

Inheritance and Expression of Valuable Agronomic Traits In F₁ Hybrids of Colored Fiber Cotton (*Gossypium Hirsutum* L.) Under Different Water Regimes

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Abstract

In this study, the inheritance of plant productivity, lint percentage, 1000-seed weight, and fiber length traits in naturally colored cotton samples, as well as their response to water deficit conditions, were investigated. Under optimal water supply conditions, the highest values of the main economically valuable traits were mainly observed in the white-fibered Sadaf variety, while the highest 1000-seed weight was recorded in the brown-fibered 011250 sample. In the F₁ hybrids obtained through diallel crossing, intermediate inheritance, positive and negative incomplete dominance, and in some cases overdominance were observed for most of the studied traits. Under simulated drought (water deficit) conditions, all parental forms and hybrid genotypes showed varying degrees of reduction in the studied traits. The obtained results are important for the selection of drought-tolerant and high-yielding cotton genotypes.

Keywords: Naturally colored cotton, diallel crossing, F₁ hybrids, plant productivity, lint percentage, fiber length, 1000-seed weight, drought stress, inheritance, dominance.

SD- Simulated drought

OC-optimal conditions

AC- Coefficient of adaptability.

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1. Introduction

At present, the demand for environmentally safe and

organic products is steadily increasing worldwide. Issues related to environmental protection, reducing the use of

chemical substances in production, and safeguarding human health are becoming increasingly important. From this perspective, naturally colored cotton deserves special attention as an environmentally sustainable and economically efficient type of raw material. By reducing the need for artificial dyeing of fibers, it decreases the ecological burden and enables the production of natural and safe products.

However, the practical significance of naturally colored cotton has not yet been fully realized due to certain limitations related to its fiber quality characteristics and technological requirements. Therefore, the comprehensive study of economically important traits in colored fiber cotton, as well as the determination of their inheritance patterns and interrelationships, represents an important scientific direction. This, in turn, provides a necessary theoretical and practical basis for the development of high-quality, high-yielding, and competitive cotton varieties.

Currently, global climate change, the reduction of water resources, and the intensification of various abiotic stress factors are significantly affecting cotton cultivation. Under such conditions, the development of new cotton varieties characterized by high productivity, improved fiber quality, tolerance to stress factors, and the ability to produce environmentally friendly products remains one of the priority tasks of the cotton industry.

Cotton fiber is one of the most important and widely used natural raw materials in the global textile industry. In recent years, the intensification of global environmental problems and the increasing concern for human health have further increased the need to utilize naturally colored cotton. Naturally colored cotton (NCC, *Gossypium hirsutum*) fibers possess inherent natural pigments, which reduce the need for additional chemical dyeing. As a result, the use of harmful substances in the textile industry is significantly reduced, which is considered an important factor in ensuring environmental sustainability [2].

Nevertheless, the large-scale adoption of colored fiber cotton has been limited by the relatively low quality characteristics of its fiber [5]. The main objective of cotton genetics and breeding is not only to increase yield but also to improve the quality characteristics of the fiber [4]. Fiber quality is a complex trait that encompasses parameters such as fiber length, strength, and fineness. Cotton yield is determined by the number of bolls per plant, plant density per unit area, the weight of cotton per

boll, and the total fiber production [3].

Research indicates that fiber quality and yield are often negatively correlated, making it difficult to improve both traits simultaneously using traditional breeding methods. Therefore, an in-depth study of the biochemical and molecular-genetic mechanisms of colored cotton is a crucial scientific approach for the coordinated improvement of fiber quality and productivity.

2. Methods

Colored fiber samples of *Gossypium hirsutum* L. were used, including the brown fiber sample with catalog number 011250 and the white fiber variety "Sadaf." F₁ hybrids were obtained through diallel crosses between these lines.

Field experiments were conducted at the experimental plots of the regional experimental base of the Institute of Genetics and Experimental Plant Biology of the Academy of Sciences of the Republic of Uzbekistan, located in Zangiota district, Tashkent region. Agronomic practices in the experimental fields were carried out in accordance with the procedures adopted at the experimental farm of the Institute of Genetics and Experimental Plant Biology of the Republic of Uzbekistan. Quantitative traits were evaluated using the methods described by V.A. Dospekhov[1].

3. Results and Discussion

Under optimal water supply conditions, among the colored fiber cotton samples, the white fiber variety "Sadaf" showed a relatively high plant productivity, with an average cotton weight per plant of 64.38 g, while the brown fiber sample 011250 exhibited a cotton weight per plant close to that of the white variety, at 60.20 g. (Table 1).

In the F₁ progeny obtained from a complete diallel crossing scheme of the samples and varieties, intermediate inheritance was observed, with productivity recorded at 63.00 g and 61.00 g, respectively.

Under simulated drought, that is, under water-deficit conditions, plant productivity decreased to varying degrees in all parental and F₁ hybrid genotypes. Strong sensitivity to water deficit for this trait was observed in the "Sadaf" variety (AC = -25.4%). In the F₁ hybrids, the highest stress sensitivity was recorded in the Sadaf × 011250 combination (AC = -16.3%). (Table 1)

Table 1. Plant productivity (g per plant) and its inheritance in F₁ hybrids of colored fiber cotton varieties.

№	Samples and F ₁ hybrids	Fiber color	OC		SD		AC(%)
			X	hp	X	hp	
1	011250	Brown	60.20	-	50.62	-	-15.9
2	Sadaf	White	64.38	-	48.03	-	-25.4
3	011250 x Sadaf	Light brown	61.00	-0.62	55.90	5.08	-8.4
4	Sadaf x 011250	Light brown	63.00	0.34	52.70	2.61	-16.3

Under conditions of optimal water supply, among the colored cotton samples of medium-staple cotton studied in our research, the highest fiber yield was observed in the white-fiber Sadaf variety (40.1%), while the lowest fiber yield was recorded in the brown-fiber 011250 sample (27.2%).

Among the F₁ hybrids, the highest fiber yield was observed in the white-fiber 011250 × Sadaf combination (34.4%). Under conditions of optimal water supply, the fiber yield trait in the F₁ hybrids exhibited positive

incomplete dominance as well as negative incomplete dominance. (Table 2)

Under water-deficit conditions, fiber yield in the samples increased relative to the control (AC = +0.1%), while in the F₁ hybrids, fiber yield decreased to varying degrees. The highest fiber yield was observed in the 011250 × Sadaf combination (33.7%). Under soil water deficiency, fiber yield in the F₁ hybrids exhibited inheritance with incomplete negative dominance. (Table 2)

Table 2. Fiber yield (%) and its inheritance in F₁ hybrids of colored fiber cotton varieties

№	Samples and F ₁ hybrids	Fiber color	OC		SD		AC(%)
			X	hp	X	hp	
1	011250	brown	27.2	-	27.3	-	+0.1
2	Sadaf	white	40.1	-	41.1	-	+0.1
3	011250 x Sadaf	Light brown	34.6	0.15	33.7	-0.07	-0.07
4	Sadaf x 011250	Light brown	31.0	-0.41	29.1	-0.74	-1.9

Under optimal water supply conditions (OC), among the group of colored fiber cotton samples, one of the most important economically valuable traits, the weight of 1,000 seeds, was highest in the brown fiber sample 011250 (122.15 g). In the F₁ hybrids, the corresponding values were 111.53 g and 121.86 g. Thus, under optimal water conditions, the trait weight of 1,000 seeds in the F₁ hybrids exhibited positive incomplete and negative overdominance inheritance patterns. (Table 3)

Under simulated drought, that is, under soil water-deficit conditions, the weight of 1,000 seeds in the colored fiber

cotton samples studied and in the F₁ hybrids decreased to varying degrees compared to the control. Strong sensitivity was observed in the brown fiber sample 011250 (AC = -14.63%) and among the F₁ hybrids in the Sadaf × 011250 combination (AC = -11.12%).

Under water-deficit conditions, for the trait weight of 1,000 seeds in the F₁ hybrid combinations, the 011250 × Sadaf and Sadaf × 011250 combinations exhibited inheritance patterns with negative incomplete dominance and positive incomplete dominance, with HP values of -0.68 and 0.13, respectively. (Table 3)

Table 3. Weight of 1,000 seeds (g) in colored fiber cotton varieties and their F₁ hybrids.

№	Samples and F ₁ hybrids	Fiber color	OC		SD		AC(%)
			X	hp	X	hp	
1	011250	Brown	122.15	-	107.52	-	-14.63
2	Sadaf	White	118.14	-	113.23	-	-4.91
3	011250 x Sadaf	Light brown	111.53	-4.30	108.44	-0.68	-3.09
4	Sadaf x 011250	Light brown	121.86	0.86	110.74	0.13	-11.12

Under optimal water supply conditions, relatively high fiber length was observed in the parental group of the white fiber variety Sadaf (33.60 mm). In the F₁ hybrids, the highest fiber length was recorded in the Sadaf × 011250 combination (31.80 mm). Under optimal water conditions, the fiber length trait in the diallel F₁ hybrid combinations exhibited negative overdominance and positive incomplete dominance inheritance patterns. (Table 4)

Under water-deficit conditions, fiber length decreased to varying degrees in all parental and hybrid genotypes compared with the control, that is, under optimal water conditions. Under this stress, the highest values of the trait were observed in the white fiber variety Sadaf and in the Sadaf × 011250 combination. Under maximum drought conditions, this trait exhibited negative overdominance inheritance.

Table 4. Fiber length (mm) in colored fiber cotton varieties and their F₁ hybrids.

№	Samples and F ₁ hybrids	Fiber color	OC		SD		AC(%)
			X	hp	X	hp	
1	011250	Brown	26.93	-	23.98	-	-2.95
2	Sadaf	white	33.60	-	31.28	-	-2.32
3	011250 x Sadaf	Light brown	25.48	-1.43	22.63	-1.37	-2.85
4	Sadaf x 011250	Light brown	31.80	0.46	27.63	-	-4.17

In the parental group, the fiber length trait showed strong sensitivity to water deficit in the brown fiber sample 011250 (AC = -2.95 mm), while among the F₁ hybrids, it was observed in the Sadaf × 011250 combination (AC = -4.17 mm). (Table 4)

4. Conclusion

According to the research results, under optimal water supply conditions (OC), relatively high values of the main economically important traits in colored fiber cotton samples were primarily observed in the white fiber variety Sadaf. In particular, high performance in plant productivity, fiber yield, and fiber length was characteristic of this variety, while the highest weight of

1,000 seeds was recorded in the brown fiber sample 011250. In the F₁ hybrids obtained from a complete diallel crossing, most traits exhibited intermediate inheritance, positive and negative incomplete dominance, and, in some cases, overdominance.

Under simulated drought, that is, under water-deficit conditions, plant productivity, the weight of 1,000 seeds, and fiber length decreased to varying degrees in all parental lines and F₁ hybrids. The strongest sensitivity to water deficit for certain traits was observed in the Sadaf variety and in the Sadaf × 011250 hybrid combination. At the same time, some hybrid combinations, particularly 011250 × Sadaf, exhibited relatively more stable

performance for certain traits, including fiber yield and other characteristics.

Overall, the obtained results provide an important scientific basis for determining the inheritance patterns of economically valuable traits in colored fiber cotton samples and for selecting F₁ hybrids that are drought-tolerant and highly productive.

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