Correlation Between Valuable Agronomic Traits in F_2-F_3 Generations of Interspecific Hybrids of Cotton

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Abstract This article presents correlation data among valuable agronomic traits in F_2 and F_3 generations of interspecific hybrids derived from crosses between *G. hirsutum* L. and *G. barbadense* L. cotton varieties. As a result of studying the correlation between valuable agronomic traits in the second and third generations of hybrids, it was revealed that there is a weak positive and negative correlation between 1000 seed weight and lint yield, a weak to moderate positive correlation with fiber length, and a moderate negative to weak positive correlation between lint yield and fiber length. Additionally, a weak to moderate positive correlation was observed between boll weight and fiber length.

Keywords Cotton, Variety, Interspecific hybridization, Hybridization, Correlation, Positive correlation, Negative correlation

1. Introduction

As with all agricultural crops, the cotton plant exhibits correlations among its agronomic traits, and the nature of these correlations—whether positive or negative, and whether weak, moderate, or strong—is of significant importance. Similar to other crops, traits in cotton such as earliness and yield, or yield and fiber quality, are often negatively correlated. This presents a challenge in breeding varieties that are early-maturing, high-yielding, and possess high fiber quality simultaneously. In some varieties and hybrids, these traits show strong negative correlations. Research has shown that in certain studied varieties and lines, there are weak, moderate, and strong positive correlations, as well as weak to moderate negative correlations between the number of fruiting branches and earliness [2]. However, it has been scientifically proven that the correlations among major agronomic traits can be modified using methods such as hybridization and selection. It is possible to weaken negative correlations or even convert them into positive ones. In the works of A. B. Amanturdiyev and R. G. Kim, boll weight—a complex quantitative trait—has been shown to inherit in intermediate, positive, or negative heterosis forms, depending on the combining ability of the parental lines in hybrids. It has also been observed to follow dominant and over-dominant inheritance patterns. A negative correlation between earliness and boll size has been reported; however, in the studied hybrids, a significant positive correlation was observed between boll weight and overall productivity [1,3].

In the scientific research of Sh. E. Namozov and S. G. Babayev [4], the degree of correlation between agronomic traits in cotton was categorized into three groups: the first group included traits with strong intercorrelation, such as boll weight and seed number per boll; the second group included traits with moderate correlation, such as lint yield and lint index; and the third group included weakly correlated traits, such as fiber length, 1000-seed weight, and number of unfertilized seeds.

This article presents the results and analysis of a study aimed at determining the correlation between valuable agronomic traits in interspecific hybrids derived from *Gossypium hirsutum* L. and *Gossypium barbadense* L. varieties.

2. Research Object

The study was conducted using the Baraka, SP-1303, ATM-1 varieties, and the T-91/21 line of *Gossypium hirsutum* L., as well as the Surxon-14 and Surxon-9 varieties of *Gossypium barbadense* L. Interspecific hybrid generations derived from these varieties through hybridization were also included as research material.

3. Results and Analysis

In this study, correlations among agronomic traits were identified and analyzed in newly developed interspecific cotton hybrids. Trait correlations were assessed in the parental forms, as well as in F_2 and F_3 hybrid generations. The objective was to evaluate how these correlations appeared in the parent

lines, how they were affected by hybridization, and whether they remained consistent or changed by the F$_3$ generation.

The analysis began with examining the correlation between 1000-seed weight—an important yield-related trait—and other agronomic characteristics. The results revealed a strong positive correlation between 1000-seed weight and boll weight in the Surxon-9, Surxon-14, SP-1303 varieties, and the T-91/21 line. The correlation coefficients were r = 0.9209, r = 0.7499, r = 0.8000, and r = 0.8229, respectively.

In ATM-1 (r = 0.3228) and Baraka (r = 0.1393), the correlation between 1000-seed weight and boll weight was weakly positive. In the F$_2$ hybrid generations, this correlation remained positive but varied in strength. In the F$_2$ Baraka × Surxon-9 combination, a weak positive correlation was observed (r = 0.1944), while in F$_2$ SP-1303 × Surxon-9, F$_2$ ATM-1 × Surxon-14, and F$_2$ T-91/21 × Surxon-14 combinations, moderate positive correlations were recorded, ranging from r = 0.3550 to r = 0.5652 (Table 1).

The next pair of traits analyzed was 1000-seed weight and lint yield. In the parent lines Surxon-9 (r = –0.0285) and Baraka (r = –0.0118), weak negative correlations were recorded. In contrast, Surxon-14, SP-1303, ATM-1, and T-91/21 exhibited weak positive correlations, ranging from r = 0.0229 to r = 0.2767. Among the hybrids, similarly weak correlations were observed. In F$_2$ Baraka × Surxon-9 (r = –0.0566) and F$_2$ ATM-1 × Surxon-14 (r = –0.0134), weak negative correlations were found, while F$_2$ SP-1303 × Surxon-9 (r = 0.0748) and F$_2$ T-91/21 × Surxon-14 (r = 0.0715) showed weak positive correlations. These outcomes suggest that hybridization may influence the direction and magnitude of trait correlations. Notably, Surxon-9 demonstrated a negative correlation between 1000-seed weight and lint yield, unlike most other lines.

The final trait pair analyzed was 1000-seed weight and fiber length. In the *G. barbadense* L. varieties Surxon-9 and Surxon-14, strong positive correlations were observed, with r = 0.8384 and r = 0.7887, respectively. Among the *G. hirsutum* L. varieties, Baraka showed a weak negative correlation (r = –0.1348), while SP-1303 showed a weak positive correlation (r = 0.1881).

Table 1. Correlation coefficients between 1000 seed weight and selected agronomic traits in parental lines and F$_2$ hybrids

№	Parental lines and combinations	With 1000-seed weight		
		Cotton weight per boll	Lint yield	Fiber length
1	Surxon-9	0.9209	-0.0285	0.8384
2	Surxon-14	0.7499	0.2767	0.7887
3	Baraka	0.1393	-0,0118	-0.1348
4	SP-1303	0.8000	0.0899	0.1881
5	ATM-1	0.3228	0.1247	0.4317
6	T-91/21	0.8229	0.0229	0.5973
7	F$_2$Baraka × Surxon-9	0.1944	-0.0566	0.0766
8	F$_2$SP-1303 × Surxon-9	0.5652	0.0748	0.2280
9	F$_2$ATM-1 × Surxon-14	0.3550	-0.0134	0.4036
10	F$_2$T-9121 × Surxon-14	0.4101	0.0715	0.3867

In the ATM-1 variety and the T-91/21 line, moderate positive correlations were identified between 1000-seed weight and fiber length, with correlation coefficients of r = 0.4317 and r = 0.5973, respectively. Among the hybrid combinations, positive correlations were also observed for these traits. Specifically, F$_2$ Baraka × Surxon-9 (r = 0.0766) and F$_2$ SP-1303 × Surxon-9 (r = 0.2280) exhibited weak positive correlations, while F$_2$ ATM-1 × Surxon-14 (r = 0.4036) and F$_2$ T-91/21 × Surxon-14 (r = 0.3867) showed moderate positive correlations.

Correlations between boll cotton weight and fiber yield were also analyzed in the studied hybrids and parental forms. Among the parent lines involved in hybridization, weak positive correlations were identified, ranging from r = 0.0676 in T-91/21 to r = 0.2555 in Surxon-9. These values suggest that there is no strong relationship between boll cotton weight and fiber yield in the parental genotypes. In the hybrid combinations, however, the nature of this relationship differed. Only the F$_2$ T-91/21 × Surxon-14 hybrid exhibited a weak positive correlation (r = 0.2163), whereas other combinations—F$_2$ Baraka × Surxon-9, F$_2$ SP-1303 × Surxon-9, and F$_2$ ATM-1 × Surxon-14—showed moderate positive correlations, with coefficients of r = 0.4164, r = 0.3370, and r = 0.5470, respectively (Table 2).

A strong positive correlation between boll cotton weight and fiber length was observed in the Surxon-9 (r = 0.8305) and Surxon-14 (r = 0.8500) varieties. In contrast, the Baraka variety exhibited a weak negative correlation (r = –0.2175). Weak positive correlations were identified in the SP-1303, ATM-1, and T-91/21 lines.

Table 2. Correlation coefficients between some agronomic traits in parental forms and F$_2$ hybrids

№	Parental lines and Combinations	Correlation between boll cotton weight	
		Fiber yield	Fiber length
1.	Surxon-9	0.2555	0.8305
2.	Surxon-14	0.1996	0.8500
3.	Baraka	0.1445	-0.4175
4.	SP-1303	0.1827	0.0789
5.	ATM-1	0.1338	0.4253
6.	T-91/21	0.0676	0.6937
7.	F$_2$Baraka × Surxon-9	0.4164	0.1314
8.	F$_2$SP-1303 × Surxon-9	0.3370	0.3570
9.	F$_2$ATM-1 ×Surxon-14	0.5470	0.4117
10.	F$_2$T-9121 × Surxon-14	0.2163	0.5669

In the studied hybrids, depending on the combination, weak to moderate positive correlations between boll cotton weight and fiber length were observed. Specifically, moderate positive correlations were recorded in the F$_2$ SP-1303 × Surxon-9 and F$_2$ T-91/21 × Surxon-14 combinations, with correlation coefficients of r = 0.3670 and r = 0.4869, respectively. The F$_2$ Baraka × Surxon-9 (r = 0.1314) and F$_2$ ATM-1 × Surxon-14 (r = 0.1017) hybrids exhibited weak positive correlations. Notably, the hybrid derived from

Baraka (which showed a weak negative correlation) and Surxon-9 (which exhibited a strong positive correlation) demonstrated a weak positive correlation. This suggests that the traits of boll cotton weight and fiber length are inherited with relatively low genetic linkage.

In the F_3 generation of the hybrids, the degree of correlation between agronomic traits was also assessed. The correlation between 1000-seed weight and boll cotton weight was found to be positive, with weak to moderate correlation depending on the hybrid combination. Specifically, in the F_3 Baraka × Surxon-9 and F_3 T-91/21 × Surxon-14 combinations, moderate positive correlations were observed, with correlation coefficients of r = 0.3970 and r = 0.3820, respectively. In the F_3 SP-1303 × Surxon-9 and F_3 ATM-1 × Surxon-14 combinations, weak positive correlations were recorded, with r = 0.2518 and r = 0.3241, respectively. These results indicate that the correlation pattern observed in the F_3 generation is similar to that seen in the F_2 generation.

The next trait analyzed was the correlation between 1000-seed weight and fiber yield. In the F_2 generation, three combinations exhibited weak negative correlations, while one showed a weak positive correlation. In the F_3 generation, however, the correlation between these traits shifted to a moderate negative level. The correlation ranged from r = –0.3987 (F_3 T-91/21 × Surxon-14) to r = –0.4421 (F_3 Baraka × Surxon-9), indicating a negative correlation in all hybrid combinations. This suggests that an increase in 1000-seed weight is associated with a decrease in fiber yield.

Furthermore, the results show that the correlation between these traits changes across generations, which may be attributed to variability in the traits themselves.

In the F_3 generation of hybrids, a weak positive correlation was observed between 1000-seed weight and fiber length. A relatively stronger correlation was found in the F_3 SP-1303 × Surxon-9 combination, with a correlation coefficient of r = 0.2683. In the remaining three hybrid combinations, the correlation between these traits remained weakly positive. This suggests that the inheritance of 1000-seed weight and fiber length may be independent of one another, or, if a correlation exists, both traits tend to change in the same positive direction.

Unlike the F_2 generation, where the correlation between boll weight and lint yield was moderately positive, the F_3 generation showed a weak positive correlation. Among the F_3 hybrid combinations, those involving the Surxon-9 variety—specifically F_3 Baraka × Surxon-9 and F_3 SP-1303 × Surxon-9—showed correlation coefficients of r = 0.1225 and r = 0.0318, respectively.

In contrast, combinations involving the Surxon-14 variety showed correlation coefficients of r = 0.2119 and r = 0.2559, respectively.

For the correlation between boll weight and fiber length, a moderate positive correlation was observed in the F_3 SP-1303 × Surxon-9 combination, with a correlation coefficient of r = 0.4516. In the other three hybrid combinations, the correlation was weakly positive (Figures 1 and 2).
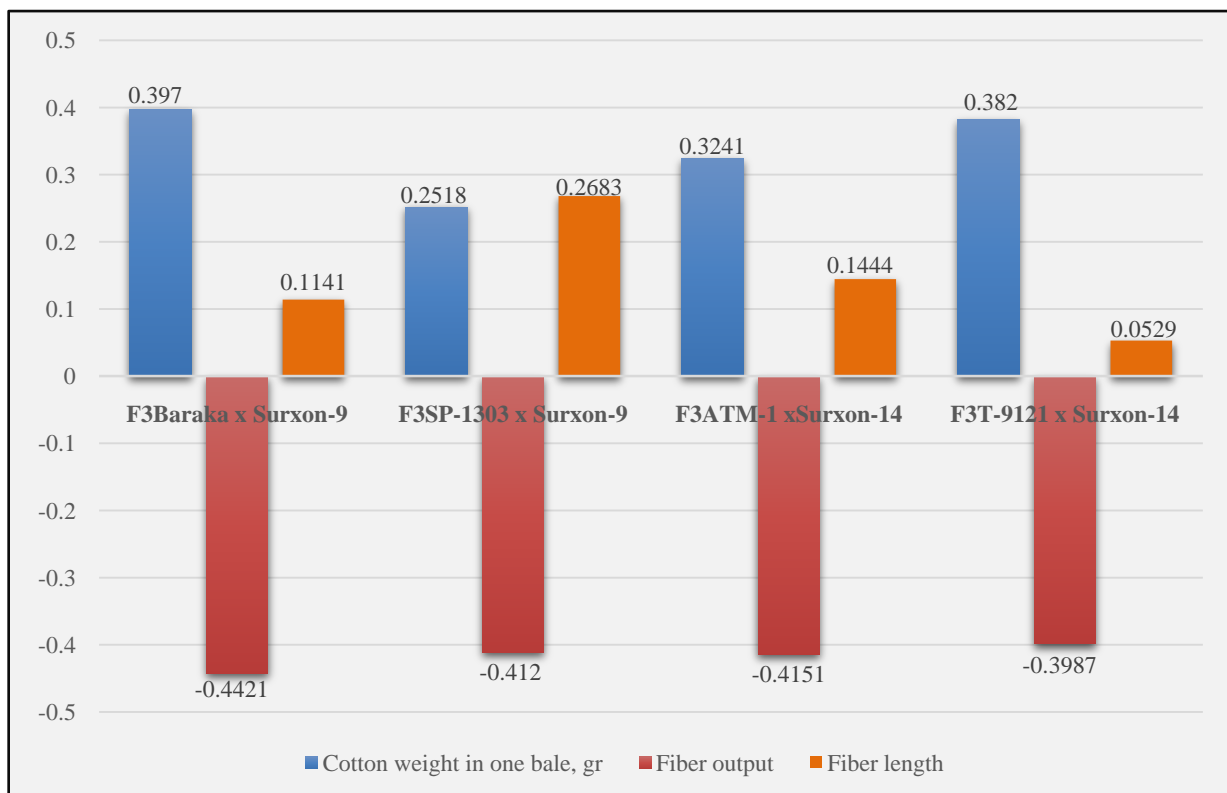

Figure 1. Correlation between 1000 seed weight and boll weight, lint yield, and fiber length
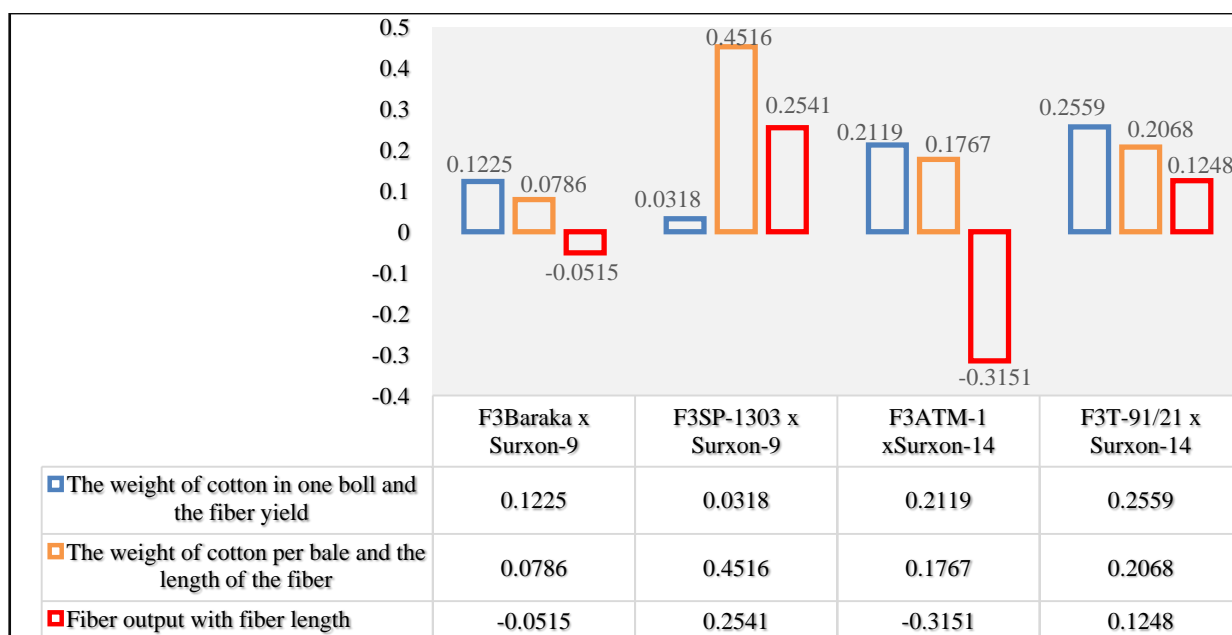
	F3Baraka x Surxon-9	F3SP-1303 x Surxon-9	F3ATM-1 xSurxon-14	F3T-91/21 x Surxon-14
☐ The weight of cotton in one boll and the fiber yield	0.1225	0.0318	0.2119	0.2559
☐ The weight of cotton per bale and the length of the fiber	0.0786	0.4516	0.1767	0.2068
☐ Fiber output with fiber length	-0.0515	0.2541	-0.3151	0.1248

Figure 2.   Correlation between valuable agronomic traits in F_3 hybrids

Depending on the combinations, weak negative and positive correlations were observed between lint yield and fiber length traits. In the F_3 Baraka x Surxon-9 and F_3 ATM-1 × Surxon-14 combinations, weak negative correlations were identified, with correlation coefficients of r = -0.0515 and r = -0.3151, respectively. In the F_3 SP-1303 × Surxon-9 and F_3 T-9121 × Surxon-14 combinations, positive correlations were observed, with values of r = 0.2541 and r = 0.1248, respectively. Although the correlations between these traits were weak, their direction—whether negative or positive—depended on the specific hybrid combination.

4. Conclusions

In conclusion, the study found that in hybrid combinations, there were strong, moderate, and weak positive correlations between 1000-seed weight and single boll weight; weak positive and negative correlations between 1000-seed weight and lint yield; and moderate to weak positive correlations between single boll weight, lint yield, and fiber length, depending on the combination. In the F_3 generation, a moderate negative correlation was observed between 1000-seed weight and lint yield. These findings suggest that the direction and magnitude of trait correlations in hybrid combinations are influenced by the segregation processes of traits in the hybrids.

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