

Causation studies for Kapas yield, yield components and lint quality traits in Mexican cotton (*Gossypium hirsutum* L.)

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ABSTRACT

Cotton is a very important crop that consists of traits with different associationship due to genetic and environmental factors. In order to determine the degree of association between seed cotton yield and important traits, a study was done using an RBD experiment with 30 hybrids. Seed cotton yield, plant height, GOT, number of sympodial braches, boll weight, bolls per plant, span length, fineness and strength data were collected and analysed. The experiment was done with 30 F₁ hybrids have delivered through Line x Tester mating configuration utilizing six lines and five testers were planted in a Randomized Block Design (RBD) with two replications at the Department of Cotton, TNAU, Coimbatore. Seed cotton yield per plant was found to have significant positive genotypic connection with boll weight (0.5810), number of bolls per plant (0.3867), plant height (0.422) and ginning percent (0.2182) however altogether and contrarily related with consistency proportion at genotypic level. The phenotypic relationship esteems likewise uncovered that seed cotton yield per plant had highly huge and positive phenotypic connection with number of bolls per plant (0.3470) and boll weight (0.4763). Path coefficients were processed to assess the commitment of individual characters to yield in cotton. The way investigation demonstrated high certain immediate impact of number of bolls per plant (0.4743) and fiber strength (0.6880) on seed cotton yield. Micronaire value displayed high sure circuitous impact on seed cotton yield through range length (0.3393), the outcome showed that number of bolls per plant had a high sure relationship with seed cotton yield and sympodial per plant recorded low certain connection with seed cotton yield. It was therefore concluded that selection of high yielding cotton hybrids could emphasize more on lint yield, boll weights, plant height and bolls per plant for better-performing lines. Gin outturn and fibre strength could be used indirectly to improve seed cotton yield through other traits.

Introduction

Cotton (*Gossypium hirsutum* L.) also renowned as most important fibre cum food crop. Cotton “White Gold” belongs to family Malvaceae is improvement programmes across the world have grown mainly in the tropics and sub-tropics as the always responded to the needs of the growers and

industry and strived to combine high yield and good fibre quality. In India, development of high yielding cotton varieties with superior fibre quality is a fundamental objective of many cotton improvement programmes. Hence the objective of the present study is to explore the association between various yield and fibre quality traits to facilitate indirect selection in cotton (Angadi *et al.*, 2016).

In plant breeding correlation studies pave the way for a better understanding of the association prevailing between highly heritable characters with most economic characters and give better understanding of the contribution of each trait in building up the genetic make-up of the crop (Jawahar and Patil, 2017). Since, seed cotton yield and fibre quality traits are complex quantitative characters, direct selection may not be a reliable approach as these traits are influenced by environmental factors. So it is important for breeders to know more about direct and indirect correlation among the different traits while selecting plants for breeding. Path coefficient analysis provides an effective aid in selection as it parts the correlation into direct and indirect components. So it's important to know more about the traits which contribute to the yield and their direct and indirect association to successfully design an effective breeding program. It is helpful in the procedure of selection and empowers the breeders to select a genotype on the basis of two or more traits simultaneously (Salahuddin *et al.*, 2010).

The present research was conducted on 30 F₁ hybrids to study the correlation and path coefficient analysis of fifteen yield, yield attributing and fibre quality traits to find the principal yield determining components and to use these traits as selection criteria for seed cotton yield improvement.

Material and Methods

This experiment was directed during summer 2020 at Department of cotton, TANU, Coimbatore. The result including 30 hybrids alongside check (Mallika) was spread out in Randomized Block Design (RBD) with two replications. Each cross was planted in two columns of 5m length with a separating of 90 x 60cm. Five plants from each genotypes were selected from each replications randomly for examining the biometrical

observations *viz.*, plant height(cm), number of sympodial branches per plant, number of bolls per plant, boll weight (g), ginning outturn (%), span length(mm), micronaire value (10-6g/in), fiber strength (g/tex) and seed cotton yield per plant(g).

Samples were ginned and their lint used for fibre quality traits in each replications with minimum ten grams of lint sample using High Volume Instrument (HVI)900 classic *viz.*, Span length (mm) were observed. After thinning one plant per hill was maintained and all normal agronomic and cultural practices were done at the right time. The mean data collected from entire hybrids were subjected to estimate the correlation and path analysis using TNAU STAT statistical analysis software. The total variance was partitioned into replication and treatment for all those seven characters. The mean data were tabulated for yield contributing traits and analysis of variance (ANOVA), estimation of critical difference and standard error were reported in tables for discussion. Heterosis were evaluated standard heterosis (standard hybrid) values. The observed mean data were statistically calculated by TNAU STAT software.

Analysis of covariance was computed in a fashion similar to that of analysis of variance formula and the statistics were utilized in calculating, phenotypic and genotypic correlation coefficients. Genotypic and phenotypic relationship among different characteristics was determined utilizing the recipe given by Singh and Narayanan (1993). Way coefficient investigation (Dewey and Lu, 1959) was done to translate the immediate and backhanded impacts of yield crediting and fiber quality attributes on seed cotton yield.

Results and Discussion

Association among seed cotton yield and its attributing characters

Correlation coefficient analysis

The genotypic and phenotypic correlation coefficients over ten biometrical traits were calculated for all entries and results are presented in Tables 1 and 2.

Genotypic correlation between seed cotton yield and other biometrical traits

The coefficients of genotypic correlation for seed cotton yield exhibited high and positively significant associations with boll weight (0.5810), number of bolls per plant (0.38) and plant height

Table 1: Genotypic correlation coefficients among seed cotton yield and attributing characters in cotton hybrids.

Traits	Y ₂	Y ₃	Y ₄	Y ₅	Y ₆	Y ₇	Y ₈	Y ₉	Y ₁₀
Y ₁	-0.0187	0.4384**	-0.0290	0.2205*	0.1602	0.0146	-0.6138**	0.1146	0.3799**
Y ₂	1.00	0.7388**	0.5446**	0.0991	-0.4685**	0.1392	0.3947**	-0.1058	-0.1758
Y ₃		1.00	-0.1213	0.2584*	0.0993	-0.2069*	-0.1159	0.2171*	0.3867**
Y ₄			1.00	-0.1283	0.5480**	0.0249	0.4278**	-0.1803	0.5810**
Y ₅				1.00	-0.3379**	-0.1595	-0.0205	0.2552*	0.2182*
Y ₆					1.00	-0.0631	0.7974**	-0.4952**	0.0460
Y ₇						1.00	0.2469*	-0.2918*	0.4080**
Y ₈							1.00	-0.7211**	0.0658
Y ₉								1.00	-0.0487

* = Significant at 5% level of Probability, ** = Significant at 1% level of Probability

Y ₁	-	Plant height(cm)	Y ₅	-	Ginning outturn (%)
Y ₂	-	Number of Sympodial branches per plant	Y ₆	-	Span length (mm)
Y ₃	-	Number of bolls/ plant	Y ₇	-	Uniformity ratio
Y ₄	-	Boll weight (g)	Y ₈	-	Fibre strength(g/tex)
Y ₉	-	Micronaire value(10 ⁻⁶ g/in)	Y ₁₀	-	Seed cotton yield per plant (g)

Table 2: Phenotypic correlation coefficients among seed cotton yield and attributing characters in cotton hybrids

Traits	Y ₂	Y ₃	Y ₄	Y ₅	Y ₆	Y ₇	Y ₈	Y ₉	Y ₁₀
Y ₁	-0.0154	0.3794**	-0.0243	0.1861	0.1490	0.0107	0.1138	0.1022	0.1802
Y ₂	1.00	0.1231	-0.0777	0.0738	-0.0302	0.1345	0.0812	-0.0739	-0.2601*
Y ₃		1.00	-0.0858	0.1772	0.0869	-0.1826	-0.1127	0.1242	0.3470*
Y ₄			1.00	-0.0358	0.0555	-0.0487	0.1210	-0.1518	0.4763**
Y ₅				1.00	-0.0120	-0.1809	0.0121	0.0982	0.1749
Y ₆					1.00	-0.0744	0.7608**	0.4269**	0.0364
Y ₇						1.00	0.2270	-0.2049	-0.3684**
Y ₈							1.00	0.6345**	-0.5631**
Y ₉								1.00	-0.0618

* = Significant at 5% level of Probability, ** = Significant at 1% level of Probability

Y ₁	-	Plant height(cm)	Y ₅	-	Ginning outturn (%)
Y ₂	-	Number of Sympodial branches per plant	Y ₆	-	Span length (mm)
Y ₃	-	Number of bolls/ plant	Y ₇	-	Uniformity ratio
Y ₄	-	Boll weight (g)	Y ₈	-	Fibre strength(g/tex)
Y ₉	-	Micronaire value(10 ⁻⁶ g/in)	Y ₁₀	-	Seed cotton yield per plant (g)

(0.37). Non-significant, positive correlation coefficients were reported span length (0.04) and fibre strength (0.06) Lastly, non-significance with negative correlation was observed in the trait number of sympodial branches per plant (-0.17).

Phenotypic correlation between seed cotton yield and other biometrical traits

Phenotypic correlation for seed cotton yield unveiled high, significant and positive associations with boll weight (0.4763 and number of bolls per plant (0.3470). Non-significance with positive correlation coefficients were observed for plant height (0.1802), ginning outturn (0.1749) and span length (0.0364). Significance with negative correlation coefficients were observed for number of sympodial branches per plant (-0.2601), uniformity ratio (-0.3684) and fibre strength (-0.5631).

Path coefficient analysis

Genotypic path analysis depicting direct and indirect effects of various yield and yield-contributing traits are presented in Table 3 and Fig 1. The residual effect was estimated as 0.80 and therefore, the existing traits seemed to be adequate for rationalizing the variation over seed cotton yield.

Direct effects

Among ten biometrical traits studied, fibre strength (0.6880) alone recorded very high, positive direct effects on seed cotton yield. Number of bolls per plant (0.4743) recorded high and positive direct effects. In contrast, negative direct effects and high ranking was observed in sympodial branches per plant and boll weight. The trait ginning outturn showed moderate positive direct effects on seed cotton yield. The fibre quality traits *viz.* span length and uniformity ratio had low negative direct effects while micronaire value had negligible negative direct effects on seed cotton yield. The remaining traits such as fibre fineness, plant height had negligible positive direct effects on seed cotton yield.

Indirect effects

Plant height exhibited high positive indirect effect on seed cotton yield through number of bolls per plant (0.2080) and fibre strength (0.0783). Micronaire value had high positive indirect effect on seed cotton yield *via* span length (0.3393) and number of bolls per plant (0.1030). Uniformity ratio also showed high and positive indirect effects for

yield across span length (0.0432). Similarly, ginning outturn (0.1226) and span length (0.0471) had high positive indirect effects on seed cotton yield while channelizing through number of bolls per plant. Boll weight obtained high positive indirect effect with seed cotton yield also through sympodial branches per plant (0.0120). Number of bolls per plant (0.0659) and boll weight (0.0500) contributed high indirect positive effect on seed cotton yield linking number of sympodial branches per plant. Micronaire value had high negative indirect effects (-0.450) on seed cotton yield by means of fibre strength. Fibre strength reported high negative indirect effects (-0.1327) on seed cotton yield, through uniformity ratio. Plant height had contributed indirectly high negative effects (-0.1098) on seed cotton yield enrouting upon span length. Similarly, boll weight (-0.0680) also reported high negative indirect effects on seed cotton yield while funneling down *via* span length. Number of sympodial branches per plant also showed high negative indirect effects (-0.0373) on seed cotton yield across number of bolls per plant.

Genotypic correlation

The genotypic connection of seed cotton yield with different segment qualities in this hybrids is introduced in Table 1. Among yield ascribing attributes, exceptionally sure genotypic and huge relationship of plant height was seen with number of bolls per plant (0.4384) and GOT% (0.2205). Exceptionally negative and critical affiliation was recorded between plant height and fiber strength (-0.6138). The quantity of sympodial branches per plant was found to have profoundly significant and positive connected with number of bolls per plant (0.7388) and boll weight (0.5446) and thusly contrarily associated with range length (- 0.4685). Additionally, boll weight had high certain and critical relationship with span length (0.5480) and fiber strength (0.4278). As opposed to this, GOT% recorded high negative and huge relationship with span length (- 0.3379), yet showed positive critical connection with micronaire value (0.2552). Range length had high negative and huge connection with micronaire value (- 0.4952) and positive relationship with micronaire value (0.7974). For different characters, consistency proportion showed high certain and critical relationship with fiber strength (0.2469) and micronaire value (0.2918). These result were in concurrence with the

Table 3: Path analysis indicating direct and indirect effects of component characters on kapas yield in cotton

Traits	Y ₁	Y ₂	Y ₃	Y ₄	Y ₅	Y ₆	Y ₇	Y ₈	Y ₉	Y ₁₀
Y ₁	0.0183	0.0050	0.2080	0.0032	0.0086	-0.1098	-0.0079	0.0783	-0.0238	0.3799**
Y ₂	-0.0003	-0.2688	0.0658	0.0049	0.0039	0.0064	-0.0748	0.0652	0.022	-0.1758
Y ₃	0.008	-0.0373	0.4743	0.0132	0.0101	-0.0680	0.1112	-0.0797	-0.0451	0.3867**
Y ₄	-0.0005	0.0120	-0.0575	-0.1091	-0.005	-0.0329	-0.0134	0.0879	0.0375	0.5810**
Y ₅	0.004	-0.0266	0.1226	0.0140	0.0389	0.0259	0.0857	-0.0141	-0.0323	0.2182*
Y ₆	0.0029	0.0025	0.0471	-0.0052	-0.0015	-0.6852	0.0339	0.5485	0.1030	0.0460
Y ₇	0.0003	-0.0374	-0.0982	-0.0027	-0.0062	0.0432	-0.5375	0.1698	0.0607	-0.4080**
Y ₈	0.0021	-0.0255	-0.055	-0.0139	-0.0008	-0.5464	-0.1327	0.6880	0.1500	0.0658
Y ₉	0.0021	0.0284	0.1030	0.0197	0.0060	0.3393	0.1569	-0.4961	-0.208	-0.0487

Residual effect = 0.80, * = Significant at 5% level of Probability, ** = Significant at 1% level of Probability

Y ₁	-	Plant height(cm)	Y ₅	-	Ginning outturn (%)
Y ₂	-	Number of Sympodial branches per plant	Y ₆	-	Span length (mm)
Y ₃	-	Number of bolls/ plant	Y ₇	-	Uniformity ratio
Y ₄	-	Boll weight (g)	Y ₈	-	Fibre strength(g/tex)
Y ₉	-	Micronaire value(10 ⁻⁶ g/in)	Y ₁₀	-	Seed cotton yield per plant (g)

discoveries of Pradeep *et al.* (2014), Asha *et al.* (2015) and Irfan *et al.* (2018). Likewise, Abdullah *et al.* (2016) and Memon *et al.* (2017).

Phenotypic correlation

The phenotypic connection of seed cotton yield with different part characteristics in this populace is introduced in Table 2. At phenotypic level, seed cotton yield per plant has shown huge positive relationship with number of bolls per plant (0.3470) and boll weight (0.4763) trailed by non-huge positive connection with plant height (0.1802), ginning outturn (0.1749) and span length (0.0364). These outcomes were in concurrence with the discoveries of Khan *et al.* (2010), Alkuddsi *et al.* (2013), Farooq *et al.* (2014), Reddy *et al.* (2015), Memon *et al.* (2017). On the other case, investigates negative relationship of seed cotton yield with boll weight and micronaire was given by Pujer *et al.* (2014). Seed cotton yield per plant was essentially and contrarily related with number of sympodial branches per plant (- 0.2601), fiber strength (- 0.5631) and consistency proportion (- 0.3684). The trait micronaire (- 0.0618) has shown non-huge negative relationship at phenotypic level. Comparative outcomes were seen by Dahiphale *et al.* (2015) and Khokher *et al.* (2017). Were the researchers Ashok and Ravikesavan (2010) and Farooq *et al.* (2014) observed a negative relationship between's seed cotton yield and fiber

strength. Unexpectedly, positive interrelation of range length, fiber strength, plant height and sympodial branches with seed cotton yield per plant was accounted for by Pradeep *et al.* (2014), Asha *et al.* (2015) and Irfan *et al.* (2018). Likewise, Abdullah *et al.* (2016) and Memon *et al.* (2017) noticed positive relationship of seed cotton yield per plant with plant stature.

Path coefficient analysis

The gauge of immediate and aberrant impacts of various yield contributing and build up quality attributes on seed cotton yield per plant was worked out through path analysis at the phenotypic level and alongside their phenotypic relationship is introduced in Table 3. The phenotypical path diagram for seed cotton yield per plant is given in Figure 1. The path investigation showed that fiber strength (0.6880) and the number of bolls per plant (0.4743) had most noteworthy direct impact on seed cotton yield per plant. Comparable outcomes were accounted for by Salahuddin *et al.* (2010), Pujer *et al.* (2014), Asha *et al.* (2015), Reddy *et al.* (2015), Angadi *et al.* (2016) and Irfan *et al.* (2018). Though characteristics like the number of sympodial branches per plant (- 0.2688), boll weight (- 0.1091), range length (- 0.6852) and consistency proportion (- 0.5375) had a negative direct impact on yield. The immediate impacts of any remaining part characteristics on seed cotton

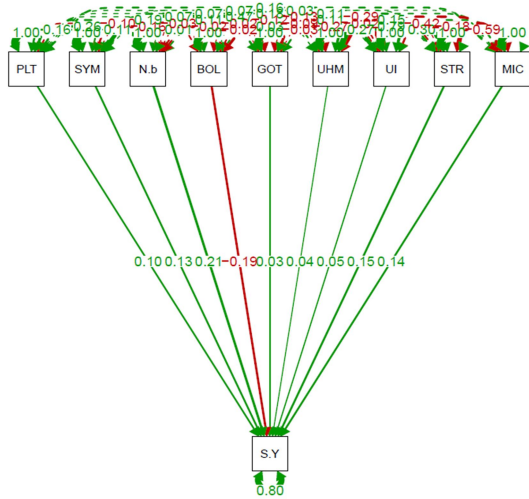


Figure 1: Phenotypical path diagram for seed cotton yield per plant

PLT	- Plant height(cm)	GOT	- Ginning outturn (%)
SYM	- Number of Sympodial branches per plant	UHM	- Span length (mm)
N.B	- Number of bolls/ plant	UI	- Uniformity ratio
BOL	- Boll weight (g)	STR	- Fibre strength(g/tex)
MIC	- Micronaire value(10^{-6} g/in)	S.Y	- Seed cotton yield per plant (g)

yield were positive however low. The positive circuitous impact of micronaire value with seed cotton yield per plant was most elevated through a

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number of bolls per plant, trailed by span length and consistency proportion. Neelima *et al.* (2008) showed that bolls per plant through boll weight and build up file, applied high certain circuitous impacts on seed cotton yield. Vinodhana *et al.* (2013) saw that boll weight applied beneficial outcomes on seed cotton yield per plant through fiber length, ginning rate and fiber strength. The backhanded impacts of any remaining segment attributes were immaterial.

Conclusion

Seed cotton yield per plant showed solid and positive relationship just as sure direct impacts on the yield contributing characters viz., sympodial branches per plant, number of bolls per plant, boll weight, ginning outturn, span length and micronaire value. Accordingly during future reproducing programs, these boundaries ought to be given push while making choice as they were significant characteristics of the seed cotton yield. The results discussed above indicate that correlation and direct and indirect effect estimates vary for different traits with variation in genetic material based on yield component traits and fibre properties. Hence, correlations and direct and indirect effect estimation would provide useful information for planning a successful breeding programme if the genetic material is grouped for yield and fibre quality characters and also it is essential to device suitable breeding methodologies for simultaneous improvement of both yield and quality parameters involving three way crosses, modified back crosses or recurrent selection.

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