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INHERITANCE OF STEM AND LEAF PUBESCENCE IN RECIPROCAL F₁ AND F₂ PROGENIES OF INTERSPECIFIC CROSSES BETWEEN GOSSYPIUM HIRSUTUM AND G. BARBADENSE

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Abstract

This study compared the inheritance of pubescence in two reciprocal interspecific cross pairs differing in parental phenotypic contrast. The crosses involved pilose L-10 and moderately pubescent Afsona of *Gossypium hirsutum* L., and smooth A-4384 and highly pubescent Marvarid of *G. barbadense* L. In the F1 generations of L-10 × A-4384 and its reciprocal A-4384 × × L-10, mean stem pubescence scores were 4.39 ± 0.21 and 4.31 ± 0.25, respectively, with degrees of dominance of hp = 0.70 and 0.66, indicating incomplete dominance toward greater pubescence. In F2, mean stem pubescence scores declined to 3.27 ± 1.11 and 3.26 ± 1.16, whereas the coefficients of variation increased to 33.83% and 35.48%; a score of 4.00 was the modal class in both populations. In Afsona × Marvarid and the reciprocal Marvarid × Afsona, F1 stem pubescence averaged 3.44 ± 0.17 (hp = 0.15) and 2.76 ± 0.25 (hp = –1.53), respectively, revealing a marked difference between reciprocal directions at the descriptive level. In their F2 populations, a score of 3.00 was the modal class and the stem–leaf correlation was r = 0.98. Within the cross pairs examined, the stronger parental phenotypic contrast in L-10 × A-4384 was associated with broader F2 phenotypic segregation, whereas the Afsona × Marvarid pair showed a more pronounced direction-dependent difference in F1.

Keywords: *Gossypium hirsutum L.; Gossypium barbadense L.; trichome; pubescence trait; reciprocal cross; F1; F2; degree of dominance; phenotypic segregation*

Introduction

Cotton (*Gossypium spp.*) genotypes differ markedly in the density, morphology, and distribution of trichomes on vegetative organs. Pubescence is a readily scored morphological trait that is useful for rapid phenotyping of breeding material and, in some genotypes, has also been associated with responses to biotic factors and adaptation (Bourland F. M., Hornbeck J. M., McFall A. B., Calhoun S. D. 2003; Hornbeck J. M., Bourland F. M. 2007). In Uzbekistan, *G. hirsutum* L. and *G. barbadense* L. accessions have been shown to differ in the morphological types of leaf and stem trichomes (Tursunov M., Sanaev N., Ergashev M., Madrakhimov M., 2024), while the inheritance of pubescence type has been evaluated from breeding and plant-protection perspectives (Xalikova M. B., Matyakubov O. A., Asqarova Z. O., Matyakubova E. U., Uzokov T. B., 2023; Umarova J. Q., 2024; Umarova J. K., 2025).

Pubescence in cotton is not governed by a single uniform genetic background. Genomic studies have identified trichome-associated QTL regions (Ahmed H., Nazir M. F., Pan Z., Gong W., Iqbal M. S., He S., et al. 2020), differences in the genetic basis of stem trichome development between cultivated tetraploid cotton species (Yuan R., Cao Y., Li T., Yang F., Yu L., Qin Y., et al., 2021), the GoSTR regulator (Xu B., Zhang J., Shi Y., Dai F., Jiang T., Xuan L., et al. 2023), and components associated with leaf-hair development (Wang X., Dai P., Li H., Wang J., Gao X., Wang Z., et al. 2024). Together, these findings support the view that the continuous phenotypic distributions and cross-specific dominance observed in hybrid generations may reflect a complex genetic architecture.

In reciprocal crosses, the same parental genotypes exchange their roles as female and male parents. Parallel evaluation of reciprocal F_1 and F_2 generations therefore allows parental phenotypic contrast, dominance, and segregation patterns to be compared within the same parental combination. Accordingly, this study compared the inheritance of stem and leaf pubescence in the reciprocal L-10 × A-4384 and Afsona × Marvarid cross pairs, with particular emphasis on dominance in F_1, phenotypic segregation in F_2, and the association between stem and leaf pubescence.

Materials and methods

The study was conducted during 2023–2025 at the Durmon Experimental Station and the Plant Immunity Laboratory of the Institute of Genetics and Plant Experimental Biology, Academy of Sciences of the Republic of Uzbekistan, in Qibray District, Tashkent Region. Field trials were established using a 60 × 20 × 5 planting arrangement in 5-m plots, with two, two, and three replicates in 2023, 2024, and 2025, respectively. The present analysis included four parental genotypes and two reciprocal cross pairs derived from them: L-10 (*G. hirsutum*, pilose) × A-4384 (*G. barbadense*, smooth) and Afsona (*G. hirsutum*, moderately pubescent) × Marvarid (*G. barbadense*, highly pubescent).

Stem and leaf pubescence were scored separately using a modified 0–5 scale based on the approaches of Bourland and Hornbeck [1, 2]: : 0 = glabrous, 1 = smooth/very sparsely pubescent, 2 = sparsely pubescent, 3 = moderately pubescent, 4 = highly pubescent, and 5 = pilose. Repeated visual assessments were made from the squaring–flowering period through the end of the growing season. Because plant-level means across repeated assessments were used, intermediate scores could occur. In F_2 populations, stem and leaf pubescence were recorded for individual plants. Complete stem-pubescence records were available for n = 244 plants in L-10 × A-4384, n = 224 in A-4384 × L-10, n = 201 in Afsona × Marvarid, and n = 203 in Marvarid × Afsona.

Results are presented as mean ± standard deviation (mean ± SD) and coefficient of variation, CV = (SD/mean) × 100. The degree of dominance in F_1 was calculated as $hp = (F_1 - MP)/(HP - MP)$, where MP is the mid-parent mean and HP is the value of the parent with greater pubescence. Phenotypic frequency distributions and Pearson's correlation coefficient (r) between stem and leaf pubescence were calculated for F_2 populations. Reciprocal F_1 combinations were compared descriptively using mean ± SD and hp; therefore, the observed differences were not interpreted as direct evidence of maternal, cytoplasmic, or parent-of-origin effects.

Results

The parental genotypes represented two different levels of phenotypic contrast. L-10

and A-4384 differed sharply in stem pubescence, with mean scores of 4.98 and 1.06, respectively, a difference of 3.92 score units. By contrast, the difference between Afsona and Marvarid was 0.81 score units. The F₁ results showed that dominance was expressed differently in the two parental contrasts (Table 1).

Table 1. *Pubescence scores and degree of dominance in the parental genotypes and reciprocal F₁ combinations*

Genotype / cross	Stem pubescence, mean ± SD	hp	Leaf pubescence, mean ± SD	hp
L-10	4,98 ± 0,06	—	4,99 ± 0,06	—
A-4384	1,06 ± 0,14	—	1,07 ± 0,15	—
F₁ L-10 x A-4384	4,39 ± 0,21	0,70	4,48 ± 0,22	0,74
F₁ A-4384 x L-10	4,31 ± 0,25	0,66	4,44 ± 0,16	0,72
Afsona	2,97 ± 0,12	—	2,96 ± 0,13	—
Marvarid	3,78 ± 0,37	—	3,88 ± 0,31	—
F₁ Afsona x Marvarid	3,44 ± 0,17	0,15	3,44 ± 0,17	0,04
F₁ Marvarid x Afsona	2,76 ± 0,25	−1,53	2,77 ± 0,25	−1,40

In L-10 × A-4384, hp values for stem and leaf pubescence were 0.70 and 0.74, respectively; in the reciprocal A-4384 × L-10 they were 0.66 and 0.72. Thus, regardless of cross direction, the F₁ phenotype shifted toward the more pubescent L-10 parent and retained an incomplete-dominance pattern. The F₁ of Afsona × Marvarid was close to the mid-parent value (hp = 0.15 for stem and 0.04 for leaf). In the reciprocal Marvarid × Afsona F₁, stem and leaf scores were lower than those of Afsona, with hp = −1.53 and −1.40, respectively. For stem pubescence, the descriptive difference between the two reciprocal F₁ combinations was 0.68 score units.

Table 2. *Phenotypic variation, stem–leaf correlation, and modal class in reciprocal F₂ populations*

F₂ cross	n	Stem mean ± SD	CV, %	Leaf mean ± SD	CV, %	r	Modal stem score (n)
L-10 × A-4384	244	3,27 ± 1,11	33,83	3,41 ± 1,09	31,85	0,95	4,00 (108)
A-4384 × L-10	224	3,26 ± 1,16	35,48	3,29 ± 1,17	35,59	0,98	4,00 (102)
Afsona × Marvarid	201	3,25 ± 0,63	19,37	3,29 ± 0,61	18,46	0,98	3,00 (78)
Marvarid × Afsona	203	3,12 ± 0,52	16,65	3,17 ± 0,51	16,20	0,98	3,00 (110)

In the L-10 × A-4384 reciprocal pair, mean pubescence decreased in F₂ whereas phenotypic variation increased markedly. Stem-pubescence CV values were 33.83% and 35.48%, and a score of 4.00 was the modal class in both populations. A total of 108 plants in L-10 × A-4384 and 102 plants in A-4384 × L-10 fell into this class. Low and intermediate phenotypes with scores of 1.00–3.50 were also frequent, while 14 and 16 plants, respectively, were recorded in the 5.00 class. These distributions demonstrate broad, multiclass phenotypic segregation from low to high pubescence in the F₂ populations (Figure 1).

The F₂ distributions of the Afsona × Marvarid reciprocal pair were comparatively narrower, with stem-pubescence CV values of 19.37% and 16.65%. In both populations, 3.00 was the modal score, encompassing 78 plants in Afsona × Marvarid and 110 plants in Marvarid × Afsona. In Afsona × Marvarid, the 3.50 and 4.00 classes contained 40 and 34 plants, respectively, compared with

25 and 23 plants in the reciprocal population. Thus, the 0.68-score descriptive difference observed between reciprocal F1 combinations narrowed to 0.13 score units in the F2 means, although phenotypic segregation remained evident (Figure 2).

Figure 1. *Frequency distribution of stem pubescence scores in the reciprocal F2 populations L-10 × A-4384 and A-4384 × L-10*

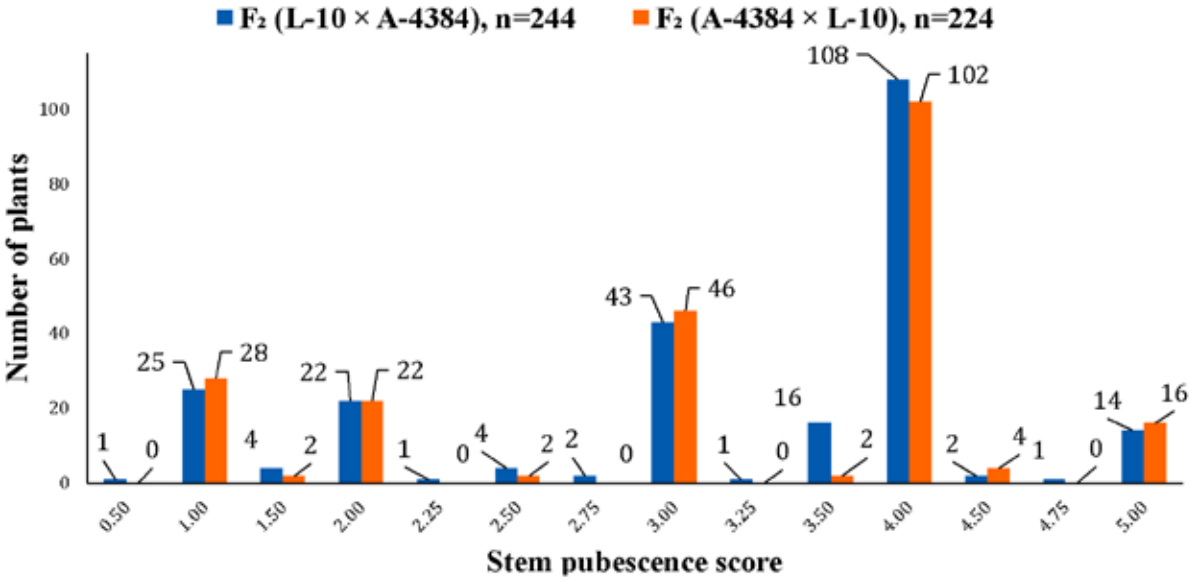
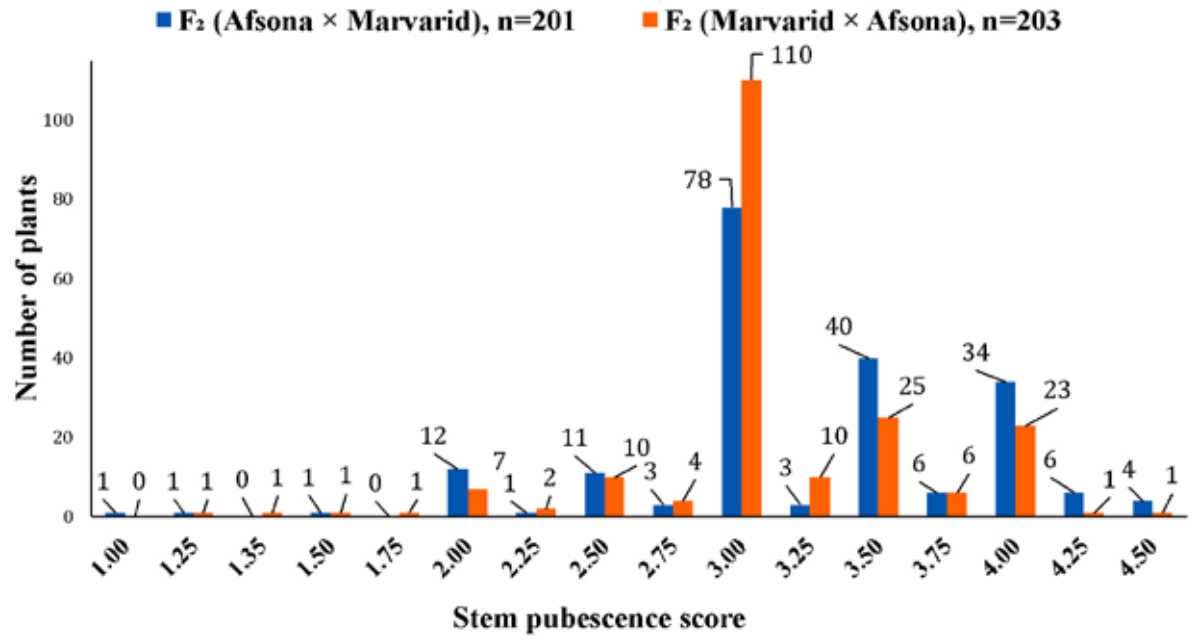


Figure 2. *Frequency distribution of stem pubescence scores in the reciprocal F2 populations Afsona × Marvarid and Marvarid × Afsona*



Stem and leaf pubescence covaried closely in all four F2 populations. Pearson's correlation coefficient was r = 0.95 in L-10 × A-4384 and r = 0.98 in A-4384 × L-10, Afsona × Marvarid, and Marvarid × Afsona. This strong association indicates coordinated phenotypic expression of pubescence on the two vegetative organs, but it does not demonstrate that stem and leaf pubescence are controlled by an identical molecular mechanism.

Discussion

The two reciprocal cross pairs displayed distinct inheritance profiles for pubescence.

In the strongly contrasting L-10 × A-4384 pair, both F_1 directions shifted toward L-10, with hp values ranging from 0.66 to 0.74. In F_2, CV increased to 31.85–35.59%, and segregation across multiple classes between scores 1.00 and 5.00 showed that the relatively uniform high-pubescence phenotype of F_1 was followed by broad phenotypic segregation in the next generation. This pattern is consistent with genomic evidence that trichome-related traits in cotton involve multiple loci and regulatory components (Ahmed H., Nazir M. F., Pan Z., Gong W., Iqbal M. S., He S., et al., 2020; Yuan R., Cao Y., Li T., Yang F., Yu L., Qin Y., et al., 2021; Xu B., Zhang J., Shi Y., Dai F., Jiang T., Xuan L., et al. 2023; Wang X., Dai P., Li H., Wang J., Gao X., Wang Z., et al., 2024).

Although the parental contrast in Afsona × × Marvarid was narrower, the descriptive difference between reciprocal F_1 combinations was more pronounced. When Afsona was used as the female parent, the F_1 mean was close to the mid-parent value; when Marvarid was the female parent, the F_1 mean fell below the Afsona value. However, because no formal reciprocal-effect test was conducted, this difference cannot be regarded as direct evidence of maternal, cytoplasmic, or parent-of-origin inheritance. The convergence of reciprocal F_2 means to 3.25 and 3.12 indicates that the descriptive difference observed in F_1 was attenuated in the F_2 generation.

The frequency distributions provided biological information that was not captured by the mean and CV alone. In the L-10 × × A-4384 pair, the modal score was 4.00, but the persistence of low-pubescence classes reduced the population means to 3.26–3.27. In the Afsona × Marvarid pair, individuals were more strongly concentrated around a score of 3.00. For breeding decisions, F_2 populations should therefore be evaluated using the modal class and the full frequency distribution together with the mean ± SD.

The strong correlations between stem and leaf pubescence (r = 0.95–0.98) indicate that scores recorded on the two organs provide highly concordant phenotypic information for rapid phenotyping. Previous studies have reported varying relationships among trichome traits on leaves, stems, bracts, and other organs (Bourland F. M., Hornbeck J. M., McFall A. B., Calhoun S. D., 2003; Hornbeck J. M., Bourland F. M., 2007). In the present study, this strong association persisted specifically in segregating F_2 populations.

From a breeding perspective, the L-10 × × A-4384 pair generated a broad pubescence range, from low-pubescence phenotypes to pilose plants, within the same F_2 population. In contrast, Afsona × Marvarid produced predominantly intermediate-pubescence forms with strong phenotypic concordance between stem and leaf. Because individual F_2 plants are not yet genetically fixed lines, selected plants should be re-evaluated in F_3 and subsequent generations. This study was phenotypic and was based on two reciprocal cross pairs; repeated formal statistical testing and molecular analyses will be required to resolve the genetic basis of the reciprocal differences.

Conclusion

In L-10 × A-4384 and A-4384 × L-10, F_1 pubescence showed incomplete dominance toward the highly pubescent L-10 parent (hp = 0.66–0.74). In F_2, CV increased to 31.85–35.59%, producing a broad segregating distribution with 4.00 as the modal score. Afsona × Marvarid and Marvarid × Afsona showed a direction-dependent descriptive difference in F_1 (stem scores of 3.44 and 2.76; hp = 0.15 and –1.53, respectively), whereas this difference was reduced in F_2, where 3.00 was the modal score in both populations. A strong positive correlation between stem and leaf pubescence was maintained across all F_2 populations (r = 0.95–0.98). Overall, F_1 phenotypic expression and F_2 segregation patterns were associated with parental phenotypic contrast and cross direction in a cross-specific manner.

References

Bourland F. M., Hornbeck J. M., McFall A. B., Calhoun S. D. A rating system for leaf pubescence of cotton. Journal of Cotton Science. 2003; 7: 8–15.

Hornbeck J. M., Bourland F. M. Visual ratings and relationships of trichomes on bracts, leaves, and stems of upland cotton. Journal of Cotton Science. 2007; 11: 252–258.

Tursunov M., Sanaev N., Ergashev M., Madrakhimov M. Types of leaf trichome and the relationship of its position in samples *G. hirsutum* L., *G. barbadense* L. ACTA NUUz. 2024; 3(3.1): 152–156. URL: https://doi.org/10.69617/nuuz.v3i3.1.1749

Xalikova M. B., Matyakubov O. A., Asqarova Z. O., Matyakubova E. U., Uzokov T. B. G‘o‘za duragaylarida zararkunandalarga bardoshlilikni ta’minlovchi tuklanish tipining irsiylanishi [Inheritance of the pubescence type associated with pest tolerance in cotton hybrids]. Agro Kimyo Himoya va O‘simliklar Karantini. 2023; Special issue 2: 284–286. [in Uzbek]

Umarova J. Q. G‘o‘za barg sathidagi tuklanish tipi irsiylanishining genetik tahlili [Genetic analysis of the inheritance of leaf-surface pubescence type in cotton]. Maktabgacha va maktab ta’limi. 2024; 8: 177–180. [in Uzbek]

Umarova J. K. The impact of some traits providing tolerance to pests in cotton in creating a clean ecological environment. Modern American Journal of Biological and Environmental Sciences. 2025; 1(8): 32–36.

Tursunov M., Narimonov A., Sanaev N., Ergashev M., Isakulova S., Ruziboev H. Inheritance and determination of stem pubescence and other morphological characters in intraspecific and interspecific hybrid generations F₁ of *G. hirsutum* L. and *G. barbadense* L. Universum: Chemistry and Biology. 2025; 8(134).

Tursunov M., Turaqulova M., Kozimov B. G‘o‘zaning F₁ duragaylarida hosil elementlarining irsiylanishi [Inheritance of yield components in F₁ cotton hybrids]. ACTA NUUz. 2025; 3(3.1): 98–100. URL: https://doi.org/10.69617/nuuz.v3i3.1.7388 [in Uzbek]

Ahmed H., Nazir M. F., Pan Z., Gong W., Iqbal M. S., He S., et al. Genotyping by sequencing revealed QTL hotspots for trichome-based plant defense in *Gossypium hirsutum*. Genes. 2020; 11(4): 368. URL: https://doi.org/10.3390/genes11040368

Yuan R., Cao Y., Li T., Yang F., Yu L., Qin Y., et al. Differentiation in the genetic basis of stem trichome development between cultivated tetraploid cotton species. BMC Plant Biology. 2021; 21: 115. URL: https://doi.org/10.1186/s12870-021-02871-4

Xu B., Zhang J., Shi Y., Dai F., Jiang T., Xuan L., et al. GoSTR, a negative modulator of stem trichome formation in cotton. The Plant Journal. 2023; 116(2): 389–403. URL: https://doi.org/10.1111/tpj.16379

Wang X., Dai P., Li H., Wang J., Gao X., Wang Z., et al. The genetic basis of leaf hair development in upland cotton (*Gossypium hirsutum*). The Plant Journal. 2024; 120(2): 729–747. URL: https://doi.org/10.1111/tpj.17017

Xie Y., Yang L., Zhao Z., Ding M., Cao Y., Hu X., Rong J. Transcriptomic exploration yields novel perspectives on the regulatory network underlying trichome initiation in *Gossypium arboreum* hypocotyl. Frontiers in Plant Science. 2025; 16: 1604186. URL: https://doi.org/10.3389/fpls.2025.1604186.

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