

# Genetic Nature of Fertility Type in Cotton Hybrids

*Malokhat Khalikova\**, *Elmira Matyakubova*, *Turgun Uzokov*, and *Sayyora Soriyeva*

Cotton Breeding, Seed Production, and Agrotechnologies Research Institute, Tashkent, Uzbekistan

**Abstract.** Studies have been conducted to evaluate the genetic potential of cotton species and to develop disease and pest resistant cotton varieties from them. The significance of the level of leaf hairiness in the representatives of the *Gossypium* L. family in tolerance to sucking pests, spider mite, aphid, was studied. Resources were obtained to measure or qualitatively assess leaf hairiness, transfer the hairiness marker for pest tolerance into the genome of *G. hirsutum* L., and create cultivars with a combination of tolerance and economic traits. In the C2 plants of the combinations obtained by cross-breeding the wild-type ridges with twisting hairiness with the analyzer L-001 line, separation of the hairiness character was noted, its ratio was 3:1 according to the phenotype (1:2:1 according to the genotype). This separation in second-generation hybrids indicates that the feather shape trait is monogenic in nature. Key words: Cotton, ridge, wild type, spider mite, interspecific hybrid, immunity, sucking pest, leaf hairiness, inheritance, dominance

## 1 Introduction

Currently, the world average is 22.0-23.0 million per year. about a ton of cotton fiber is produced. Due to the changes in the global environment, protection measures for various agricultural crops are widely used, which makes it possible to increase productivity by up to 35%. In this regard, research conducted by world scientists is aimed at creating the most convenient, effective and environmentally friendly integrated methods of plant protection, including forms of crop species with natural resistance to pests [1-2].

According to G.H. Saunders, the character of hairiness of the organs of the cotton plant has the nature of dominant or epistatic inheritance compared to alleles of the hairlessness gene.

Important scientific results have been obtained as a result of scientific research conducted in the world regarding the research of the diversity of cotton species, their valuable economic characteristics and tolerance to stress factors [3]. As a result of cytogenetic studies conducted on the research of the *G. tomentosum* species, forms with altered chromosome numbers were obtained; wild cotton species *G. tomentosum* Nutt. ex Seem has two dominant hairiness genes (H1 and H2), a trait that has been shown to be important in tolerance to some sucking pests [4]. By crossing this species with *G. hirsutum*

\* Corresponding author: [halikovamalohat@rambler.ru](mailto:halikovamalohat@rambler.ru)

L., and then crossing it with a cultural form, thickly covered with hair, resistant ridges to representatives of the Jassida family were obtained [5].

## 2 Materials and methods

The source of the research is the lines isolated on the basis of the upper (C10) joint transgressive plants of interspecific hybrids of *G. tomentosum* x *G. hirsutum* L.: T-5/8, T-21/24, T-25/27 and T-26 and *G. hirsutum* It consists of L-001 ridge belonging to L.

Hybridization was carried out between the ridges during the flowering period of the plants. Phenological observations (periods of tillering, flowering and ripening, height of the main stem, number of lobes, type of hairs on the leaf, number of hairs per 1mm<sup>2</sup>, etc.) were carried out in the primary material and hybrid plants. The thickness of the leaf was measured in 3 repetitions with an ocular-micrometer according to hybrid combinations.

Based on the methodology of B.A. Dospheov (1985) [6], the data were statistically calculated using programs prepared for the Microsoft Excel editor using a Pentium IV computer[6].

## 3 Results and discussion

In our experiments, we determined the number of hairs per 1 mm<sup>2</sup> of the leaf plate and the type of hairs in the initial parental forms and hybrids obtained with the aim of studying the nature of the inheritance of the hair type characteristic of this species. The number of hairs on the leaf plate and their variety in the initial rows and first generation hybrids were determined individually in all plants for each hybrid combination during the flowering period of the plants. The average number of hairs per 1mm<sup>2</sup> of the leaf in the L-001 ridge was 9.0, in the T-5/8 ridge 38.5, in the T-21/24 ridge 46.4, in the T-25/27 ridge 40.6 and in the T-26 ridge 20.3 (1 -table).

The number of hairs per 1mm<sup>2</sup> of the leaf in the G<sub>1</sub> plants obtained by crossing the above lines was in the range of 19.7-46.5 pieces, and the index of this sign was different in the combinations. The number of hairs per 1 mm<sup>2</sup> of the leaf in the combinations in which the L-001 ridge participated as a mother was 22.3-44.2 pieces (19.7-40.3 pieces in reciprocal combinations), in the combinations in which the T-5/8 ridge participated as a mother, 32.5-44.8 pieces (31.6-44.6 pieces in reciprocal combinations), 40.2-46.5 units in combinations in which the T-21/24 ridge was crossed as a mother (39.8-44.8 units in reciprocal combinations), 29.8-42.1 units in combinations in which the T-25/27 ridge participated as a mother (33.1-46.5 in reciprocal combinations pieces) and the T-26 ridge was 19.7-39.8 pieces in the combinations participating as a mother (22.3-40.2 pieces in reciprocal combinations).

**Table 1.** C<sub>1</sub> Inheritance of leaf hairiness in plants

	Parent forms and hybrids	Hair type	Number of tufts	The number of hairs in 1 mm <sup>2</sup>	σ	V%	hp
1.	L-001	Simple	1	9,0±0,17	0,76	8,42	-
2.	L-001 x T-26	Twisted	1	22,3±0,16	0,74	3,34	1,35
3.	T-26 x L-001	Twisted	1	19,7±0,10	0,45	2,29	0,89
4.	T-26	Twisted	1	20,3±0,17	0,77	3,79	-
5.	L-001 x T-21/24	Twisted	1-2	44,2±0,36	1,64	3,71	0,88
6.	T-21/24 x L-001	Twisted	2-4	40,3±0,22	1,01	2,52	0,67
7.	T-21/24	Twisted	4	46,4±0,42	1,90	4,11	-
8.	L-001 x T-25/27	Twisted	1-2	39,1±0,30	1,36	3,48	0,90
9.	T-25/27 x L-001	Twisted	1-2	29,8±0,16	0,73	2,44	0,31
10.	T-25/27	Twisted	2-4	40,6±0,37	1,68	4,14	-

11.	L-001 x T-5/8	Twisted	1-2	36,7±0,23	1,37	3,75	0,87
12.	T-5/8 x L-001	Twisted	2-4	36,7±0,20	0,93	2,53	0,87
13.	T-5/8	Twisted	2-4	38,5±0,28	1,27	3,29	-
14.	T-5/8 x T-21/24	Twisted	2-4	44,8±0,26	1,18	2,64	0,59
15.	T-21/24 x T-5/8	Twisted	4	44,6±0,33	1,51	3,39	0,54
16.	T-5/8 x T-25/27	Twisted	2-4	40,3±0,21	0,96	2,39	0,96
17.	T-25/27 x T-5/8	Twisted	2-4	39,6±0,22	1,01	2,56	0,04
18.	T-5/8 x T-26	Twisted	1-2	32,5±0,24	1,10	3,39	0,34
19.	T-26 x T-5/8	Twisted	2	31,6±0,20	0,89	2,83	0,24
20.	T-26 x T-21/24	Twisted	2-4	39,8±0,26	1,17	2,94	0,49
21.	T-21/24 x T-26	Twisted	2-4	40,2±0,26	1,18	2,94	0,52
22.	T-26 x T-25/27	Twisted	2	33,1±0,18	0,81	2,45	0,26
23.	T-25/27 x T-26	Twisted	2-4	30,1±0,21	0,95	3,17	0,03
24.	T-21/24 x T-25/27	Twisted	3-4	46,5±0,37	1,69	3,64	1,03
25.	T-25/27 x T-21/24	Twisted	4	42,1±0,30	1,34	3,20	-0,48

The degree of variability of the sign was 2.29-3.75% by combinations. The dominance index by the sign was -0.48 by hybrid combinations. ranged from to 1.35. In 1 case, a low indicator compared to the average indicators of the parent ridges was observed ( $hp=-0.48$ ), in 17 cases, intermediate indicators ( $hp=0.03-0.96$ ) were noted. In 2 cases, extreme dominance-heterosis was shown for the character.

According to the literature, hairiness at the leaf level in *G. tomentosum* species is controlled by two dominant genes. [7]. In our opinion, this conclusion applies to the density of hairs per 1 mm<sup>2</sup>.

H. Saydaliev (1995) found that hairs on the surface of the leaf are twisted, and this type of hair, among other factors, ensures that sucking pests cannot stick to it. [8]

In our research, from the sources obtained from the hybrids of *G. tomentosum* and *G. hirsutum* species, ridges with unique twisted shape of hairs on the leaves and body part of the plant were isolated. We could not find any understanding in the literature about the genetic control of this type of hair growth. Therefore, researchers have not studied the hereditary nature of this sign [9].

In L-001, from the lines studied in our research, the hairs on the leaf level are absolutely "normal", and we designated it as conditionally homozygous for this character. In the first generation of hybrid plants, which were designated as the second alternative phenotype, twisted hair type T-5/8, T-21/24, T-25/27 and T-26 in other lines, this character was shown as absolute dominant and 100 percent (from some hybrids except) twisted hair was noted.

In the second generation plants obtained as a result of self-pollination of  $C_1$  plants, there was no normal hairing in the combinations obtained by crossing T-5/8, T-21/24, T-25/27 and T-26 lines. That is, in these hybrids, no separation was observed. This indicates that the gene providing the trait in these lines belongs to the same series and is in a homozygous state. Therefore, the combinations involving these ranges are not listed in the table.

In the combinations obtained by crossing the lines with the L-001 line, separation was noted in  $C_2$  plants, and its ratio was 3:1 according to the phenotype (1:2:1 according to the genotype).

The above observed separation in the second generation hybrids indicates that the feather shape trait is monogenic in nature.

Based on the obtained data, it can be concluded that the twisted type of hair growth is manifested in the heterozygous and dominant homozygous state of the gene. No intermediate inheritance was observed for the trait.

The lines L-001, T-5/8, T-21/24, T-25/27 and T-26 that we involved in the experiment can be divided into two groups according to the "hair type" character at the leaf level: L-001- "normal » and T-5/8, T-21/24, T-25/27 and T-26- "screw" type. As it was mentioned above, the plants studied in  $C_1$  for this character did not have a reciprocal difference, and all the plants had hairs on the leaf level of the "twisted" type phenotype. In other words, the type of hairiness at the leaf level in the  $C_1$  plants studied by us is "twisted" type, which

indicates that this type is completely dominant in terms of phenotype regardless of the hybridization direction and that this gene is located in the nuclear chromosome. In the  $C_2$  generation of hybrid plants, in all our studied combinations, it was possible to divide the character into two phenotypic classes according to "hair type": 1. Twisted type; 2. Simple type.

Focusing on the tabular evidence, it can be seen that these phenotypic groups closely match the theoretical 3:1 ratio observed by experimental evidence, indicating that parental forms differ in character by allelic states of the same gene. This opinion is confirmed by the results of the backcross hybrids of the L-001 line with  $C_1$  plants, and the obtained results are closer to the 1:1 ratio.

The number of hairs on the level of 1 mm<sup>2</sup> of the leaf in the combinations in which the -5/8 ridge participated as a mother was 31.5-43.6 (32.7-45.8 pieces according to reciprocal combinations, variation 8.90-18.43), the variation index of the sign was 9.23-13.48%. The plants of these combinations were mainly located on the right side of the variation line, and a high degree of hairiness was recorded (Table 2).

In the second generation of T-21/24 maternal hybrid combinations, the number of hairs per 1 mm<sup>2</sup> of the leaf was the highest, 39.3-47.7 (37.3-44.3 in reciprocal combinations, variability 8.65-11.58), the variability of the sign was 6.67 -12.81%.

The number of hairs per 1 mm<sup>2</sup> of the leaf was 28.2-44.3 (30.6-47.7 in reciprocal combinations, variability 6.67-12.47%) in the combinations in which the T-25/27 ridge participated as a mother. It was noted that the coefficient of variation of the sign for these combinations is equal to 9.71-14.22%.

The number of hairs per 1 mm<sup>2</sup> of the leaf in the combinations in which the T-26 ridge participated as a mother was 20.5-37.3 (in reciprocal combinations 22.0-39.3, variability 11.21-15.70%). Character variability in these hybrids was equal to 11.58-18.18%.

As can be seen from the analysis of the tabular data, the number of hairs per 1 mm<sup>2</sup> of the leaf in the separating F<sub>2</sub> plants was almost unchanged compared to the first generation hybrids (Table 3). However, within them some dense hairy (50-54 pieces/cm<sup>2</sup>) transgressive plants were separated.

**Table 2.** Inheritance of the type of pubescence on the leaf plate in  $C_2$  plants

№	Parent form and $C_2$ plants	n	Twisted	Simple	Theoretical Expected Ratios	$\chi^2$	P
1.	L-001	20	-	20	-	-	-
2.	T-5/8	20	20	-	-	-	-
3.	T-21/24	20	20	-	-	-	-
4.	T-25/27	20	20	-	-	-	-
5.	T-26	20	20	-	-	-	-
6.	$C_1$ L-001 x T-5/8	30	30	-	-	-	-
7.	$C_2$ L-001 x T-5/8	125	98	27	3:1	0.77	0.50-0.20
8.	$C_v$ (L-001 x T-5/8)xL-001	80	49	31	1:1	4.05	0.05-0.01
9.	$C_1$ L-001 x T-21/24	30	30	-	-	-	-
10.	$C_2$ L-001 x T-21/24	116	80	36	3:1	2.25	0.25-0.10

11.	$C_V(L-001 \times T-21/24) \times L-001$	74	28	46	1:1	4.36	0.05-0.01
12.	$C_1L-001 \times T-25/27$	30	30	-	-	-	-
13.	$C_2L-001 \times T-25/27$	118	91	27	3:1	0.28	0.75-0.50
14.	$C_V(L-001 \times T-25/27) \times L-001$	95	44	51	1:1	0.52	0.50-0.25
15.	$C_1L-001 \times T-26$	30	30	-	-	-	-
16.	$C_2L-001 \times T-26$	120	89	31	3 :1	0.04	0.99-0.95
17.	$C_V(L-001 \times T-26) \times L-001$	62	25	37	1:1	2.32	0.25-0.10
18.	$C_1T-5/8 \times L-001$	30	30	-	-	-	-
19.	$C_2T-5/8 \times L-001$	111	85	26	3:1	0.14	0.75-0.50
20.	$C_V(T-5/8 \times L-001) \times L-001$	67	38	29	1:1	1.2	0.50-0.25
21.	$C_1T-21/24 \times L-001$	30	30	-	-	-	-
22.	$C_2T-21/24 \times L-001$	118	90	28	3 :1	0.09	0.99-0.95
23.	$C_V(T-21/24 \times L-001) \times L-001$	71	30	41	1:1	1.71	0.25-0.10
24.	$C_1T-25/27 \times L-001$	30	30	-	-	-	-
25.	$C_2T-25/27 \times L-001$	110	81	29	3 :1	0.10	0.75
26.	$C_V(T-25/27 \times L-001) \times L-001$	68	29	39	1:1	1.46	0.25-0.10
27.	$C_1T-26 \times L-001$	30	30	-	-	-	-
28.	$C_2T-26 \times L-001$	133	101	32	3 :1	0.06	0.99-0.95
29.	$C_V(T-26 \times L-001) \times L-001$	80	43	37	1:1	0.45	0.50

**Table 3.** Heritability and variation in the number of hairs per 1mm<sup>2</sup> of the leaf in C<sub>2</sub> plants

	Parent form and C <sub>2</sub> plants	n	Class spacing 5 (K=5)										M±m	σ	V%	h <sup>2</sup>	
			5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54					
1.	L-001	20	11	9										9,3±0,57	2,55	27,59	
2.	T-5/8	20							3	10	7			38,0±0,77	3,48	9,16	
3.	T-21/24	20								1	2	13	4	47,0±0,81	3,63	7,72	
4.	T-25/27	20							2	5	11	2		40,3±0,91	4,06	10,09	
5.	T-26	20				5	15							20,8±0,48	2,16	10,43	
6.	L-001 x T-5/8	125						12	87	22	4			32,7±0,54	6,03	18,43	0,86
7.	T-5/8 x L-001	111							28	69	11	3		36,5±0,32	3,37	9,23	0,66
8.	L-001 x T-21/24	116								11	65	31	9	43,6±0,35	3,77	8,65	0,77
9.	T-21/24 x L-001	118							9	25	46	25	13	42,3±0,50	5,42	12,81	0,88
10.	L-001 x T-25/27	118							17	57	32	10	2	38,7±0,41	4,45	11,49	0,76
11.	T-25/27 x L-001	110					18	52	35	5				28,2±0,37	3,40	13,87	0,72
12.	L-001 x T-26	120			28	63	29							22,0±0,32	3,46	15,70	0,68
13.	T-26 x L-001	133			59	57	14	3						20,5±0,32	3,73	18,18	0,67
14.	T-5/8 x T-21/24	145						5	16	61	53	10		43,6±0,37	4,44	10,19	0,82

15.	T-21/24 x T-5/8	134								1	6	40	64	23	45.8±0.35	4,07	8,90	0.78
16.	T-5/8 x T-25/27	131							3	7	28	62	31		41.2±0.40	4,62	11,20	0.82
17.	T-25/27 x T-5/8	152								15	65	62	10		39,2±0.310	3,81	9,71	0.78
18.	T-5/8 x T-26	124						6	28	67	18	5			31,5±0.38	4,25	13,48	0.73
19.	T-26 x T-5/8	119							19	43	52	5			33,8±0.37	3,99	11,83	0.73
20.	T-21/24xT-25/27	121									2	11	76	32	47.7±0.29	3,18	6,67	0.75
21.	T-25/27xT-21/24	128								5	9	47	56	11	44.3±0.40	4,48	10,10	0.82
22.	T-21/24 x T-26	115								17	41	44	13		39.3±0.41	4,41	11,21	0.78
23.	T-26 x T-21/24	158							9	27	67	55			37.3±0.34	4,32	11,58	0.77
24.	T-25/27 x T-26	136						5	19	55	44	13			33.5±0.41	4,77	14,22	0.71
25.	T-26 x T-25/27	122							53	54	11	4			30.6±0.35	3,82	12,47	0.67

T-21/24, T-25/27 ridges participated L-001 x T-21/24, T-21/24 x L-001, L-001 x T-25/27, T-5/8 x T -21/24, T-21/24 x T-5/8, T-21/24 x T-25/27, T-25/27 x T-21/24 combinations yielded plants in the 45-54 class range .

The degree of heritability of the character is quite high (0.66-0.88), which means that it is highly balanced and maintained by selection. If we take a closer look at the range of variation, the series of variation in all hybrid combinations is single-peaked, which indicates that hair abundance is incompletely dominant at the 1 mm<sup>2</sup> level. Another evidence that this character is controlled by nuclear genes is the value of  $h_2$ , which indicates that the character is 60 in the population. -80% indicates that it has a genotypic basis and that there is a high possibility of distinguishing densely hairy leaf forms in future generations.

Based on the results obtained by the character, it was concluded as follows: the genetic analysis of the number of hairs per 1 mm<sup>2</sup> level in the twist type ridges is due to the fact that there are not many polygenes involved in its genetic control, the absence of a large transgressive variation in the reciprocal hybrids of these ridges C<sub>2</sub> plants is similar in terms of their main genes, but suggesting that modifier genes may vary slightly.

## 4 Conclusion

*G. tomentosum* Nutt. ex Seem. and inter-row hybrid plants obtained on the basis of hybrids with cultured *G. hirsutum* L. type specimens showed moderate to strong heredity of the leaf thickness trait, the index was 0.20-0.50, and these evidences are influenced by agrotechnical activities, plant density per hectare, and the influence of the external environment in general. shows that it will be significant[10].

The degree of heritability of the marker number of hairs at the level of 1 mm<sup>2</sup> of the leaf is quite high (0.66-0.88), which means that it is highly balanced and maintained as a result of selections. If the range of variation is closely controlled, the variation series in all hybrid combinations is single-peaked, and hair abundance is incompletely dominant at the 1 mm<sup>2</sup> level [11]. Another evidence that this trait is controlled by nuclear genes is the value of  $h_2$ , which indicates that the trait has 60-80% genotypic basis in the population, and there is a high possibility of differentiating dense leaf hairy forms in future generations. The genetic analysis of the number of hairs at the level of 1 mm<sup>2</sup> in the twist type ridges indicates that there are not many polygenes involved in its genetic control, the fact that there is no significant transgressive variation in C<sub>2</sub> plants of the reciprocal hybrids of these ridges, that they are similar in terms of the main genes, but may differ slightly in modifier genes.

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