engineered, transgenic) organisms.

According to the FIBL in 2019, 187 out of 239 countries in the world cultivate organic agriculture (78 %), 72 of them have their own laws in the field of production and circulation of organic products. The most developed systems of regulation of organic agriculture exist in Europe, the USA, Japan, India, Canada and China [8]. However, despite the fact that the *organic JAS* brand in Japan began operating in 1999, the organic market in the country is only only 185 million yen and it is produced on an area of 9,956 hectares, i.e. 0.22 % of all cultivated land. Mainly they grow fodder crops, fruits and tea [9].

Features of the geographical location of Primorsky Territory – the proximity of the markets of the Asia-Pacific region with a high demand for organic products, including Japan, presence of priority development areas and large investment projects contribute to the focus of production on such export crops as soybeans, corn, feed, vegetables, and etc., including pumpkin.

Pumpkin (lat. *Cucurbita*) is one of the valuable melons and gourds, the fruits and seeds of which are of great nutritional value, as products that provide dietary (due to the high content of carotene, dietary fiber, macro- and micronutrients) and therapeutic and prophylactic nutrition (reduces the risk of cardiovascular, oncological and gastrointestinal diseases, is a raw material for the processing and pharmaceutical industries [10, 11]). In addition, pumpkin is an indispensable vegetable in baby food and an ideal complementary food product at an early age, which is noted not only by Russian, but also by Japanese experts.

The purpose of the study is to improve the technology of pumpkin cultivation, taking into account the requirements of organic certification JAS (Japan) in the conditions of the Primorsky Territory.

2 Materials and Methods

Experimental studies to improve the technology of cultivation of organic pumpkin were carried out on the production fields of the farm of A.I. Grishko in Sergeevka village, Partizansky district, Primorsky Territory in 2021. The area of production experience is 4 hectares, the area of the experimental plot is 1 hectare (Figure 1). The object of the study is table pumpkin plants.



Fig. 1. Sowings of pumpkin in the farm of A.I. Grishko (August of 2021).

In the course of the study, field surveys, observations and measurements were carried out using B.A. Dospekhova [12] and V.F. Belik techniques [13].

Cultivation of pumpkin was carried out taking into account the requirements of organic production and in accordance with the JAS standards (Japan), which included a set of such measures as the selection of pumpkin varieties resistant to diseases; use for sowing organic seeds; placement of the crop according to the best predecessor in the crop rotation; mechanical inter-row cultivation of pumpkin crops, as an alternative to herbicides and protection against a complex of weeds at the early stages of its development; using biological fertilizers to improve soil quality and provide nutrition for pumpkin plants; optimal terms of harvesting and storage conditions for pumpkin fruits.

3 Results and Discussion

Biological features of pumpkin. Pumpkin is a melon crop demanding for heat, moisture and soil fertility. Pumpkin seeds begin to germinate at a temperature of 13-14 °C, but the optimal temperature for the growth and development of plants and pumpkin fruits is 22-25 °C. Frosts (-1 °C), even short-term ones, lead to the loss of plants. All pumpkin varieties are drought tolerant due to their strong root system. The highest water consumption by plants occurs during the period of mass flowering and fruit formation. Pumpkin grows and bears fruit with a short daylight hours. It tolerates a little shading, but tastier fruits are formed on plants well-lit by the sun. Highly fertile loamy soils are suitable for growing crops, with a reaction of 6.5-7.5. On heavy wet soils, plant growth is inhibited. Pumpkin responds positively to fertilization, especially organic fertilization [14].

Soil and climatic features of the pumpkin growing zone. Partizansky district is located in the southern part of the Primorsky Territory. The proximity of the Sea of Japan has imparted a peculiar monsoon character to the climate. Despite the rather high percentage of humidity (average annual rate of 71 %), it can be considered soft. The meteorological conditions for the growing season in 2021 significantly differed from the average long-term values. The amount of precipitation during the period of active growth and development of pumpkin plants was more than three times lower than the norm, and the temperature regime was slightly higher than the average long-term values.

The soil cover of the experimental site is represented by brown forest podzolized soils with a high degree of stonyness [15]. According to agrochemical analysis, the content of

humus in the plow horizon was 1.8 %, mobile phosphorus – 125 mg/kg, exchangeable potassium – 140 mg/kg, pH – 5.6.

Selection of varieties. In organic farming, use of chemical means of protection is excluded, and the emphasis is on biologization and organic fertilizers, and, therefore, the efficiency of the entire production largely depends on the correct choice of varieties (hybrids) of agricultural crops. According to the study program in 2021 in the conditions of the farm of A.I. Grishko one pumpkin variety Vnuchka (Far Eastern variety) and three pumpkin hybrids of Japanese breeding: Kurishogu nneo F1, TSX-891 F1, Sweet mama F1 were cultivated.

Pumpkin variety Vnuchka is a mid-early variety of pumpkin of local selection (author A.S. Kornilov), biological ripeness occurs 90-100 days after germination. The fruit is flat-round, green, with a cream-colored pattern in the form of stripes and spots, smooth one (Figure 2). The average fruit weight is 1.7 kg. The pulp is orange, thin, starchy, dense, slightly juicy. The taste is excellent. Transportable. The fruits retain their commercial qualities for 80-90 days after picking. It is drought-resistant and resistant to waterlogging.



Fig. 2. Pumpkin variety Vnuchka.

Pumpkin hybrid Kurishogun neo F1 – a hybrid of Japanese pumpkin selection. Bush type table pumpkin. Forms 2-3 fruits per plant. Ripening period is 90-95 days. The fruit is flat-round, dark green, weighing up to 2.0 kg (Figure 3). The pulp is bright yellow with a high sugar content.



Fig. 3. Pumpkin hybrid Kurishogun neo F1.

Pumpkin hybrid TSX-891 F1 – mid-early hybrid of Japanese selection for table use. The plant is climbing, on average forms 2 fruits per plant. Ripening period is 90-95 days. The fruit is flat-round, dark green, weighing 1.7-2.2 kg (Figure 4). The pulp is bright yellow with a high sugar content.



Fig. 4. Pumpkin hybrid TSX-891 F1.

Pumpkin hybrid SweetmamaF1– a hybrid of Japanese table pumpkin selection. High-yielding bush pumpkin. Forms 2-3 large fruits per plant. Ripening period is 85-90 days. The fruit is flat-round, dark green, weighing up to 1.8-2.0 kg (Figure 5). The pulp is bright yellow with a pronounced nutty taste. Possesses high keeping quality.



Fig. 5. Pumpkin hybrid Sweet mama F1

Place in the crop rotation. The basis of any crop rotation is the alternation of crops in time and territory. This achieves the prevention of appearance and active manifestation of diseases and pests, excludes one-sided soil depletion, creates the prerequisites for the rational use of fertilizers and the fight against weeds, which is of paramount importance in organic farming due to the impossibility of using chemical plant protection products. In the conditions of the farm of A.I. Grishko in 2021, pumpkin was cultivated according to one of the best predecessors – Solidor oat variety.

Main soil cultivation. The tasks of cultivation of the soil for pumpkin are the same as in cultivation of other agricultural crops: maintaining and increasing soil fertility, improving the physical properties of the soil, incorporating fertilizers, preventing the massive spread of pests, diseases and weeds, creating optimal conditions for seed germination, plant growth and activity of beneficial microorganisms. The main cultivation of the pumpkin soil included fall plowing, which was carried out in October 2020.

Spring soil preparation. The task of spring cultivation is to level the surface of the field as much as possible, destroy weeds and preserve soil moisture. In the conditions of the farm of A.I. Grishko after the onset of physical ripeness of the soil (March), harrowing was carried out with medium harrows in 2 tracks across the autumn cultivation. We used MTZ-82 tractor, ZBS-1 tooth harrows and BZS harrow coupler.

After harrowing, 2-7 days before sowing, "EM • 1 microbiological fertilizer" Vostok EM-1 "(hereinafter referred to as a biological product) is introduced into the soil at the rate of 5 l/ha in order to reduce the phytopathogenic background; increasing soil fertility; providing plants with the necessary nutrients that microorganisms produce by fermenting organic residues in the soil; normalization of air and moisture exchange in the soil.

Treatment with a solution of a biological product was carried out with MTZ 82 tractor + OM-600 sprayer at the rate of 200-300 l/ha. Immediately after introduction of the biological product with the smallest time gap, pre-sowing cultivation was carried out to a depth of 4-5 cm (MTZ-82 + KRG-3.6) (Figure 6).



Fig. 6. Presowing cultivation, April 2021

Sowing terms and methods. The timing of sowing pumpkin depends on the biological characteristics of the crop and varieties, the planned timing of the sale of products, climatic and weather conditions.

In the Primorsky Territory, pumpkin is sown in the third decade of May, when the soil warms up to 8-12 °C and the danger of frost damage to seedlings passes.

In a production experiment, the pumpkin was sown on May 25, 2021 according to the scheme 270 cm x 30-35 cm with a seeding rate of 1.5 kg/ha and a plant density of 12,000 pcs./ha (Figure 7).



Fig. 7. Sowing pumpkin, 2021

Caring for pumpkin crops. In the system of organic farming, the use of chemical herbicides is excluded and the main way to control weeds is inter-row cultivation and manual weeding. In the early stages of development, pumpkin plants are susceptible to weeds, therefore, pre-emergence and inter-row cultivation for emergence give a good effect. In 2021, in the farm of A.I. Grishko four inter-row cultivations were carried out (MTZ 82+ KRN 2.8) in the following terms: 1st – June 16, 2nd – June 21, 3rd – July 01, 4th – July 8th. In addition, after closing the rows, manual weeding of pumpkin crops was carried out as needed.

To increase plant immunity, crop yield and quality of cultivated products, pumpkin was treated with biological product "EM-1 microbiological fertilizer "Vostok EM-1" on 6-7 real leaves at a dose of 1 ml/l.

Harvesting and accounting of the harvest. The pumpkin was harvested in the third decade of October 2021. The fruits were cut off with a pruner and left in the field for 2-3 hours until the heel dries up. Collection of fruits was carried out manually in wooden boxes with a capacity of 600 kg, followed by transportation and placement in warehouses for ripening (2 weeks).

An indicator of the effectiveness of cultivation techniques in traditional agriculture is the size of the yield obtained; in organic production, the main emphasis is on product quality. Analyzing the yield of pumpkin, it shall be noted that this indicator varied from 15.5 to 17.1 t/ha (total) and from 11.1 to 12.2 t/ha (marketable fruits). At the same time, the average weight of one pumpkin fruit was 1.63-1.98 kg (Table 1). Under the conditions of 2021, the maximum yield values were obtained for the pumpkin cultivar of local breeding Vnuchka.

Table 1. Pumpkin yield in the farm of A.I. Grishko, 2021

Variety/hybrid	Productivity, t/ha		Average weight of one fruit, kg
	general	marketable fruits	
Vnuchka	17.1	12.2	1.98
Kurishogun neo F1	15.5	11.1	1.63
TSX-891 F1	16.4	11.7	1.83
Sweet mama F1	15.8	11.3	1.67

Note: according to the organic standard JAS (Japan), the mass of one pumpkin fruit shall be in the range of 1.1-2.7 kg.

One of the indicators of the quality of organic products is the content of nitrates in it. Studies have shown that in pumpkin fruits grown according to the Japanese JAS standard, the nitrate content varied from 72 to 88 mg/kg, which did not exceed the permissible MPC value [16].

Economic calculation. The economic calculation of the production of organic pumpkin was carried out within the framework of the project of the Union of Organic Agriculture "Organic agriculture – new opportunities. The system and practices of responsible land use, sustainable development of rural areas" with use of the grant of the President of the Russian Federation for development of civil society provided by the Presidential Grants Fund [17].

The data in Table 2 show that with an average pumpkin yield of 12 t/ha, the cost of organic production is 212,160 rubles/ha, and the cost of pumpkin is 17 rubles 68 kopecks

Table 2. Economic indicators of organic pumpkin production in the farm of A.I. Grishko

Name of indicator	Measuring unit	2021
Yield	t/ha	12
Seed costs (1.5 kg/ha)	rub/ha	29,640
Fuel costs	rub/ha	10,920
Costs of EM drugs ("Vostok EM-1" and "EM-5")	rub/ha	2,000
Container - wooden boxes of 500 kg	rub.	65,000
Electricity in warehouses	rub.	2,200
General running costs	rub/ha	11,800
Salary,	rub/ha	90,600
Total costs per hectare	rub.	212,160

Preparing and conducting a certification audit at the farm of A.I. Grishko according to the Japanese standard JAS were carried out with the sponsorship of the Federal State Budgetary Institution Rosselkhoztsentr in the Primorsky Territory, and, therefore the costs were not reflected in the calculation of economic indicators of production.

4 Conclusions

Based on the results of the studies, it was established that the soil and climatic conditions of the Partizansky District of the Primorsky Territory are suitable for the cultivation of pumpkins, taking into account the requirements of the Japanese standards JAS. Compliance with the recommended agricultural practices in the cultivation of melons and gourds made it possible to obtain a yield of marketable pumpkin fruits of 11.1-12.2 c/ha with high quality indicators.

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