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Correlation and path analysis of quantitative and fiber quality traits with seed cotton yield in upland cotton

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Abstract: The experimental material comprised of 150 germplasm lines of *Gossypium hirsutum* maintained at research field of Genetics and Plant Breeding, CCSHAU, Hisar. These germplasm lines were evaluated for 12 quantitative traits (days to first flower, plant height, monopods, sympods, locules, seeds/locule, boll weight, seed index (g) lint index (g), bolls, ginning outturn (%) and fiber quality traits. The correlation studies revealed that all quantitative traits exhibit positive correlation with seed cotton yield except days to first flower and locules/boll. The highest degree of association was found with bolls/plant, sympods, plant height and boll weight. Whereas the highest direct effects were contributed by bolls/plant and boll weight. Fiber quality traits *viz.* 2.5 per cent span length, fiber strength, fiber fineness and fiber maturity showed a negative association with seed cotton yield. Hence, for an efficient selection not only the yield contributing traits should be considered but a check on quality parameters should also be heeded.

Keywords: Correlation, direct effects, fiber quality, germplasm lines, selection

Cotton is an important cash crop grown in tropical and sub-tropical regions. Cotton is the world's most dominant natural textile fiber and an important source of cattle feed and edible oil. Consumption of cotton in 2018-2019 was 5.44 million MT which is quit significant as demand for cotton yarn for export markets improves. Since ancient times cotton has played an important role in agriculture, economics and social welfare. It plays a significant role in Indian agriculture as India is the leading producer of cotton (6423 MT) with largest area under the crop (12.6 Mha) Anonymous (2020).

The ultimate aim of any breeder is to maximize yield, but yield is a complex quantitative trait governed by polygenes. Hence selection only based on yield may not be helpful therefore breeders need to know more about inter-relationship among different traits for effective selection. The inter-relationships between yield and its contributing traits are estimated by correlation coefficient analysis. It measures the relationship between various traits and determines the component characters on which selection can be effective for genetic improvement (Salahuddin *et al.*, 2010).

Correlation studies furnish the information about the nature of association is often incomplete, additional influences from other traits may skew the results in either direction which is not taken care off in correlation analysis. Under such situation, path coefficient analysis is an efficient statistical tool specially designed to quantify the inter-relationship among different components and their direct and indirect effects on yield. 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).

In the present study one hundred fifty germplasm lines of upland cotton *Gossypium hirsutum* were analyzed for 12 quantitative traits. The crop was grown in *kharif* season of 2018 -2019 at Research area of Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar. The experiment was laid out in augmented design where three check

varieties *i.e.* H1098i, H1226 and H1236 were sown after every 15 genotypes. The row was of 6m length and row to row distance followed was 1.35m,with plant to plant distance of 30cm. The 12 quantitative traits studied were, days to first flower, plant height, monopods/plant, sympods/plant, locules/boll, seeds/locule, boll weight, seed index, lint index, bolls/plant, ginning outturn (%) and seed cotton yield/plant. The Karl Pearson Correlation Coefficients of all yield attributing traits were calculated. Path-coefficient analysis was also performed asper the method suggested by Wright (1921) and elaborated by Dewey and Lu (1959) by taking yield as dependent variable.

Yield is a complex trait so it is very important to find out the nature of association among various fiber quality and quantitative traits with the seed cotton yield/plant for effective selection. For computing the nature of association, correlation coefficient analysis was carried out and values are presented in Table 1.

Seed cotton yield exhibits positive and significant association with all characters except days to first flower and locules/boll. The maximum correlation coefficient value was revealed by bolls/plant, followed by sympods/plant (0.421), plant height (0.409), boll weight (0.388), seeds/locule (0.341), monopods/plant (0.289), lint index (0.283), ginning outturn percentage (0.233) and seed index (0.191). It infers that selection for these traits in positive direction will help in increasing seed cotton yield/plant. Kumar *et al.*, (2019) reported positive association of bolls, boll weight, plant height and sympodial branches with seed cotton yield. The findings were also in corroboration with results of Asha *et al.*, (2015), Padmavathi *et al.*, (2015), Javed *et al.*, (2017) and Kumar *et al.*, (2017). Days to first flower did not show significant relationship but the negative value directs that when flowering time increases yield of plant decreases. The same was also reported by Kumar and Ravikesavan (2010) and Kumar *et al.*, (2019). Fiber quality traits *viz.*, 2.5 per cent fiber span length, fiber strength, fiber maturity and fiber fineness showed negative relationship with seed cotton yield/plant which were in congruent with Pujer *et al.*, (2014) and Babu *et al.*, (2017). It shows that direct selection for seed cotton yield with superior fiber quality is not possible in these genotypes thus, yield and fiber traits needs to be separated by generating gene segregation population by crossing programme to improve these traits.

Table 1. Association of yield and its contributing traits in 150 germplasm lines of cotton

	DFF	PH	MP	SP	NOL	NOS/L	BW	SI	LI	NOB	GOT	FL	FM	FS	FF
DFF	1														
PH	-0.024	1													
MP	0.021	0.167*	1												
SP	-0.037	0.403**	0.176*	1											
NOL	0.009	0.103	-0.063	0.055	1										
NOS /L	0.133	0.163*	0.008	0.146	0.031	1									
BW	0.027	0.193*	-0.007	0.118	0.040	0.817**	1								
SI	0.029	0.139	-0.187*	0.013	0.135	0.331**	0.596**	1							
LI	0.070	0.016	0.041	0.026	0.027	0.390**	0.463**	0.484**	1						
NOB	0.001	0.388**	0.319**	0.410**	0.140	0.144	0.116	0.028	0.127	1					
GOT	0.100	0.035	0.141	0.120	0.003	0.242**	0.209*	0.084	0.779**	0.133	1				
FL	0.029	0.001	-0.23**	-0.129	0.254**	-0.123	-0.134	-0.031	-0.083	-0.35**	-0.086	1			
FM	0.063	-0.169*	-0.30**	-0.140	0.053	-0.114	-0.102	-0.028	-0.082	-0.46**	-0.079	0.554**	1		
FS	-0.060	0.112	-0.133	0.043	0.214**	0.008	0.031	0.104	0.129	-0.165*	0.147	0.518**	0.377**	1	
FF	0.018	-0.122	-0.130	-0.22**	-0.003	-0.175*	-0.199*	-0.23**	-0.135	-0.36**	-0.072	0.375**	0.389**	0.215**	1
SCY	-0.026	0.409**	0.289**	0.421**	0.136	0.341**	0.388**	0.191*	0.283**	0.896**	0.233**	-0.38**	-0.48**	-0.139	-0.4**

*significant at 5% ** significant at 1%

Efficient selection can be made when not only direct relationship with yield but also inter-relationship between the traits is known. Plant height shows positive association with monopods/plant (0.167), sympods/plant (0.403), seeds/locule (0.163), boll weight (0.193), bolls/plant (0.388). Monopods were in close with bolls/plant (0.319) and sympods/plant (0.176). Sympods/plant is also found in positive relationship with bolls/plant (0.410). It can be explained that when plant height increases chances of getting more number of sympodial branches increases with increased space and increased number of sympodsincreases chances of more boll formation. Hence all these characters are in positive association with each other. This is in parallelism with the report of Desalegn *et al.*, (2009) and Sharma *et al.*, (2005). Seeds/locule exhibit significant and positive correlation with boll weight (0.817) and seed index (0.331). Boll weight showed positive relation with seed index (0.596), lint index (0.463) and GOT (0.209). When seeds/boll and 100 seed weight will increase, it is obvious that boll weight will also increase.

Correlation studies does not give a clear picture as it compares one variable with other and does not take into account the background effect influenced by other traits. In path coefficient analysis the residual effect helps in precise explanation about the pattern of interaction of other possible components of yield. Path coefficient analysis divided the total influence into direct and indirect effects so that the most influencing trait can be utilized as selection criteria in cotton breeding programme.

Direct and indirect effects are presented in Table 2 with residual effect as 0.099. The lesser residual effect shows lesser environmental and human error while recording data. The maximum direct positive effect was contributed by bolls/plant with value 0.782 followed by boll weight (0.342), GOT (0.044), sympods (0.037), lint index (0.034), plant height (0.031), locules/boll (0.020). Most important traits for improving seed cotton yield are bolls and boll weight as they influence yield directly to a great extent. Direct negative effect was observed for days to first flower, monopods, seeds/locule, and seed index. Hence these traits are to be selected

Table 2. Direct and indirect effects of traits on seed cotton yield in 150 germplasm lines of upland cotton

	DFF	PH	MP	SP	NOL	NOS/L	BW	SI	LI	NOB	GOT	FL	FM	FS	FF
DFF	-0.025	-0.001	0.000	0.002	0.000	-0.011	0.009	-0.002	0.002	0.001	0.004	0.000	-0.004	0.000	-0.001
PH	0.001	0.031	-0.002	0.007	0.002	-0.014	0.066	-0.008	0.001	0.303	0.002	0.000	0.010	0.001	0.009
MP	-0.001	0.005	-0.011	0.004	-0.001	-0.001	-0.002	0.011	0.001	0.249	0.006	0.001	0.018	-0.001	0.010
SP	-0.001	0.006	-0.001	0.037	0.000	-0.013	0.041	-0.003	0.001	0.232	0.003	0.001	0.006	0.000	0.012
NOL	0.000	0.003	0.001	0.001	0.020	-0.003	0.014	-0.008	0.001	0.109	0.000	-0.001	-0.003	0.002	0.000
NOS/L	-0.003	0.005	0.000	0.006	0.001	-0.085	0.280	-0.019	0.013	0.112	0.011	0.001	0.007	0.000	0.013
BW	-0.001	0.006	0.000	0.004	0.001	-0.069	0.342	-0.034	0.016	0.091	0.009	0.001	0.006	0.000	0.015
SI	-0.001	0.004	0.002	0.002	0.003	-0.028	0.204	-0.057	0.017	0.022	0.004	0.000	0.002	0.001	0.018
LI	-0.002	0.000	0.000	0.001	0.001	-0.033	0.159	-0.028	0.034	0.100	0.034	0.000	0.005	0.001	0.010
NOB	0.000	0.012	-0.003	0.011	0.003	-0.012	0.040	-0.002	0.004	0.782	0.006	0.002	0.027	-0.001	0.027
GOT	-0.003	0.001	-0.002	0.003	0.000	-0.021	0.072	-0.005	0.027	0.104	0.044	0.000	0.005	0.001	0.006
FL	-0.001	0.000	0.002	-0.006	0.005	0.010	-0.046	0.002	-0.003	-0.275	-0.004	-0.005	-0.033	0.004	-0.029
FM	-0.002	-0.005	0.003	-0.004	0.001	0.010	-0.035	0.002	-0.003	-0.358	-0.004	-0.003	-0.059	0.003	-0.030
FS	0.002	0.003	0.001	-0.001	0.004	-0.001	0.010	-0.006	0.004	-0.129	0.006	-0.003	-0.022	0.007	-0.016
FF	0.000	-0.004	0.001	-0.006	0.000	0.015	-0.068	0.013	-0.005	-0.280	-0.003	-0.002	-0.023	0.002	-0.077

Abbreviations used:

DFF-days to first flower, PH-Plant height (cm), MP- Monopods/plant, SP- Sympods/plant, NOL- locules/boll, NOS/L- seeds/locule, BW-Boll weight (g), SI-Seed index (g), LI-Lint index, NOB bolls/plant, GOT- Ginning outturn (%), FL- Fiber length (mm), FM- Fiber maturity (%), FS- Fiber strength (g/tex), FF- Fiber fineness (micronaire)

in negative direction for improving seed cotton yield. Monopod/plant, sympods/plant and locules/boll indirectly contributed to yield *via* bolls/plant with values 0.249, 0.232 and 0.109, respectively. Seed index contributed to seed cotton yield *via* boll weight (0.204). This again shows bolls and boll weigh are important trait to be selected to develop high yielding variety in cotton breeding programmes. Kumar *et al.,* (2019) reported similar results as bolls/plant recorded maximum positive direct effect on seed cotton yield/plant followed by lint index, boll weight. Negative direct effect of seed index was also reported by Thiyagu *et al.*, (2010). Correlation and path studies helps in selection of traits, determines the direction of selection and speeds up the selection procedure by giving a more clear picture about traits relationship to the breeder.

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