

Inheritance of Fiber Length in Cotton F₁ Hybrids

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Abstract The article presents the results of the research on the heredity, variability and dominance of fiber length in the F₁ generation of cotton plants. *G.hirsutum* cultivars, *G.mustelinum* wild type and hexoploid T-85 line were crossed and step hybridized. In the inheritance of the fiber length in the F₁ generation, the participation of the objects involved in reciprocal hybridization as the father or mother form does not have great importance in the inheritance and formation of the character. Among the F₁ hybrids, fiber length is higher in F₁ Kyzyl baraka x Ghalib, F₁ Namangan-77 x T-85, F₁ (Ghalib x Andijan-35) x T-85 and F₁ (Namangan-77 x Andijan-35) x T-85 combinations, F₁ G.mustelinum Miers ex Watt x Winner, F₁ G.mustelinum Miers ex Watt x Namangan-77 and F₁ (Ghalib x Namangan-77) x G.mustelinum Miers ex Watt combinations showed relatively low results.

Keywords Hybrid, Dominant, Heterosis, Allotetraploid, Mutagenesis, Reciprocal and stepwise hybridization

1. Introduction

Cotton fiber yield and quality are very important features for cotton fiber processors. Planting cotton varieties with high-quality cotton fiber for arable land is one of the most urgent tasks nowadays. This requirement requires scientists to emphasize scientific work aimed at improving fiber quality [1].

Cotton fiber, a vital component in textile and industrial applications, varies significantly in length depending on genetic factors. Typically, cotton fibers are composed of cellulose and are extracted from the seed husk through ginning processes. The length of these fibers plays a crucial role in their usability and quality for various end products.

In the study of cotton fiber characteristics, particularly fiber length, the focus is on understanding how different cotton varieties and their hybrids inherit and manifest this trait. The research highlights the importance of selecting cotton varieties with optimal.

Among the varieties studied, observations revealed significant variations in fiber length. For instance, the T-85 line exhibited the longest fibers at 39,1 mm, while the wild type *G.mustelinum* Miers ex Watt demonstrated shorter fibers at 24,7 mm. Varieties such as Ghalib, Andijan-35, Namangan-77, and Kyzyl baraka showed intermediate lengths ranging from 32,5 mm to 35,5 mm.

The study also explored the inheritance patterns of fiber length through reciprocal and stepwise hybridization. Results indicated instances of negative heterosis, where hybrid

offspring exhibited shorter fiber lengths compared to their parents, as well as positive heterosis, showing longer fibers. These findings underscore the complex genetic interactions influencing fiber length in cotton hybrids.

In conclusion, improving fiber length through selective breeding remains a critical objective for cotton researchers and breeders. The variability observed in fiber length inheritance underscores the need for continued scientific inquiry to enhance cotton varieties that meet the demands of textile.

2. Literature Review

The authors found that geographically distant medium-fiber cotton species were inherited in F₁ hybrids with intermediate, high, and medium positive dominance in fiber length, and positive heterosis results [2].

B.A. Sirojiddinov studied the inheritance of fiber length in interspecies F₁ plants of Indo-Chinese and Australian cotton species and determined that fiber length is passed from generation to generation with positive and negative complete dominance or positive and negative heterosis [3].

M.R. Kadirov and others studied the heritability of fiber yield and length by cross-breeding genotypically different forms of *G. hirsutum* L medium fiber cotton. In the F₁ generation, it was noted that this trait is inherited in cases of intermediate, high positive heterosis, medium and high positive dominance [4].

Foreign scientists studied fiber length in cotton plant and found that there is a positive correlation between fiber length, strength and fineness [5].

F. Killi, L. Efe and S. Mustafayev conducted a scientific study on the genetic and environmental variability of yield

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and fiber quality in cotton. They noted that 94,6% of heritability of fiber length is accounted for by genes, and the influence of external factors on the formation of this characteristic is small [6].

A. Manivannan, V. Wagemare studied fiber properties by crossing *G. arboreum* L. species with a diploid set of chromosomes. In the resulting hybrid plants, the average fiber length in the F₂ generation is 24,1 mm, the coefficient of variation is 34,3%, and the heritability is 68,8 [7].

Al-Ravi and Kokhel published the results of their scientific work on diallel analysis of yield and description of agrotechnical measures in *G. hirsutum* L-type forms. According to the scientific results obtained by them, it was noted that the length of the fiber is inherited under the influence of polygenes [8].

According to the conclusions of I. Umbetayev, Kh. Djumabekov fiber length and productivity in F₁ hybrid plants are transmitted to offspring in cases of complete dominance, extreme dominance and heterosis. The results of F₂ plants showed that this trait is inherited through polymer genes [9].

B.W. Gardunia studies, it has been shown that *G. mustelinum* species can be used to increase the genetic diversity of cotton and to transfer characters from wild types to elite varieties. *G. mustelinum* x *G. hirsutum* F₁, F₂ and BB₁F₁ and BB₁F₂ generations were studied in research. These hybrids were screened for recombination and selection efficiency using microsatellite markers, and introgressive barriers were identified as *G. mustelinum* species are strongly photoperiod demanding. The characteristics of fiber length, lint weight in per boll are strongly transmitted to the offspring, but a decrease in these parameters was observed in the offspring with *G. mustelinum* species as the mother [10].

It has been proven that fiber length heredity and variation in F₁-F₄ hybrids obtained from introgressive line crossings can cause drastically different results in hybrids over the years and can also be affected by external environmental factors. It has been confirmed that there is a high possibility of isolating recombinants with a positive set of fiber length markers among F₂ - F₃ hybrids created with the participation of introgressive cotton lines [11,12].

3. Materials and Methods

In the experiment, to study the inheritance of fiber length in the F₁ generation, in order to study the inheritance of hair weight in varieties belonging to the natural allotetraploid *G. hirsutum* L. and *G. mustelinum* L. species (Ghalib, Andijan -35, Namangan-77, Kyzyl baraka), *G. mustelinum* Miers ex Watt and species with a diploid number of chromosomes (F [6] (Kelajak x (ssp. *nanking* (white fiber) x *G. nelsonii*))) obtained allotetraploid by artificial mutagenesis T -85 line was used.

The statistical analysis of fiber length of F₁, F₂ and varieties plants was determined by the method of B.A. Dospekhov [13].

$$\bar{X} = A \pm \frac{f(Xv - A)}{n};$$

$$C = \frac{f(Xv - A)^2}{n};$$

$$\delta^2 \sqrt{= \frac{\sum [f(Xv - A)]^2 - C}{n - 1}};$$

$$S = \sqrt{\delta^2};$$

$$V = \frac{S \cdot 100}{\bar{X}};$$

$$m = \frac{S}{\sqrt{n}};$$

$$m\% = \frac{m \cdot 100}{\bar{X}}.$$

in which:

f- number of repetitions; *n* – number of plants; *A* – arbitrary average value; *C* – additional formula.

Dominance levels of F₁ plants were calculated using S. Wright's formula. The fiber length by mathematical processing means the arithmetic mean value (\bar{X}), the arithmetic mean error (*m*), the coefficient of variation (*V*) and the mean square deviation (*S*), the accuracy of the experiment (*m*%) was determined using the following formulas [14].

Coefficient of dominant was accounted with following G.M. Beil, R. E. Atkins formula in first link hybrids for traits: $hp = (F_1 - MP) / (P - MP)$;

here *hp* -dominate coefficient;

F₁- average arithmetic indices of trait in first link;

MP- average arithmetic indices of trait of parents' form;

P- average arithmetic indices of best paternal or maternal forms;

Trait hereditary were evaluated us follows in first link hybrid: Dominant position not observed (distance) $hp = 0$; A little dominant $0 < hp < 1$; Completely dominant $hp = 1$; Extremely dominant $hp > 1$;

Breeding coefficient (h^2) in F₂ combinations was determined by the formula given in the works of Allard (1956) [14].

4. Results and Discussion

Among the starting materials, the T-85 line showed the highest fiber length of 39,1 mm, while the wild type *G. mustelinum* Miers ex Watt showed the smallest fiber length of 24,7 mm. The fiber length of Ghalib, Andijan-35, Namangan-77 and Kyzyl baraka varieties was found to be 32,5 mm, 33,8 mm, 35,5 mm and 34,7 mm, respectively. The coefficient of variation (*V*%) of the samples of the above 4 varieties is shown in table 1. According to this sign, the

coefficient of variation of the wild type *G.mustelinum* Miers ex Watt was high $V\%=24,2$ and low $V\%=2,1$.

In both cases, a negative advantage in fiber length was observed in the F₁ plants of the Andijan-35 variety, which was reciprocally hybridized with the winning variety. Fiber length (31,9mm) in F₁ (Andijan-35 x Ghalib) hybrids, in which Ghalib variety was the parent, was inherited in the state of negative heterosis ($hp=-2$). In F₁ Ghalib x Namangan-77 and F₁ Namangan-77 x Ghalib hybrids, fiber length was found to be 33.0mm and 34,6mm, respectively. A strong negative ($hp=-0,7$) and moderate positive advantage ($hp=0,4$) was observed in the heritability of the trait. Inheritance through negative and positive heterosis was observed in mutual reciprocal F₁ plants of Ghalib and Kyzyl baraka varieties. The same results as above were recorded in the F₁ reciprocal hybrids with the participation of another Ghalib variety (Table 1).

Fiber length is negative dominance ($hp=-0,6$) and heterosis ($hp=-2,9$) in reciprocal hybrids of Andijan-35 and Namangan-77 varieties, positive and strong in reciprocal hybrids of Andijan-35 variety and wild type *G.mustelinum* Miers ex Watt ($hp=0,9$) and medium dominance ($hp=0,6$) were inherited (Table 1).

In the reciprocal hybrids of Namangan-77 cultivar Kyzyl baraka, *G.mustelinum* Miers ex Watt wild type and T-85 line, F₁ Namangan-77 x *G.mustelinum* Miers ex Watt plants showed medium positive ($hp=0,6$) and negative inheritance ($hp=-0,4$) was noted. However, in F₁ Namangan-77 x T-85 and F₁T-85 x Namangan-77 hybrids, fiber length (36,6mm, 34,5mm, respectively) was observed with satisfactory results. The most negative heterosis during the experiment ($hp=-7,3$; $hp=-11,5$) was detected in the hybrids obtained with the Kyzyl baraka variety.

Table 1. Inheritance of fiber length in parental forms and F₁ hybrids

№	Domestic and interspecific F ₁ hybrid combinations	Fiber length (mm)				
		X±m%	min-max	S	V%	hp
Parent forms						
1	Ghalib	32,5±0,9	28,3-38,3	2,7	7,5	
2	Andijan-35	33,8±0,8	30,0-37,3	2,4	6,1	
3	Namangan-77	35,5±0,3	32,0-38,0	1,1	2,8	
4	Kyzyl baraka	34,7±1,1	27,0-43,0	3,5	9,1	
5	<i>G.mustelinum</i> Miers ex Watt	24,7±2,1	12,3-33,0	6,7	24,2	
6	T-85	39,1±0,1	38,0-40,0	0,1	2,1	
F ₁ plants						
7	Ghalib x Andijan-35	32,9±0,7	30,0-36,3	2,3	6,1	-0,3
8	Andijan-35 x Ghalib	31,9±0,9	27,3-38,7	2,8	7,7	-2
9	Ghalib x Namangan-77	33,0±0,8	29,0-37,0	2,4	6,6	-0,7
10	Namangan-77 x Ghalib	34,6±0,6	32,0-38,7	2	5,1	0,4
11	Ghalib x Kyzyl baraka	32,1±0,9	24,0-37,3	2,9	8,1	-1,4
12	Kyzyl barakax Ghalib	35,9±0,9	30,0-42,3	3,1	7,8	2,1
13	Ghalib x <i>G.mustelinum</i> Miers ex Watt	33,9±0,6	34,0-37,3	1,8	4,7	1,4
14	<i>G.mustelinum</i> Miers ex Watt x Ghalib	28,3±0,23	24,3-35,7	2,3	7,2	-0,1
15	T-85 x Ghalib	32,6±1,4	27,3-40,6	4,3	12,1	-0,9
16	Andijan-35 x Namangan-77	34,1±0,5	31,3-37,0	1,7	4,4	-0,6
17	Namangan-77 x Andijan-35	32,2±0,8	27,0-37,7	2,6	7,3	-2,9
18	Andijan-35 x <i>G.mustelinum</i> Miers ex Watt	33,4±0,5	30,0-37,3	1,5	4,1	0,9
19	<i>G.mustelinum</i> Miers ex Watt x Andijan-35	32,0±0,6	28,3-35,7	1,9	5,3	0,6
20	Namangan-77 x Kyzyl baraka	32,2±0,4	24,9-29,7	1,3	3,9	-7,3
21	Kyzyl baraka x Namangan-77	30,5±0,8	25,0-34,3	2,4	6,9	-11,5
22	Namangan-77 x <i>G.mustelinum</i> Miers ex Watt	33,5±0,4	30,7-37,3	1,3	3,5	0,6
23	<i>G.mustelinum</i> Miers ex Watt x Namangan-77	27,7±1,2	21,7-31,3	3,7	11,6	-0,4
24	Namangan-77 x T-85	36,6±0,8	31,3-42,0	2,5	6	-0,4
25	T-85 x Namangan-77	34,5±0,3	33,3-35,7	0,9	2,6	-1,6
26	Kyzyl baraka x <i>G.mustelinum</i> Miers ex Watt	33,6±0,8	29,7-38,0	2,5	6,6	0,8
27	<i>G.mustelinum</i> Miers ex Watt x Kyzyl baraka	31,5±0,8	26,0-36,0	2,7	7,5	0,4
28	Kyzyl baraka x T-85	32,8±0,7	29,3-36,7	2,3	6,3	-1,9
29	T-85 x Kyzyl baraka	33,1±0,7	28,3-36,7	2,1	5,8	-1,7

№	Domestic and interspecific F ₁ hybrid combinations	Fiber length (mm)				
		X±m%	min-max	S	V%	hp
30	<i>G.mustelinum</i> Miers ex Watt x T-85	30,1±0,4	28,0-31,7	1,1	3,2	-0,3
31	T-85 x <i>G.mustelinum</i> Miers ex Watt	32,3±2,6	17,3-40,3	8,2	22,5	0,1
32	(Ghalib x Andijan-35) x Kyzyl baraka	33,6±0,8	29,0-38,7	2,4	6,3	4,5
33	(Ghalib x Andijan-35) x <i>G.mustelinum</i> Miers ex Watt	31,7±0,8	21,0-35,0	2,6	7,1	0,7
34	(Ghalib x Andijan-35) x T-85	36,2±0,9	28,0-43,0	3,1	7,6	0,1
35	(Ghalib x Namangan-77) x Kyzyl baraka	30,1±0,9	25,0-35,0	2,7	7,9	-3,3
36	(Ghalib x Namangan-77) x <i>G.mustelinum</i> Miers ex Watt	29,9±0,5	27,6-32,0	1,4	4,2	-0,1
37	(Ghalib x Namangan-77) x T-85	35,4±1,1	30,7-42,7	3,6	9	-1,1
38	(Andijan-35 x Ghalib) x Kyzyl baraka	30,6±0,6	27,0-34,3	1,8	5,2	-1,9
39	(Andijan-35 x Ghalib) x <i>G.mustelinum</i> Miers ex Watt	30,9±0,6	27,3-35,0	1,9	5,4	0,7
40	(Namangan-77 x Ghalib) x Kyzyl baraka	33,4±0,8	21,3-37,3	2,4	6,9	-25
41	T-85 x (Namangan-77 x Ghalib)	32,3±0,9	27,3-35,7	2,9	7,9	-2,1
42	(Andijan-35 x Namangan-77) x Kyzyl baraka	31,3±0,8	26,3-37,7	2,7	7,5	-10,3
43	(Andijan-35 x Namangan-77) x <i>G.mustelinum</i> Miers ex Watt	31,5±0,5	28,7-34,0	1,7	4,7	0,5
44	(Andijan-35 x Namangan-77) x T-85	34,9±0,9	29,3-42,3	2,9	7,5	-0,7
45	(Namangan-77 x Andijan-35) x Kyzyl baraka	33,4±0,8	22,0-40,7	2,6	6,9	-0,1
46	(Namangan-77 x Andijan-35) x <i>G.mustelinum</i> Miers ex Watt	31,9±0,6	28,0-36,3	1,9	5,3	0,9
47	(Namangan-77 x Andijan-35) x T-85	37,5±0,8	32,7-41,3	2,6	6,2	0,5
48	T-85 x (Namangan-77 x Andijan-35)	35,0±0,6	31,7-39,3	1,9	5	-0,1

In the course of the experiment, the inheritance of fiber length was also studied in reciprocal hybrids between the variety Kyzyl baraka, wild type *G.mustelinum* Miers ex Watt and T-85 lines. Positive results (33,6mm, hp=0,8; 31,5mm, hp=0,4 respectively) were recorded in F₁ Kyzyl baraka x *G.mustelinum* Miers ex Watt and F₁ *G.mustelinum* Miers ex Watt x Kyzyl baraka combinations.

F₁ Kyzyl barakax T-85 and F₁ T-85 x Kyzyl baraka pairs showed average fiber length, but negative heterosis was observed in heredity (Table 1).

Results of 30,1mm and 32,3mm were recorded in reciprocal hybrids of *G.mustelinum* Miers ex Watt with relatively low fiber length and T-85 with relatively high fiber length among the experimental materials. Intermediate heritability (hp=-0,3; 0,1) was noted.

F₁(Ghalib x Andijan-35) x Kyzyl baraka, F₁ (Ghalib x Andijan-35) x *G.mustelinum* Miers ex Watt and F₁ (Ghalib x Andijan-35) x T-85 combinations obtained from step crosses all showed positive results (respectively 33,6mm, hp=4,5; 31,7mm, hp=0,7; 36,2mm, hp=0,06). F₁ (Ghalib x Andijan-35) x T-85 hybrids showed a satisfactory result in terms of average fiber length, but its coefficient of variation was found to be in a narrow range. Among these plants, high-yielding bushes can be used in selection work aimed at improving fiber length.

All F₁ plants between Ghalib x Namangan-77 hybrids with Kizil baraka variety, *G.mustelinum* Miers ex Watt wild type and T-85 lines showed negative results to varying degrees (Table 1).

F₁ Andijan-35 x Ghalib, F₁ Namangan-77 x Ghalib, F₁ Andijan-35 x Namangan-77 and F₁ Namangan-77 x

Andijan-35 hybrids, also with the variety Kizil baraka, wild type *G.mustelinum* Miers ex Watt and T-85 F₁ plants were obtained by stepwise hybridization between ridges. In all combinations, the fiber length showed a result higher than 30,0 mm. In F₁ (Namangan-77 x Andijan-35) x T-85 hybrid plants, a relatively high result (37,5mm) was recorded among F₁ plants during the experiment. In F₁ (Namangan-77 x Ghalib) x Kyzyl barakaplants, extremely negative heterosis (hp=-25) was observed.

5. Conclusions

The fiber length indicators recorded in the F₁ generations obtained by reciprocal and step hybridization can basically be concluded as follows;

- in the inheritance of the fiber length in the F₁ generation, the participation of the objects involved in reciprocal hybridization as the father or mother form does not have great importance in the inheritance and formation of the character;
- it was noted that fiber length can be changed in the positive direction in the F₁ generation through stepwise crossing.
- according to the analysis of the above literature, the level of heredity of fiber length in the F₁ generation was found to be inherited as positive and negative weak, medium, strong dominance or showing different levels of heterosis.

Among the F₁ hybrids, fiber length is higher in F₁ Kyzyl baraka x Ghalib, F₁ Namangan-77 x T-85, F₁ (Ghalib x

Andijan-35) x T-85 and F₁ (Namangan-77 x Andijan-35) x T-85 combinations, F₁ *G.mustelinum* Miers ex Watt x Winner, F₁ *G.mustelinum* Miers ex Watt x Namangan-77 and F₁ (Ghalib x Namangan-77) x *G.mustelinum* Miers ex Watt combinations showed relatively low results.

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