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CORRELATION STUDIES AND PATH COEFFICIENT ANALYSIS IN UPLAND COTTON [*GOSSYPIUM HIRSUTUM* L.]

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ABSTRACT

India's industrial and agricultural sectors rely heavily on cotton, one of the country's most important cash crops and source of fibre. Cotton seeds are used to manufacture oil, while cotton fibre serves as the industry's basic material for textiles. So, a field experiment comprised of 32 genotypes of cotton was laid out in randomized block design with three replications at Main Cotton Research Station, NAU, Surat during *Kharif*, 2021-22. The study of relationships among quantitative traits is important for assessing the feasibility of joint selection of two or more traits and evaluating the effect of selection for secondary traits on genetic gain for the primary trait under consideration. Correlation coefficient analysis revealed that seed cotton yield per plant exhibited positive and significant correlation with sympodia per plant, bolls per plant, plant height, ginning percentage, lint index at both genotypic and phenotypic level. On the contrary, it expressed negative and significant association with days to 50% flowering and fibre strength. These findings of correlation revealed that emphasis should be given on selection for plants with higher sympodia per plant, bolls per plant, ginning percentage and lint index for improvement in seed cotton yield. Besides this, it revealed that traits like boll weight, seed index, upper half mean length and fibre fineness did not significantly affect seed cotton yield. Path coefficient suggested high positive direct effect on seed cotton yield per plant by seed index followed by ginning percentage, sympodia per plant and plant height. Thus, the results obtained conclude us that seed index, ginning percentage and sympodia per plant are the traits to be emphasized during selection in the breeding programs.

Key words : Correlation, Cotton, Ginning, Path analysis, Sympodia.

Introduction

Cotton was mentioned in the ancient Indian Vedas. Cotton is one of the most important and major fiber crop and popularly known as the "king of fiber". The word "cotton" is derived from arabic word "alqatan" or "qutn" (Brown and Ware, 1958). Since pre-Harappan times, cotton has been grown in India for more than 6000 years. The use of cotton for fabric dates back to prehistoric times and cotton fabric fragments have been found as far back as 4300 BC in the Indus Valley civilization (Gulati and Turner, 1928). Latest archaeological discovery in Mehrgarh puts the dating of early cotton cultivation and the use of cotton to 5000 BC. (Gumber *et al.*, 2014). It is an important commercial crop popularly known as the 'White Gold'.

Since ancient times, India has exported fine cotton fabrics to other countries. Indian cotton industry struggled in the late 19th century because of non-mechanized production and American dominance of raw cotton export. Instead of being a major exporter of cotton goods, India became the largest importer of British cotton textiles. Mohandas Gandhi believed that cotton was closely tied to Indian self-determination. In the 1920, he launched the khadi movement, a massive boycott of British cotton goods. He urged Indians to use simple homespun cotton textile, khadi. In the second half of the 20th century, a downturn in the European cotton industry led to resurgence to the Indian cotton industry. India began to mechanize and was able to compete in the world market.

Cotton is an annual crop cultivated in tropical and subtropical regions of the world. Cotton belongs to the genus Gossypium of *Malvaceae* family which contains 50 species. Out of these, four species are under commercial cultivation *viz*., *Gossypium herbaceum* (2n=26), *Gossypium arboreum* (2n=26), *Gossypium hirsutum* (2n=52) and *Gossypium barbadense* (2n=52). The New World AD-genome species, *G. hirsutum* and *G. barbadense* are superior as per the lint. India is the only country where all the cultivated species and some of their hybrid combinations are commercially grown. Cotton is one of India's most important fibre and cash crop and contributes significantly to its industrial and agricultural economies. Cotton fibre is the raw material for the cotton textile industry and cotton seeds are used to make oil. In addition to its use in cooking, cotton seed oil is used to make soap, margarine, emulsifiers, cosmetics, pharmaceuticals, rubber and plastics. Approximately 40-50 million peoples employed in the trade and processing of cotton in India and cotton provides direct livelihood to 6 million farmers.

Cotton is grown in 75 countries across the world, out of which the United States, China and India contribute 80% of total yield in the world. World total cotton production was recorded at 242.59 million bales from 323.61 lakh hectares of total cultivated area with 749 kg/ha productivity in 2022-23. In India, total production of cotton was 337.23 lakh bales from the 130.49 lakh hectares of cultivated area and 439 kg/ha productivity during 2022-23. In India, there are ten major cotton growing states which are divided into three zones, *viz*., North zone, Central zone and South zone. North zone consists of Punjab, Haryana, Rajasthan. Central zone include Madhya Pradesh, Maharashtra and Gujarat. South zone include Andhra Pradesh, Telangana, Karnataka and Tamil nadu. Gujarat is the largest cotton producing state with 106.94 lakh bales of the total production of the country from approximately 26.68 lakh hectares with 614 kg/ha productivity during 2022-23 (Anonymous, 2024).

Yield is complex character and it is composed of several components. Some of which affect the yield directly, while others affect indirectly. Hence, knowledge of association between yield and its components is necessary. Correlation coefficient analysis measures the mutual relationship between various plant characters and determines the component characters on which selection can be based for genetic improvement in yield. If the correlation is strong between a set of desirable traits then we make selection for one character, the other character will automatically be taken care. If unfavorable association exists between desirable and undesirable traits, selection may result in genetic slippage and limit genetic advance. Direction and magnitude of correlation between yield and yield contributing characters must be considered for selection of superior genotypes from diverse genetic population, but correlation does not provide information about direct and indirect effects of independent variable on dependent one. Thus, this path coefficient analysis is essential.

In a path coefficient analysis, which is given by Wright (1921) is standardized as partial regression coefficient, which helps in partitioning the correlation coefficient into direct and indirect effects of independent variables on dependent variable. One variable is measured by one's direct impact on another. Path coefficient analysis facilitates the selection process and enables breeders to select a genotype based on two or more traits simultaneously (Salahuddin *et al.*, 2010).

Materials and Methods

The experimental material of the present investigation comprised of 32 genotypes of cotton obtained from Main Cotton Research Station, Navsari Agricultural University, Surat (Gujarat) during *Kharif*, 2021. Each entry was accommodated in a single row of 5.4 m length with a spacing of 120 cm × 45 cm. A line of 12 plants were grown as a gross plot and from both sides one plant each were excluded to consider 10 plants as net plot. Observations were taken from five random plants in the plot. All cultural practices were followed and timely plant protection measures were taken to avoid damage through pests and diseases. The analysis was carried out over 12 characters *viz.*, days to 50% flowering, sympodia per plant, bolls per plant, boll weight (g), plant height (cm), ginning percentage, seed index (g), lint index (g), upper half mean length (mm), fibre fineness (mv), fibre strength (g/tex) and seed cotton yield per plant (g) to assess the correlations and path coefficients analysis in cotton.

Ginning percentage was calculated as per the following:

$$\text{Ginning }(\%) = \frac{\text{Weight of lint (g)}}{\text{Weight of total seed cotton}} \times 100 \quad (1)$$

Fiber strength was expressed in gram per tex and calculated by following formula:

$$\text{Fiber strength (g/tex)} = \frac{\text{Breaking strength (kg)} \times 15}{\text{Weight of bundle (mg)}} \quad (2)$$

Lint index was calculated as under

$$\text{Lint index}\ (g) = \frac{\text{Ginning percentage} \times \text{Seed index}\ (g)}{(100 - \text{Ginning percentage})} \quad (3)$$

The analysis of variance for randomized block design (RBD) was done for each character with the method suggested by Panse and Sukhatme (1978). Genotypic (r_g) and phenotypic (r_p) correlation coefficients were calculated by adopting the method explained by Miller *et al.* (1958). The genotypic path analysis was carried out as per the method suggested by Dewey and Lu (1959).

Results and Discussion

The ANOVA results revealed that mean squares due to genotypes were highly significant for all the characters studied indicating the presence of high genetic variation for different traits among the genotypes under study. Similar results were also obtained by Choudki *et al.* (2012) and Joshi *et al.* (2018).

Correlation Coefficient analysis

In the present experiment genotypic (r_g) and phenotypic (r_p) correlation coefficients are computed and presented in Tables 1 and 2, respectively. The results of the study are discussed below:

Days to 50% flowering: It showed significant positive correlation with fibre strength (r_g = 0.48 and r_p = 0.21) and upper half mean length (r_g = 0.25 and r_p = 0.22) at both genotypic and phenotypic levels. It had negative and significant correlation with sympodia per plant (r_g = -0.34 and r_p = -0.20) and bolls per plant (r_g = -0.30 and r_p = -0.22) at both genotypic and phenotypic levels. It gave negative and significant correlation with seed cotton yield per plant at genotypic level (r_p = -0.24). These results were confirmed by Reddy *et al.* (2015) for fibre strength and upper half mean length. Similar results were obtained by Thiyagu *et al.* (2010) and Yanal *et al.* (2013) for sympodia per plant, bolls per plant and seed cotton yield per plant.

Sympodia per plant : It was observed to possess positive and significant correlation with bolls per plant (r_g = 0.73 and r_p = 0.57), plant height (r_g = 0.51 and r_p = 0.22), fibre fineness (r_g = 0.33 and r_p = 0.29) and seed cotton yield per plant (r_g = 0.48 and r_p = 0.29) at both genotypic and phenotypic levels. It gave negative and significant correlation with days to 50% flowering (r_g = -0.34 and r_p = -0.20), ginning percentage (r_g = -0.37 and r_p = -0.26) at both genotypic and phenotypic levels. Thiyagu *et al.* (2010) and Monisha *et al.* (2019) obtained similar result for bolls per plant, plant height, seed cotton yield per plant and fibre fineness.

Bolls per plant : Trait was noticed to have positive and significant correlation with sympodia per plant (r_g = 0.73 and r_p = 0.57), seed cotton yield per plant (r_g = 0.69 and r_p = 0.53) and plant height (r_g = 0.52 and r_p = 0.32) at both genotypic and phenotypic levels. Negative and significant correlation was observed with days to 50% flowering (r_g = -0.34 and r_p = -0.22) and upper half mean length (r_g = -0.28 and r_p = -0.23) at both genotypic and phenotypic levels. Similar results were obtained by Patel *et al.* (2013), Farooq *et al.* (2014), Pradeep *et al.* (2014), Pujer *et al.* (2014), Reddy *et al.* (2015), Latif *et al.* (2015), Shahzad *et al.* (2015), Komala *et al.* (2018), Nikhil *et al.* (2018), Monisha *et al.* (2019) and Nawaz *et al.* (2019) for boll weight, plant height and seed cotton yield per plant.

Boll weight (g) : Trait manifested positive and significant correlation with plant height (r_g = 0.40 and r_p = 0.26) at both genotypic and phenotypic levels. Trait exhibited positive and significant association with lint index (r_g= 0.22) and fibre strength (r_g =0.21) at genotypic level. Similar results were found by Pujer *et al.* (2014) and Reddy *et al.* (2015) for sympodia per plant and bolls per plant.

Plant height (cm) : Plant height showed positive and significant correlation with bolls per plant (r_g = 0.52 and r_p = 0.32), seed cotton yield per plant (r_g = 0.49 and r_p = 0.29), boll weight (r_g = 0.40 and r_p = 0.26) and sympodia per plant (r_g = 0.51 and r_p = 0.22) at both genotypic and phenotypic levels. Trait had positive and significant correlation with fibre strength (r_g = 0.40) at genotypic level and there was no correlation with (r_p = 0.00) fibre strength at phenotypic level. These results were confirmed by Dahiphale *et al.* (2015) for sympodia per plant and bolls per plant. Similar results were obtained by Thiyagu *et al*. (2010), Pradeep *et al*. (2014) and Pujer *et al.* (2014) for seed cotton yield per plant.

Ginning percentage : It showed positive and significant correlation with seed cotton yield per plant (r_g = 0.26 and r_p = 0.27) at both genotypic and phenotypic levels. It had negative and significant correlation with seed index (r_g = -0.45 and r_p = -0.37), upper half mean length (r_g = -0.24 and r_p = -0.21) and sympodia per plant (r_g = -0.34 and r_p = -0.26) at both genotypic and phenotypic levels. Similar finding was reported by Thiyagu *et al.* (2010) for sympodia per plant. These results were in agreement with Monisha *et al.* (2019) for seed index, upper half mean length and fibre strength. It had positive and highly significant correlation with seed cotton yield per plant. These results were in agreement with Yanal *et al.* (2013) and Reddy *et al.* (2015).

Table 1 : Genotypic correlation coefficients of yield, its attributing traits and fibre quality parameters in cotton.

Traits	DFF	SPP	BPP	BW	PH	GP	SI	LI	UHML	FF	FS	SCYPP
DFF	1.00											
SPP	-0.34**	1.00										
BPP	-0.30 **	0.73 **	1.00									
BW	-0.10	0.08	0.20	1.00								
PH	0.11	0.51 **	0.52 **	0.40 **	1.00							
GP	0.06	-0.37 **	0.07	-0.03	-0.13	1.00						
SI	-0.04	0.19	-0.05	0.12	0.07	-0.45**	1.00					
LI	0.04	-0.07	-0.07	0.22 *	0.10	0.13	0.86 **	1.00				
UHML	0.25 *	-0.22 *	-0.28 **	0.00	0.01	-0.24 **	0.29**	0.21*	1.00			
FF	-0.11	0.33 **	0.13	0.13	-0.08	-0.10	0.27 **	0.19	-0.26 **	1.00		
FS	0.48 **	0.14	-0.14	0.21 *	0.34**	-0.50**	0.29 **	0.24 *	0.75 **	-0.24 *	1.00	
SCYPP	-0.24 *	0.48 **	0.69 **	0.15	0.49**	0.26**	0.09	0.35 **	-0.10	0.08	-0.27 **	1.00

(*, ** Significant at P=0.05 and P=0. 01 level of significance respectively. Where, DFF=Days to 50% flowering, SPP=Sympodia per plant, BPP= Bolls per plant, BW=Boll weight, PH=Plant height, GP =Ginning percentage, SI=Seed index, LI= Lint index, UHML= Upper Half Mean Length, FF=Fibre fineness, FS=Fibre strength and SCYPP=Seed cotton yield per plant).

Table 2 : Phenotypic correlation coefficients of yield, its attributing traits and fiber quality parameters in cotton.

Traits	DFF	SPP	BPP	BW	PH	GP	SI	LI	UHML	FF	FS	SCYPP
DFF	1.00											
SPP	-0.20 *	1.00										
BPP	-0.22 *	0.57 **	1.00									
BW	-0.09	0.04	0.15	1.00								
PH	0.00	0.22 *	0.32 **	0.26 **	1.00							
GP	0.04	-0.26 **	0.05	-0.01	-0.11	1.00						
SI	-0.01	0.15	-0.05	0.10	0.03	-0.37 **	1.00					
LI	0.05	-0.03	-0.07	0.16	0.04	0.17	0.69 **	1.00				
UHML	0.22 *	-0.14	-0.23 *	0.01	-0.01	-0.21 *	0.30 **	0.11	1.00			
FF	-0.04	0.29 **	0.12	0.10	-0.08	-0.08	0.27 **	0.17	-0.23 *	1.00		
FS	0.21 *	-0.03	-0.07	0.09	0.00	-0.16	0.19	-0.03	0.35 **	-0.12	1.00	
SCYPP	-0.18	0.29 **	0.53 **	0.13	0.29 **	0.27 **	0.11	0.21 *	-0.08	0.05	-0.01	1.00

(*, ** Significant at P=0.05 and P=0. 01 level of significance respectively, where DFF=Days to 50% flowering, SPP=Sympodia per plant, BPP= Bolls per plant, BW=Boll weight, PH=Plant height, GP =Ginning percentage, SI=Seed index, LI= Lint index, UHML= Upper Half Mean Length, FF=Fibre fineness, FS=Fibre strength and SCYPP=Seed cotton yield per plant)**.**

Seed index : It showed positive and significant correlation with lint index (r_g = 0.86 and r_p = 0.69), upper half mean length (r_g = 0.29 and r_p = 0.30) and fibre fineness (r_g = 0.27 and r_p = 0.27) at both genotypic and phenotypic levels. It revealed positive and significant correlation with fibre strength (r_g = 0.29) for genotypic and positive and non-significant (r_p = 0.19) for phenotypic correlation coefficient. It had negative and significant correlation with ginning percentage (r_g = -0.45 and r_p = -0.37) at both genotypic and phenotypic levels. Similar finding was reported by Yanal *et al.* (2013) and Monisha *et al.* (2019) for lint index and upper half mean length. These results were matched with Pujer *et al.* (2014) for fibre fineness and fibre strength. This result was in agreement with Thiyagu *et al.* (2010) for ginning percentage.

Lint index : It showed positive and significant correlation with seed index (r_g = 0.86 and r_p = 0.69) and seed cotton yield per plant (r_g = 0.35 and r_p = 0.21) at both genotypic and phenotypic levels. It had positive and significant correlation with upper half mean length (r_g = 0.21), fibre strength (r_g = 0.24) and boll weight (r_g = 0.22) for genotypic correlation coefficient. Similar finding was reported by Reddy *et al.* (2015) for boll weight, seed index and upper half mean length. Pujer *et al.* (2014) and Monisha *et al.* (2019) reported similar results for fibre strength.

Upper Half Mean Length (mm) : Trait had positive and significant correlation with days to 50% flowering (r_g = 0.25 and r_p = 0.22), seed index (r_g = 0.29 and r_p = 0.30) and fibre strength (r_g = 0.75 and r_p = 0.35) at both genotypic and phenotypic levels. It had positive and significant correlation with lint index (r_g = 0.21) at genotypic level. It had negative and significant correlation with bolls per plant (r_g = -0.28 and r_p = -0.23), ginning percentage (r_g= -0.24 and r_p = -0.21) and fibre fineness (r_g = -0.26 and r_p = -0.23) at both genotypic and phenotypic levels. Similar finding was reported by Pujer *et al.* (2014), Monisha *et al.* (2019), Reddy *et al.* (2015) and Hampannavar *et al.* (2020) for with days to 50% flowering, seed index, lint index and fibre strength. This result was confirmation with the findings of Thiyagu *et al.* (2010) for sympodia per plant.

Fibre fineness : It showed positive and significant correlation with sympodia per plant (r_g = 0.33 and r_p = 0.29) and seed index (r_g = 0.27 and r_p = 0.27) at both genotypic and phenotypic levels. It had negative and significant correlation with fibre strength (r_g = -0.24) at genotypic and non-significant correlation (r_p =-0.12) at phenotypic level. Similar finding was reported by Thiyagu *et al.* (2010) for sympodia per plant, seed index and fibre strength.

Fibre strength (g/tex) : This trait had positive and significant correlation with days to 50% flowering (r_g = 0.48 and r_p = 0.21) at both genotypic and phenotypic levels. It exhibited positive and significant correlation with boll weight (r_g = 0.21), plant height (r_g = 0.34), seed index (r_g =0.29) and lint index (r_g = 0.24) at genotypic level. It gave negative and significant correlation with ginning percentage (r_g = -0.50) and seed cotton yield per plant (r_g = -0.27) at genotypic level. Similar finding was reported by Reddy *et al.* (2015) for days to 50% flowering and boll weight.

Seed cotton yield per plant (g) : Trait showed positive and significant correlation with sympodia per plant (r_g = 0.48 and r_p = 0.29), bolls per plant (r_g = 0.69 and r_p = 0.53), plant height (r_g = 0.49 and r_p = 0.29), ginning percentage (r_g = 0.26 and r_p = 0.27) and lint index (r_g = 0.35 and r_p = 0.21) at both genotypic and phenotypic levels. It revealed negative and significant correlation with days to 50% flowering (r_g = -0.24), fibre strength (r_g = -0.27) at genotypic level. These findings were in conformation with Thiyagu *et al.* (2010) for days to 50% flowering and fibre strength. Similar result were obtained by Pujer *et al.* (2014), Reddy *et al.* (2015) and Monisha *et al.* (2019) for sympodia per plant; Ashokkumar and Ravikesavan (2010), Thiyagu *et al.* (2010), Vinodhana *et al.* (2013), Patel *et al.* (2013), Padmavathi *et al.* (2015), Pradeep *et al.* (2014), Pujer *et al.* (2014), Reddy *et al.* (2015), Latif *et al.* (2015), Monisha *et al.* (2019) and Hampannavar *et al.* (2020) for bolls per plant; Thiyagu *et al.* (2010), Farooq *et al.* (2014), Pradeep *et al.* (2014) and Pujer *et al.* (2014) for plant height, ginning percentage and lint index.

In most of the cases, the direction of phenotypic and genotypic correlation between various characters remained almost same. The genotypic correlation recorded higher than phenotypic correlation coefficient in traits like sympodia per plant, bolls per plant, plant height and lint index with seed cotton yield per plant. Result indicated that narrow environment effect and presence of inherent association among those traits. This is very helpful to plant breeder for practicing selection on the basis of phenotypic expression of the character for the improvement of seed cotton yield. The phenotypic correlation coefficients in very few cases were higher than their corresponding genotypic correlation coefficients which might be due to the non-genetic causes probably environment inflated the value of phenotypic correlation.

Path analysis

Yield being a complex character, is composed of several components some of them is classified as main component and has direct influence on yield, while others have indirect influence by changing the behaviour and growth of different traits. Correlation studies provide information only on the magnitude and direction of association of yield with its components and also among various components. But to know the direct effects of each independent variable on yield and indirect effects through other characters, path coefficient analysis has to be performed.

In present study, seed cotton yield per plant was considered as the dependent variable and eleven other characters were taken as independent variables. The direct and indirect effects of these independent variables on seed cotton yield per plant is presented in Table 3 and Fig. 1. The residual effect being 0.359 suggested few other excluded components being effective over seed cotton yield per plant.

Days to 50% flowering : It showed negative significant correlation with seed cotton yield per plant (-0.25). Its direct effect on seed cotton yield per plant was positive (0.02). It revealed negative indirect effects with sympodia per plant (-0.16) and fibre strength (-0.19), while positive values were observed for plant height (0.05) and upper half mean length (0.09). The indirect effects through other characters were low and negligible at

Table 3 : Genotypic path analysis for yield and yield attributing and fibre quality traits in 32 cotton genotypes

Traits	DFF	SPP	BPP	BW	PH	GP	SI	LI	UHML	FF	FS	SCYPP
DFF	**0.02**	-0.16	-0.02	-0.01	0.05	0.08	-0.07	-0.05	0.09	0.02	-0.19	**-0.25***
SPP	-0.01	**0.47**	0.05	0.01	0.23	-0.46	0.30	0.08	-0.08	-0.05	-0.06	**0.49****
BPP	-0.01	0.35	**0.06**	0.02	0.24	0.10	-0.09	0.08	-0.10	-0.02	0.06	**0.69****
BW	0.00	0.04	0.01	**0.12**	0.19	-0.04	0.19	-0.25	0.00	-0.02	-0.09	**0.16**
PH	0.00	0.24	0.03	0.05	**0.45**	-0.16	0.11	-0.12	0.00	0.01	-0.14	**0.49****
GP	0.00	-0.18	0.00	0.00	-0.06	**1.21**	-0.69	-0.15	-0.09	0.01	0.20	**0.27****
SI	0.00	0.09	0.00	0.02	0.03	-0.55	**1.53**	-0.97	0.11	-0.04	-0.12	**0.10**
LI	0.00	-0.03	0.00	0.03	0.05	0.16	1.32	**-1.12**	0.08	-0.03	-0.10	**0.35****
UHML	0.01	-0.11	-0.02	0.00	0.00	-0.30	0.46	-0.24	**0.36**	0.04	-0.30	**-0.10**
FF	0.00	0.16	0.01	0.02	-0.04	-0.12	0.43	-0.21	-0.10	**-0.15**	0.10	**0.09**
FS	0.01	0.07	-0.01	0.03	0.16	-0.61	0.44	-0.27	0.27	0.04	**-0.40**	**-0.27****

(Diagonal bold: Direct effects; *, ** Significant at P=0.05 and P=0. 01 level of significance respectively. Where, DFF=Days to 50% flowering, SPP=Sympodia per plant, BPP= Bolls per plant, BW=Boll weight, PH=Plant height, GP =Ginning percentage, SI=Seed index, LI= Lint index, UHML= Upper Half Mean Length, FF=Fibre fineness, FS=Fibre strength and SCYPP=Seed cotton yield per plant).

genotypic level. The results were in consonance with the findings of Babu *et al.* (2017) and Manonmani *et al.* (2019).

Sympodia per plant : The genotypic correlation between sympodia per plant and seed cotton yield per plant were found to be significant and positive (0.49). The direct effect of sympodia per plant on seed cotton yield was positive (0.47). This character recorded positive indirect effects through plant height (0.23), seed index (0.30) and bolls per plant (0.05). Negative indirect effects showed through ginning percentage (-0.46) and upper half mean length (-0.08). The indirect effects through other characters were low and negligible at genotypic level. Similar results were reported by Ashokkumar and Ravikesaran (2010), Shazia *et al.* (2010), Thiyagu *et al.* (2010), Vinodhana *et al.* (2013), Latif *et al.* (2015) and Padmavathi *et al.* (2015).

Bolls per plant : It had positive direct effect (0.06) on seed cotton yield per plant and also had a positive and significant correlation (0.69) with seed cotton yield per plant at genotypic level. Character manifested negative indirect effects on seed cotton seed cotton yield through upper half mean length (-0.10) and seed index (-0.09). It also recorded positive indirect effects on seed cotton yield per plant through sympodial per plant (0.04), ginning percentage (0.01) and lint index (0.08). The indirect effects through other characters were low and negligible at genotypic levels. Positive direct effect of number of bolls per plant on seed cotton yield per plant reported by Shazia *et al.* (2010), Thiyagu *et al.* (2010), Vinodhana *et al.* (2013), Dahiphale *et al.* (2015), Latif *et al.* (2015), Padmavathi *et al.* (2015), Reddy *et al.* (2015) and Chaudhari *et al.* (2017).

Boll weight (g) : It showed a genotypic direct effect in the positive direction on seed cotton yield per plant (0.12). Trait reported positive association with the seed cotton yield trait (0.16) at genotypic level. Trait had positive indirect effects on seed cotton yield per plant through plant height (0.19), seed index (0.19) and sympodia per plant (0.04). Genotypic indirect effects of the trait on seed cotton yield in the negative direction were recorded through ginning percentage (-0.04), lint index (-0.25), fibre fineness (-0.02) and fibre strength (-0.09). The indirect effects through other characters were low and negligible at genotypic level. Positive direct effect of boll weight on seed cotton yield per plant were noted by Shazia *et al.* (2010), Alkuddsi *et al.* (2013), Pujer *et al.* (2014), Reddy *et al.* (2015) and Memon *et al.* (2017).

Plant height (cm) : The direct effect of plant height on seed cotton yield per plant was positive (0.45) and the association with seed cotton yield was also positive and significant (0.49) at the genotypic level. The indirect effects of plant height on seed cotton yield per plant were also positive through number of sympodia per plant (0.24), boll weight (0.05), bolls per plant (0.03) and seed index (0.11). The indirect effects through other characters were low and negligible at genotypic level. The results were in consonance with the findings of Ashokkumar and Ravikesaran (2010), Dahiphale *et al.* (2015) and Chaudhari *et al.* (2017).

Ginning percentage : Genotypic correlation between ginning percentage and seed cotton yield per plant was found positive and significant (0.27). The direct effect of ginning percentage was positive (1.21). This

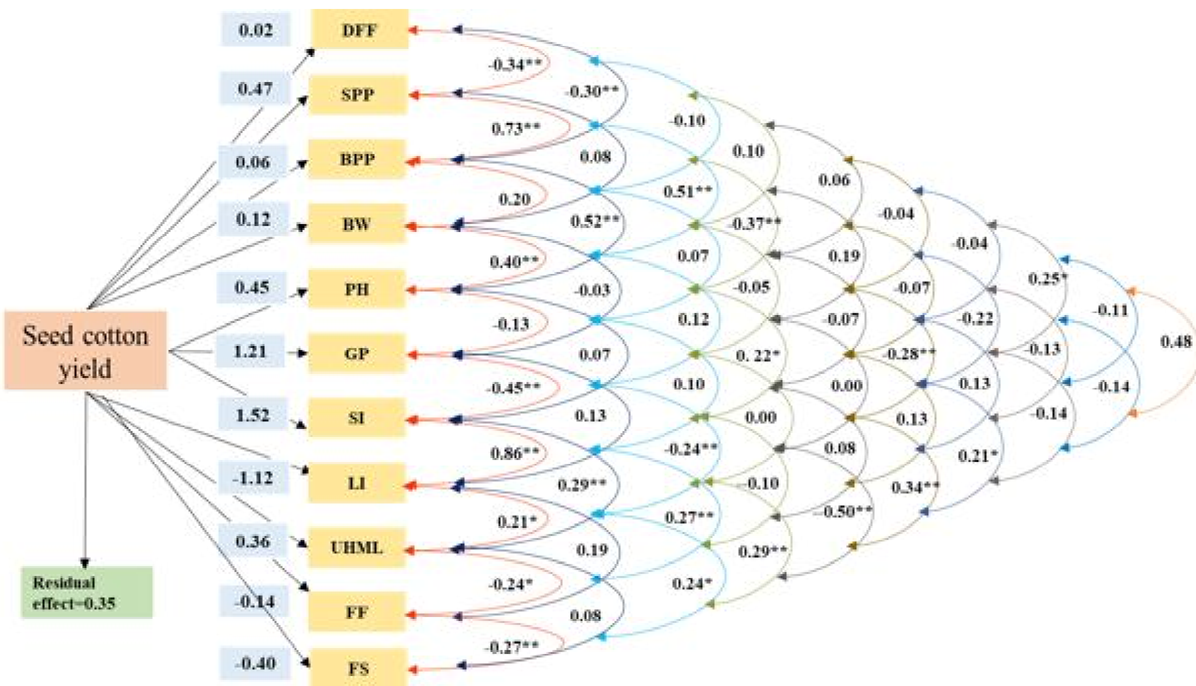

Fig. 1 : Genotypic path diagram for seed cotton yield per plant.

character pronounced positive indirect effects on seed cotton yield per plant through fibre strength (0.20). Trait manifested negative effects on seed cotton yield per plant through plant height (-0.06), sympodia per plant (-0.18), seed index (-0.69) and lint index (-0.15). The indirect effects through other characters were low and negligible at genotypic level. Similar observations were reported by Shazia *et al.* (2010), Thiyagu *et al.* (2010), Pujer *et al.* (2014), Farooq *et al.* (2014), Latif *et al.* (2015) and Memon *et al.* (2017).

Seed index (g) : The character seed index had a high genotypic direct effect in the positive direction (1.53). Trait revealed positive but non-significant (0.10) association with the yield trait. Seed index exhibited indirect effects on seed cotton yield per plant in the positive direction through number of sympodia per plant (0.09), boll weight (0.02), plant height (0.03) and upper half mean length (0.11); whereas, the trait had indirect negative effect through ginning percentage (-0.55), lint index (-0.97) and fibre strength (-0.12). The indirect effects through other characters were low and negligible at genotypic level.

Lint index (g) : It had genotypic negative direct effect (-1.12) on seed cotton yield per plant along with a significant and positive association (0.35) with seed cotton yield per plant. Trait had indirect effects on seed cotton yield per plant in the positive direction through seed index (1.32), ginning percentage (0.16), plant height (0.05) and upper mean half length (0.08); while, the trait had indirect negative effect through sympodia per plant (-0.03). The indirect effects through other characters were low and negligible at genotypic level. Similar results were reported by Reddy *et al.* (2015).

Upper Half Mean Length (mm) : It had a positive direct effect (0.36) on the seed cotton yield per plant at the genotypic level. Even the trait showed non-significant negative association with seed cotton yield per plant (-0.10). Trait exhibited indirect effects on seed cotton yield per plant in the positive direction through seed index (0.46), fibre fineness (0.04); while trait had indirect negative effect through sympodia per plant (-0.11), ginning percentage (-0.30), lint index (-0.24) and fibre strength (-0.30). The indirect effects through other characters were low and negligible at genotypic level. Similar findings were reported by Dahiphale *et al.* (2015) and Reddy *et al.* (2015).

Fibre fineness (mv) : Fibre fineness manifested positive non-significant correlation with seed cotton yield per plant (0.09) and its direct effect on seed cotton yield per plant was negative (-0.15). Trait revealed indirect effects on seed cotton yield per plant in the positive direction through sympodia per plant (0.16), seed index (0.45); while, trait had indirect negative effect through lint index (-0.21) and ginning percentage (-0.12). The indirect effects through other characters were low and negligible at genotypic level. The result was in consonance with the findings of Pujer *et al.* (2014), Farooq *et al.* (2014) and Padmavathi *et al.* (2015).

Fibre strength : It had a genotypic negative direct effect (-0.40) on seed cotton yield per plant along with a significant and negative association (-0.27) with seed cotton yield per plant. Trait reported found indirect effects on seed cotton yield per plant in the positive direction through seed index (0.44), upper half mean length (0.27) and plant height (0.16); while, trait had indirect negative effect through lint index (-0.27). The indirect effects through other characters were low and negligible at genotypic level. Similar reports were given by Ashokkumar and Ravikesavan (2010), Farooq *et al.* (2014) and Pujer *et al.* (2014).

Conclusion

These findings of correlation revealed that emphasis should be given on selection for plants with higher sympodia per plant, bolls per plant, ginning percentage and lint index for improvement in seed cotton yield. Besides this, it revealed that traits like boll weight, seed index, upper half mean length and fibre fineness did not significantly affect seed cotton yield.

Path coefficient suggested high positive direct effect on seed cotton yield per plant by seed index followed by ginning percentage, sympodia per plant and plant height. Thus, the results obtained conclude us that seed index, ginning percentage and sympodia per plant are the traits to be emphasized during selection in the breeding programs.

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