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Study of Correlation and Path Analysis of Seed Cotton Yield and its Attributing Traits in *Desi* Cotton (*Gossypium arboreum* L.) under Rainfed condition

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ABSTRACT: The experimental material comprised of 50 genotypes of *Gossypium arboreum* was grown during *Kharif* 2021-22 under rainfed conditions at Research Area of Cotton Section, Department of Genetics and Plant Breeding, CCSHAU, Hisar with the objective to determine correlation coefficient and path analysis. Randomized block design was used with three replication and each genotype was grown in single row of 6 m length with a spacing of 67.5 × 30 cm. These genotypes were evaluated for eight morphological, six physiological and three biochemical traits. The correlation studies revealed that seed cotton yield per plant showed highly significant and positive correlation with plant height, number of bolls per plant, boll weight and number of seeds per boll and also, positive and significant correlation with crude protein content. Furthermore, Path analysis indicated that maximum value for direct effects were observed for number of bolls per plant followed by boll weight, relative water content, seed oil content, proline content, number of monopods per plant. Therefore, selection should be done on the basis of these studied traits for further enhancement of seed cotton yield in future cotton breeding programme.

Keywords: Correlation, *Gossypium arboreum*, path, yield.

INTRODUCTION

Cotton, commonly known as "King of Fibers", is the most important fibre as well as cash crop. At global level, USA, China, India, Pakistan, Uzbekistan, Turkey, Brazil, Greece, Argentina and Egypt are the major cotton producing countries which contribute about 85% of the world's cotton production. Globally, cotton was grown on an area of 33.19 million hectares with production of 25.73 million tonnes (Anonymous, 2022). It has a pivotal role in strengthening Indian economy and farming community by contributing in national and international trade, industrial activities, earning foreign exchange and generating employment directly or indirectly for 60 million people in our country (Saritha and Patil 2020). In India, during 2021-2022 a production of 340 lakh bales was recorded from an area of 123 lakh hectares with a productivity of 469 kg/ha (Cotton Corporation of India, 2022). Cotton is mainly cultivated for fibre yield, moreover, it is also a source of textile raw materials, seed yields, seed oil and protein. Major four cultivated species of cotton are categorized into two sub-species *i.e.*, diploid species (2n=2x=26) popularly known as old world cotton (*Gossypium arboreum* and *G. herbaceum*) and tetraploid species (2n=2x=52) commonly known as new world cotton(*G. hirsutum* and *G. barbadense*). India is the only country whereall the four cultivated species are grown. The yield potential of *G. arboreum has* not been fully realized as the crop is cultivated under poor crop management conditions (Jogender *et al*., 2023).

Development of cotton varieties and hybrids having greater yield potential with acceptable fibre characteristics is the main objective of cotton breeders. Breeders are always aimed to maximize the yield but it is a complex polygenic trait which is governed by interaction among number of quantitative traits. Hence direct selection based on *per se* yield may be misleading therefore breeders need to know more about inter-relationship among different traits for effective selection. Knowledge of association among traits and direct & indirect effects of each trait on main yield is an additional advantage which aids the selection process (Sharma *et al*., 2023). Correlation coefficient analysis measures the magnitude of association among various

plant traits and also determines the component traits on which selection depend for improvement of seed cotton yield and fibre quality. It furnishes the information about the nature of association which 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 to quantify the inter-relationship among different component trait and their direct and indirect effects on yield. Therefore, path coefficient analysis may offer a lot of realistic images of the interrelation, because it partitions the correlation coefficient into direct and indirect effects of variables (Sainath *et al.*, 2022). Ultimately, this kind of analysis could help the cotton breeder to design the selection strategies to improve seed cotton yield. Hence, the present experiment was conducted to find the nature of genetic association among various traits and their direct and indirect effect on seed cotton yield of *Gossypium arboreum* L.

MATERIAL AND METHOD

During *Kharif* 2021-22, 50 elite *desi* cotton (*Gossypium arboreum* L.) genotypes (Table 1) were raised at Research Area of Cotton Section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar (Haryana) in randomized block design replicated thrice, each in single row of 6 m length with a spacing of 67.5 × 30 cm. In the experimental field, only pre-sowing irrigation was applied and after that no irrigation was applied during the entire crop season. Recommended package of practice was followed during whole crop season. Five plants at random were selected from each genotype and data on eight morphological (plant height, number of monopods per plant, days to first flower, number of bolls per plant, boll weight, seed cotton yield per plant, number of seeds per boll, ginning out turn), six physiological traits (relative water content, photosynthesis rate, stomatal conductance, transpiration rate, total chlorophyll content, proline content) and three biochemical traits (crude protein content, seed oil content, gossypol content) were recorded. Correlation coefficients between different characters were analyzed as per Al-Jibouri *et al*. (1958). Phenotypic correlation coefficients were further partitioned into direct and indirect effects by path analysis as suggested by Dewey and Lu (1959).

Table 1: List of 50 *Desi* cotton elite genotypes.

Sr. No.	Genotypes	Sr. No.	Genotypes	Sr. No.	Genotypes
1.	P 185	**18**	P 547	**35**	HD 556
2.	P 410	**19**	P 548	**36**	FFS-2
3.	P 425	**20**	HD 535	**37**	FFS-3
4.	P 530	**21**	P551	**38**	FFS-4
5.	P 531	**22**	P555	**39**	FFS-5
6.	P 533	**23**	P557	**40**	FFS-6
7.	P536	**24**	HD 426	**41**	HD 444
8.	HD 521	**25**	P 554	**42**	HD 453
9.	P 535	**26**	P 397	**43**	CINA 344
10.	P 540	**27**	HD 328	**44**	FFS-7
11.	P552	**28**	HD 442	**45**	FFS-8
12.	HD 534	**29**	DA-2 /02	**46**	HD 459
13.	P478	**30**	DA-3 /02	**47**	CISA 6
14.	P 514	**31**	DA-4 /02	**48**	HD 123
15.	P 543	**32**	FFS-1	**49**	HD 324
16.	P545	**33**	PAIG 129	**50**	HD 432
17.	P 546	**34**	HD399		

RESULT AND DISCUSSION

Correlation coefficient analysis. Correlation coefficient is a statistical tool which measure the degree as well as direction of a relationship between two or more variables. It is important to find out and analyze the association between yield and its contributing traits at genotypic and phenotypic level as it aids in efficient selection process. In the present experiment, correlation coefficients between seed cotton yield per plant and its contributing traits were estimated at genotypic and phenotypic level both. The estimates of correlation coefficients were compared with tabulated values at 5% and 1% levels of significance for analyzing their significance (Table 2). Seed cotton yield per plant, at both genotypic and phenotypic level, showed highly significant and positive correlation with plant height (0.362 and 0.323), number of bolls per plant (0.972 and 0.940), boll weight (0.056 and 0.031) and number of seeds per boll (0.109 and 0.201) whereas, highly significant and negative correlation with relative water content (-0.343 and -0.385), transpiration rate (-0.260 and -0.285) respectively. At genotypic level, it exhibited highly significant and positive correlation with number of monopods per plant (0.223) and also, positive and significant correlation with crude protein content (0.196) whereas, it exhibited negative significant correlation with seed oil content (-0.165). Seed cotton yield per plant exhibited positive

significant correlation with number of monopods per plant (0.201) but negative and highly significant correlation with seed oil content (-0.227) at phenotypic level. It indicated that the selection based on plant height, number of bolls per plant, boll weight, number of seeds per boll and crude protein content would ultimately improve seed cotton yield. So, these traits can be directly selected for breeding programme. Rai *et al.* (2020) found that seed cotton yield exhibited a significant positive association with plant height, number of monopods per plant, the number of bolls per plant, boll weight and ginning out turn at both genotypic and phenotypic levels. Pujer *et al.* (2014b) revealed that seed cotton yield was positively and significantly correlated with bolls per plant, plant height, boll weight, monopodial branches. Similar conclusions were derived by Erande *et al.* (2014); Kalpande *et al.* (2014); Latif *et al.* (2015); Chaudhari *et al.* (2017); Chinchane *et al.* (2018); Rai and Sangwan (2020); Satish *et al.* (2020); Sainath *et al.* (2022); Kumar *et al.* (2023).

Path coefficient analysis. Path coefficient analysis was used for partitioning of direct and indirect effects of different traits on seed cotton yield per plant considering seed cotton yield per plant as dependable variable and remaining traits as independent variables. For this, correlation matrix at phenotypic level were taken into consideration (Table 3).

Maximum value for direct effects were observed for number of bolls per plant (0.8440) followed by boll weight (0.2505), relative water content (0.0300), seed oil content (0.0262), proline content (0.0220), number of monopods per plant (0.0183), plant height (0.0160), days to first flower (0.0136) and crude protein content (0.0050). The estimation of path analysis revealed that emphasis should be given to number of bolls per plant trait as it showed highest direct effect positive effect among all studied traits on seed cotton yield per plant. Residual effect was 0.1002 which indicated that component traits under study were responsible for about 90% of variability in seed cotton yield per plant. Similar findings were observed by Rauf *et al.* (2004); Farooq *et al.* (2014); Latif *et al.* (2015); Nikhil *et al.* (2018b); Arunkumar and Murthy (2020); Rai *et al.* (2020); Kumar *et al.* (2023); Jogender *et al.* (2023). The results on the basis of path analysis suggested that the direct contribution of above-mentioned traits to seed cotton yield would be highly important for planning an appropriate selection programme.

Table 2: Genotypic correlation coefficients (below diagonal) and phenotypic correlation coefficients (above diagonal) among seed cotton yield per plant and other characters.

Variable	PH	NM/P	DFF	NB/P	BW	NS /B	GOT	RWC	PR	SC	TR	TCC	PC	CPC	SOC	GC	SCY/P
PH	**1**	0.087	0.149	0.311**	-0.041	-0.045	0.005	-0.047	0.035	0.112	-0.117	-0.058	0.184*	-0.054	0.114	0.259**	**0.323****
NM/P	0.119	**1**	-0.068	0.212**	-0.056	-0.043	-0.135	-0.028	0.017	-0.184*	0.098	-0.009	0.008	0.246**	-0.004	0.026	**0.201***
DFF	0.160*	-0.043	**1**	-0.111	0.152	-0.016	0.118	0.056	0.339**	-0.034	0.127	0.111	0.280**	0.056	0.018	0.193*	**-0.068**
NB/P	0.331**	0.241**	-0.125	**1**	-0.249**	0.132	-0.042	-0.410**	0.006	-0.004	-0.211**	-0.045	0.006	0.188*	-0.209*	-0.117	**0.940****
BW	-0.044	-0.032	0.169*	-0.296**	**1**	-0.079	-0.052	0.183*	0.013	-0.166*	-0.110	0.037	-0.052	-0.077	0.087	0.007	**0.031****
NS /B	-0.097	-0.093	-0.004	0.202*	-0.151	**1**	-0.101	-0.013	0.028	-0.231**	-0.014	0.084	-0.030	0.083	0.094	-0.146	**0.201****
GOT	0.009	-0.241**	0.186*	-0.055	-0.027	-0.145	**1**	0.091	0.118	-0.055	0.078	-0.015	0.094	-0.047	0.035	-0.065	**-0.068**
RWC	-0.049	-0.035	0.062	-0.442**	0.226**	-0.040	0.126	**1**	-0.170*	-0.024	0.271**	0.058	0.173*	-0.053	0.032	0.171*	**-0.385****
PR	0.035	0.024	0.354**	0.009	0.008	0.059	0.144	-0.171*	**1**	-0.148	0.081	0.081	-0.048	-0.175*	-0.099	0.013	**-0.005**
SC	0.114	-0.217**	-0.038	0.001	-0.191*	-0.436**	-0.066	-0.026	-0.149	**1**	-0.045	0.033	-0.014	0.011	0.136	0.285**	**-0.060**
TR	-0.118	0.121	0.133	-0.222**	-0.118	-0.024	0.084	0.276**	0.082	-0.045	**1**	0.128	0.142	0.055	0.113	0.150	**-0.285****
TCC	-0.173*	0.178*	0.382**	-0.088	0.125	0.337**	0.096	0.221**	0.251**	0.105	0.429**	**1**	0.025	-0.097	0.126	0.073	**-0.102**
PC	0.216**	0.005	0.364**	0.021	-0.070	-0.223**	0.267**	0.217**	-0.062	-0.012	0.173*	0.380**	**1**	-0.067	-0.024	0.183*	**0.030**
CPC	-0.056	0.311**	0.056	0.195*	-0.056	0.100	-0.063	-0.060	-0.183*	0.005	0.060	-0.375**	-0.059	**1**	0.006	-0.016	**0.154**
SOC	0.132	0.003	0.032	-0.247**	0.077	0.380**	0.002	0.025	-0.113	0.156	0.135	0.181*	-0.043	-0.011	**1**	0.137	**-0.227****
GC	0.282**	0.029	0.212**	-0.126	0.009	-0.318**	-0.094	0.197*	0.010	0.307**	0.170*	0.156	0.239**	-0.021	0.158	**1**	**-0.128**
SCY/P	**0.362****	**0.223****	**-0.069**	**0.972****	**0.056****	**0.109****	**-0.057**	**-0.343****	**-0.005**	**-0.059**	**-0.260****	**-0.036**	**0.016**	**0.196***	**-0.165***	**-0.113**	**1**

** Significant at 1% level of significance, * Significant at 5% level of significance

PH: Plant height (cm), **NM/P**: Number of monopods per plant, **DFF**: Days to first flower, **NB/P**: Number of bolls per plant, **BW**: Boll weight (g), **NS/B**: Number of seeds per boll, **GOT**: Ginning out turn (%), **RWC**: Relative water content (%), **PR**: Photosynthesis rate (µmol CO_2 $m^{-2}s^{-1}$), **SC**: Stomatal conductance (m mol H_2O $m^{-2}s^{-1}$), **TR**: Transpiration rate (m mol H_2O $m^{-2}s^{-1}$), **TCC**: Total chlorophyll content (SPAD value), **PC**: Proline content (µmoles/g), **CPC**: Crude protein content (%), **SOC**: Seed oil content (%), **GC**: Gossypol content (%) and **SCY/P**: Seed cotton yield per plant (g).

Table 3: Path coefficient analysis showing direct (diagonal and bold) and indirect effects of component traits on seed cotton yield per plant.

Variable	PH	NM/P	DFF	NB/P	BW	NS/B	GOT	RWC	PR	SC	TR	TCC	PC	CPC	SOC	GC
PH	**0.0160**	0.0017	0.0025	0.0052	-0.0007	-0.0011	0.0001	-0.0008	0.0006	0.0018	-0.0019	-0.0014	0.0032	-0.0009	0.0020	0.0044
NM/P	-0.0019	**0.0183**	0.0010	-0.0042	0.0008	0.0012	0.0036	0.0006	-0.0004	0.0037	-0.0020	-0.0009	-0.0001	-0.0052	0.0000	-0.0005
DFF	0.0021	-0.0007	**0.0136**	-0.0016	0.0022	-0.0001	0.0022	0.0008	0.0047	-0.0005	0.0018	0.0025	0.0045	0.0008	0.0004	0.0028
NB/P	0.3370	0.2380	-0.1247	**0.8440**	-0.2894	0.1649	-0.0518	-0.4479	0.0086	-0.0009	-0.2268	-0.0559	0.0153	0.1999	-0.2418	-0.1276
BW	-0.0107	-0.0105	0.0407	0.0697	**0.2505**	-0.0273	-0.0093	0.0525	0.0024	-0.0456	-0.0288	0.0153	-0.0156	-0.0159	0.0202	0.0020
NS/B	0.0002	0.0002	0.0000	-0.0004	0.0003	**-0.0024**	0.0003	0.0001	-0.0001	0.0008	0.0000	-0.0003	0.0003	-0.0002	-0.0005	0.0005
GOT	-0.0001	0.0028	-0.0023	0.0007	0.0005	0.0017	**-0.0145**	-0.0016	-0.0019	0.0009	-0.0012	-0.0003	-0.0028	0.0008	-0.0002	0.0012
RWC	-0.0014	-0.0010	0.0018	-0.0129	0.0063	-0.0008	0.0034	**0.0300**	-0.0051	-0.0007	0.0082	0.0031	0.0060	-0.0017	0.0008	0.0056
PR	-0.0003	-0.0002	-0.0030	-0.0001	-0.0001	-0.0003	-0.0011	0.0014	**-0.0085**	0.0013	-0.0007	-0.0011	0.0005	0.0015	0.0009	-0.0001
SC	-0.0025	0.0045	0.0008	0.0000	0.0041	0.0071	0.0014	0.0006	0.0033	**-0.0223**	0.0010	-0.0012	0.0003	-0.0002	-0.0033	-0.0067
TR	0.0034	-0.0033	-0.0038	0.0063	0.0033	0.0005	-0.0024	-0.0080	-0.0024	0.0013	**-0.0290**	-0.0061	-0.0047	-0.0017	-0.0037	-0.0047
TCC	0.0010	-0.0006	-0.0022	0.0006	-0.0007	-0.0017	-0.0002	-0.0012	-0.0015	-0.0006	-0.0024	**-0.0115**	-0.0015	0.0020	-0.0015	-0.0011
PC	0.0045	0.0001	0.0073	0.0003	-0.0014	-0.0025	0.0043	0.0044	-0.0012	-0.0003	0.0035	0.0030	**0.0220**	-0.0014	-0.0008	0.0048
CPC	-0.0003	0.0014	0.0003	0.0010	-0.0003	0.0004	-0.0003	-0.0003	-0.0009	0.0000	0.0003	-0.0009	-0.0003	**0.0050**	-0.0003	0.0004
SOC	0.0033	0.0000	0.0007	-0.0061	0.0021	0.0058	0.0004	0.0007	-0.0028	0.0039	0.0033	0.0034	-0.0009	-0.0018	**0.0262**	0.0039
GC	-0.0020	-0.0002	-0.0015	0.0009	-0.0001	0.0016	0.0006	-0.0014	-0.0001	-0.0022	-0.0012	-0.0007	-0.0016	-0.0006	-0.0011	**-0.0075**
SCY/P	**0.3483**	**0.2505**	**-0.0688**	**0.9034**	**-0.0226**	**0.1470**	**-0.0633**	**-0.3701**	**-0.0053**	**-0.0594**	**-0.2759**	**-0.0530**	**0.0246**	**0.1804**	**-0.2027**	**-0.1226**

Residual effect= 0.1002

PH: Plant height (cm), **NM/P**: Number of monopods per plant, **DFF**: Days to first flower, **NB/P**: Number of bolls per plant, **BW**: Boll weight (g), **NS/B**: Number of seeds per boll, **GOT**: Ginning out turn (%), **RWC**: Relative water content (%), **PR**: Photosynthesis rate (µmol CO_2 $m^{-2}s^{-1}$), **SC**: Stomatal conductance (mmol H_2O $m^{-2}s^{-1}$), **TR**: Transpiration rate (mmol H_2O $m^{-2}s^{-1}$), **TCC**: Total chlorophyll content (SPAD value), **PC**: Proline content (µmoles/g), **CPC**: Crude protein content (%), **SOC**: Seed oil content (%), **GC**: Gossypol content (%) and **SCY/P**: Seed cotton yield per plant (g).

Maximum positive indirect effects were exhibited by plant height (0.3370) through number of bolls per plant followed by number of monopods per plant (0.2380) through number of bolls per plant; crude protein content (0.1999) through number of bolls per plant; number of seeds per boll (0.1649) through number of bolls per plant; number of bolls per plant (0.0697) through boll weight; relative water content (0.0525) through boll weight; days to first flower (0.0407) through boll weight; proline content (0.0153) through number of bolls per plant and total chlorophyll content (0.0153) through boll weight. Highest negative indirect effects were shown by relative water content (-0.4479) through number of bolls per plant; boll weight (-0.2894) through number of bolls per plant; seed oil content (-0.2418) through number of bolls per plant; transpiration rate (-0.2268) through number of bolls per plant; total chlorophyll content (0.0559), ginning out turn (-0.0518), stomatal conductance (-0.0456) through boll weight, transpiration rate (-0.0288) through number of bolls per plant and number of seeds per boll (-0.0273) through boll weight.

CONCLUSIONS

Correlation and path analysis are effective statistical tools for plant breeders as these tools aid in identification of suitable traits to be used as selection criteria for improvement of yield of a crop. Correlation analysis indicated that simultaneous selection based on plant height, number of bolls per plant, boll weight and number of seeds per boll will aid in improvement of seed cotton yield since these traits had significant positive correlation with seed cotton yield per plant. Furthermore, path analysis revealed that number of bolls per plant had positive and high direct effect on seed cotton yield per plant. Therefore, direct selection for this trait will accelerate the improvement of yield in *desi* cotton.

FUTURE SCOPE

Correlation and path analysis demonstrated that enhancement in yield may be possible by selecting traits such as plant height, number of bolls per plant, boll weight and number of seeds per boll as selection criteria for cotton improvement. The relationship between yield and its contributing traits reveals the ideal cotton improvement criterion.

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Conflict of Interest. None.

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