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ASSESSMENT OF GENETICS VARIABILITY IN COTTON GENOTYPES FOR EARLY MATURITY, YIELD AND FIBER QUALITY

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ABSTRACT

The present investigation was carried out during the 2023 cropping season at the Agriculture Research Cotton Institute (A.R.C.), Tandojam, to assess the significant differences among cotton genotypes for early maturity, yield, and fiber-related traits in upland cotton (*Gossypium hirsutum* L.). Multiple cotton genotypes, including a commercial check variety, were evaluated for important agronomic and fiber characteristics such as plant height, monopodial and sympodial branches per plant, number of bolls per plant, boll weight, seed cotton yield, lint weight, and ginning out turn (GOT). Analysis of variance revealed highly significant differences ($P < 0.05$) among genotypes for most of the studied traits, indicating substantial genetic diversity. Genotype D-85 showed superior performance in terms of sympodial branches and boll number, reflecting its yield potential, while D-82 recorded maximum plant height. The check variety Mehran exhibited higher lint weight, whereas genotype D-88 produced the highest ginning out turn. Earliness-related traits exhibited variable responses among genotypes, suggesting their usefulness in selecting early maturing lines. The observed variability in yield and fiber traits highlights the potential of these genotypes for selection and improvement. Overall, the study confirms the existence of significant differences among cotton genotypes, which can be effectively exploited in breeding programs aimed at developing early maturing, high-yielding, and better fiber-quality cotton varieties.

Keywords: *Gossypium hirsutum*, Genetic variability, Early maturity, Yield traits, Fiber characteristics, Cotton genotypes.

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INTRODUCTION

Cotton (*Gossypium hirsutum* L.), commonly referred to as “white gold,” is one of the most important natural fiber crops in the world due to its soft, white, and cellulose-based vegetative fiber. Cotton fiber is primarily used in the textile industry for the production of yarn, clothing, bedding materials, towels, and curtains, making it a vital raw material for global textile markets (Stewart & Rossi, 2010). In Pakistan, cotton is a major cash crop and plays a pivotal role in national economic development. It contributes significantly to agricultural value addition and foreign exchange earnings. During the 2022–23 growing season,

cotton was cultivated on approximately 2.5 million hectares, contributing about 0.6% to the national GDP and 2.4% to the agricultural sector (GoP, 2023). Upland cotton (*G. hirsutum* L.) accounts for nearly 90% of global fiber production, making it the most widely cultivated cotton species worldwide (Li et al., 2019). It is a tetraploid species ($2n = 4x = 52$) valued for its high yield potential and adaptability. However, the average seed cotton yield in Pakistan remains far below the genetic potential of existing cultivars (Farooq et al., 2019).

This yield gap emphasizes the urgent need for genetic improvement through effective breeding strategies focused

on early maturity, yield enhancement, and fiber quality improvement. Genetic variability within breeding populations is a fundamental prerequisite for successful selection and crop improvement. The availability of diverse genetic resources enables breeders to develop superior genotypes with improved productivity, fiber traits, and stress tolerance (Desheva & Cholakov, 2018). Morphological and agronomic traits have been extensively used to assess genetic diversity in cotton due to their simplicity and direct relevance to yield performance, although these traits can be influenced by environmental conditions (Sundar et al., 2014).

Understanding the relationships among yield, fiber, and maturity traits is essential for designing effective breeding programs. Correlation and regression analyses provide insights into the degree and direction of association between traits, allowing breeders to select indirectly for complex yield attributes through easily measurable characters (Cieniawska et al., 2022). Traits showing strong positive associations with yield can serve as reliable selection indices, whereas negative associations highlight potential trade-offs that must be managed during selection (Ahmed et al., 2008). Keeping in view the declining cotton productivity and the importance of early maturing, high-yielding, and superior fiber-quality cultivars, the present study was undertaken to assess the significant differences among cotton genotypes for early maturity, yield, and fiber traits.

MATERIALS AND METHODS

Experimental site and design

The present study was conducted during the 2023 cropping season at the Agriculture Research Cotton Institute (ARC), Tandojam. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications to minimize experimental error and environmental variability among treatments.

Experimental material

A total of eight upland cotton genotypes were evaluated in the study. These genotypes consisted of seven advanced lines along with one commercial check variety: D-82, D-83,

D-84, D-85, D-86, D-87, D-88 and Mehran (Check variety).

Traits studied

Data were recorded on important agronomic and fiber-related traits as follows: Plant height (cm), Number of sympodial branches plant⁻¹, Number of monopodial branches plant⁻¹, Number of bolls plant⁻¹, Boll weight (g), Seed cotton weight (g) and Lint weight (g) and Ginning out turn (%).

Procedure for recording observations

Plant height (cm) was measured at crop maturity using a measuring tape from the base of the plant to the terminal bud of randomly selected plants in each plot, and mean values were calculated. The number of sympodial and monopodial branches plant⁻¹ was recorded by counting branches on selected plants at maturity, followed by averaging. The total number of bolls plant⁻¹ was counted at crop maturity from randomly selected plants, and the mean was calculated. Boll weight, seed cotton weight, and lint weight were recorded from five randomly selected plants per treatment at the time of first picking. Seed cotton obtained from these plants was ginned to separate lint from seed. Ginning out turn (GOT) percentage was calculated using the following formula:

$$\text{GOT\%} = \frac{\text{Lint yield per plant}}{\text{Seed cotton yield per plant}} \times 100$$

Statistical analysis

The recorded data were subjected to analysis of variance (ANOVA) following the procedure described by Gomez and Gomez (1984) to determine significant differences among genotypes.

RESULTS

The study was conducted during season 2023 at Cotton Research Institute, A.R.C., Tandojam in order to estimation of heritability analysis for quantitative and qualitative traits of upland cotton (*Gossypium hirsutum* L.) for different characteristics such as: plant height (cm), number of sympodial branches plant⁻¹, number of monopodial branches plant⁻¹, number of bolls plant⁻¹, boll weight (g), seed cotton weight (g), lint weight (g) and ginning out turn (%). The ANOVA and mean performance results are given in Tables 1 and 2.

Table 1: Mean squares of cotton genotypes for plant height (cm), number of sympodial branches, number of monopodial branches and number of bolls plant⁻¹.

Genotype	D.F.	Plant height (cm)	Number of sympodial branches	Number of monopodial branches	Number of bolls plant ⁻¹
Replications	2	6.76	0.005	0.0018	1.511
Genotypes	7	261.08*	33.157*	0.0142*	16.184*
Error	14	6.52	0.759	0.0009	1.037

* indicates significant level at 5% of probability level. ** indicates highly significant level at 1% of probability level.

Table 2: Mean squares of cotton genotypes for boll weight (g), seed cotton weight (g), lint weight (g) and ginning out turn (%).

Genotype	D.F.	Boll weight (g)	Seed cotton weight (g)	Lint weight (g)	Ginning out turn (%)
Replications	2	0.0079	3.175	27.116	0.0606
Genotypes	7	0.1275*	10.804*	41.414*	4.6203*
Error	14	0.0150	8.376	5.144	0.2146

* indicates significant level at 5% of probability level. ** indicates highly significant level at 1% of probability level.

^{NS} = Non-significant

Growth and yield performance of tested genotypes

Plant height (cm)

Table 2 displays the results regarding plant height (cm) and shows that genotype D-82 performed all the other tested genotypes in terms of maximum plant height 134.00 cm. This was followed by D-85 with a plant height of 124.18 cm, D-88 with 117.34 cm, D-84 with 116.45 cm, D-86 with 115.32 cm, D-83 with 111.33 cm and D-87 with 108.67 cm. However, genotype Mehran (Check variety) had the minimum plant height of all the genotypes, measuring 104.10 cm.

Number of sympodial branches plant⁻¹

The genotype D-85 showed the maximum (23.46) number of sympodial branches plant⁻¹, followed by D-84 with 22.93, D-86 with 21.73, D-87 with 19.13, D-82 with 19.00, D-88 with 16.40 and D-83 with 15.26. On the other hand, the genotype Mehran (Check variety) had the lowest number of sympodial branches plant⁻¹ at 15.26.

Number of monopodial branches plant⁻¹

The genotype D-88 showed the maximum (1.26) number of sympodial branches plant⁻¹, followed by D-87 with 1.25, Mehran (Check variety) with 1.22, D-85 with 1.19, D-83 with 1.18, D-86 with 1.15 and D-84 with 1.14. On the other hand, the genotype D-82 had the lowest number of sympodial branches plant⁻¹ at 1.05.

Number of bolls plant⁻¹

Genotype D-85 significantly ($P < 0.05$) surpassed other commercial lines with maximum number of bolls plant⁻¹ (29.46), followed by D-823 (28.00), D-84 (27.60), D-86 (27.00), D-88 (25.93), D-87 (25.53) and D-83 (24.60); while the lowest number of bolls plant⁻¹ were (21.93) produced by the genotype Mehran (Check variety).

Boll weight (g)

The genotype Mehran (Check variety) was comparable to the other tested genotypes in terms of the boll weight, producing 3.23 g, followed by D-84 with 3.06 g, D-83 with 2.96 g, D-86 with 2.93 g, D-88 with 2.76 g, D-87 with 2.73 g and D-82 with 2.70 g. However, D-85 had the lowest boll weight with 2.63 g.

Seed cotton weight (g)

The results showed that genotype D-86 outperformed other commercial lines in terms of maximum seed cotton yield plant⁻¹ with a weight of 15.94 g. This was followed by Mehran (Check variety) with 14.93 g, D-85 with 14.54 g, D-84 with 13.92 g, D-88 with 13.06 g, D-83 with 11.35 g and D-87 with 11.15 g. However, the genotype D-82 had the lowest seed cotton yield plant⁻¹ with 11.02 g.

Lint weight (g)

Table 3 displays the results regarding lint weight (g) is presented in table 4.3 showed that genotype Mehran (Check variety) surpassed all the tested genotypes and produced maximum lint weight (36.23 g), followed by D-87 (35.43 g), D-88 (34.86 g), D-85 (34.40 g), D-86 (33.90 g), D-84 (33.03 g) and D-83 (27.64 g); while D-82 displayed minimum lint weight (26.22 g).

Ginning out turn (%)

According to the results, the genotype D-88 significantly ($P < 0.05$) exceeded other commercial lines in terms of maximum ginning out turn 39.18%. This was followed by D-82 with 38.15%, D-84 with 38.49%, Mehran (Check variety) with 37.60%, D-83 with 36.87%, D-87 with 36.41% and D-85 with 35.91%. However, the lowest ginning out turn was recorded for the genotype D-86 at 35.85%.

Table 2(a): Performance of cotton genotypes for plant height (cm), number of sympodial branches, number of monopodial branches and number of bolls plant⁻¹.

Genotypes	Plant height	No. of sympodial branches	No. of monopodial branches	Number of bolls plant ⁻¹
D-82	134.00 A	19.00 C	1.05 D	28.00 AB
D-83	111.33 DE	15.26 D	1.18 BC	24.60 E
D-84	116.45 C	22.93 AB	1.14 C	27.60 BC
D-85	124.18 B	23.46 A	1.19 BC	29.46 A
D-86	115.32 CD	21.73 B	1.15 C	27.00 BCD

D-87	108.67 E	19.13 C	1.25 A	25.53 DE
D-88	117.34 C	16.40 D	1.26 A	25.93 CDE
Mehran (Check)	104.10 F	15.26 D	1.22 AB	21.93 F
LSD 0.05 (%)	2.0863	0.7115	0.0250	0.8316

Table 3: Performance of cotton genotypes for boll weight (g), seed cotton weight (g), lint weight (g) and ginning out turn%.

Genotypes	Boll weight (g)	Seed cotton weight (g)	Lint weight (g)	Ginning out turn (%)
D-82	2.70 E	170.1 A	26.22 B	38.15 BC
D-83	2.96 BC	180.56 A	27.64 B	36.87 DE
D-84	3.06 AB	192.78 A	33.03 A	38.49 AB
D-85	2.63 E	141.06 A	34.40 A	35.91 F
D-86	2.93 BCD	175.08 A	33.90 A	35.85 F
D-87	2.73 DE	168.36 A	35.43 A	36.41 EF
D-88	2.76 CDE	176.64 A	34.86 A	39.18 A
Mehran (Check variety)	3.23 A	200.26 A	36.23 A	37.60 CD
LSD 0.05 (%)	0.1002	2.3632	1.8520	0.3782

Coefficients among various traits in cotton genotypes

Plant height (cm)

The results showed that plant height had positive and significant with the number of sympodial branches plant⁻¹ ($r=0.4056^*$) and number of bolls plant⁻¹ ($r=0.6988^*$). This trait had negative and significant with monopodial branches ($r=-0.6198^*$), boll weight ($r=-0.5540^*$) and lint weight ($r=-0.4884^*$). However, this trait had positive but non-significant with ginning out turn ($r=0.1469^{ns}$). This trait had negative but non-significant with seed cotton weight ($r=-0.0837^{ns}$).

Sympodial branches plant⁻¹

The results showed that the sympodial branches plant⁻¹ had a positive and significant with number of bolls plant⁻¹ ($r=0.7667^*$). The sympodial branches plant⁻¹ had negative and significant with boll weight ($r=-0.2708^*$). This trait had positive but non-significant with seed cotton weight ($r=0.2383^{ns}$) and lint weight ($r=0.0885^{ns}$). However, this trait negative but non-significant with monopodial branches ($r=-0.2914^{ns}$).

Monopodial branches plant⁻¹

The results showed that the monopodial branches plant⁻¹ had a positive and significant with number of lint weight ($r=0.4939^*$). The monopodial branches plant⁻¹ had negative and significant with number of bolls plant⁻¹ ($r=-0.4569^*$). This trait had positive but non-significant with boll weight ($r=0.0373^{ns}$) and seed cotton weight ($r=0.0585^{ns}$). This trait negative but non-significant with ginning out turn ($r=-0.0445^{ns}$).

Number of bolls plant⁻¹

The results showed that number of bolls plant⁻¹ had a negative and significant with boll weight ($r=-0.6404^*$) and

ginning out turn ($r=-0.1761^*$). This trait had positive and significant with seed cotton weight ($r=0.0221^{ns}$). Negative and non-significant with lint weight ($r=-0.1827^{ns}$).

Boll weight (g)

The results showed that boll weight had a positive and significant with seed cotton weight ($r=0.2537^*$) and lint weight ($r=0.1423^*$). This trait had a positive and non-significant with ginning out turn ($r=0.1923^{ns}$).

Seed cotton weight (g)

The results showed that seed cotton weight had a positive but non-significant with lint weight ($r=0.2830^{ns}$). However, this trait negative and non-significant with ginning out turn ($r=-0.1576^{ns}$).

Lint weight (g)

The results showed that lint weight had a negative but non-significant with ginning out turn ($r=-0.1160^{ns}$).

DISCUSSION

The present study showed that the genotype D-82 performed all the other tested genotypes in terms of maximum plant height 134.00 cm. However, genotype Mehran (Check variety) had the minimum plant height of all the genotypes, measuring 104.10 cm. The genotype D-85 showed the maximum (23.46) number of sympodial branches plant⁻¹. On the other hand, the genotype Mehran (Check variety) had the lowest number of sympodial branches plant⁻¹ at 15.26. The genotype D-88 showed the maximum (1.26) number of sympodial branches plant⁻¹, while the genotype D-82 had the lowest number of sympodial branches plant⁻¹ at 1.05. Genotype D-85 significantly ($P<0.05$) surpassed other commercial lines with maximum number of bolls

plant⁻¹ (29.46), while the lowest number of bolls plant⁻¹ were (21.93) produced by the genotype Mehran (Check variety). The genotype Mehran (Check variety) was comparable to the other tested genotypes in terms of the boll weight, producing 3.23 g. However, D-85 had the lowest boll weight with 2.63 g.

The genotype Mehran (Check variety) surpassed all the tested genotypes and produced maximum lint weight (36.23 g), while D-82 displayed minimum lint weight (26.22 g). The genotype D-88 significantly ($P < 0.05$) exceeded other commercial lines in terms of maximum ginning out turn 39.18%. However, the lowest ginning out turn was recorded for the genotype D-86 at 35.85%. The results are further compared with the study of Balouch et al. (2019) on cotton genotypes, it was reported that the genotype IR-8 had the longest panicle length (40.7 cm) compared to other tested genotypes, while the genotype IR-28 had the shortest panicle length (17.6 cm). Similarly, in another study conducted by Hossain et al. (2017) on cotton genotypes, it was reported that the genotype BRRI dhan56 had the longest panicle length (28.8 cm) compared to other tested genotypes, while the genotype BRRI dhan34 had the shortest panicle length (16.2 cm).

The results indicated that the genotype D-69/22 had the highest seed cotton yield per plant (165.66 g) among all the tested genotypes, while the genotype D-68/22 produced the lowest seed cotton yield per plant (92.43 g). For example, in a study conducted by Nazir et al. (2019) on cotton genotypes, it was reported that the genotype FH-114 had the highest seed cotton yield (4.59 t ha⁻¹) compared to other tested genotypes, while the genotype CIM-616 had the lowest seed cotton yield (2.24 t ha⁻¹). Similarly, in another study conducted by Amiri & Pahlevani (2018) on cotton genotypes, it was reported that the genotype S-12-22 had the highest seed cotton yield (2.96 t ha⁻¹) compared to other tested genotypes, while the genotype Marcabucag-44 had the lowest seed cotton yield (1.35 t ha⁻¹).

CONCLUSION

The results confirmed the presence of substantial genetic variability among the evaluated cotton genotypes, as evidenced by significant differences for most of the studied traits. This genetic diversity provides a strong basis for effective selection and genetic improvement in future cotton breeding programs.

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