Ethiop. J. Agric. Sci. 32(2) 119-132 (2022)

Character Association Study and Path Analysis for Fiber Yield and its Attributes in Improved Ethiopian Cotton (*Gossypium hirsutum* L.) Varieties

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Abstract

This research was designed to study the association of various agronomic and fiber quality related traits and the relative importance of fiber yield attributes. The experimental design used was Randomized Complete Block Design of three replications. The result showed a positive and significant association among four agronomic traits (fiber yield, ginning percentage, seed cotton yield and boll number per plant) and micronaire. Similarly, a highly significant association among fiber quality traits was observed in a desirable direction. However, the genotypic correlation (r_g) and phenotypic correlation (r_p) analysis indicated a non-significant and low association for most agronomic and fiber quality traits. Fiber yield exhibited positive and highly significant genotypic and phenotypic correlation with ginning percentage (r_g = 0.874 and r_p = 0.807) and seed cotton yield (r_g = 0.954 and r_p = 0.948). The path coefficient analysis revealed that ginning percentage and seed cotton yield had a high and positive direct effect on fiber yield. Furthermore, about 65.15% of fiber yield was contributed by ginning percentage and seed cotton yield. In conclusion, this study revealed that simultaneous selection for ginning percentage and seed cotton yield with balanced fiber quality traits probably improves fiber yield.

Keywords: Character association, cotton, fiber yield, path analysis.

Introduction

Cotton (*Gossypium* spp.) is one of the most economically important crop plants and it represents the largest source of natural textile fibers in the world. Among the four cultivated species of Gossypium; *Gossypium hirsutum* L. constitutes the utmost percentage of world cotton production due to its adaptability to wide agro-ecologies and high yielding potential. *Gossypium hirsutum* L. was named due to its hairiness (hirsute) and is commonly known as Upland cotton, American cotton, or Mexican cotton. It is believed that *Gossypium hirsutum* L. was cultivated in the south-west United States of America as early as the first century AD (Fryxell, 1979). These early semi-domesticated forms spread out into the rest of Mesoamerica, northern South America, and the Caribbean. Selection then occurred for reduced dormancy in seed, the annual habit of growth, and photoperiod independent flowering creating genotypes more alike to modern cultivars (Iqbal *et al*., 2001).

In Ethiopia, perennial new-world cotton and old-world cotton species were home grown farm yard crops by subsistence farmers for home use and to meet their family needs until the1960s. Since then, *Gossypium hirsutum* L. has been extensively grown as an annual crop by three major groups of cotton producers, i.e, the smallholder/peasant farms, large state farms and private commercial farms (Donis Gurmessa, 2019). Moreover, cotton production has also shown an accelerated increase in seed cotton yield production and the annual acreage has been increased to 100-120 thousand hectares. At present, cotton is one of the most important cash crops in Ethiopia and it is an important source of input for the textile mills, ginning factories, cottage industries, oil mills and handloom sector.
Empirical cotton breeding was based upon the concept of selecting the best high-yielding single progeny from the segregating populations to develop an improved variety. It helped in releasing high-yielding varieties with superior fiber quality through conventional breeding (Mubarik *et al*., 2020). Seed cotton yield and cotton fiber yield is the most economically important to cotton producers while fiber quality is the primary focus for spinning mills. Breeders often have to balance increases in fiber yield with improvements in fiber quality. The improvement of cotton fiber yield depends on the utilization of the available genetic resources through the use of advanced scientific disciplines in the breeding methods for factors influencing fiber yield (Zeng *et al*., 2018).

Cotton yield is a complex, polygenically controlled trait resulting from a combined effect of entire yield components exposed under a particular set of environmental conditions. Consequently, the selection for desirable genotypes based on yield only would not be very effective, which showed the importance of considering other yield contributing traits during selection (Baloch *et al*., 2016; Monicashree and Balu, 2018). Moreover, the magnitude and type of association between yield and its components themselves are influenced by genetic constitution and the environment. Thus, the corresponding change which occurs in one parameter at the expense of the proportionate change in the other must be envisaged through exploration of genotypic and phenotypic correlations. Furthermore, the partitioning of correlation coefficient into direct and indirect contributions (effects) of various traits towards the trait of interest (dependent variable) to assess the cause-effect relationship is needed as described by Dewey and Lu (1959). This work was therefore undertaken to study the character association and the relative importance of direct and indirect effects of each trait on cotton fiber yield.

Materials and Methods

Description of the study areas, plant materials, experimental design and data analysis

A field experiment has been conducted in 2016 and 2017 at Weyto and Shellie cotton-growing areas of the South region of Ethiopia under irrigated conditions. Weyto is located at 5° 23’31" N latitude and 36^{o} 58’41” E longitude at an elevation of 550 meters above sea level, while Shellie is located at 5° 51’42” N latitude and 37^{o} 28’32” E longitude at an elevation of 1120 meters above sea level. A total of ten cotton varieties viz. Ionia, Stam-59A, Deltapine-90, Bulk-202, Cucurova-1518, Sille-91, Carolina Queen, Cu-okra, Arba, and Acala SJ2 were used. The experimental design used was Randomized Complete Block Design with three replications with a plot size of 5 rows of 5m length and 0.9m row width and spacing between plants was 20cm. All agronomic practices and plant protection measures were applied as per recommended package for cotton. Before data collection five consecutive plants, in total 15 from the three central rows marked with wool threads and used as sample plants for data collection of all traits considered except seed cotton yield and fiber yield per hectare. Plant height was measured using a wooden ruler from the ground to the tip of the plant. Both opened and unopened bolls were counted and averaged for boll number per plant. The weight of thirty opened bolls (2 from each sampled plant) was averaged to determine boll weight and ginned to measure ginning percentage (the percentage of fiber). The resulting fiber of these 30 bolls was used to test fiber quality traits (micronaire, fiber length, fiber length uniformity index, short fiber index, and fiber strength) using USTER HVI 1000 under a controlled laboratory environment. All plants from the central rows were harvested and weighed including 30 picked bolls to determine seed cotton yield per hectare. Fiber yield per hectare was calculated by dividing the product of seed cotton yield and ginning percentage for 100. Genotypic coefficient of correlation and phenotypic coefficient of correlation was computed as per Miller *et al*. (1958).

$$r_g = \frac{\sigma^2 gyz}{\sqrt{(\sigma^2 gy)(\sigma^2 gz)}}$$

Where, r_g = Genotypic coefficient of correlation, $\sigma^2 gyz$ = Genotypic covariance of traits y & z, $\sigma^2 gy$ = Genotypic variance of trait y, $\sigma^2 gz$ = Genotypic variance of trait z.

$$r_p = \frac{\sigma^2 pyz}{\sqrt{(\sigma^2 py)(\sigma^2 pz)}}$$

Where, r_p = Phenotypic coefficient of correlation, $\sigma^2 pyz$ = Phenotypic covariance of traits y & z, $\sigma^2 py$ = Phenotypic variance of trait y, $\sigma^2 pz$ = Phenotypic variance of trait z.

The statistical significance of the coefficient of correlations was determined using a t-test as described by Gomez and Gomez (1984). Path coefficient analysis and the residual effect were computed following the method of Dewey and Lu (1959).

$$Rij = pij + \sum rikpkj$$

Where, Rij = Mutual association between the independent character (i) and dependent character (j) as measured by the correlation coefficient. pij = Component of direct effects of the independent character (i) and dependent character (j) as measured by the path coefficient and, Σrikpkj= Summation of components of indirect effect of a given independent character (i) on the given independent character (j) via all other independent character (k).

$$h = \sqrt{1 - R^2}$$

Where, h= residual effect R^2 = Σpij*rij, pij = Component of direct effects of the independent
character (i) and dependent character (j) as measured by the path coefficient. rij = Mutual association between the independent character (i) and dependent character (j) as measured by the correlation coefficient.

The percentage contribution of each agronomic trait and the mutual contribution between any two traits were calculated according to Lawal (2009).

$$C_x = (P_x)^2 * 100$$

$$C_{xy} = (2P_xP_yr_{xy}) * 100$$

Where: C_x = Individual contribution of x trait, C_{xy} = Mutual contribution of x and y trait, P_x = direct effect of trait x, P_y = direct effect of trait y, r_{xy}= coefficient of correlation between x and y trait.

All the statistical analysis was carried out using SAS software version 9.3.

Results

Phenotypic and genotypic correlation among traits

The genotypic and phenotypic correlation between all possible pairwise agronomic and fiber quality traits were computed and presented in Table 1. Seed cotton yield showed positive and highly significant ($P \leq 0.01$) genotypic correlation (r_g) with fiber yield (r_g = 0.954). A significant and positive genotypic correlation of seed cotton yield at $P \leq 0.05$, was also observed with boll number per plant (r_g = 0.741), ginning percentage (r_g = 0.690) and micronaire (r_g = 0.690). The remaining agronomic (plant height and boll weight) and fiber quality traits (fiber length, fiber length uniformity index, short fiber index and fiber strength) had non-significant and negative genotypic correlation with seed cotton yield. In contrast, highly significant ($P \leq 0.01$) and positive phenotypic correlation (r_p) of seed cotton yield was observed with boll number (r_p = 0.646), ginning percentage (r_p = 0.581) and fiber yield (r_p = 0.948). A significant ($P \leq 0.05$) and negative phenotypic correlation of seed cotton yield with plant height (r_p = -0.444) and positive phenotypic correlations with micronaire (r_p = 0.560) was also observed. On the contrary, non-significant and negative phenotypic correlation of seed cotton yield with boll weight and fiber quality traits (fiber length, fiber length uniformity index, and short fiber index and fiber strength) were observed. Moreover, boll number had significant and negative genotypic correlation with boll weight (r_g = -0.666), and significant and positive phenotypic correlation with ginning percentage (r_p = 0.459).

The data pertaining to fiber yield indicated highly significant positive genotypic correlation with ginning percentage (r_g = 0.874) at $P \leq 0.01$ and also significant positive genotypic correlation with boll number per plant (r_g = 0.735) and micronaire (r_g = 0.751) at $P \leq 0.05$. Short fiber index showed positive non-significant genotypic correlation with fiber yield and the remaining traits also showed non-significant but negative genotypic correlations (i.e., exclusive to seed cotton yield) with fiber yield. At phenotypic level, there were highly significant positive correlations of fiber yield with boll number per plant (r_p = 0.642) and micronaire (r_p = 0.644) and also negative and significant correlation existed with plant height (r_p = -0.393). The remaining traits appeared to have non-significant phenotypic correlations (i.e., exclusive to seed cotton yield) with fiber yield.

Considering fiber length highly significant ($P \leq 0.05$) genotypic correlation detected with fiber length uniformity index (r_g = 0.953), short fiber index (r_g = -0.931) and fiber strength (r_g = 0.964). Similarly, at phenotypic level fiber length had highly significant ($P \leq 0.01$) correlation with fiber length uniformity index (r_p = 0.820), short fiber index (r_p = -0.845) and fiber strength (r_p = 0.877) and also positive significant correlation with plant height (r_p = 0.416) observed at $P \leq 0.05$. Micronaire and all agronomic traits (plant height, boll number per plant, boll weight, seed cotton yield, ginning percentage and fiber yield) had no significant genotypic correlation with fiber length. Similarly, except for plant height, there were no significant phenotypic correlation of the remaining agronomic traits and micronaire with fiber length. Fiber strength had highly significant ($P \leq 0.01$) genotypic and phenotypic correlation with fiber length uniformity index (r_g = -0. 900 and r_p = 0.799) and short fiber index (r_g = -0.927 and r_p = -0.855). Plant height showed a significant ($P \leq 0.05$) correlation fiber strength (r_p = 0.431) at phenotypic level. Micronaire showed highly significant ($P \leq 0.01$) genotypic correlation with boll number per plant (r_g = 0.820) and boll weight (r_g = -0.807), and phenotypic correlation with ginning percentage (r_p = 0.697) and boll weight (r_p = -0.641). Furthermore, micronaire had significant genotypic correlation with ginning percentage (r_g = 0.733) and phenotypic correlation with boll number per plant (r_p = 0.521). At phenotypic level fiber length uniformity index was appeared to have highly significant (P ≤0.01) correlation with short fiber index (r_p = -0.845) and a significant correlation with ginning percentage (r_p = -0.410).

Table 1. Pairwise genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficients of agronomic and fiber quality traits

Traits	PH	BNP	BW	SCY	GOT	FY	Mic	FL	FLUI	SFI	FS
PH		-0.399	-0.050	-0.567	-0.193	-0.450	-0.138	0.477	0.347	-0.401	0.470
BNP	-0.234		-0.666*	0.741*	0.606	0.735*	0.820**	-0.117	-0.074	-0.046	-0.033
BW	0.008	-0.329		-0.253	-0.342	-0.292	-0.807**	0.187	0.142	-0.058	0.087
SCY	-0.444*	0.646**	-0.262		0.690*	0.954**	0.690*	-0.136	-0.069	-0.090	-0.031
GOT	-0.213	0.459*	-0.237	0.581**		0.874**	0.733*	-0.333	-0.461	0.219	-0.193
FY	-0.393*	0.642**	-0.267	0.948**	0.807 **		0.751*	-0.221	-0.230	0.019	-0.094
Mic	-0.192	0.521*	-0.641**	0.560*	0.697**	0.664**		-0.252	-0.237	0.073	-0.135
FL	0.416*	-0.093	0.186	-0.156	-0.294	-0.224	-0.174		0.953**	-0.931**	0.964**
FLUI	0.280	-0.036	0.052	-0.102	-0.410*	-0.229	-0.238	0.820**		-0.951**	0.900**
SFI	-0.349	-0.069	-0.050	-0.045	0.209	0.045	0.116	-0.845**	-0.876**		-0.927**
FS	0.431*	-0.039	0.067	-0.006	-0.178	-0.069	-0.127	0.877**	0.799**	-0.855**	

Note: * = significant at p≤0.05, **= significant at p≤0.01, PH = Plant height, BNP = Boll number per plant, BW = Boll weight, SCY = Seed cotton yield, GOT = Ginning percentage, FY = Fiber yield, M = Micronaire, FL = Fiber length, FLUI = Fiber length uniformity index, SFI = Short fiber index, FS = Fiber strength.

Path coefficient analysis

The genotypic path coefficient analysis (Table 2, Figure 1) showed seed cotton yield had the maximum positive direct effect (0.685) on fiber yield followed by ginning percentage (0.427). The positive indirect effect of seed cotton yield with fiber yield was highest through boll number per plant (0.507), followed by through ginning percentage (0.473) and micronaire (0.473), whereas that of ginning percentage was via, micronaire (0.313), seed cotton yield (0.294) and via boll number per plant (0.259). The direct effect of boll number per plant (-0.009) and micronaire (-0.027) was negative. Similarly, the indirect effect of both boll number per plant and micronaire on fiber yield were negative. The genotypic path analysis residual effect was 0.024.

Table 2. Genotypic path coefficient analysis indicating direct and indirect effects of characters on fiber yield.

Traits	BNP	SCY	GOT	M	r_g
BNP	-0.009	0.507	0.259	-0.022	0.735*
SCY	-0.007	0.685	0.294	-0.019	0.954**
GOT	-0.005	0.473	0.427	-0.020	0.874**
M	-0.007	0.473	0.313	-0.027	0.751*

Residual effect = 0.024

Note: BNP = Boll number per plant, SCY = Seed cotton yield, GOT = Ginning percentage, M = Micronaire, r_g = genotypic correlation with fiber yield.

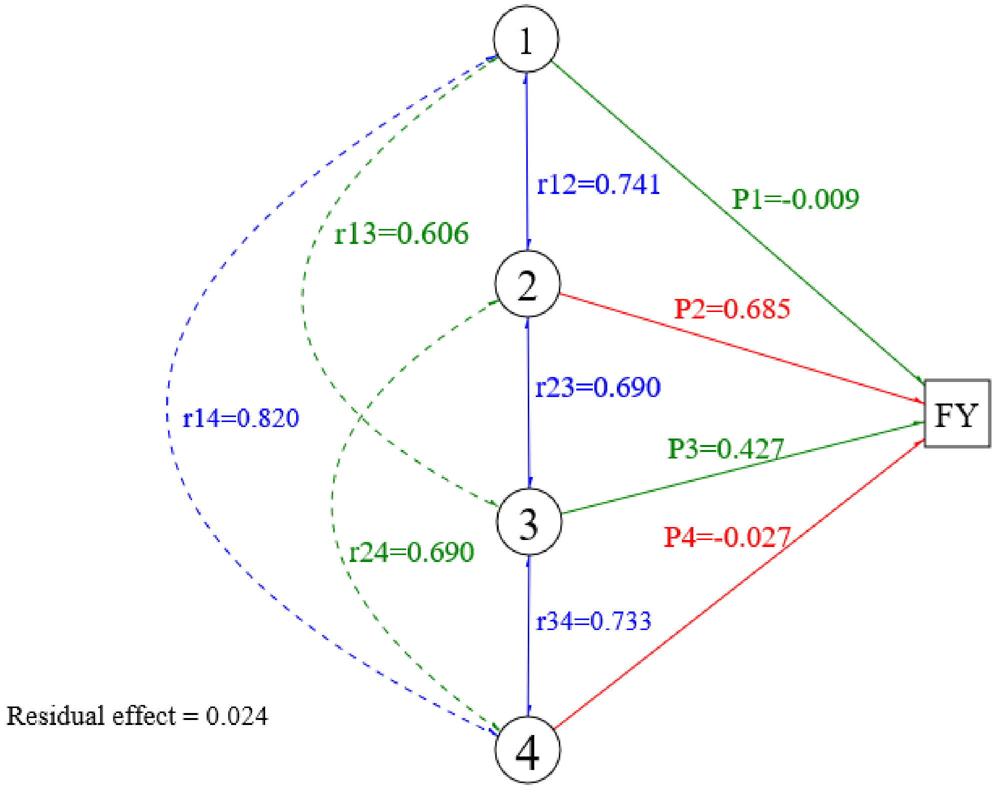

Figure 1. Diagrammatic representation of genotypic direct effects (P1 to P4) and correlation coefficients (r12 to r34). FY= Fiber yield, 1= Boll number per plant, 2= Seed cotton yield, 3= Ginning percentage, 4=Micronaire.

The phenotypic path coefficient analysis (Table 3, Figure 2) showed seed cotton yield had the maximum positive direct effect (0.736) on fiber yield, followed by ginning percentage (0.399) and plant height (0.014). The positive indirect effect of seed cotton yield with fiber yield was highest through boll number per plant (0.476), followed by through ginning percentage (0.428) and micronaire (0.412), whereas that of ginning percentage was via, micronaire (0.278), seed cotton yield (0.232) and via boll number per plant (0.183). The direct effect of plant height was positive (0.014), whereas that of boll numbers per plant and micronaire were zero and negative (-0.023), respectively. Moreover, the indirect effect of both plant height and boll number per plant on fiber yield was negative. Similarly, the indirect effect of micronaire via boll number per plant, seed cotton yield and ginning percentage was negative. The positive indirect effect of micronaire was through plant height. The phenotypic path analysis residual effect was 0.042.

Table 3. Phenotypic path coefficient analysis indicating direct and indirect effects of characters on fiber yield.

Traits	PH	BNP	SCY	GOT	M	r_p
PH	0.014	0.000	-0.327	-0.085	0.004	-0.393*
BNP	-0.003	-0.002	0.476	0.183	-0.012	0.642**
SCY	-0.006	-0.001	0.736	0.232	-0.013	0.948**
GOT	-0.003	-0.001	0.428	0.399	-0.016	0.807**
M	-0.003	-0.001	0.412	0.278	-0.023	0.664**

Residual effect = 0.042

Note: PH = Plant height, BNP = Boll number per plant, SCY = Seed cotton yield, GOT = Ginning percentage, M = Micronaire, r_p = phenotypic correlation with fiber yield.

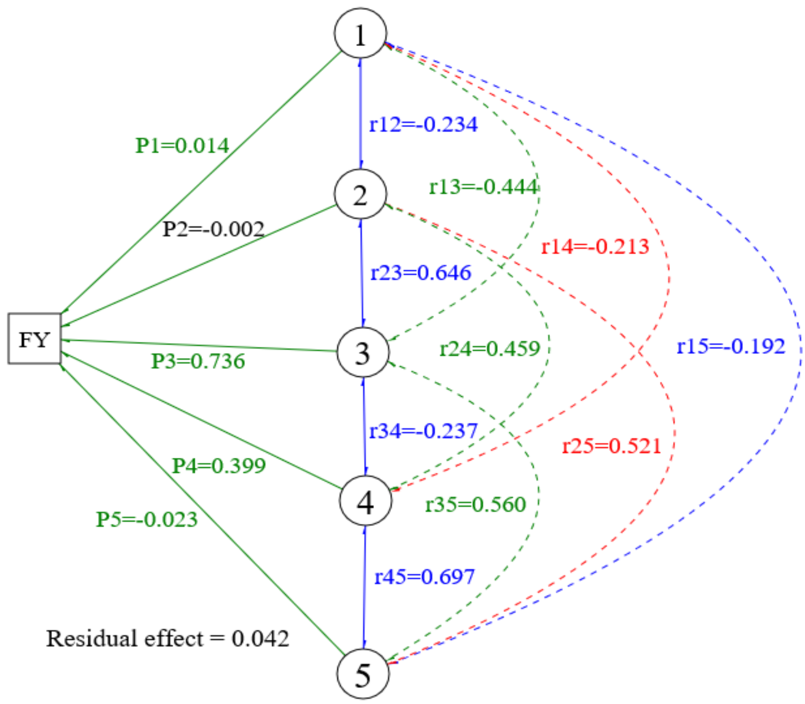

Figure 2. Diagrammatic representation of phenotypic direct effects (P1 to P5) and correlation coefficients (r12 to r45). FY= Fiber yield, 1= Plant height, 2= Boll number per plant, 3= Seed cotton yield, 4= Ginning percentage, 5=Micronaire.

The contribution of each agronomic character and mutual contribution between all possible pairwise agronomic traits is presented in Table 4. Seed cotton yield and ginning percentage contributed 46.9% and 18.23%, respectively to fiber yield. Boll number per plant had 0.01% whilst micronaire showed 0.07% contribution to fiber yield. The mutual contribution of seed cotton yield and ginning percentage recorded 40.36% contribution to fiber yield. The least of -2.55% belongs to mutual contribution between seed cotton yield and micronaire, followed by mutual contribution of -1.69% between ginning percentage and micronaire.

Table 4. Percentage contribution of some agronomic traits to cotton fiber yield

Fiber yield attributes	Contribution (%)
Boll number per plant	0.01
Seed cotton yield	46.92
Ginning percentage	18.23
Micronaire	0.07
Boll number per plant and seed cotton yield	-0.91
Boll number per plant and ginning percentage	-0.47
Boll number per plant and Micronaire	0.04
Seed cotton yield and ginning percentage	40.36
Seed cotton yield and micronaire	-2.55
Ginning percentage and micronaire	-1.69
Total	100

Discussions

Cotton plant traits are linked naturally and thus improvement in one trait may affect the other traits (Yaqoob *et al*., 2016). Fiber yield is the most important industrial raw material for which cotton plants are widely cultivated. It is a complex quantitative trait controlled by micro-functional multiple genes affected by the environment. Grafius (1959) stated that, there may not be any gene for yield, but operates only through other components. In a similar manner, fiber yield is the product of many character interactions. Consequently, it's essential to know the component characters involved in interaction and the direct and indirect effects of one trait on another through correlation and path analysis so that one can select desirable plant material.

In this study there was a significant and highly positive (0.735 to 0.954) genotypic correlation between fiber yield and boll number per plant, seed cotton yield, ginning percentage and micronaire. Significant genotypic correlation between the different pairs of characters indicates strong correlation between those characters genetically and changes brought about by selection (artificial and or natural) among correlated traits. Similarly, the phenotypic correlation coefficient showed a positive and significant (0.642 to 0.948) correlation between fiber yield and boll number per plant, seed cotton yield, ginning percentage, and micronaire. The observed high positive correlation between fiber yield and fiber yield contributing components, suggested that these traits are dependable indicators for high fiber yielding varieties. Previous studies in cotton have also reported significant positive genotypic and phenotypic correlation of fiber yield with boll number per plant, seed cotton yield, and ginning percentage (Balakrishna *et al*., 2016; Alehegn Workie, 2020; Amein *et al*., 2020), and micronaire (Balakrishna *et al*., 2016; Merdasa *et al*, 2020). Plant height had a significant negative phenotypic correlation with fiber yield. This suggests that selection for plant height will have negative effects on fiber yield improvement of cotton. Negative correlation of traits signify that it is difficult or practically impossible to improve through simultaneous selection of those traits. Comparatively, the magnitude of phenotypic correlation coefficient between fiber yield and fiber yield contributing traits (boll number per plant, seed cotton yield and ginning percentage) were slightly lower than that of the corresponding genotypic correlation coefficient. Accordingly, the observed association was largely due to genetic factors rather than the environmental influence. In other words, there is an inherent association of fiber yield of cotton with boll number per plant, seed cotton yield and ginning percentage. Hence, the role of environmental factors played was minor in the expression of these traits that justified the possibility of correlated response to selection. Similar observations were also noted earlier by Asad *et al* (2002), Babu *et al* (2017) and Queiroz *et al* (2019) in cotton.

Inter correlation among the important component traits is also essential to decide upon which trait is to be given due weightage while exercising selection. The data showed four traits including seed cotton yield, boll number per plant, ginning-out turn and micronaire value showed significant positive phenotypic and genotypic correlations with each other, indicating that increase in one of traits will cause increase in the other. Many research works revealed the significant and positive genotypic and or phenotypic correlation of seed cotton yield with boll number per plant (Babu *et al*., 2017; Nikhil *et al*., 2018; Kumar *et al*., 2019; Amein *et al*., 2020), ginning percentage (Yaqoob *et al*., 2016; Hampannavar *et al*., 2020; Merdasa *et al*., 2020) and micronaire (Balakrishna *et al*., 2016; Yaqoob *et al*., 2016; Monicashree and Balu, 2018).

Fiber quality traits (fiber length, fiber length uniformity index, short fiber index and fiber strength) found to have negative non-significant correlation with economically important traits (seed cotton yield and fiber yield). Numerous studies reported negative correlation of fiber strength, fiber length uniformity index and fiber length with seed cotton yield and/or fiber yield (McCarty *et al*.,2006; Farias *et al*., 2016; Balakrishna *et al*., 2016; Monicashree and Balu, 2018; Nikhil et al., 2018; Queiroz *et al*., 2019; Alehegn Workie, 2020; Merdasa, et al. 2020). The fiber quality traits including fiber length, fiber length uniformity index, short fiber index and fiber strength exhibited highly significant inter genotypic and phenotypic correlation among each other. Apart from short fiber index the increase of one or more of these traits will increase the other. The negative correlation for short fiber index with other fiber components is considered desirable. Earlier findings reported similar trends (Balakrishna *et al*., 2016; Monicashree and Balu, 2018, Nikhil *et al*., 2018; Queiroz *et al*., 2019; Alehegn, 2020; Amein *et al*., 2020; Chapepa *et al*.,2020).

Traits with significant correlation with fiber yield were considered in the path analysis and partitioned to the direct and indirect effects. The genotypic correlation path analysis revealed that seed cotton yield and ginning percentage had a high (0.685 and 0.427) positive direct effect on fiber yield. This is in line with the highest genotypic correlation of fiber yield with seed cotton yield and ginning percentage. Thus, direct selection on the bases of seed cotton yield and ginning percentage will be useful to increase cotton fiber yield. In other words, an increase in seed cotton yield and ginning percentage will ultimately increase the fiber yield.

On the other hand, despite the positive and significant genotypic correlation with fiber yield, boll number per plant and micronaire recorded a negative direct effect on fiber yield. If a given trait has positive correlation and the direct effect of that trait is negative or negligible, the positive correlation of the trait is due to the indirect effects through other traits. Consequently, the positive correlation of boll number per plant and micronaire with fiber yield was probably, due to the positive indirect effects through seed cotton yield and ginning percentage. Under this situation, both seed cotton yield and ginning percentage have to be considered simultaneously for fiber yield improvement.

Seed cotton yield had a positive indirect effect on fiber yield through boll number per plant, micronaire and ginning percentage. Similarly, ginning percentage showed a positive indirect effect on fiber yield through boll number per plant, micronaire, and seed cotton yield. The positive direct and indirect effect of seed cotton yield and ginning percentage trait indicates their importance as selection criteria for cotton fiber yield improvement. The low value (0.024) obtained in residual effects indicated that other factors such as environmental influence and sampling errors, and variables not considered in this study were of less (2.4%) effect to fiber yield and about 97.6% of the variability in fiber yield was contributed by the traits studied in path analysis. Seed cotton yield and ginning-out turn had a total of 65.15% contribution to fiber yield. Moreover, the mutual association between seed cotton yield and ginning percentage showed the highest percentage contribution of 40.36.

The phenotypic correlation path analysis revealed that similar to the genotypic path analysis result, the direct effect of seed cotton yield and ginning percentage on fiber yield was high (0.736 and 0.399). Similarly, the indirect effect of seed cotton through boll number and ginning percentage, and also the indirect effect of ginning percentage through boll number per plant and seed cotton yield were positive. A similar finding was earlier reported by Alehegn Workie (2020).

The direct effect of plant height was negligible. Furthermore, unlike the positive significant phenotypic correlation of boll number per plant and micronaire with fiber yield, the path analysis showed negative direct and indirect effects of these traits on fiber yield. This indicates that improvement on these characters would not result in better performance and subsequent fiber yield improvement. Boll number per plant and micronaire whose correlation coefficient values were positive, exerted negative direct effects on fiber yield. The miss match between correlation and direct effects is probably due to the indirect effects of other characters through these traits. As the residual effect indicates, the contribution of component characters studied in the phenotypic path analysis on fiber yield was 95.8% and the role of other independent variables which were not included in the study on the fiber yield is about 4.2%.

Conclusion

The study of genotypic and phenotypic correlation indicated the presence of significant association among most agronomic and fiber quality traits. Seed cotton yield and ginning percentage were the most contributing traits for cotton fiber yield. However, non-significant and low phenotypic and genotypic correlation value was observed between fiber yield and most valued fiber quality traits (exclusive to micronaire). Moreover, simultaneous selection based on seed cotton yield and ginning percentage should be considered as important selection criteria for higher cotton fiber yield with balanced fiber quality traits.

Acknowledgments

We thank Ethiopian Institute of Agricultural Research for financial support and Ethiopian Textile Industry Development Institute for their cooperation during the fiber quality testing process.

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