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Association and path coefficient analysis for seed cotton yield, its attributing traits and fibre quality parameters in upland cotton (*Gossypium hirsutum* L.)

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Abstract : Cotton is an important fibre crop worldwide. Yield and fibre quality are most important and complex traits as they are dependent on interaction of genetic architecture of plant and environment. The present experiment was conducted in randomized block design (RBD) with three replications at the Research Area of Cotton Section, Department of Genetics and Plant Breeding, CCS Haryana Agriculture University, Hisar, during *kharif*, 2021. Thirty three genotypes of upland cotton (*Gossypium hirsutum* L.) were evaluated for seed cotton yield its related traits *viz.*, boll number, boll weight, ginning outturn and fiber quality traits *viz.*, fibre length, fibre strength and fibre fineness. The correlation and path coefficients among yield attributes and fibre quality were estimated. Correlation coefficients revealed that seed cotton yield (SCY) exhibited significant and positive correlation with boll weight (0.55) followed by boll number (0.30), fibre fineness (0.31) and ginning outturn (0.25). Boll weight (0.703) recorded the highest positive direct effect on seed cotton yield followed by boll number (0.446), ginning outturn (0.289), fibre length (0.139) and fibre fineness (0.123). These findings suggested that selection based these traits would be quite effective to improve the seed cotton yield in upland cotton.

Keywords: Cotton, fibre quality, genetic variability seed cotton yield

Cotton is the cornerstone in the textile industry which is also known as "White Gold". It belongs to the family *Malvaceae* and is one of the most important fibre and cash crop in the world. Out of 50 species of *Gossypiu*m only four species have been cultivated *viz*; *Gossypium arboreum*, *Gossypium herbaceum*, *Gossypium hirsutum* and *Gossypium barbadense* (Brubaker *et al.*, 1999). India is the only country in the world where all four species are cultivated. The *Gossypium hirsutum* also known as upland cotton/American cotton/Mexican cotton has long staple cotton, it occupied nearly 90 per cent of the global land area of cotton production because of its wider adaptability and high lint yield. In India it is cultivated on area 130.49 lakh ha with production 337.23 lakh bales and productivity 439 kg/ha (Anonymous, 2022). India has the distinction of having the largest area under cotton cultivation which is 13.0 million hectares but productivity of the country is still low. The range of genetic variability present in the population determines the success of any breeding programme. The intensive selection for yield maximization has substantially reduced the variation in germplasm. The objective of the present study was to explore the association between various yield and fibre quality traits to facilitate selection and inclusion of elite germplasm in breeding programmes (Kumar, *et al.*, 2023). In plant breeding correlation studies give 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). Direct selection may not be a reliable method because seed cotton yield and fibre quality traits are complex quantitative characters and are influenced by environmental factors (Jangid *et al.*, 2019). Therefore, while selection, it is crucial breeder to understand the direct and indirect effects between the various traits. Path coefficient analysis is a useful selection tool because it divides the correlation into direct and indirect components. So, it is important to know more about the traits which contribute to the yield and their direct and indirect association to successfully design an effective breeding programme.

The experiment was conducted at Research Area of Cotton Section, Department of Genetics and Plant Breeding, CCS Haryana Agriculture University, Hisar during *kharif,* 2021. Thirty three genotypes of upland cotton (*Gossypium hirsutum* L.) were sown in randomized block design (RBD) with three replications. Each genotype was sown in two rows of 6 m length with row to row and plant to plant spacing of 67.5 cm and 30 cm, respectively. The observations were recorded on boll number, boll weight (g), ginning outturn (%), seed cotton yield (kg/ha) and fiber quality traits *viz.*, fibre length (mm), fibre strength (g/tex) and fibre fineness (µg/inch). Analysis of variance was done for different characters as per the standard procedure suggested by Fisher (1925). Genotypic and phenotypic coefficients of variation were estimated (Burton and Devane, 1953) and categorized as per the method suggested by Shivasubramanian and Menon (1973). Heritability in broad sense was calculated as the ratio of genotypic variance to the phenotypic variance and expressed as percentage. The calculated heritability and genetic advance were calculated. The correlation coefficients among all possible character combinations at phenotypic 'r (p)' and genotypic 'r (g)' level was estimated as per Al-Jibouri *et al.*, (1958). The path coefficient analysis was calculated as per the formula given by Wright (1921). The INDOSTAT and R software were used to analyze the data.

The mean sum of squares due to genotypes was highly significant for all traits. It revealed that adequate variability was present in the material under study for seed cotton yield and its contributing traits as well as fibre quality traits. The extent of genetic variability determines the scope of improvement. The magnitude of variation is not important, but the extent of heritable variation is critical for achieving a goal. The variability of various yield traits in thirty three cotton genotypes was estimated (Table 2). In the present study, PCV is slightly greater than the GCV for all the characters indicating that there is little influence of environment in the expression of these traits. Low GCV and PCV were recorded for ginning outturn (7.6 and 7.9%), fibre length (1.8 and 3.3%), fibre strength (4.5 and 5.4%) and fibre fineness (7.1 and 7.5%, respectively). Moderate GCV and PCV were observed for boll number (17.5 and19.3%) and boll weight (13.0 and 13.3%, respectively). High GCV and PCV were recorded for seed cotton yield *i.e.* 22.9 and 24.8 per cent, respectively. Similar results were reported by Soomro *et al.*, (2010).

High heritability indicated that a greater proportion of phenotypic variance has been attributed to genotypic variation and on the basis of phenotypic expression reliable selection for these traits could be practiced. High heritability with high genetic advance as percent mean was observed in traits such as seed cotton yield (43.4%), boll weight (26.1%) and boll number (32.9%) which indicated that these traits were governed by additive gene action.

Thus, selection would be more effective for improvement in seed cotton yield, boll weight and bolls/plant. Similar findings were recorded by Hafiz *et al.*, (2013), Dhivya *et al.*, (2014) and Reddy *et al.*, (2019). In their studies, ginning outturn and seed index recorded high heritability with moderate genetic advance as percent mean indicating that variations for these characters is due to interaction of both additive and non-additive genetic factors.

Table 1: List of cotton genotypes used in the study

Sr. No.	Name of genotype	Sr. No.	Name of genotype	Sr. No.	Name of genotype
1	H 1480	12	H 1533	23	H 1578
2	H 1564	13	H 1531	24	H 1603
3	H 1491	14	H 1547	25	H 1584
4	H 1518	15	H 1553	26	H 1577
5	H 1566	16	H 1557	27	H 1590
6	H 1521	17	H 1098 i	28	H 1582
7	H 1539	18	H 1535	29	H 1593
8	H 1569	19	H 1546	30	H 1594
9	H 1528	20	H 1551	31	H 1595
10	H 1529	21	H 1574	32	H 1600
11	H 1530	22	H 1577	33	H 1555

Table 2: Estimates of genetic variabilty for different characters in cotton

Traits	Coefficient of variation (%)		Heritability (%)	Genetic advance
	Genotypic (GCV)	Phenotypic (PCV)	(h^2)	as per cent mean (GA)
Seed cotton yield (kg/ha)	22.9	24.8	84.8	43.4
Boll weight (g)	13.0	13.3	95.0	26.1
Boll number	17.5	19.3	82.6	32.9
Ginning outturn (%)	7.6	7.9	91.9	15.0
Fibre length (mm)	1.8	3.3	30.6	2.1
Fibre strength (g/tex)	4.5	5.4	70.4	7.8
Fibre fineness (µ/inch)	7.1	7.5	90.3	14.0

Correlation analysis

Direct selection for seed cotton yield is not effective as it is a complex quantitative character and influenced by environment. The change in one character brings about a series of changes in other characters, since they are interrelated. Therefore, the study of correlation between yield and yield components are of considerable importance in selection programmes.

For the effective selection, it is necessary to find out the nature of association among various traits with the seed cotton yield. For computing the nature of association of various traits with seed cotton yield, correlation coefficient analysis was carried out at phenotypic level (Fig. 1).

Seed cotton yield (SCY) exhibited significant and positive correlation with boll weight (0.55) followed by boll number (0.30), fibre fineness (0.31), ginning outturn (0.25) and fibre strength (0.11) (Fig. 1). Fibre length had significant and positive association with fibre strength (0.63) followed by fibre fineness (0.15) and boll weight (0.11), whereas, it had significantly negative association with ginning outturn (-0.25) followed by boll number (-0.18)

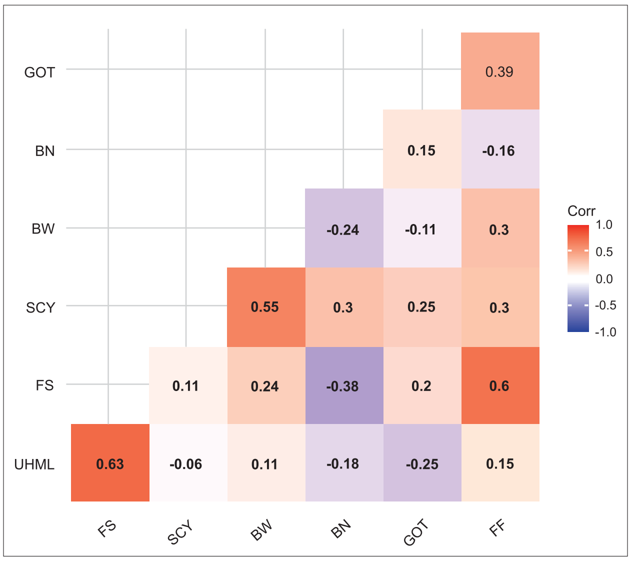

Fig. 1. Correlation coefficients among various traits in cotton genotypes

Table 3: Path coefficient analysis for yield attributing and fibre quality traits in cotton genotypes

Traits	Boll weight (g)	Boll number	Ginning outturn (%)	Fibre length (mm)	Fibre strength (g/tex)	Fibre fineness (µg/inch)	Seed cotton yield (rg) (kg/ha)
Boll weight (g)	0.703	-0.114	-0.032	0.020	-0.039	0.037	0.576
Boll number	-0.180	0.446	0.047	-0.038	0.062	-0.020	0.316
Ginning outturn (%)	-0.077	0.072	0.289	-0.042	-0.031	0.050	0.260
Fibre length (mm)	0.100	-0.123	-0.087	0.139	-0.132	0.026	-0.076
Fibre strength (g/tex)	0.185	-0.186	0.060	0.125	-0.147	0.081	0.118
Fibre fineness (µ/inch)	0.214	-0.074	0.117	0.030	-0.097	0.123	0.313

and seed cotton yield (-0.06). Similar results were observed by Magadum *et al.*, (2012). Therefore, a rational increase in yield is therefore possible through simultaneous selection for component characters under hybridization programmes as the majority of significant morphological parameters showed a strong positive association with seed cotton yield. Fibre strength had positive and significant association with seed cotton yield (0.11), boll weight (0.24), ginning outturn (0.2) and fibre fineness (0.6). Tulasi *et, al.*, (2014) and Nisar *et al.*, (2022) also reported significant and negative association with fibre fineness. Boll weight had significant and negative correlation with boll number (-0.24) and ginning out turn (-0.11) whereas, it was significantly and positively associated with fibre fineness (0.3). Boll number was found to be significantly and positively correlated with ginning outturn (0.15) and had significant and negative association with fibre fineness (-0.16). Ginning outturn had significant and positive correlation with fibre fineness (0.39). These results confirmed the findings of Asha *et al.*, (2015), Angadi *et al.*, (2016) and Irfan *et al.*, (2018).

Path coefficient analysis

The estimation of direct and indirect effects of different yield attributing and fibre quality traits on seed cotton yield was worked out through path analysis (Table 3). Among the studied traits, boll weight (0.703) had the highest positive direct effect on seed cotton yield followed by boll number (0.446), ginning outturn (0.289), fibre length (0.139) and fibre fineness (0.123), whereas, fibre strength (-0.147) exerted negative direct effect on seed cotton yield. Therefore, a direct selection for these traits is suggested for seed cotton yield improvement. Boll weight had positive indirect effect on seed cotton yield via fibre length (0.020) and fibre fineness (0.037).

Fibre fineness exerted high positive indirect effect on seed cotton yield through traits like boll weight (0.214), ginning outturn (0.117) and fibre length (0.030). The component of residual effect was 0.368. This indicated that 63. 2 per cent variability was accounted for association of seed cotton yield with dependent traits. Hence, these traits should be considered important for improvement in the seed cotton yield as theses directly contributed towards seed cotton yield. Similar results were observed by Dahiphale and Deshmukh (2018), Reddy *et al.*, (2019) Mudhalvan *et al.*, (2021).

CONCLUSION

The results indicated that correlation, direct and indirect effect estimates vary for different traits due to variation in genetic material based on yield component traits and fibre properties. The seed cotton yield had shown strong and positive association as well as high positive direct effects of boll weight, boll number, fibre fineness and ginning outturn. Thus, in future breeding programmes, these parameters should be given priority while doing selection for high seed cotton yield.

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