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ANALYSIS OF THE MEIOTIC PROCESS IN NEW COMPLEX INTERSPECIFIC F₁ HYBRIDS OF COTTON OBTAINED WITH THE PARTICIPATION OF THE 'SULTON' COTTON VARIETY

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Abstract

This study examined chromosome pairing at metaphase I of meiosis in 10 F₁ cotton hybrid combinations derived from introgressive lines crossed with Sulton in 2025. Four combinations exhibited regular pairing with 26 closed bivalents, indicating high meiotic stability. The remaining combinations showed varying degrees of pairing abnormalities, including univalents, open bivalents, and quadrivalents, suggesting possible structural chromosomal differences between parental forms. These findings identify promising combinations for further

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breeding evaluation and highlight the importance of cytogenetic analysis in selecting meiotically stable cotton hybrids.

Keywords: Cotton, introgressive lines, F₁ hybrids, meiosis, chromosome pairing, meiotic stability, cytogenetic analysis.

Introduction

In cotton breeding worldwide, interspecific hybridization with *G. barbadense*, *G. tomentosum*, and other wild species is widely employed to enrich the genome of *G. hirsutum*. In leading cotton-producing countries such as the United States, China, and India, genetic mapping and targeted introgression studies are being conducted using cytogenetic collections, including translocation lines and hypoaneuploid lines. Scientific studies have demonstrated that the identification and selection of fertile introgressive lines through the maintenance of meiotic stability and cytogenetic control of chromosome pairing and conjugation represent key factors for achieving stable productivity and utilizing these lines as valuable genetic resources in breeding programs.

To study the cytological characteristics of F₁ cotton hybrids obtained from crosses between introgressive cotton lines, flower buds of hybrid plants derived from 17 cross combinations were fixed for cytological analysis.

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Table 1 Analysis of Chromosome Pairing at the Metaphase I Stage of Meiosis in F₁ Hybrids, 2025

№	Cross Combinations	Average number of cells		
		Univalent	Bivalent	Quadrivalent
1	F ₁ T-4672-73/16 x Sulton	2	21	2
2	F ₁ T-4674-77/16 x Sulton	-	-	-
3	F ₁ T-4679-81/16 x Sulton	-	-	-
4	F ₁ T-4684-86/16 x Sulton	0	26	0
5	F ₁ T-138/16 x Sulton	2	25	0
6	F ₁ T-470/1/16 x Sulton	-	-	-
7	F ₁ T-95/16 x Sulton	-	-	-
8	F ₁ T-158/16 x Sulton	0	26	0
9	F ₁ T-200/16 x Sulton	-	-	-
10	F ₁ T-MVG/16x Sulton	6	23 (3 open bivalents)	0
11	F ₁ T-58/16 x Sulton	14	19	0
12	F ₁ T-1979/16 x Sulton	0	26	0
13	F ₁ T-175/248/16 x Sulton	-	-	-
14	F ₁ T-12/06/16 x Sulton	-	-	-
15	F ₁ T-4747-48/16 x Sulton	0	26 (1 open bivalents)	
16	F ₁ T-BSG/16 x Sulton	0	26 (1 open bivalents)	0
17	F ₁ T-588/16 x Sulton	0	26	0

However, the analysis of chromosome pairing at the metaphase I stage of meiosis was conducted for only 10 of the 17 cross combinations because flower buds at this developmental stage were not available in the remaining seven cross combinations. Four hybrid cross combinations (F₁T-4684-86/16 × Sulton; F₁(T-158/16 × Sulton); F₁(T-1979/16 × Sulton); and F₁(T-588/16 × Sulton)) exhibited high meiotic stability. In these hybrids, 26 normal closed bivalents were observed at metaphase I of meiosis, while no other chromosome associations were detected

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(see Table 1). However, various meiotic abnormalities were observed at metaphase I in some pollen mother cells (PMCs) of the remaining six cross combinations. In two PMCs of one cross combination, $F_1T-4672-73/16 \times$ Sulton, a single quadrivalent chromosome association was recorded (Figure 1a). In the remaining eight of the 42 PMCs examined, open bivalents were observed alongside normal closed bivalents and a small number of paired univalents.

The formation of quadrivalent chromosome associations in the hybrid plants of the above-mentioned cross combination indicates the presence of translocations resulting from differences in the chromosome complements of the parental forms. The occurrence of open bivalents and univalent chromosomes suggests the presence of cryptic structural chromosomal alterations in the parental forms involved in the crosses. The formation of paired univalents was also detected in the PMCs of three other hybrid combinations. However, in the PMCs of two cross combinations, $F_1T-138/16 \times$ Sulton and $F_1T-MVG/16 \times$ Sulton, up to four univalent chromosomes were observed alongside normal bivalents (Figure 2a,b) (Figure 1b), whereas in another combination, $F_1T-58/16 \times$ Sulton, up to 14 univalent chromosomes were observed (Figure 3a). Apparently, the chromosomes of the parental forms involved in the crosses were sufficiently homologous to undergo pairing during meiotic prophase. However, the presence of cryptic structural variation may have resulted in premature chromosome separation and the formation of “pseudounivalents” at metaphase I of meiosis. The other two cross combinations, $F_1T-4747-48/16 \times$ Sulton and $F_1T-BSG/16 \times$ Sulton, were characterized by the occurrence of a very small number of open bivalents in the PMCs alongside normal closed bivalents (Figure 3b).

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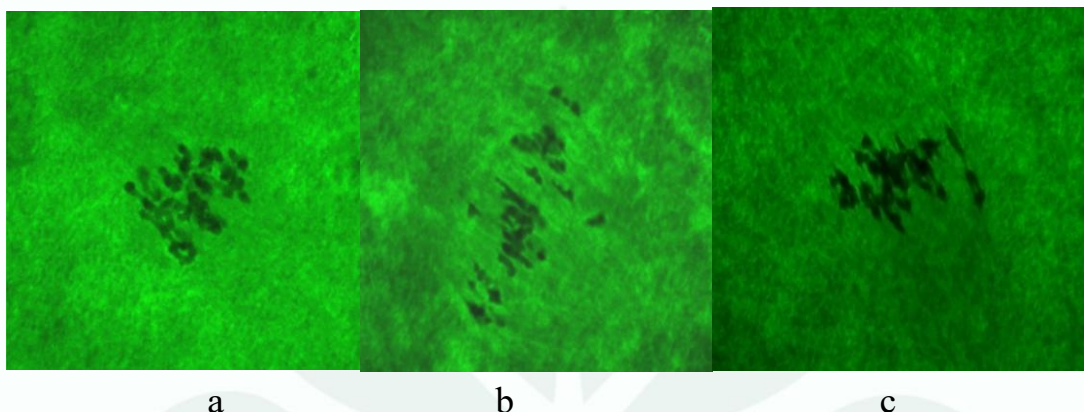


Figure 1. Chromosome configurations at metaphase I of meiosis in F_1 hybrids: (a) $F_1T-4672-73/16 \times Sulton$: 26 bivalents and one quadrivalent; (b) $F_1T-138/16 \times Sulton$: 26 bivalents, two of which are open bivalents; (c) $F_1(T-158/16) \times Sulton$: 26 bivalents. Open bivalents are indicated by arrows.

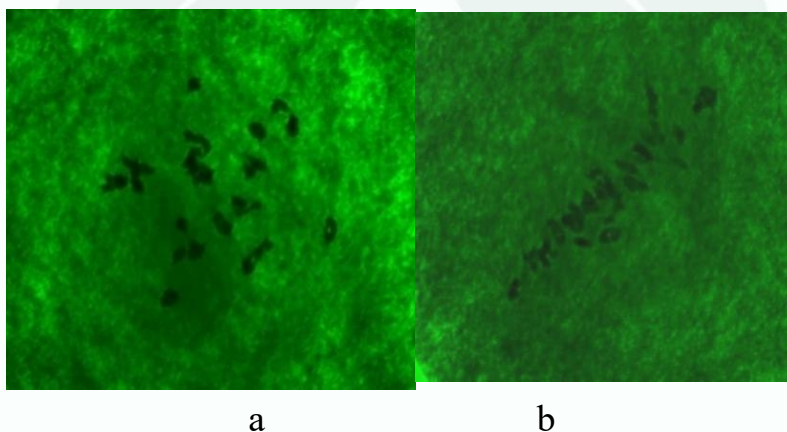


Figure 2. Chromosome configurations at metaphase I of meiosis in the $F_1T-MVG/16 \times Sulton$ hybrid: (a, b) 26 bivalents.

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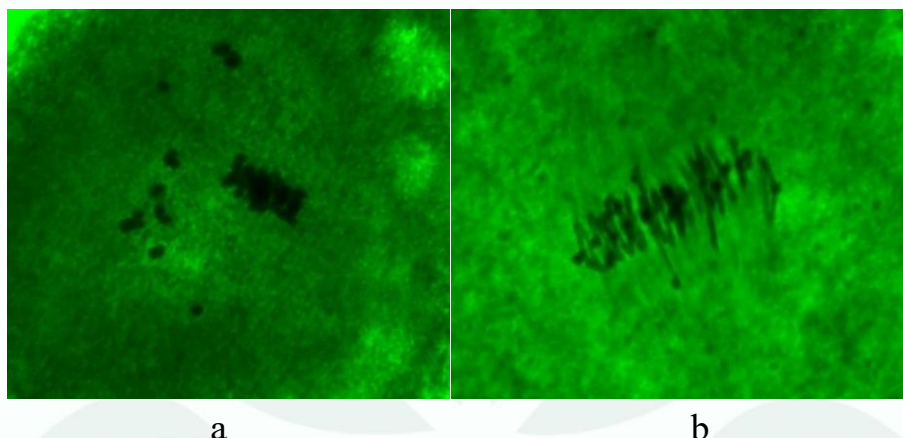


Figure 3. Chromosome configurations at metaphase I of meiosis in F_1 hybrids: (a) $F_1T-58/16 \times$ Sulton: 19 bivalents and 14 univalents; (b) $F_1L-T-BSG/16 \times$ Sulton: 26 bivalents, two of which are open bivalents. Open bivalents are indicated by arrows.

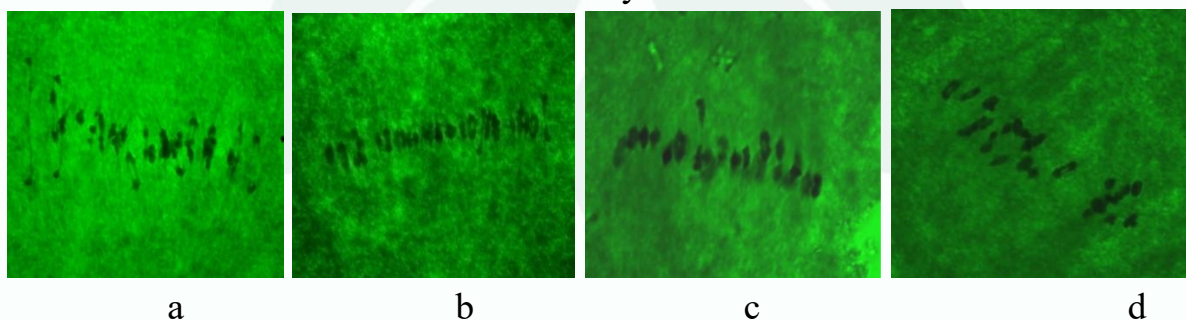


Figure 4. Chromosome configurations at metaphase I of meiosis in the F_1 T-158/16 $\times$ Sulton hybrid: (a) 26 bivalents, two of which are open bivalents; (b) 26 bivalents; (c) 26 bivalents, one of which is an open bivalent; (d) 26 bivalents. Open bivalents are indicated by arrows.

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