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COMPREHENSIVE ASSESSMENT OF PARTHENO-CARPIC SMOOTH-FRUITED CUCUMBER HYBRIDS IN WINTER GREENHOUSES BASED ON BIOMETRIC PARAMETERS, YIELD, AND ECONOMIC EFFICIENCY

KARACHUN V. L. – Doctor of Philosophy

orcid.org/0009-0006-8525-2080

State Biotechnological University

LEBEDYNSKYI I. V. – Candidate of Agricultural Sciences, Associate Professor

orcid.org/0000-0002-9245-5437

State Biotechnological University

YAROVY H. I. – Doctor of Agricultural Sciences, Professor

orcid.org/0000-0003-1319-4601

State Biotechnological University

ROMANOV O. V. – Candidate of Agricultural Sciences, Associate Professor

orcid.org/0000-0001-8144-4911

State Biotechnological University

Formulation of the problem. Cucumber (*Cucumis sativus* L.) is one of the leading vegetable crops of protected soil, which is due to the high consumer demand for fresh fruits due to their valuable taste and dietary properties and the possibility of year-round cultivation in two or three crop rotations [4, 15]. Cucumber fruits contain a significant amount of biologically active substances, in particular vitamins of groups B and C, carbohydrates, as well as calcium and phosphorus ions, which determine their nutritional, therapeutic, and prophylactic value. In the structure of sown areas of protected soil, this crop occupies more than 50%, which confirms its key importance for modern vegetable growing [2, 3]. In the countries of the European Union, the dominant position in industrial greenhouse production is occupied by smooth-fruited parthenocarpic cucumber hybrids, which are the main type of crop and occupy the first place in terms of cultivation volumes. Their wide distribution is due to high yield, stable fruit formation in different growing conditions, fruit uniformity, attractive appearance, and high commercial qualities that meet the requirements of the European market and network trade [9, 10, 11].

In the conditions of greenhouse development, the relevance of introducing such hybrids into the assortment is increasing in other countries, in particular in Ukraine, where the issue of adapting European parthenocarpic hybrids to the conditions of winter greenhouses requires a scientifically based assessment. The effectiveness of their use is largely determined by the biometric indicators of plants, yield potential, and economic feasibility of cultivation.

Given the increased requirements of the modern market for product quality and profitability of production, conducting a comprehensive assessment of parthenocarpic hybrids of smooth-fruited cucumber by biometric indicators, yield, and economic efficiency is a relevant and practically significant direction of scientific research.

Analysis of recent research and publications. In Poland, cucumber occupies a significant part of the protected soil area and is one of the key vegetable plants in industrial greenhouses. To ensure a stable early and winter-spring harvest, Polish farmers use modern technologies for growing F_1 hybrids, in particular parthenocarpic smooth-fruited

hybrids, such as *Mewa F₁*, *Yani F₁*, and *Pacto F₁*. The farms use intensive cultivation systems, in particular hydroponics, microclimate control, and additional lighting, which allows obtaining high-quality fruits. The total yield of such hybrids in Polish greenhouses per crop rotation is 29–38 kg/m², which confirms their high productive potential [6, 9, 10].

Parthenocarpic smooth-fruited cucumber hybrids are characterized by stable fruiting and high yield of marketable products [13]. According to Polish research, their cultivation in greenhouses with variable sowing dates and various methods of artificial lighting provides a yield of over 40 kg/m² during 16 weeks of fruiting [7, 8]. Hybrids *Mewa F₁*, *Yani F₁*, and *Melen F₁* are defined as standards of intensive greenhouse production in Poland, demonstrating stable fruit marketability of over 90 %, as well as economic efficiency with an income of approximately 60 euros per 1 m² and profitability at the level of 32 % [11]. Ukrainian scientists, in particular Sergienko O. V., Shabetya O. M., Ivchenko T. V., and others, are actively researching parthenocarpic cucumber hybrids. In their works, they evaluate new F_1 hybrid combinations by morpho-biometric indicators, productivity, and variability in protected soil conditions. The results showed that heterotic hybrids are characterized by high yield, stable fruiting, and improved fruit quality characteristics compared to parental lines, which confirms the effectiveness of using heterosis to create highly productive parthenocarpic cucumbers for intensive cultivation in greenhouses [2, 3]. In addition, other Ukrainian scientists have also achieved significant results in studying the variability and adaptation of such hybrids to protected soil conditions, which is important for the development of highly efficient technologies for their cultivation [12, 14].

The purpose of the research is to comprehensively evaluate parthenocarpic smooth-fruited cucumber hybrids in winter greenhouses under the conditions of the IV light zone in terms of biometric indicators, yield, marketability, and economic efficiency for introduction into intensive greenhouse production.

Materials and research methods. The research was conducted at the high-tech enterprise LLC TK “Dniprovsky”, which is located in the Dnipropetrovsk region, for three

years, from 2022 to 2024. All research was conducted in winter glass greenhouses of the «Anthracite» type: span width 6.4 m, column height from the foundation to the tray 3.0 m (total greenhouse height 3.6 m), column pitch 3.0 m, and trellis height 2.2 m from the substrate. Cucumber plants were grown using the method of small-volume hydroponics on the mineral wool substrate “Begrow”. All microclimate processes in the greenhouse (temperature, humidity, ventilation, and carbon dioxide supply) are automated and controlled from a computer. Also, the computer system (*Priva Integro*) regulates the number of irrigations, solution concentration, acidity, time, and amount of nutrient solution supply for each plant, necessary for moistening the substrate and optimal nutrition of each plant.

The research was conducted with smooth-fruited cucumber hybrids of foreign selection (Netherlands): *Melen F₁* (*Enza Zaden*) (control), *Pakto F₁* (*Seminis*), *Jani F₁*, and *Mewa F₁* (*Rijk Zwaan*). The included smooth-fruited cucumber hybrids are intended for cultivation in protected soil, in particular in greenhouses. The fruits of these hybrids are cylindrical, dark green in color with a smooth, thin skin, well-aligned in size, and do not require sorting, which ensures their high marketability. The length of the fruits is 21–24 cm, and the weight is 200–250 g. Vigorous plants have the ability to form more than two ovaries in one internode, which contributes to high yields even in low light and stressful growing conditions. The hybrids are adapted to cultivation in early terms, starting from mid-December, and demonstrate stable fruit formation in protected soil.

Layout of experiments using the systematic method in four replications. The area of the plot is 10 m², the total area of the plot is 14 m², and the total area of the experiment is 224 m². The seeds were sown in mineral wool cubes “Begrow” (100 × 100 mm) previously saturated with irrigation solution. At the age of 11 days from germination, the seedlings were arranged in a scheme of 20 plants per m². At the age of 24 days, the seedlings were planted in a permanent place in the greenhouse. The plant layout is 1.6 × 0.25 m, with 4 plants per mineral wool substrate “Begrow” (100 × 20 × 7.5 cm). The volume of the substrate under one plant is 3.75 l. Plant density is 2.5 plants per m². The number of plants in the plot is 25 pieces. Cucumber plants were grown using the recommended technology for winter greenhouses, and protection against diseases and pests was carried out using an integrated protection system. Cucumber harvest was carried out every other day during all fruiting months (February-June). Accounting

and observations in the experiment were carried out in accordance with generally accepted methods according to the “Methods of Research in Vegetable and Melon Growing” [1]. Economic efficiency was calculated based on the cost of the crop and the costs of obtaining it for each option according to actual data.

Research results. During the three years of research, systematic observations were made of the course of phenological phases of plant growth and development. The analysis results showed that no significant differences in the course of phenological phases were detected between the years of research. Seeds were sown on December 10, and seedlings of smooth-fruited cucumber hybrids were planted in a permanent place of cultivation in the greenhouse on the 24th day after the emergence of shoots – January 3. Table 1 shows the average for 2021–2024 indicators of the duration of phenological phases of plant growth and development – *Melen F₁* (control), *Yani F₁*, *Pakto F₁*, and *Mewa F₁*. The analysis covers the timing of the onset of the main phases of ontogenesis (seedlings, flowering, and fruiting), the duration of interphase periods, and the total duration of the fruiting period.

It was found that under the same growing conditions, the emergence of seedlings in all studied hybrids occurred simultaneously – on December 14, which indicates a high energy of seed germination. The beginning of the flowering phase was characterized by some variability and falls on the period from the 40th to the 45th day from germination. The earliest plants of the *Yani F₁* hybrid entered the flowering phase on the 40th day, while the latest – the *Pakto F₁* hybrid – entered on the 45th day. The period from germination to the beginning of fruiting was 56–60 days. The shortest interphase period was observed in plants of the *Yani F₁* hybrid (56 days), while in *Melen F₁* (control), *Pakto F₁*, and *Mewa F₁*, its duration was 60 days. The interval between flowering and fruiting phases was relatively stable and varied from 15 to 19 days, with minimum values in *Pakto F₁* and maximum values in *Mewa F₁*. The total duration of the fruiting period (from the first to the last harvest) in the studied hybrids was long and ranged from 123 to 127 days; the highest indicator was observed in plants of the *Yani F₁* hybrid (127 days), while in *Melen F₁* (control), *Pakto F₁*, and *Mewa F₁*, it was 123 days. During the research period, it was found that the studied smooth-fruited cucumber hybrids differed significantly in biometric indicators compared to plants of the *Melen F₁* hybrid in the control (Table 2).

Table 1

Duration of phenological phases of growth and development of smooth-fruited cucumber hybrids (average for 2021–2024)

Hybrid	Phase entry, date			Duration of the period, days			
	shoots	flowering	fruiting	before plants enter the phase			first–last collection
				flowering	fruiting from		
					shoots	flowering	
<i>Melen F₁</i> (c)	14.12	27.01	12.02	44	60	16	123
<i>Yani F₁</i>	14.12	23.01	08.02	40	56	16	127
<i>Pakto F₁</i>	14.12	28.01	12.02	45	60	15	123
<i>Mewa F₁</i>	14.12	24.01	12.02	41	60	19	123

The total stem length of plants of the *Melen F₁* hybrid (control) for the entire vegetation period was 294.1 cm. In plants of the *Jani F₁* hybrid, this indicator was higher by 20.4 cm (+6.9 %), and in *Mewa F₁*, by 18.4 cm (+6.3 %). At the same time, in the *Pakto F₁* hybrid, the stem length was slightly shorter than the control and was 290.6 cm, which is 3.5 cm (-1.2 %) less compared to *Melen F₁*. The number of leaves per plant in *Melen F₁* (control) was 61.7 pcs. In the *Jani F₁* and *Mewa F₁* hybrids, this indicator exceeded the control by 3.2 pcs. (+5.2 %) and 7.4 pcs. (+12.0 %). In contrast, in *Pakto F₁* the number of leaves was lower than the control by 1.9 pcs. (-3.1 %). In terms of the number of lateral shoots, the *Melen F₁* hybrid (control) formed an average of 14.2 pcs. Plants of the *Yani F₁* hybrid had a slight advantage over the control (+0.4 pcs.; +2.8 %), while *Mewa F₁* significantly exceeded it – by 2.0 pcs. (+14.1 %). In the plants of the *Pakto F₁* hybrid, the number of lateral shoots was 1.8 pcs. less than the control (-12.7 %).

Plants of the *Melen F₁* hybrid (control) formed an average of 53.8 fruits over the entire fruiting period. In the *Jani F₁* hybrid, the number of fruits was 5.1 pcs. more (+9.5 %), and in *Mewa F₁* – by 1.4 pcs. (+2.6 %). In turn, the plants of the *Pakto F₁* hybrid were inferior to the control in the number of fruits by 1.9 pcs. (-3.5 %). The average fruit weight in the control was 216.6 g. In the *Yani F₁* hybrid, the average fruit weight was higher by 14.9 g (+6.9 %), and in the *Mewa F₁* by 13.0 g (+6.0 %). In the *Pakto F₁* hybrid, the average fruit weight exceeded the control and

was 225.8 g, which is 9.2 g (+4.2 %) more compared to *Melen F₁* (control).

Analysis of the dynamics of the yield of smooth-fruited cucumber hybrids during the fruiting period indicates significant differences between the studied hybrids in terms of the intensity of product formation relative to the control variant *Melen F₁*.

In February, the plants of the *Melen F₁* hybrid (control) formed a yield of 1.4 kg/m². The *Yani F₁* hybrid exceeded the control by 0.8 kg/m², while the plants of the *Pakto F₁* hybrid were inferior in yield to the control by 0.2 kg/m². The yield of the *Mewa F₁* hybrid was slightly higher than the control and was 1.8 kg/m² (Fig. 1).

In March, a significant increase in yield was observed in all variants. The control hybrid provided 6.1 kg/m². The *Yani F₁* hybrid exceeded the control by 0.3 kg/m², while *Pakto F₁* was inferior to *Melen F₁* (control) by 0.3 kg/m².

In April, the intensity of crop yield increased significantly. In the control variant, the yield was 7.5 kg/m². The *Yani F₁* hybrid formed 1.1 kg/m² more production compared to the control, *Mewa F₁* – 0.5 kg/m² more, while *Pakto F₁* was inferior to *Melen F₁* by 0.2 kg/m².

The maximum yield was observed in May. The control hybrid *Melen F₁* provided 9.2 kg/m². The *Yani F₁* hybrid exceeded the control by 1.5 kg/m², *Mewa F₁* by 1.2 kg/m², and *Pakto F₁* formed a yield 0.2 kg/m² higher than the control variant.

In June, a decrease in the intensity of fruiting was noted in all the studied hybrids due to the end of the growing

Table 2

Biometric indicators of smooth-fruited cucumber hybrids (average for 2022–2024)

Hybrid	Hybrid				NIR _{0,05}
	<i>Melen F₁</i> (c)	<i>Yani F₁</i>	<i>Pakto F₁</i>	<i>Mewa F₁</i>	
Total stem length for the entire growing season, cm	294,1	314,5	290,6	312,5	8,14-10,01
Number of leaves on the plant during the entire growing season, pcs	61,7	64,9	59,8	69,1	1,60-3,37
Number of lateral shoots, pcs	14,2	14,6	12,4	16,2	0,51-0,80
Number of fruits per plant for the entire fruiting period, pcs	53,8	58,9	51,9	55,2	0,40-0,71
Average fruit weight for the entire fruiting period, g	216,6	231,5	225,8	229,6	2,56-3,15

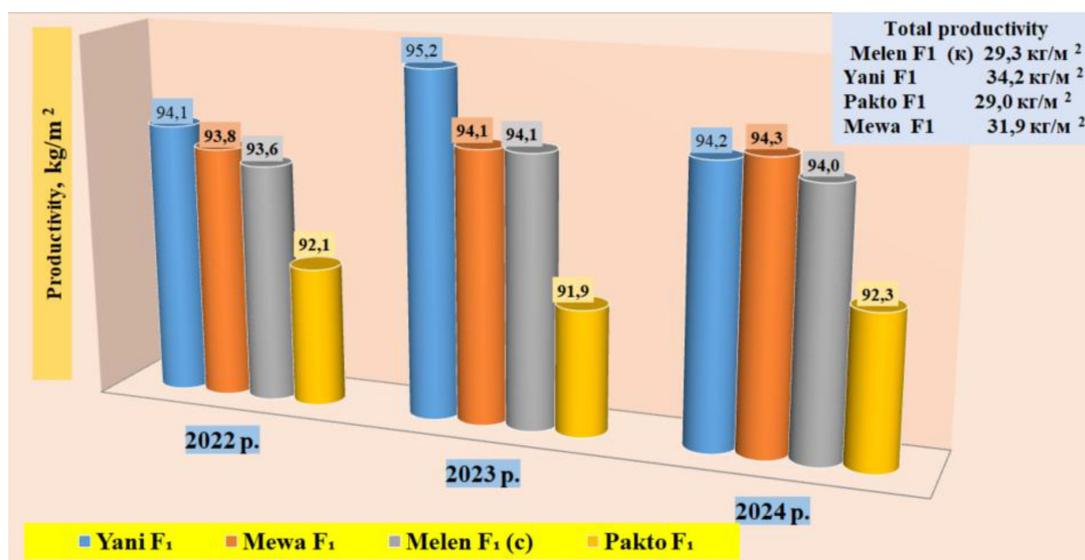


Fig. 1. Dynamics of the harvest of smooth-fruited cucumber hybrids for the entire fruiting period, on average for 2022–2024

period (plant death in the second decade of June). The yield of *Melen F₁* was 5.1 kg/m². The *Yani F₁* hybrid exceeded the control by 1.2 kg/m², *Mewa F₁* by 0.5 kg/m², while *Pakto F₁* formed a yield 0.2 kg/m² higher than the control.

Table 3 presents the results of the assessment of the total yield of smooth-fruited cucumber hybrids for the entire fruiting period. Plants of the *Melen F₁* hybrid (control) produced a yield of 29.3 kg/m², with fluctuations in the indicator from year to year from 28.9 to 29.7 kg/m².

The obtained data on yield show that the highest level over the three years of research was formed by the *Yani F₁* hybrid – 34.2 kg/m², which significantly exceeded the control by 4.9 kg/m², or 16.7 %. The high productivity of this hybrid was stable throughout the entire research period and fluctuated within 33.7–34.6 kg/m² depending on the year. The *Mewa F₁* hybrid occupied an intermediate position in terms of yield. Its average indicator was 31.5 kg/m², which provided an increase in yield compared to the control by 2.2 kg/m², or 7.5 %. The yield of *Mewa F₁* was characterized by insignificant variability over the years (31.1–32.1 kg/m²), which indicates the relative stability of crop formation. The lowest average yield indicators were formed by the plants of the *Pakto F₁* hybrid – 29.0 kg/m², which were inferior by 0.3 kg/m², or 1.0 %, which indicates the absence of a significant advantage of this hybrid in terms of productivity compared to *Melen F₁*.

Thus, the results of the research confirm the pronounced specificity of the genotype of smooth-fruited cucumber hybrids

to the formation of yield, among which the most productive and promising is the *Yani F₁* hybrid, while the *Mewa F₁* hybrid is characterized by a sufficiently high and stable level of yield.

Over the years of research (2022–2024), the marketability of the fruits of smooth-fruited cucumber hybrids was stably high – 91.9–95.2 % (Fig. 2).

The average marketability of the *Melen F₁* hybrid (control) was 93.9 %. The highest indicator during the research period was formed by the *Yani F₁* hybrid – 94.5%, which was 0.6 % higher than the control. The *Mewa F₁* hybrid also had higher marketability of fruits compared to the control (94.1 %), with an increase of 0.2 %. The lowest values were noted in the *Pakto F₁* hybrid – 92.1 %, which is 1.8 % less than the control.

The economic efficiency of growing smooth-fruited cucumber hybrids in winter greenhouses in 2021–2024 was formed under the influence of the yield level, sales price, and structure of production costs (Table 4).

The *Melen F₁* hybrid (control) provided a yield of 29.3 kg/m² at an average selling price of 57.9 UAH/kg, which allowed us to obtain a yield of 1697.9 UAH/m². The highest indicators of economic efficiency were formed by the *Yani F₁* hybrid, the yield of which was 34.2 kg/m², which exceeded the control by 16.7 %. With almost the same average selling price, this ensured an increase in profitability to 1990.2 UAH/m². Thus, the decisive factor in increasing economic efficiency was the increase in yield and not the

Table 3

Yield of smooth-fruited cucumber hybrids for the entire fruiting period (average for 2022–2024)

Hybrid	Yield, kg/m ²				Yield increase	
	2022	2023	2024	average yield	kg/m ²	%
<i>Melen F₁</i> (c)	28,9	29,7	29,2	29,3	–	–
<i>Yani F₁</i>	34,3	34,6	33,7	34,2	4,9	16,7
<i>Pakto F₁</i>	28,4	29,5	29,1	29,0	–0,3	–1,0
<i>Mewa F₁</i>	32,1	31,2	31,1	31,5	2,2	7,5
<i>NIR</i> _{0,05} kg/m ²	0,99	0,99	0,68			

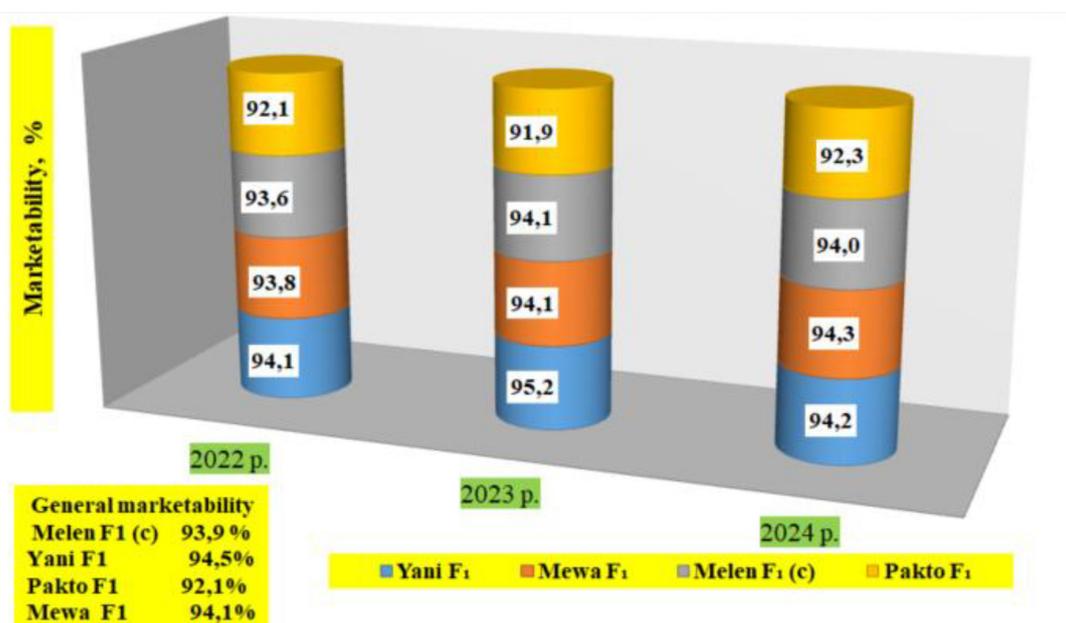


Fig. 2. Marketability of smooth-fruited cucumber hybrids for the entire fruiting period (average for 2022–2024)

Table 4

Economic efficiency of growing smooth-fruited cucumber hybrids on average for 2021–2024

Economic efficiency indicator of production	Hybrid			
	<i>Melen F₁</i> (c)	<i>Yani F₁</i>	<i>Pakto F₁</i>	<i>Mewa F₁</i>
Yield, kg/m ²	29,3	34,2	29,0	31,5
Average price (2022–2024), UAH	57,9	58,2	55,9	58,1
Yield on area, UAH/m ²	1697,9	1990,2	1620,5	1831,6
Energy costs, UAH/m ²	811,4	811,4	811,4	811,4
Salary costs, UAH/m ²	298,7	311,2	302,1	309,7
Costs for raw materials and supplies, UAH/m ²	201,1	206,5	204,4	206,5
Packaging, logistics, marketing costs, UAH/m ²	94,5	96,2	93,8	95,7
Fixed costs, UAH/m ²	14,2	14,2	14,2	14,2
Other costs, UAH/m ²	21,6	21,6	21,6	21,6
Total production costs, UAH/m ²	1311,2	1329,1	1317,9	1327,6
Full cost, UAH/m ²	1441,5	1461,1	1447,5	1459,1
Conditional net profit, UAH/m ²	256,4	529,1	173,0	372,5
Net profit growth, UAH/m ²	0,0	272,7	-83,4	116,1
Profitability level, %	17,8	36,2	12,0	25,5

price situation. The total production costs in the studied variants were close in magnitude (1311.2–1329.1 UAH/m²), which indicates the same technological model of cultivation. The dominant share in the cost structure was occupied by energy carriers, which is a characteristic feature of winter greenhouse production and significantly limits the possibilities of reducing the cost of production. The total cost of production ranged from 1441.5 to 1461.1 UAH/m²; however, the increase in costs in the variant with the *Yani F₁* hybrid was fully compensated by the increase in gross revenue. As a result, the conditional net profit reached 529.1 UAH/m², which exceeded the control by 272.7 UAH/m², and the profitability level increased to 36.2 %. The *Mewa F₁* hybrid was characterized by a moderately high yield (31.5 kg/m²) and a stable sales price, which provided a conditional net profit of 372.5 UAH/m² and a profitability level of 25.5 %. This confirms its economic feasibility as an alternative option for production. The least effective hybrid was the *Pakto F₁*, which had the lowest selling price at a cost level close to control. This led to a decrease in yield, conditional net profit (173.0 UAH/m²), and profitability to 12.0 %, which is 5.8 % less than the control option.

The results obtained confirm that in conditions of high energy intensity of greenhouse cucumber production, the main reserve for increasing economic efficiency is the intensification of production through the use of high-yielding hybrids. An increase in yield, even with a slight increase in cost, provides a significant increase in profit and profitability. At the same time, a decrease in the selling price, in the absence of compensation by yield, leads to a significant deterioration in economic indicators even with stable costs.

Conclusions and suggestions.

Under the same conditions in winter greenhouses, all the studied hybrids of smooth-fruited cucumber are suitable for cultivation in winter-summer crop rotation. Analysis of biometric indicators shows that plants of the hybrids *Yani F₁* and *Mewa F₁* exceeded the hybrid *Melen F₁* (control) in most parameters of growth and development. The length of the stem in *Yani F₁* was 6.9 % longer, in *Mewa F₁* it was 6.3 %, while in *Pakto F₁* it was 1.2 % shorter. The number of leaves

in *Yani F₁* exceeded the control by 5.2 %, in *Mewa F₁* by 12.0 %, and in *Pakto F₁* by 3.1 % shorter. In terms of the number of lateral shoots, *Yani F₁* exceeded the control by 2.8 %, *Mewa F₁* by 14.1 %, and *Pakto F₁* by 12.7 %. The average fruit weight in *Yani F₁* was 6.9 % higher, in *Mewa F₁* it was 6.0 %, and in *Pakto F₁* it was 4.2 %. The data obtained indicate the advantages of the cucumber hybrids *Yani F₁* and *Mewa F₁* in terms of plant growth and development intensity.

According to the results of three-year studies, it was found that smooth-fruited cucumber hybrids differed significantly in the level and stability of total yield, which is due to the specific features of their genotype. The highest yield was formed by the *Yani F₁* hybrid – 34.2 kg/m², which significantly exceeded the control (*Melen F₁*) by 4.9 kg/m², or 16.7 %, and was characterized by high stability of the indicator over the years of research. The *Mewa F₁* hybrid provided an average yield of 31.5 kg/m², which is 2.2 kg/m², or 7.5 %, more than the control.

The economic efficiency of growing smooth-fruited cucumber hybrids was determined primarily by the level of yield. The highest economic efficiency indicators were formed by the *Yani F₁* hybrid, the yield of which was 34.2 kg/m², which was 4.9 kg/m² (16.7 %) higher than the control (29.3 kg/m²). At an average selling price of 57.9 UAH/kg, this provided a yield of 1990.2 UAH/m², a conditional net profit of 529.1 UAH/m², and a profitability level of 36.2 %, which was 272.7 UAH/m², or 18.4 % higher than the *Melen F₁* cucumber hybrid.

The results obtained indicate the feasibility of using the *Yani F₁* and *Mewa F₁* hybrids for growing in winter greenhouses.

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Карачун В. Л., Лебединський І. В., Яровий Г. І., Романов О. В. Комплексна оцінка партенокарпічних гібридів гладкоплідного огірка в зимових теплицях за біометричними показниками, урожайністю та економічною ефективністю

У статті наведено комплексну оцінку партенокарпічних гібридів гладкоплідного огірка (Мелен F_1 , Яні F_1 , Мева F_1 та Пакто F_1) за біометричними показниками рослин, урожайністю та економічною ефективністю вирощування в зимових теплицях типу «Антрацит» у Степовій зоні України. У країнах ЄС переважають гладкоплідні партенокарпічні гібриди огірка, які займають лідируюче місце у промисловому тепличному виробництві. Їх популярність зумовлена високою врожайністю, стабільним плодотворенням, однорідністю та привабливістю плодів, а також високими товарними якістьми, що відповідають вимогам європейського ринку. В умовах високої енергоємності тепличного виробництва огірка головним резервом підвищення економічної ефективності є інтенсифікація виробництва за рахунок використання високопродуктивних гібридів. Дослідження проводили на високотехнологічному підприємстві ТОВ ТК «Дніпровський» у 2022–2024 рр. Для дослідження обрали гладкоплідні гібриди зарубіжної селекції (Нідерланди): Мелен F_1 (Enza Zaden, контроль), Пакто F_1 (Seminis), Яні F_1 та Мева F_1 (Rijk Zwaan). Фенологічні спостереження показали одночасну появу сходів усіх гібридів (14 грудня) та початок цвітіння на 40–45-ту добу від сходів. Найкоротший період від сходів до плодоношення мав Яні F_1 (56 діб), у інших гібридів він складав 60 діб. Загальна тривалість плодоношення коливалася від 123

до 127 діб, найбільша – у Яні F_1 . Біометричні показники свідчать, що рослини Яні F_1 та Мева F_1 перевищували контроль (Мелен F_1) за більшістю параметрів росту. Трирічне дослідження показали, що найбільший приріст урожайності відносно контролю забезпечив Яні F_1 (+16,7 %), Мева F_1 мав помірний приріст (+7,5 %), а Пакто F_1 поступався контролю (–1,0 %), що підкреслює значення генотипу у формуванні продуктивності. Економічна оцінка свідчить, що найбільш ефективним у зимових теплицях є Яні F_1 завдяки високій врожайності та прибутковості. Мева F_1 рекомендований як економічно доцільна альтернатива, тоді як використання Пакто F_1 менш виправдане через нижчі показники рентабельності.

Ключові слова: огірок, гладкоплідний гібрид, зимові теплиці, врожайність, економічна ефективність, рентабельність, партенокарпічний.

Karachun V. L., Lebedynskyi I. V., Yarovyi H. I., Romanov O. V. Comprehensive assessment of parthenocarpic smooth-fruited cucumber hybrids in winter greenhouses based on biometric parameters, yield, and economic efficiency

The article presents a comprehensive assessment of parthenocarpic smooth-fruited cucumber hybrids (Melen F_1 , Yani F_1 , Mewa F_1 , and Pakto F_1) in terms of plant growth and development, yield, and economic efficiency of cultivation in “Anratsyt”-type winter greenhouses in the Steppe zone of Ukraine. In the European Union, smooth-fruited parthenocarpic cucumber hybrids dominate industrial greenhouse production. Their widespread use is attributed to high yield, stable fruit setting, uniformity and attractiveness of fruits, as well as high marketable quality meeting European market requirements.

In conditions of high energy intensity of greenhouse cucumber production, the main way to improve economic efficiency is intensification through the use of high-yielding hybrids. The research was conducted at the high-tech enterprise LLC TC “Dniprovskiy” in 2022–2024. The study included foreign smooth-fruited cucumber hybrids (Netherlands): Melen F_1 (Enza Zaden, control), Pakto F_1 (Seminis), Yani F_1 , and Mewa F_1 (Rijk Zwaan).

Phenological observations showed simultaneous seedling emergence for all hybrids (December 14) and the beginning of flowering on days 40–45 after emergence. The shortest period from seedling emergence to fruiting was observed in Yani F_1 (56 days), while in other hybrids it was 60 days. The total fruiting duration ranged from 123 to 127 days, with the longest observed in Yani F_1 .

Biometric measurements indicated that Yani F_1 and Mewa F_1 plants exceeded the control (Melen F_1) in most growth and development parameters. Three-year studies showed that Yani F_1 provided the highest yield increase relative to the control (+16.7 %), Mewa F_1 had a moderate increase (+7.5 %), while Pakto F_1 was lower than the control (–1.0 %), highlighting the significant role of genotype in yield formation.

Economic evaluation demonstrated that Yani F_1 was the most efficient in winter greenhouses due to high yield and profitability. Mewa F_1 is recommended as an economically viable alternative, whereas the use of Pakto F_1 is less justified due to lower profitability.

Key words: cucumber, smooth-fruited hybrid, winter greenhouse, yield, economic efficiency, profitability, parthenocarpic.

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