Research Journal of Agricultural Science, 57 (2), 2025; ISSN: 2668-926X

http://doi.org/10.59463/RJAS.2025.2.10

HETEROSIS EFFECT IN PARTHENOCARPIC FIRST GENERATION CUCUMBER HYBRIDS

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Abstract. *The aim of the scientific research conducted in 2022-2023 in film greenhouses and open ground was to evaluate a set of the main useful traits (early, total and standard fruit yield) and study the heterosis effect in six hybrid combinations of parthenocarpic cucumber created on the basis of the maternal form ZhL-85. One of the main issues in cucumber plant breeding is the nature and degree of heterosis depending on the parental forms involved in the crossing and growing conditions (open and protected ground). The main source material was the institute's selection samples - the maternal form ZhL-85 and paternal lines 79, 81, 84, 101, 103, E-23. The studies were conducted using generally accepted standard methods in solar-heated film greenhouses and open ground. New hybrid combinations of parthenocarpic cucumber were obtained, and high positive competitive heterosis was revealed over the years in three of them when grown in film greenhouses and open ground. According to the results of the studies, the most promising and competitive samples for the main economically valuable traits are parthenocarpic heterotic hybrids of universal purpose F1 85 x 101, F1 85 x E-23 and F1 85 x 103. These hybrids are early maturing, characterized by a high degree of parthenocarpy, bouquet type of flowering (1-5 ovaries are formed in one node), friendly return of early and high yield of standard crop, with beautiful, even, short fruits of gherkin type (shape index 3.2-3.6), white-spined, medium-tuberculate, highly transportable, dark green in colour, intended for fresh consumption and canning; tolerant to downy mildew and resistant to bacteriosis and true powdery mildew.*

Key words: *cucumber, hybrid combination, parthenocarpy, productivity, heterosis effect, competitive heterosis, film greenhouse, open field.*

INTRODUCTION

Cucumber occupies one of the leading places in global production. It is traditionally one of the most beloved cultures among the people. The constant increase in the area under this crop is facilitated by its relative precocity, universality, rent, as well as the constant demand for fruits among the population, which guarantees a hundred-mile market [1].

Currently, the most pressing issue in the field of selection, seed growing and agricultural technology of cucurbits crops, in particular cucumber, is the creation of new hybrids that combine high yield of fruits and seeds, complex resistance to diseases that have high-quality products [2, 3, 4] and for parthenocarpy hybrids – and a high degree of parthenocarpy [5].

One of the most important directions in plant breeding is heterosis, a complex biological phenomenon observed in the first generation after crossing various varieties and plant lines. The nature and degree of expression of heterosis in each specific case depends on the conditions for growing a particular culture [6]. The level of heterosis changes on average over the years of research [7].

Breeding science does not yet have a more powerful means of increasing the yield of cucumbers, and many other cucurbits crops, than using heterosis, which appears in first-generation hybrids [8].

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Many foreign scientists in their works pay great attention to the study of the degree and nature of the expression of various types of heterosis (true, hypothetical and competitive), assessing the main economically valuable characteristics, in particular, the early, total and commercial (standard) yield of cucumber [9, 10, 11, 12, 13, 14, 15, 16].

Studying the physiological and biological effect of heterosis in cucumber, T. Khomenko et al. [17] revealed that the majority of cucumber hybrids, whose lines have a high combinational ability, have a heterotic effect.

The purpose of our research was to study the heterosis effect in parthenocarpic cucumber hybrids created on the basis of the maternal form FL-85 and the expression of competitive heterosis according to the main economically valuable characteristics in different years of laying experiments.

Selection work on cucumber culture (Cucumis sativus L.) is associated with the creation of heterosis cucumber hybrids that meet the requirements of the modern market [18].

MATERIALS AND METHODS

The scientific work was carried out at the Pridnestrovian Research Institute of Agriculture in 2022-2023.

The research was carried out in film greenhouses with solar heating and open field. For two years, during the entire growing season (from april to september), the climatic conditions for growing cucumbers both in a film greenhouse and in the open field were not entirely favorable. The growth and development of cucumber was strongly influenced by night and daytime temperature fluctuations, uneven precipitation, and hence low humidity.

The main selection material for the work was samples obtained in the laboratory of cucurbits of the Pridnestrovian Research Institute of Agriculture – the maternal form of FL-85 and six paternal lines – 79, 81, 84, 101, 103, E-23.

The control sample was FL-85 (super-superelite) on the basis of which all six hybrid combinations were created.

Evaluation of F_1 hybrids was carried out according to parthenocarpy, early, total and yield of standard fruits.

The degree of expression of parthenocarpy was calculated according to the Cucumber Selection Guidelines [19].

Crop counting was carried out after one day, early yield was determined for the first 15 days of fruiting [20].

The degree of expression of competitive heterosis by economically valuable characteristics was determined according to D.S. Omarov [21].

Mathematical processing of the obtained experimental data was performed by methods of analysis of variance according to B.A. Dospekhov [22].

http://doi.org/10.59463/RJAS.2025.2.10

RESULTS AND DISCUSSIONS

Currently, there is a fairly large assortment of short-fruited parthenocarpic cucumber hybrids for universal use in production, that is, intended for cultivation both in the open field and under temporary film shelters.

The task of modern heterosis breeding is to obtain competitive parthenocarpic cucumber hybrids with a complex of economically valuable traits and properties.

In 2022-2023, six parthenocarpic hybrid combinations based on the maternal form of FL-85 were evaluated in a film greenhouse and open field.

As the obtained research data show (Table. 1), in a film greenhouse, according to the degree of expression of parthenocarpy, only two hybrid combinations (85 x E-23 and 85 x 101) significantly exceeded the original form of FL-85, respectively, by 6 and 8%, two were at the level, and the rest were inferior.

The hybrid combination 85 x 101 is characterized by the highest early and total yields, which significantly exceeded FL-85, respectively, by more than 3 and 2 times. Hybrid combinations of 85 x 79 and 85 x E-23 also had significantly higher data, respectively, by 43 and 50% for early, 33 and 32% for total yield and 85 x 103 – only for total yield – by 44% and had a significantly high yield of standard fruits (94 – against 85% in the maternal form, i.e. 11% higher). The rest of the hybrids were at, with the exception of 85 x 101, which reliably lost.

In the open ground (Table. 1) four hybrid combinations, with the exception of two, significantly exceeded the original parent form by 53-176% in early yield and five hybrids, with the exception of one (85 x 81) – by 33-92% in total yield.

In the yield of standard fetuses, all hybrid combinations were at the FL-85 level, with the exception of one (85 x 101), which was significantly inferior to the original form.

Therefore, in terms of the set of useful features, both when evaluated in a film greenhouse and in open field, the best were three hybrid combinations (85 x 101, 85 x E-23, 85 x 103) based on the original maternal form of the FL-85.

Table 1

Evaluation of hybrid combinations of parthenocarpic cucumber according to the main economically valuable characteristics (film greenhouse, open field, 2022-2023)

Name sample	Signs											
	Partenocarpia, %			Yield, kg/m², t/ha						Exit standard fruits, %		
				early			total					
	years											
	2022	2023	average	2022	2023	average	2022	2023	average	2022	2023	average
Film greenhouse												
FL-85 (super-superelite)	91	88	90	2,9	3,1	3,0	12,0	12,6	12,3	86	83	85
85 x 79	86	92	89	4,4	4,1	4,3	17,3	15,4	16,4	88	85	87
85 x 81	83	80	82	2,5	3,3	2,9	10,1	12,8	11,5	80	85	83
85 x 84	87	81	84	4,3	3,4	3,9	16,1	14,3	15,2	83	88	86
85 x 101	95	98	97	9,6	8,8	9,2	27,0	25,2	26,1	78	80	79
85 x 103	93	92	93	4,2	3,7	4,0	16,5	18,9	17,7	95	93	94

http://doi.org/10.59463/RJAS.2025.2.10

85 x E-23	96	93	95	4,7	4,3	4,5	15,1	17,3	16,2	86	82	84
$LSD_{0,95}$			3			1,2			3,1			5
Open field												
FL-85 (super-superelite)				8,8	11,8	10,3	21,2	33,1	27,2	80	83	82
85 x 79				14,7	22,4	18,6	47,5	50,2	48,9	79	77	78
85 x 81				9,4	13,5	11,5	28,4	39,9	34,2	77	83	80
85 x 84				12,3	16,7	14,5	30,7	41,4	36,1	79	80	80
85 x 101				27,7	29,1	28,4	43,1	47,5	45,3	74	75	75
85 x 103				18,8	25,4	22,1	46,3	52,1	49,2	84	88	86
85 x E-23				12,4	19,2	15,8	37,1	49,9	43,5	74	85	80
$LSD_{0,95}$						4,5			8,2			6

The analysis of six hybrid combinations of first-generation cucumber in reciprocal crosses with the original maternal form of FL-85 on the basis of the main economically valuable features made it possible to evaluate the expression of competitive heterosis, which is an important criterion for evaluating F_1 hybrids on a complex of features in practical selection.

According to the results of the obtained data (Table 2), in the spring film greenhouse according to data for 2022 and 2023, a positive competitive heterosis on the basis of parthenocarpia was noted, respectively, in 50 and 67% of hybrids of the total number of hybrid combinations; according to the signs of early and total yield, respectively, in 84 and 100% of the total hybrids; according to the yield of standard fruits, respectively, in 33 and 67% of hybrids from the total number of samples.

The highest positive competitive heterosis for two years was observed in three hybrid combinations (85 x 101, 85 x E-23, 85 x 103) on the grounds of parthenocarpia, early and total yield and in the combination 85 x 103 – on the yield of standard fruits.

Table 2

Effects of competitive heterosis in cucumber F_1 hybrids according to the main economically valuable characteristics (film greenhouse, open field, 2022-2023)

Hybrid combination, F_1	Signs							
	Parthenocarpia		Yield				Exit standard fruits	
			early		total			
	years							
	2022	2023	2022	2023	2022	2023	2022	2023
Film greenhouse								
85 x 79	-5,5	4,5	51,7	32,3	44,2	22,2	2,3	2,4
85 x 81	-8,8	-9,1	-13,8	6,5	-15,8	1,6	-7,0	2,4
85 x 84	-4,4	-7,8	48,3	9,7	34,2	13,5	-3,5	6,0
85 x 101	4,4	11,4	231,0	183,9	125,0	100,0	-9,3	-3,6
85 x 103	2,2	4,5	44,8	19,4	37,5	50,0	10,5	12,0
85 x E-23	5,5	5,7	62,0	38,7	25,8	37,3	0	-1,2
Open field								
85 x 79			67,0	89,8	124,0	51,7	-1,25	-7,2
85 x 81			6,8	14,4	34,0	20,5	-3,8	0

http://doi.org/10.59463/RJAS.2025.2.10

85 x 84			39,8	41,5	44,8	25,1	-1,25	-3,6
85 x 101			214,8	146,6	103,3	43,5	-7,5	-9,6
85 x 103			113,6	115,3	118,4	57,4	5,0	6,0
85 x E-23			40,9	62,7	75,0	50,8	-7,5	2,4

The data of Table 2 under open ground conditions of 2022 and 2023 indicate that a positive competitive heterosis was observed in 100% of hybrid combinations in terms of early and total yield, and in the yield of standard fruits, respectively, in 17 and 50% of samples of the total amount. The maximum effects of competitive heterosis in terms of early and total yield for two years, as in the conditions of a film greenhouse, were noted in three hybrid combinations – 85 x 101, 85 x 103, 85 x E-23, and in the sample 85 x 103 – in the yield of standard fruits.

The greatest difference in years was noted on the basis of "yield of standard fruits" during growing, both in a film greenhouse and in open field.

Accordingly, two hybrid combinations (85 x 101 and 85 x E-23) are characterized by high positive effects of competitive heterosis for three of the four traits and one (85 x 103) for all four traits when grown in protected soil; in open ground, the same two hybrid combinations (85 x 101 and 85 x E-23) for two of the three signs and one (85 x 103) for all three signs.

Thereby, the obtained research results on the degree of expression course heterosis in early, total and yield of commercial (standard) cucumber fruits in unheated greenhouses and open field are consistent with studies conducted in Russia by L.A. Chistyakova and O.V. Baklanova [23], abroad – A.K. Singh, N.C. Gautam, R.D. Singh [10]; S. Anita, H.H. Ram [13]; K. Kaur, R.K. Dhall [16] and others.

CONCLUSIONS

1. The most promising parthenocarpic hybrids, selected on the basis of the maternal form of FL-85, are three hybrid combinations – 85 x 101, 85 x E-23, 85 x 103.

2. A high positive competitive heterosis in terms of the main economic prices in 2022 and 2023 was noted in the three above hybrid combinations when grown in film greenhouses and open field.

3. The results of the conducted research are confirmed by the works of domestic and foreign scientists.

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