# Selecting industrial sweet pepper varieties for Khorezm region, Uzbekistan

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**Abstract.** Industrial varieties and hybrids of sweet pepper intended for deep processing were selected for slightly saline soils in the northern regions of Uzbekistan. The optimal timing and planting schemes for obtaining a high yield from selected, promising varieties and hybrids of sweet pepper have been determined. In most developed countries of the world, the current stage of the activity of the agro-industrial complex is characterized by the transition to the model of innovation development, the main focus of which is the mutual synergy of Science, Education and production activities. The introduction of innovations into agriculture is becoming one of the main factors in increasing production and employment.

## 1 Introduction

Agriculture in Uzbekistan is one of the leading sectors of the economy, providing 25% of the country's gross domestic product and 26% of employment (UZRSSC, 2021). The cultivation of fruits and vegetables is characterized by the most profitable type of activity for the cluster, farmers and dexkans, and professional business entities [1].

The main part of vegetable products is grown in open fields. Greenhouses make up a quarter of the total area. Around the world, vegetable crops of 30-35 varieties are grown on an industrial scale, but their types change in accordance with the climatic conditions of each country, for example, in Uzbekistan, 10-15 main types, namely tomatoes, carrots, onions, cucumbers, cabbage, potatoes, garlic, sweet and hot peppers, eggplants, legumes and green vegetables, melons, watermelons, zucchini [3].

The main type of cultivated pepper (Capsicum annium L.) belongs to family Solaneceae. Sweet pepper fruit is rich in vitamins, mineral salts and dry matter, being that the fruit surpasses all vegetables in terms of forming ascorbic acid (vitamin C). The fruit contains 54-118 mg% in 100 g of the yield mass during the technical period, and up to 368-535 mg% ascorbic acid when fully biological. [10].

In addition to vitamin C, vitamins A (carotene) – 4.60 mg, v1 (thiamine) – 0.06 mg, v2 (riboflavin) – 0.01 mg are also present. The fruit content of this crop is 85.5-91.0% water, 14.4% dry matter, 1.3-1.5% protein, 5.4-5.7% carbohydrates, 1.4-1.8% cellulose like

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substances. Sweet pepper contains 0.01-0.15 percent capsaicin alkaloid, giving it a pungent taste, flavor. The amount of thiamine also increases [2].

In order to provide the population of Uzbekistan with a wide range of affordable and high-quality vegetable products, it is necessary to create varieties with high yields suitable for the conditions of the region, resistant to environmental stress factors, export-oriented and meeting the requirements of deep processing. The organization of their primary seed production and their introduction into production is one of the main tasks.

On the selection of sweet pepper, cultivation technology, the effect of mineral and biologically active substances on the plant following scientists such as E.V.Ermolova, B.J.Azimov, M.X.Aromov, R.F.Mavlyanova, V.I.Zuev, T.E.Ostanokulov, R.A. Khakimov, F.F. Rasulov, A.R. Khasanov, Sh. Like Mamadaliev from Uzbekistan and V.F. Pivovarov, E.G. Dobruskaya, L.K. Gurkina, V.V. Borodichev, E.S. Glushikhina, V.E. Zarubyan, G.S. Martirosyan, P. Bowen, B. Frey, Del Amar, F.M Yil, Z.F. Fawzy, E.N. Abdel-Samad, A.M. El-Bessiony, S.L.M. Martinez, Ganzalez-Rayrich, G. Nabi, E. Rafique, A. Parwan, A. Hossein have conducted scientific research [3; 4; 5; 6].

It is not secret that in the northern regions of our republic, Karakalpakstan and Khorezm regions, as a result of the salt content in the soil, the income received decreases every year, and large areas become unsuitable for agriculture. However, it is possible to use these lands effectively by choosing types of crops that are resistant to salt, affordable, suitable for processing, exporting and growing better products from them. It is extremely necessary to provide additional jobs to the population and create processing enterprises in order to increase their incomes.

By selecting varieties of sweet peppers that meet the requirements of deep processing and the organization of their primary seed production, it is possible to grow high-quality products on these plots of land. On the part of entrepreneurs of the Khorezm region, there is great interest in the production and export of sweet pepper paste, but to this day, not only in the northern, but also in the central and southern regions of the republic, deep and scientifically based research has not been conducted on the selection of industrial varieties of sweet pepper and the improvement of some elements of technology their cultivation.

And to fix this problem, you need to complete the following tasks. Including:

- Selection of precocious, high-yielding, deep-processing, thick-mashed, export varieties of sweet pepper suitable for the climatic conditions of the Khorezm region;

- Organization of seed production of local, precocious, high-yielding varieties for export; - Improvement of some elements of cultivation technology in the soil and climatic conditions of Karakalpakstan and Khorezm region;

- Improving the knowledge and skills of farmers and individual entrepreneurs who grow sweet peppers in Karakalpakstan and Khorezm region by organizing demonstration workshops in the field of production of high-quality and exported crops.

## 2 Materials and Methods

The object of the study: 42 samples of sweet peppers from different countries of the world and their plants.

The subject of the study: consists in the primary assessment of 42 samples of sweet pepper in the climatic conditions of the Khorezm region; based on the study of the gene pool, the selection of primary sources resistant to environmental stress factors; the selection of new varieties adapted to local conditions, improvement of quality and elements of cultivation technology (3 different terms and 5 planting schemes).

The purpose of the study: to select varieties suitable for deep processing of sweet peppers, which ripen at various times in accordance with the climatic conditions of the

Khorezm region; to organize their primary seed production and improve individual elements of cultivation technology.

The research was carried out using the methodology of "Studying the world collection" (VIR, 1984), State variety testing of agricultural crops (1971), The biochemical composition of collection samples (A.I. Ermakov, N.P.Arasimovich et al. 1987) and statistical analysis of data on B.A. Dospekhov (1985).

## 3 Results and Discussion

The results of the study were demonstrated to farmers, agricultural workers and the population in the village of Gandimion, Khiva district;

The increase in yield is explained by the fact that varieties were selected and seeds of high reproduction were obtained.

The place where the research was conducted and its climatic conditions.

Khorezm Oasis, one of the northern oases of the Republic, is located in the northern part of the vast Turonian lowland, which covers the flat part of Central Asia. It occupied the Left bank of the ancient delta of the Amu Darya. Its eastern border is a rocky plateau, and its western border is with Turkmenistan. According to the geographical location of Karakalpakstan and Khorezm region, it is located in the northern part of Uzbekistan. These areas belong to an extremely arid region, where the annual rainfall is 80-90 millimeters, and they mainly fall during the winter and spring periods. The climate of the oasis is sharply continental. Summers are hot and dry. In July, the average air temperature is +28°C, the average absolute air temperature is +41°C, sometimes the temperature rises to +46°C.

The peculiarity of the Khorezm oasis is that there is enough light and heat, and the duration of sunshine is 2700-3000 hours per year, while in summer it is 360-400 hours per month, and in winter it is 90-130 hours. The air temperature varies greatly during one day (10-150 degrees in winter and 15-200 degrees in summer). The period favorable for plant growth and development is 165-175 days per year, and this indicator is 45-50 days less than in the central and southern regions of our republic. For this reason, vegetable crops in Khorezm and Karakalpakstan are grown in open areas mainly in one period, that is, in early spring.

Soil. The soil of the experimental field is gray-earth, groundwater lies at a depth of 1.5-1.7 meters, and is highly saline. As a rule, fields sown with crops other than rice are washed three to four times a year. In the experimental field in previous years, where rice was grown, it was washed twice, and in the case of other crops - three times. The amount of salts in the soil, the content of the climate, and the high level of heat have a positive effect on increasing the dry matter content in fruits of vegetable crops, as well as on increasing their taste qualities. An example of this is the taste of melons, tomatoes and other vegetable crops grown in Khorezm.

Research field where agrotechnical activities carried out.

Before planting seedlings, 260 kg of ammophos per hectare and 100 kg of potassium were introduced. During the growing season, 2 treatments, 1 weeding and 2-fold fertilizing (160 kg each) with nitrogen fertilizers and spraying of leaves with microbiological fertilizers in the form of a suspension were carried out.

The climatic conditions of the Khorezm region are unique, and the fact that the methods of growing sweet peppers in regions relatively remote from the river and areas close to the Amu Darya differ sharply from each other is evident in our three-year studies (2022-2024).

The experimental field of 2022 was located in the Gurlan district, near the banks of the Amudarya, where the groundwater lay at a depth of 1.5-2 m and was heavily saline. In 2023, experiments were conducted in the Khiva district, where groundwater lay at a depth of 2.5-3 m, on slightly saline lands, and in 2024 - in the Khiva and Gurlen districs.

Selection of promising samples of sweet pepper based on the study of the world collection.

In the early spring period (April 25), seedlings of 42 samples of sweet pepper were planted in the collection nursery, originating from 11 countries of the world (Uzbekistan - 12, from Europe – 14, Ukraine -8, the rest from the USA, Korea and others) in one repeat, in 1 row (70 cm wide and 6 m long (4.2 m2)).

The studied varieties showed the appearance of seedlings 10-16 days after sowing. The emergence of seedlings in the varieties Emerald, Gift of Moldova, Pamir, Smorogd, Bulgarian 79, California miracle, EC01-144, C7103 sprouted 3-4 days later, compared with the standard variety Gift of Tashkent. The period from full germination to flowering in the studied varieties was 80-90 days, and according to the duration of the period they were divided into 2 groups.

The first group included varieties with a duration of this period up to 85 days, the second group included varieties with a duration of more than 90 days. The first group included the varieties "Dawn of the East", "Nargiza", "Tong", "Star", "Swallow", "Bulgarian 79", C24177, C24043, EC 01-144 F1, D 11000 F1, Jayxun F1, El Real F1, Adriatico F1, Figoro F1, Donna F1, IB0018. The second group includes varieties Dar Tashkent, Emerald, Nargiza, Sabo, Shodlik, Gift of Moldova, Pamir, Maxi Bell, California miracle, Gampion, Smorogd, LP180060, Laylak bell. The same situation was observed in F1 hybrids. The standard hybrids Jeyhun F1 and El Real F1, Adriatico F1, Figaro F1, Dovras F1, Pccraft F1 from vfccjds [it took 82-90 days to germinate before flowering, and the hybrids Donna F1, Vedrana F1, Mercedes F1 - 80 days.

The duration of the period from the full emergence of seedlings to the initial technical ripeness of fruits in the studied varieties was 107-137 days. The studied varieties were divided into 3 groups depending on the duration of the growing season:

a) the first group included varieties with a growing season of up to 100 days: Nargiza, Dawn and hybrids C 24177, C24043, Donna, Samander;

b) the second group includes varieties with a growing season of up to 125 days: Gift of Tashkent, Dawn of the East, Sabo, Yulduz, Shadlik, Swallow, Bulgarian 79, Gift of Moldova, Smorogd, California miracle, Pamir, Lilac Bell and several more varieties;

c) only one Emerald variety with a growing season of more than 125 days was included in the third group (table 1).

It took 102-124 days for the hybrids to mature technically, and all of them were assigned to the middle-ripening group. In cultivated varieties and hybrids of sweet pepper, the number of fruits, weight and productivity of one plant are different, the highest indicators in terms of the number of fruits per plant were observed in varieties C24177, C24043, Marjona, Laylak bell and it amounted to 11.5-14.5 pieces.

his is 174.2-219.7% more than the standard variety. Relatively high indicators in terms of the number of fruits were noted in the varieties of Bolgarsky 79, Podarok Moldovi. The number of fruits in these varieties was 8.0-9.2 units and was 121.2-139.4% more than in the standard variety (Table 2).

**Table 1.** Duration of the phases of development of selected collection samples of sweet pepper (2021-2023)

| № | Name of varieties and samples | from sowing to emergence, day | | from emergence, day | | | |
|---|---|---|---|---|---|---|---|
| | | | | before flowering | | technical ripeness | |
| | | 10% | 75% | 10% | 75% | 10% | 75% |
| 1 | Dar Tashkenta st | 10 | 12 | 77 | 81 | 107 | 112 |
| 2 | Marjona | 9 | 11 | 74 | 80 | 106 | 112 |
| 3 | $F_1$ Bogatir | 8 | 10 | 74 | 80 | 106 | 112 |
| 4 | $F_1$ Mersedes | 8 | 10 | 75 | 80 | 107 | 115 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5 | LP180060 | 10 | 14 | 75 | 80 | 108 | 115 |
| 6 | $F_1$ Jayhun | 10 | 13 | 75 | 82 | 108 | 115 |
| 7 | Bolgarskiy 79 | 11 | 15 | 75 | 80 | 108 | 115 |
| 8 | Lastochka | 11 | 14 | 75 | 80 | 108 | 116 |
| 9 | $F_1$ Aristotel | 9 | 11 | 78 | 83 | 110 | 118 |
| 10 | Anastasiya | 8 | 12 | 78 | 83 | 112 | 120 |
| 11 | Zarya Vostoka | 11 | 13 | 75 | 80 | 110 | 120 |
| 12 | Kaliforniyskaya chudo | 13 | 16 | 82 | 90 | 120 | 130 |
| 13 | Laylak bell | 10 | 13 | 82 | 90 | 120 | 134 |
| 14 | Zumrad | 12 | 15 | 82 | 89 | 122 | 137 |
| V% | | | | 4,2 | 4,7 | 5,9 | 6,7 |
| x= | | | | 76,0±2,8 | 82,0±3,4 | 108,2±5,8 | 116,6±7,2 |

In the Zumrad, Californiyskaya chudo varieties, the number of fruits on the plant was small and amounted to 63.6-95.5% compared to the standard variety. The largest number of fruits was observed in the Vedrana F1 hybrids (9.2 don), C30414B F1 (12 pcs.), and in them this indicator was 112.2-146.3% higher than in the standard hybrid.

It was noticed that the fruit weight of each variety and hybrid of the first generation sweet pepper varied depending on the shape of the fruit, the size and thickness of the pulp. As for the weight of the fruit, the difference between varieties and hybrids has become greater. Varietal samples in accordance with this designation were divided into four groups:

a) fruit weight of the first group up to 50 g-C24177, C24043;

b) the weight of the fruits of the second group is up to 50-80 g - Tong, Lastochka, Podarok Moldova, Bolgarskiy 79, Aristotle F1;

c) the weight of fruits of the third group of varieties reaches 80-100 g - Dar Tashkent, Marjona, Dar Tashkent 2, Vedrana, Anastasia, Laylak bell, Bogatir, PL 6726, Mercedes;

g) the fourth group includes varieties with a fruit weight of more than 100 g: Marjona, Californiyskaya chudo, Anastasiya, Laylak bell.

For breeding work, varieties of the third and fourth groups are mainly of great importance, for use as an initial material and in production, and for deep processing, varieties of all groups are of great importance.

**Table 2.** The number and weight of commercial fruits in sweet pepper samples (2021-2023)

| № | The name of the variety and hybrids | During the period of full fruit ripening | | | | | |
|---|---|---|---|---|---|---|---|
| | | the number of fruits removed from the plant (A) | | the weight of the fruit (B) | | the yield from the plant (C) | |
| | | pieces | % | g | % | g | % |
| 1 | Dar Tashkenta (st) | 6,6 | 100,0 | 89,7 | 100,0 | 594,7 | 100,0 |
| 2 | Zumrad | 5,2 | 78,8 | 135,0 | 150,5 | 702,0 | 118,0 |
| 3 | Tong | 8,4 | 127,3 | 72,5 | 80,8 | 609,0 | 102,4 |
| 4 | Yulduz | 7,2 | 109,1 | 90,8 | 101,2 | 653,8 | 109,9 |
| 5 | Lastochka | 7,0 | 106,1 | 75,2 | 83,8 | 526,4 | 88,5 |
| 6 | Podarok Moldovi | 9,2 | 139,4 | 65,2 | 72,7 | 599,8 | 100,9 |
| 7 | Bolgarskiy 79 | 8,4 | 127,3 | 68,5 | 76,4 | 575,4 | 96,8 |
| 8 | Kaliforniyskoe chudo | 5,0 | 75,8 | 120,5 | 134,3 | 602,5 | 101,3 |
| 9 | $F_1$ C 24177 | 14,5 | 219,7 | 40,2 | 44,8 | 582,9 | 98,0 |
| 10 | $F_1$ C 24043 | 11,5 | 174,2 | 49,8 | 55,5 | 572,7 | 96,3 |
| 11 | $F_1$ Vedrana | 9,2 | 112,2 | 98,5 | 93,3 | 906,2 | 152,3 |
| 12 | $F_1$ C304114B | 12,0 | 146,3 | 70,5 | 66,8 | 846,0 | 142,2 |
| 13 | Laylak bell | 8,2 | 124,2 | 85,2 | 95,0 | 698,6 | 117,5 |
| 14 | $F_1$ Bogatir | 7,5 | 113,6 | 100,0 | 111,5 | 750,0 | 126,1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 15 | $F_1$ ПЛ 6726 | 8,5 | 128,8 | 85,2 | 95,0 | 724,2 | 121,8 |
| 16 | $F_1$ Aristotel | 8,0 | 121,2 | 72,6 | 80,9 | 580,8 | 97,7 |
| 17 | $F_1$ 1601 | 6,8 | 103,0 | 84,6 | 94,3 | 575,3 | 96,7 |
| 18 | $F_1$ Mersedes | 7,2 | 109,1 | 86,8 | 96,8 | 625,0 | 105,1 |
| 19 | Marjona | 6,3 | 95,5 | 94,2 | 105,0 | 593,5 | 99,8 |
| 20 | LP180060 | 6,2 | 93,9 | 82,2 | 91,6 | 509,6 | 85,7 |
| 21 | Line 29 | 6,8 | 103,0 | 91,1 | 101,5 | 619,5 | 103,6 |
| A-B - r = -0,91 ± 0,07, A-C - r = - 0,023 ± 0,16 | | | | | | | |

In general, in terms of yield or productivity of a single plant, the difference between cultivars was large. In comparison with the standard variety, varieties with a high productivity index of one plant were identified. The yield of these varieties was 653,8-750,0 g/plant, which is 109,9-126,1% higher than that of the standard variety. The yield of plants of the varieties Podarok Moldovi, Californiyskaya chudo, Anastasia, Marjona equaled the standard variety. The yield of the remaining varieties was lower compared to the standard variety.

The yield of the first generation hybrids was significantly higher compared to the varieties. The yield of the standard variety Dar Tashkenta is 594,7 g/plant, for the hybrid Zumrad, this figure was 865,9 g. The yield of the hybrid was 145,6% higher than that of the standard variety.

The highest yield was observed in such hybrids as Vedrana F1, Laylak bell, Bogatir and PL 6726 and amounted to 906.2-947.7 g. The remaining hybrids had a yield of 84.0-98.1% compared to the standard hybrid.

The classification of fruits of the studied cultivars is one of the important indicators. The fruits of the standard variety Dar Tashkent have a conical shape, the color is light green at technical ripeness, the thickness of the fruit pulp is 3-4 mm. Such fruits are considered haridorgir in the domestic and foreign markets. Varieties with conical fruits of light green color were bred: Nargiza, Yulduz, Lastochka, Podarok Moldova, C24177.

Hybrids of the first generation, such as Jeyhun F1, Marjona, Aristotle, which embodied such features, were identified. In most hybrids, it was observed that the shape of the fruits is prismatic, the color is green, dark green. Many of these hybrids are introduced from European countries, and the demand for such varieties or hybrids in the domestic market of our country is not so great at the moment. however, the demand for varieties and hybrids with this indicator will definitely increase in the future.

The varieties Zumrad, Californiyskaya chudo, Laylak bell, Bogatir, Anastasia were identified, the fruits of which have a prismatic shape, green, dark green color with technical ripeness. Such varieties can serve as a initial material for breeding work and are cultivated for export.

According to the thickness of the fruit pulp, varietal specimens were divided into the following groups: very thin (<1 mm), thin (1,1-2 mm), medium (2,1-4,0 mm), thick (4,1-5,0 mm), very thick (>5 mm) (Table 3).

**Table 3.** Morphological indicators of fruits of promising varieties and hybrids of sweet pepper (2021-2023).

| № | Varieties and hybrids | fruits of technical ripeness: | | |
|---|---|---|---|---|
| | | shape | color | wall thickness, mm |
| 1 | Anastasiya rannospeliy | cone-shaped | light green | 4.5 |
| 2 | Lastochka | Flat-cone-shaped | light green | 4.2 |
| 3 | Laylak bell | Oblong | dark green | 3.8 |

| | | | | |
|---|---|---|---|---|
| 4 | Kaliforniyskaya chudo | short three-lobed | light green | 5.0 |
| 5 | Bogatir $F_1$ | cone-shaped | reddish | 5.2 |
| 6 | PL 6726 $F_1$ | cone-shaped | green | 5.2 |
| 7 | Aristotel $F_1$ | cone-shaped with lobes | light green | 4.6 |
| 8 | Mersedes $F_1$ | cone-shaped | reddish | 4.5 |
| 9 | Dar Tashkenta | cone-shaped | reddish | 4.0 |
| 10 | Marjona | Four-lobed | purple green | 5.5 |
| 11 | LP180060 $F_1$ | cone-shaped | light green | 3.6 |
| 12 | Carolina $F_1$ | Four-section oblong | light green | 4.3 |
| 13 | Line 29 | cone-shaped | reddish | 4.0 |
| 14 | IB0018 | cone-shaped | reddish | 4.0 |

Varieties with thin fruit pulp - Bulgarian 79, LP180060, medium thickness (2.1-4.0 mm, belongs to the largest group) - are represented by varieties Dar Tashkent, Dawn of the East, Tong, Yulduz and 20 samples. According to the thickness of the fruit pulp, the Colifornian miracle variety and the Bogatyr hybrid were isolated (5 mm).

Determination of optimal timing and planting schemes for promising varieties and hybrids of sweet pepper.

The 16 varieties of sweet pepper selected on the basis of the study of the collection (Table 4) were planted in 2022 at the Davron farm in the Khorezm region of the Khiva district and in 2023 in the Gurlen district at the experimental site of the Khorezm Experimental Station of the Scientific Research Institute of vegetable, melon crops and potato for planting at various dates (1, 5, 10 and 15 february) and schemes (70x30, 70x20, 70x15, (90x40)X15/2, (90x40)x20/2 cm).

**Table 4.** List of selected varieties and hybrids

| № | Varieties name | № | Varieties name |
|---|---|---|---|
| 1 | Anastasia | 9 | Mersedes $F_1$ |
| 2 | Lastochka | 10 | Dar Tashkenta |
| 3 | Laylak bell | 11 | Zumrad $F_1$ |
| 4 | Californiyskaya chudo | 12 | Marjona $F_1$ |
| 5 | Bogatir $F_1$ | 13 | LP180060 $F_1$ |
| 6 | PL 6726 $F_1$ | 14 | Carolina $F_1$ |
| 7 | Aristotel $F_1$ | 15 | Line 29 |
| 8 | 1601 $F_1$ | 16 | IB0018 |

It was noted that the sown seeds of varieties and hybrids germinate after 9-16 days. While the seeds sown on February 1 germinated on February 10, 75% of them were obtained on February 16 (Table 5). It was noted that, despite the high seed quality, the tested varieties and hybrids had different seed germination.

The best germination rate (65-75%) was observed in the samples Anastasia, Swallow, California Miracle, Lilac Bell. 55-60-day seedlings of bell pepper were planted at the experimental site on April 15, 20, 25 and 30 at 5 different (planting scheme) seedling densities in accordance with the research calendar plan, and work was carried out on taking care of it by timely carrying out appropriate agrotechnical measures.

The appearance of buds and flowers on plants of the first term (April 15), planted with 60-day seedlings, was observed on May 5. While the opening of the first flowers was observed in 35-45% of plants of the varieties Dar Tashkent, Anastasia and Swallow, the earliest flowering was observed in hybrids Aristotle, Mercedes and PL6726. In accordance with the flowering process, it was found that the first fruits on the plants also appeared on May 17 in the above-mentioned varieties and hybrids. The process of full flowering (75%) of varieties and hybrids during this period took 20-26 days (5 tables).

From the seeds of Bulgarian pepper of the 2nd term (April 20), that is, planted on February 5, shoots took place on February 16-20. Compared to the first term, the seeds germinated with a difference of 2-3 days. At that time, the germination process was the same as in the first term, but the process of mass germination manifested itself much faster and stronger. Both the number of seedlings and their quality were significantly higher than in the first period, and amounted to 33-63% in all samples, with the exception of Laylak bell (10%), PL6726 (14%) and Marjona (26%) varieties.

In the experimental field, where the bell pepper was planted in the 2nd term, the appearance of the first flowers (May 12), the process of mass flowering (May 18) and the appearance of the first fruits (May 25) was noted 3-4 days earlier than the first planting period. This pattern persisted during the growing season between phases: the appearance of full shoots, flowering and fruiting, in accordance with the age of seedlings that were planted with sweet pepper in the main crop.

**Table 5.** The effect of the sowing period on the phenological parameters of sweet pepper (2022-2023).

| № | Sowing dates | from sowing to germination, days | | from germination to flowering, days | | from germination to technical ripening of fruits, days | |
|---|---|---|---|---|---|---|---|
| | | 10% | 75% | 10% | 75% | 10% | 75% |
| Dar Tashkenta (St) | | | | | | | |
| 1. | 15.04. | 10 | 16 | 86 | 97 | 128 | 154 |
| 2. | 20.04. | 9 | 14 | 83 | 94 | 126 | 155 |
| 3. | 25.04 st | 10 | 15 | 84 | 95 | 127 | 158 |
| 4. | 30.04 | 9 | 15 | 85 | 95 | 127 | 157 |
| | Average | 9 | 15 | 84 | 95 | 127 | 158 |
| Marjona | | | | | | | |
| 1. | 15.04. | 11 | 17 | 88 | 96 | 136 | 158 |
| 2. | 20.04. | 10 | 16 | 84 | 92 | 127 | 154 |
| 3. | 25.04 st | 11 | 16 | 88 | 94 | 130 | 156 |
| 4. | 30.04 | 10 | 16 | 89 | 95 | 132 | 156 |
| | Average | 10 | 16 | 87 | 94 | 131 | 156 |
| Bogatir $F_1$ | | | | | | | |
| 1. | 15.04. | 10 | 15 | 88 | 97 | 130 | 155 |
| 2. | 20.04. | 8 | 13 | 84 | 92 | 127 | 153 |
| 3. | 25.04 st | 9 | 14 | 86 | 95 | 130 | 155 |
| 4. | 30.04 | 9 | 15 | 87 | 96 | 129 | 156 |
| | Average | 9 | 14 | 85 | 95 | 130 | 155 |
| Kaliforniyskaya chudo | | | | | | | |
| 1. | 15.04. | 11 | 17 | 86 | 95 | 130 | 150 |
| 2. | 20.04. | 10 | 14 | 84 | 92 | 127 | 154 |
| 3. | 25.04 st | 11 | 16 | 85 | 92 | 128 | 156 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4. | 30.04 | 10 | 15 | 86 | 93 | 129 | 158 |
| | Average | 10 | 16 | 85 | 93 | 128 | 157 |
| Carolina $F_1$ | | | | | | | |
| 1. | 15.04. | 11 | 17 | 84 | 95 | 128 | 154 |
| 2. | 20.04. | 10 | 15 | 82 | 90 | 126 | 151 |
| 3. | 25.04 st | 10 | 16 | 83 | 92 | 127 | 152 |
| 4. | 30.04 | 9 | 15 | 83 | 93 | 127 | 153 |
| | Average | 10 | 16 | 83 | 92 | 126 | 153 |
| Laylak bell | | | | | | | |
| 1. | 15.04. | 10 | 16 | 86 | 97 | 131 | 152 |
| 2. | 20.04. | 10 | 14 | 84 | 92 | 127 | 151 |
| 3. | 25.04 st | 11 | 16 | 85 | 93 | 129 | 155 |
| 4. | 30.04 | 10 | 15 | 86 | 94 | 130 | 157 |
| | Average | 10 | 15 | 85 | 94 | 129 | 157 |

10% of the seeds of sweet pepper varieties sown on February 10 began to germinate on February 19. The fastest seed germination was observed in the varieties Dar Tashkent, Kaliforniyskaya chudo, Anastasia, Laylak bell, as well as in hybrids 1601, Karolina, Bogatyr and Mercedes. In the third (April 25) and fourth (April 30) periods, it should be noted that the process accelerated even more than in the previous two periods, while an increase in external temperature had a positive effect on the germination process, but in the first period this process maintained a difference of 6-7 days. The average period of full flowering was 25-31 days.

Analyzing the results of the fifth variant of planting sweet peppers in the Khorezm region with seedlings of 55-60 days, it was found that the most optimal option is the sowing date of April 20. One of the main reasons for this may be the fact that during the period when the seedlings were planted on April 15, early frosts will damage more seedlings, and the rest of the time (April 25, 30) their pollination of flowers will decrease due to high air temperature during full flowering (Table 6).

**Table 6.** The effect of planting dates on the characteristics of sweet peppers (2022-2023).

| № | Sowing dates | the number of fruits from 1 bush | yield from 1 bush pieces | Yield | |
|---|---|---|---|---|---|
| | | | | $м^2$/кg | +/- st % |
| Dar Tashkent (st) | | | | | |
| 1. | 15.04. | 5,6 | 459,3 | 2,53 | 92,7 |
| 2. | 20.04. | 6,6 | 594,7 | 3,27 | 119,8 |
| 3. | 25.04 control | 6,2 | 496,4 | 2,73 | 100 |
| 4. | 30.04 | 6,0 | 494,2 | 2,72 | 99,6 |
| | Average | 6,1 | 511,2 | 2,81 | 100 |
| Marjona | | | | | |
| 1. | 15.04. | 5,3 | 463,5 | 2,55 | 93,4 |
| 2. | 20.04. | 6,3 | 593,5 | 3,26 | 119,4 |
| 3. | 25.04 control | 6,3 | 496,7 | 2,73 | 100 |
| 4. | 30.04 | 6,3 | 494,5 | 2,72 | 99,6 |
| | Average | 6,1 | 512,1 | 2,82 | 100,3 |
| Bogatir $F_1$ | | | | | |
| 1. | 15.04. | 6,7 | 630,0 | 3,46 | 92,3 |
| 2. | 20.04. | 7,5 | 750,0 | 4,12 | 110 |
| 3. | 25.04 control | 6,9 | 682,2 | 3,75 | 100 |

| | | | | | |
|---|---|---|---|---|---|
| 4. | 30.04 | 6,8 | 680,5 | 3,74 | 99,7 |
| | Average | 6,98 | 685,7 | 3,77 | 134,2 |
| Kaliforniyskaya chudo | | | | | |
| 1. | 15.04. | 4,9 | 502,1 | 2,76 | 87,6 |
| 2. | 20.04. | 5,0 | 602,5 | 3,31 | 105,1 |
| 3. | 25.04 control | 4,8 | 572,5 | 3,15 | 100 |
| 4. | 30.04 | 4,8 | 565,3 | 3,11 | 98,7 |
| | Average | 4,9 | 560,6 | 3,08 | 109,6 |
| Carolina $F_1$ | | | | | |
| 1. | 15.04. | 5,35 | 469,6 | 2,58 | 93,5 |
| 2. | 20.04. | 6,2 | 509,6 | 2,8 | 101,4 |
| 3. | 25.04 control | 5,73 | 501,2 | 2,76 | 100 |
| 4. | 30.04 | 5,69 | 500,1 | 2,75 | 99,6 |
| | Average | 5,74 | 495,1 | 2,72 | 96,8 |
| Laylak bell | | | | | |
| 1. | 15.04. | 7,7 | 658,2 | 3,62 | 99,2 |
| 2. | 20.04. | 8,2 | 698,6 | 3,84 | 105,2 |
| 3. | 25.04 назорат | 7,8 | 663,4 | 3,65 | 100 |
| 4. | 30.04 | 7,7 | 660,6 | 3,63 | 99,5 |
| | Average | 7,9 | 670,2 | 3,69 | 131,3 |

When the influence of timing was studied planting on the productivity of one plant of sweet pepper varieties, it was noticed that during the planting period on April 15, fruits with the smallest volume and weight (82-94 g) were obtained, and in the period on April 20, the largest and most weighty fruits (85-120 g) were obtained.

It was noted that results close to the second term (78-117 g) were obtained in sweet pepper varieties planted in the control variant and on April 30. However, it was observed that in the control and in the last variant (April 25), compared with the variants on April 15 and 20, fruit damage from sun exposure was higher.

The weight of fruits taken from one plant and the yield indicators obtained from an area of 1 m2 were also close to the data obtained by the number of fruits, and depending on the timing of sowing, as noted, amounted to 459.3 - 750 g and 2.53 – 4.12 kg, respectively. The highest yield was observed in varieties planted on April 20 (3.26 – 4.12 kg/m2). Hybrids of Marjon, Bogatyr, Karolina and Lilac Bell, California miracle varieties were identified, which have better indicators compared to the control variety Dar Tashkent.

When obtaining a high yield of sweet peppers, it is necessary to correctly determine the area of nutrition or the number of plants in the field (planting scheme). In this experiment, when the plant began to grow and develop, the number of plants in the field had an effect on the blooms of 10%. With a feeding area of 0.10-0.21 m2, the plant took an average of 84 days to bloom by 10%. When the feeding area of the plant was 0.07-0.09 m2, the plant took 80-81 days to bloom by 10%. With the planting scheme (90×40)x15/2, it was noticed that the flowering of 10% of plants accelerated (Table 7). In the conditions of the Khorezm region, the planting scheme with a width of 70 cm is rarely used. On cotton and other vegetable crops, aisles with a width of 60 cm or 90 cm are more often used.

It was found that in the experimental plots planted by us, where beds 70 cm wide with a feeding area of 0.10-0.21 m2 were used, when watered with a continuous layer, there was a lag in the growth and development phase of sweet pepper samples for 2-3 days compared with plants planted on beds 90 cm wide, due to plant lodging and damage to the root system of plants after watering (Table 7).

Similar indicators were observed in the phases of full flowering (75%) and technical ripeness. As a result of the conducted research, we note that it is advisable to plant seedlings of sweet pepper in a two-line method on beds 90 cm wide and taking into account irrigation methods of the dehkans of the Khorezm region.

From the appearance of mass shoots to 10% and 75% of the technical ripeness of sweet pepper fruits, as the area of plant nutrition decreases, fruit maturation accelerates. With a control scheme of 70 × 30 cm, it took 124-153 days for the technical ripening of fruits in the Dar Tashkent variety, and in other varieties and hybrids - 126-156 days, while with a two-line scheme, the fruits ripen after 119 and 148 days, respectively. With a decrease in the area of nutrition, the technical and biological maturation of fruits was accelerated by 2-5 days.

**Table 7.** Phenological indicators of sweet pepper varieties, under various planting schemes (2022-2023)

| Planting scheme, sм | feeding area, $m^2$ | from full emergence to ...., day | | | |
|---|---|---|---|---|---|
| | | before flowering | | before fruit ripening | |
| | | 10% | 75% | 10% | 75% |
| Dar Tashkent (st) | | | | | |
| 70×30 (control) | 0,21 | 84 | 95 | 125 | 152 |
| 70×20 | 0,14 | 82 | 93 | 124 | 151 |
| 70×15 | 0,10 | 83 | 93 | 125 | 154 |
| (90×40)x15/2 | 0,07 | 80 | 90 | 120 | 150 |
| (90×40)x20/2 | 0,09 | 79 | 91 | 121 | 150 |
| Marjona | | | | | |
| 70×30 (control) | 0,21 | 84 | 92 | 127 | 153 |
| 70×20 | 0,14 | 86 | 93 | 130 | 153 |
| 70×15 | 0,10 | 88 | 95 | 131 | 153 |
| (90×40)x15/2 | 0,07 | 82 | 91 | 129 | 150 |
| (90×40)x20/2 | 0,09 | 81 | 90 | 130 | 150 |
| Bogatir $F_1$ | | | | | |
| 70×30 (control) | 0,21 | 83 | 92 | 128 | 153 |
| 70×20 | 0,14 | 85 | 94 | 127 | 154 |
| 70×15 | 0,10 | 83 | 94 | 126 | 153 |
| (90×40)x15/2 | 0,07 | 81 | 90 | 125 | 148 |
| (90×40)x20/2 | 0,09 | 81 | 90 | 124 | 149 |
| Kaliforniyskaya chudo | | | | | |
| 70×30 (control) | 0,21 | 84 | 91 | 127 | 156 |
| 70×20 | 0,14 | 83 | 91 | 126 | 155 |
| 70×15 | 0,10 | 82 | 93 | 125 | 153 |
| (90×40)x15/2 | 0,07 | 80 | 89 | 123 | 147 |
| (90×40)x20/2 | 0,09 | 81 | 90 | 124 | 148 |
| Carolina $F_1$ | | | | | |
| 70×30 (control) | 0,21 | 81 | 90 | 124 | 151 |
| 70×20 | 0,14 | 84 | 95 | 130 | 150 |
| 70×15 | 0,10 | 81 | 90 | 125 | 149 |
| (90×40)x15/2 | 0,07 | 80 | 89 | 124 | 148 |
| (90×40)x20/2 | 0,09 | 80 | 90 | 125 | 148 |
| Laylak bell | | | | | |
| 70×30 (control) | 0,21 | 83 | 92 | 125 | 153 |
| 70×20 | 0,14 | 82 | 91 | 123 | 152 |

| | | | | | |
|---|---|---|---|---|---|
| 70×15 | 0,10 | 82 | 90 | 121 | 150 |
| (90×40)x15/2 | 0,07 | 80 | 88 | 120 | 148 |
| (90×40)x20/2 | 0,09 | 81 | 87 | 119 | 148 |
| $V_1$% | | 2,9 | - | 2,9 | |
| x= | | 81,2±2,1 | | 120,2±3,1 | |

In studies on the planting scheme, an increase in the number of fruits on the plants of the tested varieties of sweet pepper was observed with a decrease in the area of nutrition. Although such cases are also taken into account in the mass of sweet pepper fruits, it can be noted that it is equal to the arithmetic mean square of the study error (Table 8).

**Table 8.** The effect of planting schemes on the quantity and weight of sweet pepper fruits (2022-2023)

| Planting schemes, sm | Dar Tashkenta | | Bogatir $F_1$ | | Dar Tashkenta | | Bogatir $F_1$ | |
|---|---|---|---|---|---|---|---|---|
| | During the period of technical ripeness of fruits on the plant | | | | | | | |
| | the number and weight of fruits on the plant pieces | | | | | | | |
| | pieces | % | pieces | % | g | % | g | % |
| 70×30 (control) | 5,6 | 100,0 | 6,4 | 100,0 | 82,0 | 100,0 | 94,0 | 100,0 |
| 70×20 | 6,0 | 107,1 | 6,5 | 101,5 | 82,4 | 100,4 | 98,2 | 104,4 |
| 70×15 | 6,1 | 108,9 | 6,7 | 104,7 | 82,0 | 100,0 | 98,8 | 105,1 |
| (90×40)x15/2 | 6,3 | 112,5 | 7,0 | 109,3 | 83,8 | 102,2 | 99,1 | 105,4 |
| (90×40)x20/2 | 6,6 | 117,8 | 7,5 | 117,2 | 84,1 | 102,5 | 100,3 | 106,7 |
| r = | 0,94+0,19 | | 0,95±0,18 | | | | | |

## 4 Conclusion

Breeding tests of sweet pepper varieties and F1 hybrids, conclusions on the timing and planting schemes.

1. The period from full germination of seedlings to mass flowering in sweet pepper varieties was 80-90 days, and they were divided into 2 groups according to the duration of the period. The first group included the varieties Lastochka", Jeyxun F1, IB0018 and the second - Dar Tashkenta, "Zumrad", "Nargiza", "Californiyskaya chudo, Laylak bell.

2. The duration of the period from the full emergence of seedlings to the beginning of technical ripeness of fruits in the studied varieties was 107-137 days. The studied varieties were divided into 3 groups (100, 125 and more than 125 days) depending on the duration of the growing season.

3. The number and average weight of fruits and productivity of one plant are different in the cultivated varieties of sweet pepper, and the highest indicators in terms of the number of fruits per plant were observed in varieties C24177, C24043, Marjona, Laylak bell and it amounted to 11.5-14.5 pieces.

4. Varieties and hybrids Kaliforniyskaya chudo, Anastasiya, Marjona, Laylak Bell, P180060, 1601, Carolina, Bogatir and Mersedes were identified, which have a significantly higher plant productivity index than the standard variety (653.8-750.0 g/plant or 109.9-126.1%).

5. When the effect of planting dates on sweet pepper varieties was studied, the maximum yield (3.26 – 4.12 kg/m2) was observed during the sowing period on April 15,

varieties Marjona, Bogatir, Carolina, Laylak bell, Kaliforniyskaya chudo were isolated, which had better indicators compared to the Dar Tashkent variety.

6. As the area of plant nutrition decreased, the period of technical and biological fruit maturation accelerated. With a control scheme of 70 ×30 cm, it took 124-153 days for the technical ripening of fruits in the Dar Tashkent variety, and 126-156 days for other varieties and hybrids, while with a two-line planting scheme, the fruits of the sweet pepper varieties ripen after 119 and 148 days, respectively. With a decrease in the area of nutrition, the technical and biological maturation of fruits is accelerated by 2-5 days.

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