J. Farm Sci., 38(4): (358-362) 2025

RESEARCH PAPER

Character association of yield and its contributing traits in F_4 and F_5 populations derived from intra-hirsutum cotton (*Gossypium hirsutum* L.) crosses

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(Received: September, 2025 ; Accepted: November, 2025)

DOI: 10.61475/JFS.2025.v38i4.06

Abstract: This study explores the phenotypic correlations among yield and fiber quality traits in 84 genotypes of cotton (*Gossypium hirsutum* L.) aiming to identify key traits for yield improvement. The study was conducted during the *kharif* 2023 season at MARS, Raichur. The experiment included F_4 and F_5 cotton populations using an augmented block design. Observations were made on plant height, monopodia, sympodia, boll number, lint yield, boll weight and fiber traits such as fiber strength, elongation and micronaire value. Results revealed that seed cotton yield exhibited significant positive correlations with plant height (0.431), number of monopodia (0.340), number of bolls per plant (0.727), boll weight (0.649) and lint yield (0.953). While fiber elongation and micronaire value also correlated positively with seed cotton yield, these associations were non-significant. Among fiber quality traits, lint index showed a significant positive association with ginning outturn and seed index suggesting their potential for improving both yield and quality traits. This study underscores the importance of plant height, monopodia, number of bolls, boll weight and lint yield as selection criteria in breeding programs targeting higher cotton yields.

Key words: Cotton, Checks, F_4, F_5 generations, Genotypes, Phenotypic correlation

Introduction

Cotton (*Gossypium hirsutum* L.) belongs to a very large and economically important genus of family Malvaceae. Cotton is a crop of global importance as an ultimate source of natural fibre. It is also known as "white gold" or king of fibre, owing to its major share in textile. As a crop and a commodity, cotton occupies a unique position in India's economy, since it is crucial to the country's agricultural and industrial activity. It provides the basic raw material (cotton fibre) to the cotton textile industry and also provides direct livelihood to 6 million farmers in India and the cotton trade and processing employs roughly 40-50 million people (Anon., 2023).

Cotton is mainly sown in tropical and subtropical areas of more than 80 countries of the world. The major cotton-producing countries are USA, China, India, Pakistan, Uzbekistan, Turkey, Brazil, Greece, Argentina and Egypt. In India, major cotton cultivating states are ten in number, which reside in three geographical zones *viz*., the North Zone (Punjab, Haryana and Rajasthan), the Central Zone (Maharashtra, Madhya Pradesh and Gujarat) and the Southern Zone (Andhra Pradesh, Karnataka and Tamil Nadu). The leading cotton-producing state in India is Gujarat followed by Maharashtra. About 66% of the Cotton production in India comes from the states of Maharashtra, Gujarat, Andhra Pradesh, and Telangana which are collectively known as the Cotton Basket of India (Anon., 2023).

India accounts for approximately 41% of the world's total cotton area and 26% of global cotton production. India ranks first with respect to area and production and 8th rank with respect to productivity of cotton. India occupies an area of 130.49 lakh hectare with a production of 337.23 lakh bales of 170 kg each and 439 kg/ha productivity. In Karnataka, cotton was grown in an area of 8.97 lakh hectare with a production of 21.48 lakh bales and productivity of 407 kg/ha lint.

The different components of seed cotton yield often exhibit varying degrees of association with seed cotton yield as well as among themselves. In order to accumulate an optimum combination of seed cotton yield contributing characters in a single genotype, it is essential to know the relationships among themselves. Character association studies provide a better understanding of yield components which helps the plant breeders to improve yield through indirect selection for highly heritable traits which are associated with yield (Shinde *et al*., 1996). To determine such association, correlation analysis is used in present study.

Material and methods

The present investigation was carried out during *kharif* season 2023 at the Main Agricultural Research Station, Raichur. The study included 84 cotton genotypes of F_4 and F_5 populations derived from intra-hirsutum cotton (*Gossypium hirsutum* L.) crosses along with three checks. The experiment was laid out in augmented block design with a plot size of six meters and with the spacing of 75 × 30 cm. All recommended agronomic and plant protection practices were followed regularly as per need for better crop stand and expression. Observations on traits like plant height (cm), number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight (g), seed cotton yield per plant (g), lint yield per plant (g), lint index, seed index (g), ginning outturn

(%), upper half mean length (mm), fibre strength (g/tex), fibre elongation (%) and micronaire value (ig/inch) were recorded on randomly chosen five plants in each entry.

Results and discussion

Yield is a complex polygenic inherited trait resulting from multiplicative interaction of its contributing traits. It is highly influenced by the environment; hence selection based on yield alone may limit the improvement. On the other hand, the yield attributing traits are less complex in inheritance and are influenced by environment to a lesser extent. Thus, effective improvement in yield may be brought about through selections on yield attributing characters. The correlation coefficient helps a breeder in determining the direction of selection and number of characters to be considered in improving the yield. Correlation coefficients not only denote the total association existing between a pair of traits with themselves; but it is the result of the interaction between various features of the plant and also measures the relationship existing between pair of traits.

In the current investigation, phenotypic correlation estimates were obtained for fourteen characters in 84 cotton genotypes. The results are presented in Table 1. The associations among different traits are discussed below.

The seed cotton yield had showed significantly positive phenotypic correlation with plant height (0.431), number of monopodia per plant (0.340), number of bolls per plant (0.727), boll weight (0.649) and lint yield per plant (0.953). These results are in agreement with the findings of Jangid *et al*. (2022) for lint yield per plant, boll weight whereas, Jayshankar (2017) for plant height, number of monopodia per plant and number of bolls per plant. The results indicate that these traits are most important for yield per se and should be selected for further study as indirect selection criteria.

Non-significant positive association of seed cotton yield was noticed with with number of sympodia per plant (0.032), seed index (0.193), upper half mean length (UHML) (0.022), fibre strength (0.010), fibre elongation (0.143) and micronaire value (0.100). Similar results were reported by Rao (2008) and Kishore *et al*. (2011) for number of sympodia per plant; Sirisha *et al*. (2016), Rajamani (2016) and Hampannavar *et al*. (2020) for seed index; Rao and Gopinath (2013) for UHML; Komala *et al*. (2018), Palve *et al*. (2021) and Gowda *et al*. (2022) for fibre strength.

Plant height trait had shown significant positive phenotypic correlation with seed cotton yield (0.432), number of monopodia per plant (0.311), number of sympodia per plant (0.437), number of bolls per plant (0.316), boll weight (0.336) and lint yield (0.456) whereas, trait exhibited non significant positive phenotypic correlation for seed index (0.140), lint index (0.078), fibre strength (0.051), fibre elongation (0.052) and micronaire value (0.166). Similar results were observed by Reddy *et al*. (2015) and Sirisha *et al*. (2016) for number of monopodia per plant; Sirisha *et al*. (2016) and Jayshankar (2017) for number of sympodia per plant and seed index; Reddy *et al*. (2015) for boll weight, lint index and fibre strength; Jayshankar (2017) for number of bolls per plant.

Significantly and positively correlation was observed by a trait number of monopodia per plant at phenotypic level with seed cotton yield (0.340), lint yield per plant (0.299), plant height (0.311) while it showed non-significant positive phenotypic correlation with number of bolls per plant (0.113), boll weight (0.185) and fibre elongation (0.129). This result was in accordance with findings of Nawaz *et al*. (2019) and Rai and Sangwan (2020) for seed cotton yield and Erande *et al*. (2014) for lint yield per plant whereas, Jayshankar (2017) and Irfan *et al*. (2018) reported positive correlation of number of monopodia per plant with number of bolls per plant. Jayshankar (2017) reported positive correlation of number of monopodia per plant with boll weight.

Number of sympodia per plant trait had showed significantly positive phenotypic correlation with seed index (0.266), plant height (0.437) and lint index (0.253) followed by showing non-significant positive phenotypic correlation with number of bolls

Table 1. Phenotypic correlation among 14 yield, yield attributing and fibre quality traits of F_4 and F_5 populations derived from intra-*hirsutum* cotton (*Gossypium hirsutum* L.) crosses

Trait	PH	MON	SYM	NOB	BW	LY	LI	GOT	SI	UHML	FS	FE	MIC	SCY
PH	1	0.311**	0.437**	0.316**	0.336**	0.456**	0.078	-0.052	0.140	-0.032	0.051	0.052	0.116	0.431**
MON		1	-0.105	0.113	0.185	0.299**	-0.287**	-0.164	-0.154	-0.119	-0.126	0.129	-0.193	0.340**
SYM			1	0.175	-0.118	0.040	0.253*	0.019	0.266*	0.145	0.042	-0.111	0.177	0.032
NOB				1	0.213	0.742**	-0.146	-0.118	-0.025	-0.149	-0.026	0.012	0.079	0.727**
BW					1	0.581**	0.021	-0.394**	0.434**	0.271*	0.088	0.140	-0.003	0.649**
LY						1	-0.027	-0.097	0.078	-0.057	-0.029	0.152	0.091	0.953**
LI							1	0.542**	0.529**	0.181	-0.048	-0.080	0.187	-0.188
GOT								1	-0.419**	-0.267*	-0.116	-0.028	-0.117	-0.385**
SI									1	0.470**	0.069	-0.060	0.329**	0.193
UHML										1	0.392**	-0.032	-0.034	0.022
FS											1	-0.057	-0.062	0.010
FE												1	0.120	0.143
MIC													1	0.100

* Significant at 5% (p = 0.05) ** Significant at 1% (p = 0.01)

PH-Plant height (cm), MON-Number of monopodia per plant, SYM-Number of sympodia per plant, NOB-Number of bolls per plant, BW-Boll weight (g), SCY-Seed cotton yield per plant (g), LY-Lint yield per plant (g), LI-Lint index, GOT-Ginning outturn (%), SI-Seed index (g), UHML-Upper half mean length (mm), FS-Fibre strength (g/tex), FE-Fibre elongation (%), MIC-Micronaire (ig/inch)

per plant (0.175), fibre strength (0.042), micronaire value (0.177), ginning outturn (0.019), UHML (0.145) and lint yield (0.040). The result obtained similar to results reported by Sirisha *et al*. (2016) and Jayshankar (2017) for plant height and lint index; Reddy *et al*. (2015) and Sirisha *et al*. (2016) for seed index; Reddy *et al*. (2015) and Rajamani (2016) for UHML; Sirisha *et al*. (2016) and Rajamani (2016) for ginning outturn; Jayshankar (2017) for number of bolls per plant.

The trait had showed non-significant positive phenotypic correlation with boll weight, number of monopodia per plant and fibre elongation. The similar result was obtained by Rajamani (2016) for boll weight.

A significant and positive phenotypic correlation was observed by trait number of bolls per plant with seed cotton yield (0.727), plant height (0.316) and lint yield per plant (0.742) followed by showing non-significant positive phenotypic correlation with number of monopodia per plant (0.113), number of sympodia per plant (0.175), boll weight (0.213), fibre elongation (0.012) and micronaire value (0.079). The trait exhibited non-significant and negative correlation with lint index (-0.146), ginning outturn (-0.118), seed index (-0.025), UHML (-0.149) and fibre strength (-0.026). The results were in accordance with findings of Ali *et al*. (2020) and Rai and Sangwan (2020) for seed cotton yield; Rao and Gopinath (2013) for micronaire value.

Boll weight exhibited significant and positive correlation with seed cotton yield (0.649), plant height (0.336), seed index (0.434), UHML (0.271) and lint yield per plant (0.581). This trait had showed non-significant positive phenotypic correlation with number of monopodia per plant (0.185), number of bolls per plant (0.213), lint index (0.021), fibre elongation (0.140) and fibre strength (0.088). Ginning outturn (-0.394) is the only trait which exhibited significant and negative correlation with boll weight. The obtained results were in accordance with Ali *et al*. (2020) and Rai and Sangwan (2020) for seed cotton yield per plant; Erande *et al*. (2014) for lint yield per plant; Sirisha *et al*. (2016) and Jayshankar (2017) for seed index; Reddy *et al*. (2015) for UHML; Sirisha *et al*. (2016) for lint index.

Lint yield per plant has recorded a highly significant and positive association with seed cotton yield (0.953), number of bolls per plant (0.742), boll weight (0.581), plant height (0.456) and number of monopodia per plant (0.299), while it showed non-significant positive correlation with seed index (0.078), number of sympodia per plant (0.040), fibre elongation (0.152) and micronaire value (0.091) at the phenotypic level. This trait showed a non significant and negative association with lint index (-0.027), ginning outturn (-0.097), UHML (-0.057) and fibre strength (-0.029). Similar trends were also evident from the studies Erande *et al*. (2014) and Reddy *et al*. (2015) and Jangid *et al*. (2022) for seed cotton yield; Erande *et al*. (2014) for number of monopodia per plant; Sirisha *et al*. (2016) for boll weight.

Strong significant and positive correlation exhibited by lint index with ginning outturn (0.542), seed index (0.529) and number of sympodia per plant (0.253) at the phenotypic level. Lint index has recorded a non significant and positive association with plant height (0.078), boll weight (0.021), UHML (0.181) and micronaire value (0.187). Similar results were reported by Reddy *et al*. (2015) and Shabbir *et al*. (2016) for seed index; Reddy *et al*. (2015), Jangid *et al*. (2019) and Kumar *et al*. (2019) for ginning outturn; Rajamani (2016), Sirisha *et al*. (2016) and Jayshankar (2017) for UHML; Reddy *et al*. (2015), Sirisha *et al*. (2016) and Jayshankar (2017) for micronaire value.

The significant and positive association of seed index was found with UHML (0.470), micronaire value (0.329), boll weight (0.434), number of sympodia per plant (0.266) and lint index (0.529). This trait has showed non-significant and positive association with seed cotton yield (0.193), fibre strength (0.069), lint yield per plant (0.078) and plant height (0.140). The results were similar to the findings obtained by Kumar *et al*. (2019), Jangid *et al*. (2019) and Hampannavar *et al*. (2020) for lint index; Rajamani (2016), Sirisha *et al*. (2016) and Chaudhari *et al*. (2017) for UHML; Reddy *et al*. (2015) and Sirisha *et al*. (2016) for number of sympodia per plant; Jayshankar (2017) for boll weight; Rajamani (2016), Jayshankar (2017) and Manan *et al*. (2022) for micronaire value.

Ginning outturn has recorded a highly significant and positive association with lint index (0.542), while it showed non-significant positive correlation with number of sympodia per plant (0.019). It exhibited significant and negative correlation with seed cotton yield (-0.385), seed index (-0.419) and UHML (-0.267) at the phenotypic level. Similar reports were given by Chaudhari *et al*. (2017) for lint index; Kumar *et al*. (2019), Jangid *et al*. (2019) and Satish *et al*. (2020) for seed cotton yield.

UHML had showed significant and positive correlation with fibre strength (0.392) and boll weight (0.271) whereas, non significant positive correlation with seed cotton yield (0.022), lint index (0.181) and number of sympodia per plant (0.145). UHML had shown a significant and negative correlation with ginning outturn (-0.053). This trait showed non-significant and negative correlation with micronaire (-0.034), fibre elongation (-0.032) and lint yield (-0.057) at the phenotypic level. Similar findings were reported by Reddy *et al*. (2015), Rajamani (2016), Sirisha *et al*. (2016), Chaudhari *et al*. (2017) and Jayshankar (2017) for fibre strength.

The trait fibre strength has shown significant positive association with UHML (0.392) and non significant positive phenotypic correlation with seed cotton yield (0.010) and seed index (0.069). Chaudhari *et al*. (2017) and Jayshankar (2017) reported significant positive association of fibre strength with UHML. Rajamani *et al*. (2013) reported non-significant and positive association of fibre strength with seed cotton yield.

Fibre elongation trait has showed non-significant and positive association with seed cotton yield (0.143), micronaire value (0.120), lint yield (0.152) and boll weight (0.140). The obtained results were in accordance with Komala *et al*. (2018), Palve *et al*. (2021) and Gowda *et al*. (2022) for seed cotton yield per plant.

Micronaire value has exhibited a significant and positive correlation with seed index (0.329) and a non significant and

positive association with seed cotton yield (0.100), fibre elongation (0.120), lint index (0.187) and lint yield (0.091). The results were similar to the report obtained by Rajamani (2016), Jayshankar (2017) and Manan *et al*. (2022) for seed index.

Conclusion

The character association studies revealed that strong significant positive association of seed cotton yield per plant (g) with plant height, number of monopodia per plant, number of bolls per plant, boll weight and lint yield per plant. Among fibre quality traits, fibre elongation and micronaire value exhibited positive correlation with seed cotton yield per plant. Thus, during future breeding programmes, above component traits should be given thrust while making selection as they were major attributes for improvement of seed cotton yield.

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