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The manifestation of the heterosis effect in F_1 hybrids with naturally colored cotton fiber.

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ABSTRACT

The article presents the manifestation on the heterosis effect in F_1 hybrids with naturally colored cotton fiber. Determine the effect of heterosis based on the dominance coefficient (hp) and indicators of true heterosis. As a result of the research, 3 hybrid combinations with the effect of heterosis were identified.

In the combination F_1(*G.hirsutum* L Arkansas green lint (hairy) x Omad), the dominance coefficient for fiber yield was 0,9, fiber length 0,1, number of bolls on the plant 19, weight of raw cotton per boll 5,0, weight 1000 pieces of seeds 2,1. The micronaire index was 4,7, the specific breaking load of the fiber was 30,5. In the hybrid combination F_1(*G.hirsutum* L Cambodia 664 x L-4), the dominance coefficients were equal to fiber yield of 0,3, fiber length 3, number of bolls on a plant 27, mass of raw cotton per boll 1,2, mass of 1000 seeds 0,4. The micronaire index was 4,7, specific breaking load of fiber 33. In the hybrid combination F_1(*G.hirsutum* L. 2-6-14 ware H 11 x L-248), the dominance coefficient were equal to fiber yield 0,4, fiber length (-1), number of bolls per plant 6,2, weight raw cotton 3, weight of 1000 pieces of seeds 0,6. The micronaire index was 4,3, the specific tearing load of the fiber was 33. The selected hybrid combinations, according to research result, are recommended both for the effect of heterosis and as a source material for the creation of high – yielding cotton varieties.

Key words: heterosis, dominance coefficient, yield and fiber length, cotton samples with naturally colored fiber.

INTRODUCTION.

Due to the severe environmental pollution observed in recent years, the demand for organic products in agriculture has increased. Chemical dyes used in the textile industry top the list of substances that cause serious environmental damage during production. Based on this, we set the task to determine the effect of heterosis in F_1 hybrids obtained from hybrids with naturally colored cotton fiber. Heterosis breeding remains the main solution to the problem of increasing yields per unit area of crops, which is a very urgent task facing breeders and geneticists. In this regard, the manifestation of heterosis by economically valuable traits in F_1 hybrids obtained with a sample of naturally colored cotton fiber was studied, since the high yield of hybrids is ensured by the manifestation of a heterosis effect by economically valuable traits.

The main goal was to identify combinations with a high heterosis effect and select the most promising hybrids for further work in creating high-yielding cotton varieties with naturally colored fiber. Heterosis and the degree of phenotypic dominance are statistical indicators that fully reflect the transmission of hereditary information from parents to descendants [15]. Heterosis is the result of the work of the totality of the diversity of genes, pathways of interaction and processes operating at different system levels and stages of development of a living organism. The contribution of structural and non-structural DNK polymorphism to the realization of sweet pepper F_1 heterosis was studied in order to identify the presence of a direct relationship between the level of genetic polymorphism of the original parental forms and heterosis in the F_1 generation of their hybrids. When studying the structural polymorphism of DNK using microsatellite markers, it was found that part of the variation in the manifestation of heterosis can be explained by polymorphism, which is revealed by SSR analysis. It has been established that the total number of polymorphic loci and the ratio coefficient of polymorphic and monomorphic loci can serve as an additional criterion for selecting promising crossing combinations. The existence of epigenetic DNK variation can explain the absence of a linear relationship between the level of structural DNK divergence and F_1 heterosis, as well as the manifestation of heterosis during hybridization of genetically similar material [№6]. Currently, the heterosis effect is widely used in the breeding of various crops [1, 2, 3, 5, 7, 9, 10, 11, 12, 13, 16]. According to A.V.Kilchevsky, the study of the manifestation of heterosis should be carried out in the following stages:

- the study of the genetic nature of a quantitative trait,
- analysis of the degree of genetic divergence of the original parental forms,
- improving methods for selecting valuable starting forms based on molecular markers,
- the analysis of the combinational abilities of the parents in the corresponding crossing schemes,
- ecological organization of the breeding process,

- the use of periodic selection in order to accumulate and concentrate desirable alleles in the initial populations and increase the effect of heterosis in new breeding cycles [8]. Optimization of the hybrid seed production system, including through the use of sterile forms.

By creating heterotic hybrids, it is possible to solve not only the problem of increasing yields, but also the problem of overcoming negative correlations between economically valuable traits [4]. This advantage of the heterosis effect increases the need to use heterosis hybrids in the selection of cotton with naturally colored fiber, since there is an inverse correlation between the fiber color attribute and its qualitative indicators in the samples. In this regard, the manifestation of heterosis by economically valuable traits in cotton hybrids with naturally colored fiber was studied.

The purpose of the research. To study the manifestation of heterosis according to economically valuable characteristics in F_1 hybrids with naturally colored cotton fiber and to identify combinations with the effect of heterosis.

MATERIAL AND METHODS.

The study was conducted at the Research Institute of Plant Genetic Resources. Samples of the national Genebank of the Research Institute of Plant Genetic Resources and introgressive lines created during many years of scientific research were used as parent forms. 21 hybrid combinations have been studied in the research. The coefficients of feature dominance were determined by the formula S.Wright cited in the works of Y.M.Beil, R.E.Atkins [№16].

$$hp = \frac{F_1 - MP}{P - MP}$$

Here: hp is the coefficient of dominance;

F_1 - is the average value of the trait indicators in the hybrid combination; MP is the average value of the trait between both parents;

P - is the value of the attribute in the best parent.

In F_1 plants, the dominance of one or another trait is determined according to the following principle.

hp=0 - dominance does not exist;

0<hr<1-incomplete dominance;

hp=1 - total dominance;

hp>1 - heterosis.

The value of true heterosis was calculated by Omarov [13]. True heterosis characterizes a stronger manifestation of the trait in F_1 compared to the best parent form.

$$G\text{true.} = \frac{F1 - Pmax}{Pmax} \times 100\%$$

Here: F_1 - is the average value of the trait in the hybrid combination;

P_{max} -is the value of the trait in the best parent. Cotton samples with naturally colored fiber were obtained from the National Genebank of the Research Institute. Genetic resources of plants and used as maternal forms in crossbreeding. Introgressive cotton lines created in scientific research for many years have been used as paternal forms.

RESULT AND DISCUSSION.

The productivity of cotton is determined by the number of pods per plant and the weight of the raw cotton of one box. The genetic analysis of the sign of the number of boxes on one cotton plant was carried out repeatedly on different species. The paratypical variability of the sign of the number of boxes on a plant is so strong that it can completely obscure the differences. It has been established that the productivity of hybrids is due to the additive and dominant effects of genes, as well as the effects of over dominance. Inheritance of traits the number of pods per plant and the mass of raw cotton per pods of cotton in F_1 hybrids ranged from hybrid depressions to heterosis (*Table 1*). The heritability coefficient (hp) ranged from -5 to 27 in hybrid combinations. High heterosis on this trait was observed in 17 of the 21 studied hybrid combinations. The greatest heterosis was observed in hybrid combinations F_1(*G.hirsutum* L Cambodia 664 x L-4), F_1(L-7 x *G.hirsutum* L Cambodia 664) and F_1(*G.hirsutum* L Arkansas green lint (hairy) x Omad), heritability coefficients (hp) were 27, 21 and 19, respectively. The greatest heterosis was observed in hybrid combinations F_1(*G.hirsutum* L Cambodia 664 x L-4), F_1(L-7 x *G.hirsutum* L Cambodia 664) and F_1(*G.hirsutum* L Arkansas green lint (hairy) x Omad), heritability coefficients (hp) were 27, 21 and 19, respectively. Negative heterosis on this trait was observed only in two hybrid combinations. Another indicator that determines the productivity of cotton is the mass of raw cotton in one box. It is noted in the literature that there is a negative correlation between the number of boxes per plant and the mass of raw cotton of one box of cotton [№14]. Positive heterosis was observed in 16 of the 21 studied hybrid combinations by weight of raw cotton of one box. Negative heterosis (hp-0.6; -0.3; -0.2) was observed in 3 hybrid combinations. The greatest heterosis on this trait was observed in the following hybrid combinations: F_1(*G.hirsutum* L.stonovilla 213 x L-248) - 9.5; F_1(*G.hirsutum* L Arkansas green lint (hairy) x Omad) - 5.0; F_1(G.*hirsutum* L. stanovilla 213 x L-248) -7.2. In all studied hybrid combinations, it was observed that the true indicators of heterosis in fiber yield, which differ from other signs, were negative. However, in hybrid combinations F_1(*G.hirsutum* L. Arkansas green lint (hairy) x Omad); F_1*(G.hirsutum* L. simpkins urg. 540 x L-6); F_1(*G.hirsutum* L.G.hirsute 2-6-14 ware H 11 x L-248); F_1(*G.hirsutum* L. stonovilla x L-248) incomplete dominance was observed, and the dominance coefficient was 0.9; 0.8; 0.4, respectively. Positive heterosis was observed by weight of 1000 pieces of seeds in 8 hybrid combinations, and the dominance coefficients (hp) were in the range of 2.1-4.1. High heterosis was observed in the following hybrid combinations: F_1(*G.hirsutum* L. Nells Sellst 50 x L-5); F_1(*G.hirsutum* L. Xaki 313 x L-6); F_1(*G.hirsutum* L. stonovilla 213 x L-248). Negative heterosis was observed in 8 hybrid combinations. We can observe a similar situation when inheriting fiber length. High fiber length heterosis was observed in hybrid combinations F_1(*G.hirsutum* L. Xaki 313 x L-6); F_1(L-7 x *G.hirsutum* L Cambodia 664) and F_1(*G.hirsutum* L Cambodia 664 x L-4). The dominance coefficients were 5.0; 4.5; 3, respectively. It is known that the micronaire and the specific breaking load of the fiber are also important indicators that determine the quality of the fiber. In all hybrid combinations isolated by the effect of heterosis, the micronaire indices were 4.4 and 4.7, that is, they are within the optimal limits for medium fibrous cotton varieties. The indicators of the specific breaking load of the fiber in hybrid combinations F_1(*G.hirsutum* L. Xaki 313 x L-6); F_1(L-7 x *G.hirsutum* L Cambodia 664) and F_1(*G.hirsutum* L Cambodia 664 x L-4) were equal to 30.2; 33.5 and 33 g/tex, respectively (Table *2*).

Conclusion. As a result of the research, the following hybrid combinations were identified, observed heterosis by a complex of signs: F_1(*G.hirsutum* L Arkansas green lint (hairy) x Omad); F_1(*G.hirsutum* L Cambodia 664 x L-4); F_1(*G.hirsutum* L Cobalt T-16 x L-3) and F_1(*G.hirsutum* L.G.hirsute 2-6-14 ware H 11 x L-248).

Table 1. Dominance coefficient (hp) and indicators of true heterosis for an economically valuable trait in F_1 hybrids with naturally colored cotton fiber.

№	Parent forms	Number of bolls per plant, things.			Mass of raw cotton per box, grams.			Fiber output,%.			Weight of 1000 pieces of seeds, grams.			Fiber length, inch.		
		X	hp	$Г_{ист}$	X	hp	$Г_{ист}$	X	hp	$Г_{ист}$	X	hp	$Г_{ист}$	X	hp	$Г_{ист}$
1	Л-248	27	–	–	4,0	–	–	39,6	–	–	100	–	–	1,21	–	–
2	Л-1	25	–	–	4,9	–	–	41,7	–	–	100	–	–	1,08	–	–
3	Л-2	25	–	–	5,4	–	–	39,8	–	–	100	–	–	1,17	–	–
4	Л-3	10	–	–	5,6	–	–	38,7	–	–	112,2	–	–	1,18	–	–
5	Л-4	18	–	–	5,2	–	–	37,8	–	–	104	–	–	1,17	–	–
6	Л-5	19	–	–	5,8	–	–	34,8	–	–	134,4	–	–	1,16	–	–
7	Л-6	25	–	–	4,9	–	–	41,7	–	–	100	–	–	1,08	–	–
8	Л-7	26	–	–	5,2	–	–	38,4	–	–	100	–	–	1,14	–	–
10	*G.hirsutum* L simpkins urg. 540	9	–	–	3,9	–	–	27,0	–	–	145,2	–	–	0,99	–	–
11	*G.hirsutum* L. stonovilla 213	9	–	–	3,8	–	–	26,1	–	–	111,9	–	–	0,84	–	–
12	*G.hirsutum* L Cambodia 664	7	–	–	3,6	–	–	27,4	–	–	132,3	–	–	1,11	–	–
13	*G.hirsutum* L Kasch	9	–	–	3,1	–	–	31,6	–	–	117,9	–	–	0,89	–	–
14	*G.hirsutum* L Arkansas green lint (hairy)	11	–	–	4,9	–	–	26,0	–	–	137,8	–	–	0,96	–	–
15	*G.hirsutum* L Omad.	12	–	–	4,9	–	–	40,0	–	–	109,2	–	–	1,16	–	–
16	*G.hirsutum* L Cobal T-16	9	–	–	4,5	–	–	15,7	–	–	127	–	–	0,84	–	–
18	*G.hirsutum* L. Nells Sellst	8	–	–	4,8	–	–	21,5	–	–	129	–	–	0,95	–	–
19	*G.hirsutum* L. Xaki 313	10	–	–	4,7	–	–	34,4	–	–	116,1	–	–	1,11	–	–
20	*G.hirsutum* L. Nankeen spot R2	14	–	–	6,3	–	–	28,9	–	–	181,6	–	–	1,02	–	–
21	*G.hirsutum* L.G.hirsute 2-6-14 ware H 11	12	–	–	4,8	–	–	17,8	–	–	127,5	–	–	0,89	–	–
22	*G.hirsutum* L.	15	–	–	4,7	–	–	18,8	–	–	130,5	–	–	0,87	–	–
Hybrid combinations																
23	F_1(*G.hirsutum* L. stonovilla 213 x Л-248)	18	10	1,25	5,6	9,5	0,3	33,7	0,13	-0,1	118,6	2,1	0,05	1,05	0,15	-0,1
24	F_1(*G.hirsutum* L Cambodia 664 x Л-6)	21	15	2,5	3,8	-0,6	-0,1	33,9	-0,08	-0,1	130,5	0,8	-0,01	1,17	0,4	-0,03

25	F_1(*G.hirsutum* L Kasch x Л-2)	33	13	3,7	6,0	1,0	0,1	34,9	-0,1	-0,1	114,4	0,6	-0,02	1,08	0,3	-0,07
26	F_1(*G.hirsutum* L Arkansas green lint (hairy) x Omad)	21	19	0,8	5,5	5,0	0,1	39,8	0,9	-0,005	111,5	-0,8	-0,19	1,07	0,1	-0,07
27	F_1(*G.hirsutum* L Cobal T-16 x Л-3)	7	–5	–0,3	4,9	1,1	0,08	28,3	0,09	-0,2	111,7	-1,0	-0,1	0,99	-0,1	-0,16
28	F_1(*G.hirsutum* L Kasch x Omad)	13	1,6	0,2	5,6	1,7	0,1	35,0	-0,1	-0,1	111,6	-0,4	-0,05	1,1	-1	-0,05
29	F_1(*G.hirsutum* L Cambodia 664 x Л-4)	21	27	1,8	3,5	1,2	-0,2	34,5	0,3	-0,08	111,9	-0,4	-0,15	1,23	3	0,1
30	F_1(*G.hirsutum* L. Nells Sellst 50 x Л-5)	10	3	0,17	5,3	1,5	0,01	29,9	0,2	-0,1	142,9	4,1	0,06	1,09	0,5	-0,06
31	F_1(*G.hirsutum* L Kasch x Л-2)	11	2	0,3	5,6	1,3	0,07	22,0	-3,3	-0,4	121,5	1,4	0,03	1,16	0,9	-0,08
32	F_1(*G.hirsutum* L. Xaki 313x Л-1)	12	1,8	0,2	5,5	1,6	0,03	38,5	0,13	-0,07	108,9	0,1	-0,06	1,09	0,0	-0,01
33	F_1(*G.hirsutum* L. Nankeen spot R2x Л-2)	13	0,7	0,3	4,7	–0,2	–1,6	34,5	0,03	-0,1	114,2	-0,6	-0,3	1,07	-0,2	-0,08
34	F_1(*G.hirsutum* L Cobal T-16 x Л-3)	12	5	0,2	5,8	2,7	0,1	31,3	0,3	-0,1	131,0	1,5	0,03	1,05	0,2	-0,1
35	F_1(Л-7 x *G.hirsutum* L Cambodia 664)	17	21	0,7	4,1	–0,3	–0,2	28,9	-0,7	-0,2	129,1	0,8	-0,02	1,22	5,0	0,07
36	F_1(*G.hirsutum* L. Xaki 313 x Л-6)	18	4,2	-0,4	5,6	2,3	0,07	31,3	-1,8	-0,2	121,2	1,6	0,04	1,18	4,5	0,05
37	F_1(*G.hirsutum* L Cobal T-16 x Л-248)	12	4	0,5	5,4	4	0,2	29,1	0,12	-0,2	123,2	-0,7	-0,02	0,98	-0,25	-0,19
39	F_1(*G.hirsutum* L. Xaki 313 x Л-6)	48	16,2	-0,4	5,0	2,5	0,04	33,0	-1,3	-0,2	132,9	3,07	0,1	1,18	4,5	0,06
40	F_1(*G.hirsutum* L G.hirsute 2-6-14 ware H 11 x Л-3)	12	1	0,09	5,1	4,9	5	28,5	0,02	-0,2	129,2	1,2	0,01	1,01	-0,13	-0,1
41	F_1(*G.hirsutum* L. stonovilla 213 x Л-248)	10	2	0,25	5,2	7,2	0,2	35,7	0,4	-0,09	114,2	1,3	0,02	1,12	0,55	-0,07
42	F_1(*G.hirsutum* L x Л-248)	10	–0,25	0,6	5,3	4,3	0,6	30,8	0,1	-0,2	108,6	-0,4	-0,1	1,05	0,05	-0,12
43	F_1(*G.hirsutum* L.G.hirsute 2-6-14 ware H 11 x Л-248)	25	6,2	0,3	5,2	3	0,16	33,3	0,4	-0,1	123,3	0,6	-0,03	1,08	0,18	-0,1
44	F_1(*G.hirsutum* L simpkins urg. 540 x Л-6)	20	6,5	1,2	5,1	1,6	0,06	40,3	0,8	-0,03	113,4	-0,4	-0,2	1,11	1,6	0,02

Table 2. **Indicators of micronaire and specific tensile load of fiber in F_1 hybrids with naturally colored cotton fiber.**

№	**Parent forms**	**Mic**	**Str**	**Fiber Light**
1	Л-248	4,7	32,4	White
2	Л-1	5,1	29,3	White
3	Л-2	4,2	30,6	White
4	Л-3	4,8	32,7	White
5	Л-4	4,6	32,5	White
6	Л-5	4,7	30,5	White
7	Л-6	5,1	29,3	White
8	Л-7	4,8	31,2	White
9	*G.hirsutum* L simpkins urg. 540	5,1	26,0	Light brown
10	*G.hirsutum* L. stonovilla 213	5,5	30,4	Light brown
11	*G.hirsutum* L Cambodia 664	5,1	28,6	Brown
12	*G.hirsutum* L Kasch	4,8	23,4	Light brown
13	*G.hirsutum* L Arkansas green lint (hairy)	4,5	25,4	Green
14	*G.hirsutum* L Omad	4,7	33,1	White
15	*G.hirsutum* L Cobal T-16	3,6	22,0	Green
16	*G.hirsutum* L. Nells Sellst	4,9	25,9	Pale pink
17	*G.hirsutum* L. Xaki 313	4,7	29,6	Light brown
18	*G.hirsutum* L. Nankeen spot R2	5,2	27,7	Light brown
19	*G.hirsutum* L.G.hirsute 2-6-14 ware H 11	3,9	27,4	Green
20	*G.hirsutum* L.	2,9	22,2	Brown
21	F_1(*G.hirsutum* L. stonovilla 213 x Л-248)	5,3	29,4	Light brown
22	F_1(*G.hirsutum* L Cambodia 664 x Л-6)	4,2	34,5	Brown
23	F_1(*G.hirsutum* L Kasch x Л-2)	4,7	30,4	Light brown
24	F_1(*G.hirsutum* L Arkansas green lint (hairy)xOmad)	4,7	30,5	Light brown
25	F_1(*G.hirsutum* L Cobal T-16 x Л-3)	4,8	28,5	Brown -green
26	F_1(*G.hirsutum* L Kasch x Omad)	4,8	28,6	Light brown
27	F_1(*G.hirsutum* L Cambodia 664 x Л-4)	4,7	33,0	Brown
28	F_1(*G.hirsutum* L. Nells Sellst 50 x Л-5)	4,7	30,8	Pale pink
29	F_1(*G.hirsutum* L Kasch x Л-2)	4,6	32,9	Light brown
30	F_1(*G.hirsutum* L. Xaki 313x Л-1)	5,2	28,8	Light brown
31	F_1(*G.hirsutum* L. Nankeen spot R2 x Л-2)	5,4	35,4	Brown
32	F_1(*G.hirsutum* L Cobal T-16 x Л-3)	4,9	30,3	Green
33	F_1(Л-7 x *G.hirsutum* L Cambodia 664)	4,4	33,5	Light brown
34	F_1(*G.hirsutum* L. Xaki 313 x Л-6)	3,9	30,2	Brown
35	F_1(*G.hirsutum* L Cobal T-16 x Л-248)	4,9	28,3	Green
36	F_1(*G.hirsutum* L. Xaki 313 x Л-6)	4,7	31,5	Brown
37	F_1(*G.hirsutum* L G.hirsute 2-6-14 ware H11xЛ-3)	4,6	29,5	Green
38	F_1(*G.hirsutum* L. stonovilla 213 x Л-248)	5,4	34,4	Light brown
39	F_1(*G.hirsutum* L x Л-248)	4,4	28,7	Green
40	F_1(*G.hirsutum* L.G.hirsute 2-6-14 ware H11xЛ-248)	4,3	28,9	Green
41	F_1(*G.hirsutum* L simpkins urg. 540 x Л-6)	5,0	28,9	Light brown

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