Inheritance of yield and fiber length in hybrids cotton of the first generation F_1

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Abstract. The patterns of inheritance and variability of economically valuable traits in cotton, manifestations of heterosis, as well as its preservation in hybrid populations with a high inheritance potential during intraspecific and genotypically distant hybridization were determined. Thus, in order to obtain heterosis hybrid combinations in Fl for the "fiber yield" trait, cotton varieties with the same or closele related indicators of this trait were involved in crossing (UF0800038 K 113 / UF0800040 K 111, UF0800038 K 113 /UF0800256 0212). Dominance of one of the parent forms according to the trait "fiber length" in F_1 plants is manifested in hybrids that differ sharply in terms of indicators. An intermediate type of trait inheritance was observed in hybrids genotypically close and geographically distant in origin. When studying the variability and inheritance of the trait "fiber length" in parental varieties and their F_1 hybrids, it was found that positive overdominance or positive heterosis for the fiber length trait was observed in hybrids with different genotypes and in geographically distant forms. Negative superdominance based on fiber length, i.e. negative heterosis, was found in hybrids with different genotypes and indicators, as well as in samples geographically distant in origin. In general, analyzing the fiber length inheritance data, it can be concluded that the F_1 hybrid combinations mainly showed negative and positive overdominance. Therefore, it can be argued that the fiber length in F1 hybrids is mainly regulated by dominant genes.

1 Introduction

Taking into account Today, in the countries of the world where cotton is grown, the issue of creating varieties that would be characterized by high yield, good fiber quality indicators, resistance to diseases, pests and adverse environmental factors is urgent.

Cotton processing allows you to obtain hundreds of different products, without which the existence of many branches of the national economy is unthinkable today. However, the main product of growing this crop is fiber. Increasing the yield of cotton varieties and at the same time providing the textile industry with high-quality fiber has always been the focus of attention of researchers [1].

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Selection for product quality is important and directly related to selection for productivity. The concept of crop product quality is quite broad and is determined by the direction of its use.

The creation of precocious varieties with a high fiber yield is of great importance, which allows to dramatically increase its production per unit area without additional costs, except for the selection process. The introduction of varieties in which the yield of fiber is only 1% higher than that of the standard allows the state to obtain additional meters of fabric.

Therefore, scientists have recently focused their efforts on creating cotton varieties that would meet the requirements of modern industry.

In breeding work, special attention is paid to determining the patterns of inheritance and variability of economic and valuable traits, the manifestation of heterosis, as well as its preservation in hybrid populations with a high potential of inheritance under intraspecific and genotypically distant hybridization [2-7].

Three forms of genetic effects have been identified (partial, full, superdominant), while the main contribution to heterosis is made by the superdominant effect [8].

The phenomenon of heterosis is widespread and has been used in agricultural crops for about a century as a multigenic complex trait, extrapolated as the sum total of many phenotypic traits [9].

The study of heterosis is very important for the identification of promising hybrid combinations for further development of the material, as well as for use as such for the commercial cultivation of hybrids [10]. After all, heterosis is a phenomenon when hybrid offspring show better qualities than their parental inbred lines [11]. However, in order for heterosis to occur during the creation of a variety, parental forms must be distinguished by better genetics, be physiologically effective and have a high combining ability [12, 13].

Nowadays, much attention is paid to the study of the genetics of fiber yield. In connection with the transition of cotton farming to crop planning and the absence of varieties of the G. hirsutum L. species with a fiber yield higher than 38% in production, the creation of varieties with high quality indicators has become an important task of selection. Therefore, the relevance of this issue is beyond doubt.

The purpose of the study is to determine the patterns of inheritance and variability of fiber yield in cotton in the first generation.

2 Methods

The study was conducted on the fields of selective crop rotation at the Institute of Irrigated Agriculture. Standard agronomic practices were used, including soil preparation with ammonium nitrate and sowing at optimum soil temperature. The study included extensive evaluations based on fixed samples and morphological classifications according to established varietal testing methods. Experimental data were statistically analyzed and dominance levels in F1 plants were calculated using specific formulas. Based on fiber yield, parental forms were classified to obtain a comparative assessment of their economic traits and hybrid potential.

3 Results and Discussions

Experiments were conducted in the selective crop rotation fields of the selection department of the Institute of Irrigated Agriculture of the National Academy of Sciences during 2020 - 2023. The subjects of the research were collection samples of cotton of different maturity groups and hybrid material.

The agrotechnical conditions for conducting the experiments were generally accepted for the Southern Steppe of Ukraine and were conducted on dark-chestnut medium-loam slightly saline soils. The predecessor is winter wheat. For pre-sowing cultivation, 1 t/ha of ammonium nitrate was applied. Sowing was carried out in the first decade of May, when the soil temperature at a depth of 5 cm reached 18–20 °CThe samples in the collection nursery were sown in single-row sections 3 m long for collection samples and 5 m for hybrids, with 15 cm between rows, without repetitions. In the collection nursery, the standard zoned cotton variety Dneprovskaya 5, bred by the Institute of Irrigated Agriculture, was placed every 9 samples; parental forms were used in the hybrid sections. During the vegetation period, the crop was watered twice with a flow rate of 400-500 m^3 of water per hectare.

Weather conditions during the years of research were typical for the Southern Steppe zone of Ukraine, which contributed to an objective assessment of the collection material and the selection of the best numbers according to economically valuable characteristics.

The crossing was carried out according to the generally accepted method with castration and isolation of buds on the eve of flowering and synthetic pollination of flowers on the day of opening. The evaluation of traits was carried out on 10 permanently fixed samples according to the method of the State Commission for Variety Testing of Agricultural Crops [14]. The morphological description and classification by economic traits were carried out according to the "Wide Unified Classifier - Handbook of the Genus Gossypium hirsutum L." [15]. Statistical processing of experimental data was carried out according to the Methodology of Field and Laboratory Research on Irrigated Lands edited by R.A. Vozhekhova [16].

The research material was the parental forms of cotton varieties UF0800038 K113, UF0800064 Namangan-77, UF0800040 K111, UF0800256 0212, UF0800170 Stoneville 213, UF0800025 3988 and medium fiber cotton of the species G. hirsutum L. Crossing occurred for the use of classical methods of genetics and cotton selection. Comparative morphological analysis of hybrid plants, phenological observations, hybridological and variation-statistical analyzes were carried out.

In F_1 plants, the degree of dominance (hp) was determined according to the formula proposed by H. Daskalev [17].

hp = (MP-F1) / (P-MP),

where hp is the coefficient of dominance;

MP is the average indicator of parental forms;

F_1 – indicator of hybrids;

P is an indicator of the best father.

In the first hybrid generation, the inheritance of traits was observed, which was expressed in the following order:

hp = 0 – the case of dominance was not observed;

0 < hp < 1 - partial dominance;

hp = 1 – complete dominance;

hp >1 - superdominance or heterosis.

Parental forms and indicators of fiber yield of hybrid plants in the F1 nursery were studied.

Parental forms of cotton varieties UF0800038 K113, UF0800064 Namangan-77, UF0800040 K111, UF0800256 0212, UF0800170 Stoneville 213, UF0800025 3988 and medium fiber cotton of G. hirsutum L. and their hybrids were involved in the hybridization crossing combinations.

Parental forms and indicators of fiber yield of hybrid plants in the F1 nursery were studied. According to the results of the analysis of the fiber yield feature, the parent forms studied were divided into 5 groups according to the "Broad Unified Classifier-Reference of the genus Gossypium hirsutum (L.): very low - < 30% of the mass of raw cotton (1 point), low – 30-32% (3 points), medium – 33-35% (5 points), high 36-38% (7 points) very high - >

38% (9 points) [15].

The group of varieties with a very "high" fiber yield included: UF0800025 3988u (40.1%) and UF0800064 Namangan -77 (39.1%), samples with a high index - UF0800038 K 113 (37.9%) and UF0800040 K 111 (38.0%), the third group, with average fiber yield, consists of varieties UF0800256 0212 (35.0%) and UF0800170 Stoneville 213 (35.0%) (Table 1).

Table 1. Inheritance of fiber yield in hybrids of the first generation F_1, %.

♀ / ♂		UF0800038 K 113	UF0800064 Namangan -77	UF080004 0 K 111
UF0800038 K 113	X+Sx	38.8±0.4	36.7±0.5	39.9±0.8
	σ	0.7	1.0	1.5
	hp	-	-1.3	3.6
UF0800064 Namangan -77	X+Sx	38.4±0.7	39.5±0.5	36.9±0.7
	σ	1.2	0.8	1.3
	hp	0.8	-	-2.8
UF0800040 K 111	X+Sx	39.6±0.8	37.4±0.9	38.2±0.6
	σ	1.1	1.3	1.1
	hp	2.8	-1.8	-
UF0800256 0212	X+Sx	38.5+-0.8	38.7+-1.1	39.1+-0.5
	σ	1.4	1.7	0.8
	hp	1.1	-0.7	2.2
UF0800170 Stoneville 213	X+Sx	37.1±0.7	37.9±0.9	42.1±0.8
	σ	1.9	1.1	0.9
	hp	-0.3	0.8	4.6
UF0800025 3988 u	X+Sx	38.0±0.9	38.2±0.5	40.3±0.6
	σ	1.9	1.1	0.9
	hp	-1.7	-2.8	0.5

Cotinuation of table 1.

♀ / ♂		UF0800256 0212	UF0800170 Stoneville 213	UF080002 5 3988u
UF0800038 K 113	X+Sx	39.6±0.7	38.6±0.6	36.8±0.7
	σ	1.0	0.9	1.1
	hp	4.6	0.8	-2.6
UF0800064 Namangan -77	X+Sx	38.5±0.6	39.9±0.8	37.6±0.6
	σ	1.0	1.5	0.9
	hp	0.6	-1.3	-3.9
UF0800040 K 111	X+Sx	39.6±0.5	33.5±0.8	37.7±0.7
	σ	0.9	1.2	1.3
	hp	2.5	-3.3	-1.4
UF0800256 0212	X+Sx	37.5±0.6	35.8±1.1	39.9±0.5
	σ	0.9	1.1	1.1
	hp	-	-1.4	-0.5
UF0800170 Stoneville 213	X+Sx	38.1±0.7	36.1±0.6	37.0±0.8
	σ	1.6	1.3	1.6
	hp	15	-	-0.7
UF0800025 3988 u	X+Sx	40.8±0.8	39.0±0.7	41.4±0.8
	σ	1.6	1.3	1.6
	hp	0.7	0.7	-1.1

Among the investigated combinations, very high fiber yield in the first generation hybrid nursery was characterized by: UF0800170 Stoneville 213 x UF0800040 K 111 (42.1%), UF0800025 3988u x UF0800256 0212 (40.8%), UF0800025 3988u x UF0800040 K 111 (4 0.3 %), UF0800038 K 113 x UF0800040 K 111 (39.9%), UF0800040 K 111 x UF0800038

K 113 (39.6%), UF0800038 K 113 x UF0800256 0212 (39.6%), UF0800064 Namangan-77x UF0800170 Stone ville 213 (39.9%), UF0800040 K 111 x UF0800256 0212 (39.6%), UF0800038 K 113 x UF0800040 K 111 (39.9%), UF0800040 K 111 x UF0800038 K 113 (39.6%), UF0800038 K 113 x UF0800256 0212 (39.6%), UF0800064 Namangan-77x UF0800170 Stoneville 213 (39.9%), UF0800040 K 111 x UF0800256 0212 (39.6%), UF0800256 0212 x UF0800040 K 111 (39.1). %), UF0800256 0212 x UF0800025 3988u (39.9%), UF0800256 0212 x UF0800038 K 113 (38.5%), UF0800256 0212 x UF0800064 Namangan-77 (38.7%), UF0800170 Stoneville 213 x UF080 0256 0212 (38, 1%), UF0800025 3988u x UF0800064 Namangan-77 (38.2%), UF0800025 3988u x UF0800170 Stoneville 213 (39.0%).

High fiber yield was possessed by: UF0800038 K 113 / UF0800064 Namangan 36.7%, UF0800038 K 113 / UF0800025 3988u (36.8%), UF0800064 Namangan -77 / UF0800040 K 111 (36.9%), UF0800064 Namangan / UF0800025 3988u (37.6%), UF0800042 №123/ UF0800064 Namangan (37.4%), UF0800042 №123/ UF0800025 3988u (37.7%), UF0800256 0212/ UF0800256 0212 (37.5%), UF0800170 Stoneville 213/ UF0800038 K 113 (37.1%), UF0800170 Stoneville 213/ UF0800025 3988u (37.0%).

Average fiber yield rates of 33.5% were observed in population UF0800042 №123/ UF0800170 Stoneville 213.

The results of the analysis of plants of 39 hybrid combinations of the first generation based on the trait "fiber output" obtained by diallelic crossing showed that in 7 combinations the dominance of the parental or maternal form was observed, in 13 - an intermediate degree of dominance with a deviation to the parental or maternal form was detected, 19 combinations - showed positive or negative overdominance.

Complete dominance of the paternal or maternal form according to the studied trait was characterized by hybrid combinations of F1 in plants with sharply different indicators, including: UF0800038 K 113 x UF0800064 Namangan-77 (hr=-1.3), UF0800064 Namangan-77 x UF0800170 Stoneville 213hr=-1.3), UF0800040 K 111 x UF0800025 3988y (hr=-1.34 and UF0800256 0212x UF0800170 Stoneville 213 (hr=-1.4). The average indicator of F1 plants with an intermediate degree of dominance was observed in combinations obtained from parents with average indicators of fiber yield, including: UF0800038 K 113 x UF0800170 Stoneville 213hp=0,8), UF0800170 Stoneville 213x UF0800038 K 113 hp=-0,3), UF0800170 Stoneville 213x UF0800064 Наманган- 77 hp = 0,8), UF0800170 Stoneville 213x UF0800025 3988y (hp = -0,7), UF0800025 3988y x UF0800040 K 111 (hp = 0,5), UF0800025 3988y x UF0800256 0212 (hp = 0,7) та UF0800025 3988y x UF0800170 Stoneville 213 (hp = 0,7).

Thus, research has established that the heredity of the trait of fiber yield in F1 plants depends on the genotype and indicator of the parent varieties. So in hybrids UF0800038 K 113 x UF0800064 Namangan-77 (36.7%), UF0800038 K 113 x UF0800025 3988u (36.8%), UF0800064 Namangan-77 x UF0800040 K 111 (36.9%), UF0800064 Namangan-77 x UF0800025 3988y (37.6%), UF0800040 K 111x UF0800064 Namangan-77 (37.4%), UF0800040 K 111x UF0800170 Stoneville 213 (33.5%), UF0800040 K 111x UF0800025 3988y (37.7%). 800256 0212x UF0800170 Stoneville 213 (35.8%), UF0800170 Stoneville 213 x UF0800038 K 113 (37.1%), UF0800170 Stoneville 213 x UF0800064 Namangan-77 (37.9%), UF0800170 Stoneville 213 x UF0800025 3988 in (37.0 %), UF0800025 3988u x UF0800038 K 113 (38.0%) all types of inheritance were also detected.

The data in Table 1 show that heterosis in Fl plants was observed in hybrid combinations where varieties with the same or close fiber yield indicators were crossed. However, in many hybrid combinations, a somewhat weak reciprocal difference was manifested - evidence that cytoplasmic genes are also partially involved in the genetic control of the fiber yield trait in F1 plants [18].

Research has established that in the plants of the hybrid nursery of the first generation, the paternal or maternal form prevailed in terms of fiber output, depending on their indicator and origin. While the degree of intermediate inheritance of the studied trait in F1 plants depended on the contrast of the indicator and the geographical distance of the parental forms selected for crossing [19], a positive degree of inheritance for the trait of fiber yield in F1 hybrids was observed when genotypically close and geographically distant parents were involved in crossing forms.

The fiber yield of the variety varies greatly, depending on the soil and climatic conditions, meteorological conditions and agricultural cultivation techniques. The fiber yield rates vary from 3 to 4%. In irrigated areas and areas with high air humidity and good moisture supply, the output decreases due to an increase in seed weight. On the contrary, in arid conditions, the yield can increase due to a decrease in seed weight. In cases where the decrease in seed mass is combined with a sharp drop in the index, the yield may decrease [20].

The negative degree of dominance, or negative heterosis, was manifested by the genotypic and geographical distance of parental forms and their contrasting indicators. The genetic analysis of combinations with high fiber yield in the first generation F1 hybrids revealed the dominance of the maternal form [21].

Similar research results were obtained by scientists Al-Mamun M., Ul-Allah and others. [22, 23].

To increase fiber production per unit area, it is necessary to create new high-yielding cotton varieties by involving in crossing sources of high and very high fiber yield [24]

Due to the differences between the varieties of Huseyin et al. and Damtew et al. [25, 26] observed different fiber yield in hybrid cotton populations F2, F3, F4.

One of the ways to increase the yield of cotton and improve its quality indicators is sowing at the optimal time, which allows obtaining cotton fiber with a 35% lower short fiber content than when sowing at other times. The optimal temperature for the formation of fiber length is considered to be from 15 to 21 °C. [27]. It is especially necessary to adhere to the sowing time of the crop in the soil at a temperature of 12°C at the depth of seed placement.

The period with average daily air temperatures of 10 °C and above, i.e. active growth and development of plants, in the conditions of the Southern Steppe of Ukraine lasts 183-189 days [28]. It is important that during the vegetation period of cotton the sum of effective temperatures above 10 °C is not lower than 14 °C .

As a result of the scientific work carried out with the gene pool of cotton during 1996-2003, samples were examined for fiber quality.The data in Table 2 show that all varieties are medium fibrous with a staple mass length of 29.0-31.1 mm.

According to the breaking load, the sample of the Ukrainian selection 1718u was the strongest - 5.3 Gs, although these indicators correspond to "average" in terms of gradation. All other studied samples had low strength, 2542u – very low.

As for the relative breaking load, the results of the experiment show that all the studied samples belonged to the 1st grade in terms of breaking load.

By metric number or tonnage, sample 2542y had a thin to very thin fiber, which was 7520 conventional units, samples Balkan 425, Chirpan 539, Avangard 264 had thin fibers - their metric number was in the range of 6520-6692 conventional units. According to the type of fiber, almost all samples belonged to the medium-fiber type - V type.

The results of the analysis of fiber quality of cotton samples of ecological variety testing for the period 2009-2010 showed that according to fiber quality indicators such as: relative breaking load, maturity coefficient, Chirpan 539 was at the level of the Pidozerskyi 4 standard [29] (Table 3).

Table 2. Characterization of the best cotton varieties of Ukrainian and Bulgarian selection in terms of fiber quality, average for 1996-2003.

The name of the sample	Staple mass length, mm	Breaking load, Gs	Relative breaking load, gs - tex
Dniprovskyi 5, standard	29.8	4.5	26.8
502u	30.6	4.4	27.5
1718u	28.2	5.3	27.8
2542u	29.6	3.9	29.1
Balkan 425	30.2	4.0	25.7
White source	29.3	4.2	29.6
Ogosta	29.5	4.5	26.3
Guarantor	29.7	4.2	26.6
Chirpan 603	29.7	4.2	26.1
Chirpan 539	29.0	4.2	27.2
Vanguard 264	31.0	4.2	27.1
Interspecies hybrid №64	31.1	4.2	26.0

Cotinuation of table 2.

The name of the sample	Metric number, m	Type	Class
Dniprovskyi 5, standard	6062	VI	2
502u	6361	V	2
1718u	5240	VI	3
2542u	7520	VII	2
Balkan 425	6626	VI	2
White source	6348	VI	2
Ogosta	5828	7	1
Guarantor	6383	VI	2
Chirpan 603	6246	VI	2
Chirpan 539	6520	VI	3
Vanguard 264	6692	V	2
Interspecies hybrid №64	6078	V	3

Table 3. Results of analysis of fiber quality of cotton samples of ecological variety testing for the period 2009-2010.

The name of the sample	Staple length, mm		Breaking load			
			fibers, GS		relative, GS-tex	
	2009	2010	2009	2010	2009	2010
Podozerskyi 4 (standard)	28.4	30.4	4.6	4.4	27.9	24.6
Dniprovskyi 5,	28.5	30.5	4.8	4.7	29.6	25.3
Chirpan 539	25.8	26.8	4.5	4.9	26.3	24.5
Vanguard 264	27.2	28.2	-	4.3	-	24.5

Cotinuation of table 3.

The name of the sample	Metric number		Maturity factor		Type		Class	
	2009	2010	2009	2010	2009	2010	2009	2010
Podozerskyi 4 (standard)	6080	5510	2.0	1.9	VII	-	1	1
Dniprovskyi 5,	6140	5480	1.9	1.9	VII	-	1	1
Chirpan 539	5880	5030	1.9	2.1	VI	VII	1	1
Vanguard 264	-	5730	-	1.9	-	VII	-	2

Fiber length is negatively correlated with fiber yield, as well as fiber yield and, to a lesser extent, raw cotton yield. There is a very high positive correlation between fiber length and tonality - the correlation coefficient reaches 0.7-0.9. Fiber tone also shows a strong negative genetic correlation with fiber yield and weak with raw cotton yield [30].

Since the length and tone characterize the quality of the cotton fiber, it can be assumed that the quality of the fiber negatively correlates with the most important economic and valuable features of cotton — productivity and fiber yield. That is why one of the difficult problems of cotton selection is the creation of varieties that combine high productivity with good fiber quality [31].

A clearly expressed inverse correlative relationship is observed between yield and fiber length, noted by many researchers. The correlation coefficient between these signs can reach from insignificant or weakly negative to -0.8. According to Karademir E. et al. the correlation between fiber length and yield varies from 0.45 to 0.78. This complicates the selection of long-fiber varieties with high fiber yield [32]. Varieties of the species G. barbadense L., which have the longest and thinnest fiber, usually combine it with a very low yield; such varieties include UF0800142 Bukhara 3 (UZB) 35.2 mm, UF0800279 Cotton (TKM) 35.7 mm., UF0800282 Joloten 14 (TKM) 35.3 mm.

An example of a correlation caused by the pleiotropic effect of a gene can be the correlation between the presence of a seed coat and the amount of fiber; pubescent-seeded forms mainly have a higher fiber yield than forms with micropylar pubescence and gymnosperms.

Correlations of cotton traits change in the process of hybridization, mutational variability, and the action of selection. Coupling-induced correlations change as a result of spontaneous crossovers. To get the most reliable result, it is necessary to carry out a large scale of work [33].

Not every crossing is accompanied by the manifestation of hybrid power in the offspring. Only certain pairs of parental forms produce heterozygous offspring. Heterosis is most often manifested when crossing geographically and genetically distant forms. According to the above signs, heterosis can be manifested independently, that is, it can have a discrete character [34].

In the studies, hybrid combinations of crossings of cotton varieties were evaluated according to the variability and inheritance of the trait "fiber length" in parental varieties and their F1 hybrids.

According to the "Broad unified classifier-handbook of the genus Gossypium hirsutum L." fiber length is classified into 5 groups: very short - <25 mm (1 point), short - 26-30 mm (3 points), medium - 31-35 mm (5 points), long - 36-40 mm (7 points), very long - > 40 mm (9 points) [19].

The results of the analysis of the fiber length for 2003-2006 of the studied varieties made it possible to divide them into 3 groups: by long fiber, medium and short. The first group included the cotton variety UF0800040 K 111 (36.8 mm), the second group is represented by

UF0800038 K 113 (35.5 mm) and UF0800256 0212 (35.6 mm), the third consists of the varieties UF0800025 3988u (30.0 mm), UF0800170 Stoneville 213 (29.9 mm) and UF0800064 Namangan-77 (29.6 mm).

The following hybrid combinations in F1 were characterized by "long" fiber: UF0800038 K 113 x UF0800256 0212 (36.3 mm), UF0800064 Namangan-77 x UF0800170 Stoneville 213 (36.2 mm), UF0800040 K 111 x UF0800256 0212 (36. 1 mm); "average" fiber length indicators were: UF0800038 K 113 x UF0800064 Namangan-77 (35.4 mm), UF0800256 0212 x UF0800040 K 111 (35.7 mm), UF0800064 Namangan-77 x UF0800256 0212 (35.8 mm), UF0800256 0212 x UF0800064 Namangan-77 (35.4 mm), UF0800064 Namangan-77 x UF0800040 K 111 (34.5 mm), UF0800040 K 111 x UF0800038 K 113 (34.2 mm), UF0800040 K 111 x UF0800170 Stone ville 213 (34.2 mm), UF0800170 Stoneville 213 x UF0800040 K 111 (34.2 mm), UF0800040 K 111 x UF0800025 3988u (34.2 mm), UF0800256 0212 x UF0800170 Stoneville 213 (34.3 mm), UF0800025 39 88 in x UF0800038 K 113 (34.4 mm) and the "short" fiber had: UF0800025 3988u x UF0800040 K 111 (29.8 mm), UF0800038 K 113 x UF0800040 K 111 (29.4 mm), UF0800038 K 113 x UF080017 0 Stoneville 213 (29.9 mm), UF0800256 0212 x UF0800038 K 113 (29.9 mm), UF0800038 K 113 x UF0800025 3988u (29.5 mm), UF0800064 Namangan-77 x UF0800038 K 113 (30.0 mm), UF0800064 Namangan -77 x UF0800025 3988u (30.0 mm), UF0800025 3988u x UF0800064 Namangan-77 (29.9 mm), UF0800040 K 111 x UF0800064 Namangan-77 (30.0 mm), UF0800256 0212 x UF0800025 3988u ,0 mm), UF0800025 3988u x UF0800256 0212 (30.0 mm), UF0800170 Stoneville 213 x UF0800038 K 113 (30.0 mm), UF0800170 Stoneville 213 x UF0800064 Namangan-77 (29.9 mm), UF0800170 Stoneville 213 x 0 800256 0212 (29.9 mm), UF0800170 Stoneville 213 x UF0800025 3988u (29.4 mm) and UF0800025 3988u x UF0800170 Stoneville 21 (29.5 mm).

The analysis of 39 samples based on the "fiber length" trait, obtained by diallel crossing, showed that in 8 combinations there was dominance of the parental or maternal form, in 14 - intermediate dominance with a deviation to the parental or maternal form, and in 17 combinations positive or negative overdominance was manifested .

According to the trait "fiber length" in hybrids of the first generation of F1, the dominance of the paternal or maternal form was observed in the combinations: UF0800064 Namangan-77 x UF0800040 K 111 (hp = 1.2), UF0800040 K 111 x UF0800064 Namangan-77 (hp = - 1, 2) and UF0800256 0212 x UF0800025 3988u (hp = - 1.1), created by parental forms with sharply different indicators.

According to the intermediate degree of dominance, hybrids with average values of the studied trait were distinguished, including: UF0800064 Namangan-77 x UF0800025 3988u (hp = 0.8), UF0800040 K 111 x UF0800170 Stoneville 213 (hp = 0.3), UF0800040 K 111 x UF0800025 3988u (hp = 0.3), UF0800025 3988u x UF0800170 Stoneville 213 (hp = - 0.2), UF0800170 Stoneville 213 x UF0800040 K 111 (hp = 0.3) and UF0800025 3988u x UF08000 38 K 113 (hp = 0.5).

Positive overdominance was observed in hybrids with different genotypes and fiber length indicators, including: UF0800038 K 113 x Namangan-77 (hp = 1.6), UF0800038 K 113 x UF0800256 0212 (hp = 2.3) and with medium indicators of the studied trait: UF0800064 Namangan-77 x UF0800256 0212 (hp = 5.1), UF0800256 0212 x UF0800040 K 111 (hp = 2.5), UF0800064 Namangan-77 x UF0800170 Stoneville 213 (hp = 4.6), UF0800040 K 111 x UF0800256 0212 (hp = 3.0), UF0800256 0212 x UF0800064 Namangan-77 (hp = 4.8) and UF0800025 3988u x UF0800040 K 111 (hp = 2.7).

A number of hybrid combinations were characterized by negative overdominance, including: UF0800038 K 113 x UF0800040 K 111 (hp = - 5.9), UF0800064 Namangan-77 x UF0800038 K 113 (hp = -1.5), UF0800040 K 111 x UF0800038 K 113 (HP = - 1,4), UF0800256 0212 x UF0800038 K 113 (HP = - 1.3), UF0800038 K 113 x UF0800170 Stoneville 213 (HP = - 3,9) (hp = -1.9), UF0800038 K 113 x UF0800025 3988u (hp = - 6.2), UF0800170 Stoneville 213 x UF0800064 Namangan -77 (hp = -3.4), UF0800170 Stoneville 213 x UF0800256 0212 (hp = - 1.8), UF0800170 Stoneville 213 x UF0800025 3988u (hp = - 1.4), UF0800025 3988u x UF0800040 K 111 (hp = - 2.7), UF0800025 3988u x UF0800064 Namangan-77 (hp = - 2.9), UF0800025 3988u x UF0800256 0212 (hp = - 1.7) and UF0800025 3988u x UF0800170 Stoneville 213 (hp = -1.7) - that is, hybrids with different genotypes and indicators, as well as geographically distant forms.

As can be seen from Table 4, in the studied hybrid combinations, all degrees of inheritance are traced, as they were influenced by the genotype and indicators of parental forms. According to the trait of fiber length, a reciprocal difference was observed in all backcrosses, which indicates the participation, in most cases, of cytoplasmic genes in controlling the inheritance of the trait along with nuclear genes, except for the combinations UF0800040 K 111 x UF0800256 0212, UF0800256 0212 x UF0800040 K 111, UF0800064 Namangan -77 x UF0800256 0212, UF0800256 0212 x UF0800064 Namangan-77, UF0800040 K 111 x UF0800170 Stoneville 213, UF0800170 Stoneville 213 x UF0800256 0212, UF0800256 0212 x UF08000 38 K 113, UF0800064 Namangan-77 x UF0800025 3988u, UF0800025 3988u x UF0800064 Namangan- 77, UF0800256 0212 x UF0800025 3988y, UF0800025 3988y x UF0800256 0212 and UF0800025 3988y x UF0800170 Stoneville 213.

Thus, the dominance of one of the parental forms in fiber length in F1 plants is manifested in hybrids that differ sharply in their parameters. An intermediate type of inheritance of fiber length was observed in genotypically close and geographically distant hybrids. Positive overdominance or positive heterosis in fiber length was observed in hybrids with different genotypes and in geographically distant forms. Negative overdominance in fiber length, i.e. negative heterosis, was found in hybrids with different genotypes and parameters, as well as in samples that are geographically distant in origin.

Table 4. Inheritance of fiber length in F_1 hybrid nursery plants (mm).

♀/♂		UF0800038 K 113	UF0800064 Namangan -77	UF0800040 K 111
UF0800038 K 113	X+Sx	34.4±0.3	35.3±0.5	29.4±0.7
	σ	0.5	1.0	1.5
	hp	-	1.6	-5.9
UF0800064 Namangan -77	X+Sx	30.0±0.3	33.5±0.4	34.4±0.6
	σ	0.7	1.0	0.5
	hp	-1.5	-	1.2
UF0800040 K 111	X+Sx	34.1±0.5	30.0±0.6	35.1±0.3
	σ	0.7	-1.2	0.7
	hp	-1.4	-1.2	-
UF0800256 0212	X+Sx	29.9±0.6	35.3±0.5	35.6±0.6
	σ	1.1	0.8	1.0
	hp	-1.3	4.8	2.5
UF0800170 Stoneville 213	X+Sx	30.0±0.5	29.9±0.6	34.1±0.4
	σ	0.8	1.0	0.6
	hp	-1.9	-3.4	0.3
UF0800025 3988u	X+Sx	34.3±0.5	29.9±0.2	29.8±0.3
	σ	1.1	0.5	0.8
	hp	0.5	-2.9	2.7

Cotinuation of table 4.

♀/♂		UF0800256 0212	UF0800170 Stoneville 213	UF0800025 3988u
UF0800038 K 113	X+Sx	36.2±0.6	29.9±0.4	29.5±0.5
	σ	1.1	0.7	0.8
	hp	2.3	-3.9	-6.2
UF0800064 Namangan -77	X+Sx	35.7±0.5	36.1±0.7	30.0±0.4
	σ	0.8	1.1	0.6
	hp	5.1	4.6	0.8
UF0800040 K 111	X+Sx	36.0±0.4	34.1±0.7	34.1±0.5
	σ	0.8	1.1	09
	hp	3.0	0.3	0.3
UF0800256 0212	X+Sx	34.4±0.3	34.2±0.4	30.0±0.7
	σ	0.7	0.9	1.2
	hp	-	-0.2	-1.1
UF0800170 Stoneville 213	X+Sx	29.9±0.6	33.8±0.5	29.4±0.4
	σ	1.2	0.7	0.9
	hp	-1.8	-	-1.4
UF0800025 3988u	X+Sx	30.0±0.4	29.5±0.2	33.8±0.3
	σ	0.9	0.6	0.8
	hp	-1.7	-1.7	-

In general, analyzing the data on the inheritance of fiber length in Table 4.19, it can be concluded that F1 hybrid combinations mainly exhibited negative and positive overdominance. Thus, the results of the studies showed that fiber length in F1 hybrids is mainly regulated by dominant genes.

4 Conclusions

In order to increase fiber production per unit area, it is necessary to create new high-yielding cotton varieties by involving sources of high and very high fiber yield in enrichment. Among the investigated combinations, very high fiber yield in the first generation hybrid nursery was characterized by: UF0800170 Stoneville 213 x UF0800040 K 111 (42.1%), UF0800025 3988u x UF0800256 0212 (40.8%), UF0800025 39 88u x UF0800040 K 111 (40, 3%), UF0800038 K 113 x UF0800040 K 111 (39.9%), UF0800040 K 111 x UF0800038 K 113 (39.6%), UF0800038 K 113 x UF0800256 0212 (39.6%), UF0800064 Namangan-77x UF080017 0 Stoneville 213 (39.9%), UF0800040 K 111 x UF0800256 0212 (39.6%), UF0800038 k 113 x UF0800040 k 111 (39.9%), UF0800040 k 111 x Uf0800038 k 113 (39.6%) .

When studying the variability and inheritance of the trait "fiber length" in parent varieties and their F1 hybrids, it was found that positive overdominance or positive heterosis for the fiber length trait was observed in hybrids with different genotypes and in geographically distant forms, namely: UF0800038 K 113 x UF0800064 Namangan -77 (hr=-1.3), UF0800064 Namangan-77 x UF0800170 Stoneville 213hr=-1.3), UF0800040 K 111 x UF0800025 3988u (hr=-1.34 and UF0800256 0212x UF0800170 Kaminville 213 (hr=- Thus, studies have established that the heredity of fiber yield in F1 plants depends on the genotype and indicator of the parent varieties. It was investigated that heterosis in Fl plants according to the trait "fiber length" was observed in hybrid combinations where varieties with the same or similar indicators were crossed. The following hybrid combinations were characterized by the "long" fiber in F1: UF0800038 K 113 x UF0800256 0212 (36.3 mm), UF0800064 Namangan-77 x UF0800170 Stoneville 213 (36.2 mm), UF0800040 K 111 x UF0800256

0212 (36.1 mm). According to the trait "fiber length" in the first generation F1 hybrids, the dominance of the paternal or maternal form was observed in the combinations: UF0800064 Namangan-77 x UF0800040 K 111 (hp = 1.2), UF0800040 K 111 x UF0800064 Namangan-77 (hp = - 1, 2) and UF0800256 0212 x UF0800025 3988u (hp = - 1.1), created by parental forms with sharply different indicators.

Negative overdominance according to the trait "fiber length", that is, negative heterosis was observed in hybrids with different genotypes and indicators, as well as in geographically distant samples of origin UF0800038 K 113 x UF0800040 K 111 (hp = - 5.9), UF0800064 Namangan-77 x UF0800038 K 113 (hp = -1.5), UF0800040 K 111 x UF0800038 K 113 (hp = - 1.4), UF0800256 0212 x UF0800038 K 113 (hp = - 1.3), UF0800038 K 113 x UF0800170 Stoneville 213 (hp = - 3.9), UF0800170 Stoneville 213 x UF0800038 K 113 (hp = -1.9), UF0800038 K 113 x UF0800025 3988u (hp = - 6.2), UF0800170 Stoneville 213 x UF0800064 Namangan -77 (hp = -3.4), UF0800170 Stoneville 213 x UF0800256 0212 (hp = - 1.8), UF0800170 Stoneville 213 x UF0800025 3988u (hp = - 1.4), UF0800025 3988u x UF0800040 K 111 (hp = - 2.7), UF0800025 3988u x UF0800064 Namangan-77 (hp = - 2.9), UF0800025 3988u x UF0800256 0212 (hp = - 1.7) and UF0800025 3988u x UF0800170 Stoneville 213 (hp = -1.7) – that is, hybrids with different genotypes and indicators, as well as geographically distant forms.

In general, analyzing the fiber length inheritance data, it can be concluded that the F1 hybrid combinations mainly showed negative and positive overdominance. Therefore, it can be stated that the length of the fiber in F1 hybrids is mainly regulated by dominant genes.

References

1. A. Khudaikuliyev. Selection of cotton Gossypium hirsutum L. for fiber quality Ashgabat: Science p.224. (1976).
2. R. H. Herbst, D. Bar-Zvi, S. Reikhav, I. Soifer, M. Breker, G. Jona, E. Shimoni, M. Schuldiner, A.A. Levy and N. Barkai. Heterosis as a consequence of regulatory incompatibility. *BMC Biology*. 15:38. (2017). DOI 10.1186/s12915-017-0373-7.
3. S. Tian, X. Xu, X. Zhu, F. Wang, X. Song and T. Zhang. Overdominance is the major genetic basis of lint yield heterosis in interspecific hybrids between *G. hirsutum* and *G. barbadense*. 123(3): 384–394. (2019). doi: 10.1038/s41437-019-0211-5.
4. C. Li, T. Zhao, H. Yu, C. Li, X. Deng, Y. Dong, F. Zhang, Y. Zhang, L. Mei, J. Chen and S. Zhu. Genetic basis of heterosis for yield and yield components explored by QTL mapping across four genetic populations in upland cotton. *BMC Genomics*. 19:910 (2018). https://doi.org/10.1186/s12864-018-5289-2.
5. H. Fu, L.O. Atramentova. Inheritance of traits in F_1 hybrids of diploid einkorn wheat of the spring crop. The Journal of V. N. Karazin Kharkiv National University. *Series "Biology*". 38, 30–34. (2022). https://doi.org/10.26565/2075-5457-2022-38-3.
6. J. Xie, W. Wang, T .Yang., Q. Zhang, Z. Zhang, X. Zhu, N. Li, L. Zhi, X. Ma, S. Zhang, Y. Liu, X. Wang, F. Li, Y. Zhao, X. Jia, J. Zhou, N. Jiang, G. Li, M. Liu, S. Liu, H. Zhang. Large-scale genomic and transcriptomic profiles of rice hybrids reveal a core mechanism underlying heterosis. *Genome Biology*. 23(1):264.(2022). DOI: 10.1186/s13059-022-02822-8.
7. N.Kannan, K. Saravanan. Heterosis and combining ability analysis in tetraploid cotton (G.hirsutum L. and G.barbadense L.). *Electronic Journal of Plant Breeding*. 7(2):341.(2016). DOI: 10.5958/0975-928X.2016.00042.9.
8. X. Guo, Y. Guo, J. Ma, F. Wang, M. Sun, L. Gui, J. Zhou, X. Song, X. Sun. Mapping Heterotic loci for yield and agronomic traits using chromosome segment introgression

lines in cotton. *Journal of Integrative Plant Biology*. Vol. 55, Issue 8. P. 759-774. (2013). https://doi.org/10.1111/jipb.12054.

9. Z. Sarfraz, M.S. Iqbal, Z. Pan, Y. Jia, S. He, Q. Wang, H. Qin, J. Liu, H. Liu, J. Yang, Z. Ma, D. Xu, J. Yang, J. Zhang, W. Gong, X. Geng, Z. Li, Z. Cai, X. Zhang, A. Huang, X. Yi, G. Zhou, L. Li, H. Zhu, Y. Qu, B. Pang, L. Wang, M.S. Iqbal, M. Jamshed, J. Sun and X. Du. Integration of conventional and advanced molecular tools to track footprints of heterosis in cotton. BMC *Genomics*. 19:776 (2018). https://doi.org/10.1186/s12864-018-5129-4.
10. R. Chapara, S. Madugula. Heterosis for seed fibre quality traits cotton (*Gossypium hirsutum* L.) *J. Forest Res*. Vol.10. Iss.3, No:253 (2021).
11. A. Narayanan, D. Wang. Ideal ratio mask estimation using deep neural networks for robust speech recognition. In: 2013 IEEE International Conference on Acoustics, Speech and Signal Processing: IEEE International Conference on Acoustics, Speech and Signal Processing: May 26, 7092–7096. (2013). https://doi.org/10.1109/ICASSP.2013.6639038.
12. S. Basbag, R. Ekinci, O. Gencer. Combining ability and heterosis for earliness characters in line× tester population of *Gossypium hirsutum* L. Hereditas. 144(5):185–90.(2007). DOI: 10.1111/j.2007.0018-0661.01998.x.
13. X. Geng, Y. Qu, Y. Jia, S. He, Z. Pan, L. Wang, X. Du. Assessment of heterosis based on parental genetic distance estimated with SSR and SNP markers in upland cotton (*Gossypium hirsutum* L.). BMC genomics. 22(1):1–11. Geng et al. BMC Genomics, 2021. 22:123. (2021). https://doi.org/10.1186/s12864-021-07431-6.
14. V.V. VolKodav. Methods of state variety testing of agricultural crops. Issue three (oil, technical, spinning and fodder crops). Kyiv: Aleph. 76 p. (2001).
15. R.A. Vozhehova, V.K. Ryabchun, V.O. Borovyk, Yu.O. Stepanov, M.P. Malyarchuk, Yu.O. Lavrynenko, I.O. Bydnina, I.M. Belyaeva Viiddis ovttastahttojuvvon klassifiserejeaddji lea Gossypium hirsutum L-šlája giehtagirji. Dieđalaš akademiija čáhcebohcciid instituhtta. Grin D.S. LLC. 49 p. (2015).
16. V.O. Ushkarenko, R.A. Vozhegova, S.P. Holoborodko, Kokovikhin, S.V. Methodology of field experiment (Irrigated agriculture). (Kherson: Gryn D.S. (2014).
17. H. Daskalov H., Iordanov M., Ognyanova A. Heterosis in tomatoes Sofia: Bulgarian Academy of Sciences. 179 p. (1967).
18. G.M. Beil, R.E. Atkins. Inheritance of quantitative characters in grain sorghum. *J. Sci.* 39 (3): 345-358. (1965).
19. O.J. Jalilov. Breeding of early ripening fruitful varieties of cotton with high- quality fiber. *Rep. Acad. of Siences of UzSSR*. No. 3. P.13-14. (1976).
20. N.G. Simongulyan, S.R. Mukhamedkhanov, F.N. Shafrin. Bomulla genetihkka, válljen ja sieđgabuvttadeapmi: Oahppogirji. oahpponeavvu agronoma, fágabargi gilli universitehtat 3. čálus, lassi. T.: Mehnat. 320 p. (1987).
21. V.A. Avtonomov. Variability, inheritance characteristics In geographically distant hybrids F_1 - F_2 cotton G. *hirsutum* L. State of selection and seed production of cotton and prospects for its development: *Mat. int. scientific. conf.* Tashkent. P. 36-41. (2006).
22. M. Al-Mamun, M.Y. Rafii, A.B. Misran, Z. Berahim, Z. Ahmad, M.H. Khan. Heterosis and Combining Ability Estimate on Yield and Yield-Related Traits in a Half Diallel Crosses of Kenaf (*Hibiscus Cannabinus* L.) in Malaysia. *Journal of Natural Fibers*. Vol. 20 - Issue 1. (2023). https://doi.org/10.1080/15440478.2023.2192541є.
23. S. Ul-Allah, A. Rehman, M. Hussain, M. Farooq. Fiber yield and quality in cotton under

drought: Effects and management. *Agricultural Water Management* .Vol. 255, 1, 106994. (2021). https://doi.org/10.1016/j.agwat.2021.106994.

24. O.J. Jalilov. Breeding of early ripening fruitful varieties of cotton with high- quality fiber. *Rep. Acad. of Siences of UzSSR*. No. 3. P.13-14. (1976).
25. B. Huseyin, D. Burcu, K. Tunay, I. Emre, G. Huseyin. Comparison of mean yield components and fiber quality parameters of advanced bulk generations in f2, f3 and f4 interspecific and intraspecific cotton populations. *Turkish Journal of Field Crops*. 22(1):14-23.(2017). https://doi.org/10.5897/AJPS2021.2148.
26. S. Damtew, D. Gurmessa, M. Balcha, A.G. Egziabher, B. Gudeta, A. Workie, M. Arega. Performance of cotton genotypes (*Gossypium hirsutum* L.) for yield and yield component traits under irrigated climatic conditions of Ethiopia. Vol.16(10), pp. 270-275. (2022). https://doi.org/10.5897/AJPS2021.2148.
27. A. Qaiser, A. Shakeel. Effect of Different Sowing Times and Cultivars on Cotton Fiber Quality under Stable Cotton-Wheat Cropping System in Southern Punjab, Pakistan. *Pakistan Journal of Life and Social Sciences.* 16(2):77-84. (2018).
28. R. Vozhehova, V. Borovyk, S. Kokovikhin, O. Kokovikhina, L. Boiarkina, O. Shkoda. Evaluation of cotton gene pool samples in different years of heat supply in the conditions of the southern steppe of Ukraine. *Scientific Papers. Series A. Agronomy*, Vol. LXV, No. 2. (2022). ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785. 313-318.
29. .O. Borovyk, Yu.O. Stepanov, V.V. Klubuk, V.A. Baranchuk, M.L. Osinii, V.I. Kuzmych. Ecological testing of Bulgarian cotton varieties in the southern region of Ukraine. Irrigated agriculture: Between. topics of science coll. Kherson. Vol. 55. C.274-282 (2011).
30. M.A. Asad, F.M. Azhar, Z. Iqbal. Association of yield with various economic traits in *Gossypium hirsutum* L. *Int J Agri Biol.* 4: 105–106. DOI:10.3923/pjbs.2000.1237.1238. (2002).
31. C.W.Smith, S. Hague, E. Hequet, P. Thaxton, I. Brown. Development of extra-long staple upland cotton. *Crop science.* 48: 1823–1831.(2008). DOI:10.2135/cropsci2008.01.0052.
32. E. Karademir, C. Karademir, R. Ekinci, O. Gencer. Correlations and Path Coefficient Analysis Between Leaf Chlorophyll Content Yield and Yield Components in Cotton (G.hirsutum L.) under Drought Stress Conditions. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca* 37(2). (2009). DOI: 10.15835/nbha3723146.
33. A. Ullah, A. Shakeel, H.G. Ahmed Muhu-Din, M. Naeem, M. Ali, A.N. Shah, L. Wang, M. Jaremko, N.R. Abdelsalam, R.Y. Ghareeb and M.E. Hasan. Genetic basis and principal component analysis in cotton (*Gossypium hirsutum* L.) grown under water deficit condition. *Front Plant Sci.* 13: 981369. (2022). doi: 10.3389/fpls.2022.981369.
34. S.A. Patil, M.R. Naik, A.B. Patil, G.R. Chaugule. Heterosis for seed cotton yield and its contributing characters in cotton (*Gossypium hirsutum* L.). *Plant Archives*. 11(1):461-465. (2011).