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Assessment of genetic variability and association analysis in upland cotton (*Gossypium hirsutum* L.)

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ABSTRACT : The research work comprised of genetic variability, heritability, genetic advance, correlation and path analysis for 13 traits with 67 genotypes of cotton (*Gossypium hirsutum* L.) was carried out during winter 2017 at Tamil Nadu Agricultural University, Cotton Research Station, Srivilliputtur. The genotypic differences were significant for all the traits. High estimates of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were observed for seed cotton yield, monopodia and bolls / plant. Moderate phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) was observed for seed index and fibre fineness. High heritability was observed for monopodia / plant, sympodia / plant, bolls / plant, seed index, ginning percentage, 2.5 per cent span length, uniformity ratio, bundle strength, fibre fineness and seed cotton yield. Monopodia and bolls / plant, fibre fineness and seed cotton yield / plant showed high heritability coupled with high genetic advance over mean indicated the preponderance of additive gene action in the inheritance of these traits. The correlation study revealed that plant height, monopodia, sympodia, bolls / plant and ginning percentage had a significant positive association with seed cotton yield / plant. Path analysis revealed that bolls / plant has positive and high direct effect on seed cotton yield / plant.

Key words: Correlation, cotton, heritability, path analysis, variability, yield

Cotton is one of most important commercial crop and India ranks first in area and second in production next to China in global level. The area under cotton cultivation is decrease day by day and also the productivity of cotton in India is very low compared to other cotton growing countries. Therefore, it is essential to develop new high yielding cultivars with good fibre quality parameters to improve production level. Germplasm serves as a valuable source material as it provides scope for building of genetic variability, which is a prerequisite for any breeding programme. Study of genetic variability, heritability and genetic advance in the germplasm will help to determine the real potential value of the genotype. Further, effectiveness of selection in any breeding programme mainly depends upon the knowledge of association of the characters. Phenotypic correlation indicates the extent of the observation having relation between two characters while genotypic correlation provides an estimate of inherent association between the genes controlling any two characters. Selection based on correlation analysis alone is in-effective, hence path coefficient analysis helps in partitioning the observed correlation coefficient into components of direct and indirect

influences and provide better insight of character relationship. The cause negative effect of the trait is very essential for formulating selection indices for genetic improvement of yield and can be done by path analysis. Hence the present study was planned to assess the genetic variability, heritability, genetic advance, correlation and path analysis for various yield and yield contributing characters in a set of genotypes. Such information may be fruitful in formulating efficient selection programme for synthesis and development of new cotton genotypes with improved yield and its contributing traits.

MATERIALS AND METHODS

The present experiment was conducted in the research field of the Tamil Nadu Agricultural University, Cotton Research Station, Srivilliputtur during the winter 2017. The mean maximum and minimum temperature prevailed during the cropping period was 31.5ÚC and 24.2ÚC respectively and an average rainfall of 740 mm which was received in 24 rainy days. The experimental site is located at 9" 5'N latitude, 77" 6'E longitudes and an altitude of 137.92m above mean sea level. The crop has grown in sandy clay loam soil texture with pH of 8.2.

The experimental material comprised of fifty intra *hirsutum* hybrids, its parents and two checks. The F_1s were developed by crossing five female parents used as lines *viz.,* RB 602, BGDS 1033, CO 14, SVPR 5 and SVPR 2 and ten male parent used as testers *viz.,* TCH 1819, CNH 19, COD 5-1-2, GSHV 177, SCS 1207, Suraj, African I-2, TCH 482-7, TCH 484-4 and TCH 486-2 in a line x tester mating fashion. Thus, the sixty seven genotypes were raised during winter 2017-2018 in two replications in a randomized block design (RBD) with double rows of 4.5m length and spacing of 100cm between rows and 45cm between plants. Recommended agronomic practices and need based plant protection measures were adopted during crop season.

Data were recorded from five selected plants in each entry for thirteen characters *viz.,* plant height (cm) (PH), monopodia (NM), sympodia (NSy), bolls / plant (NB), boll weight (g) (BW), seed index (SI), lint index (LI), ginning percentage (GP), seed cotton yield / plant (g) (SCY/P), 2.5 per cent span length (mm) (SL), bundle strength (g/tex) (BS), fibre fineness (µ) (FF) and uniformity ratio (%) (UR). Observations on five fibre quality traits in each replication were recorded with 10g of lint sample by High Volume Instrument (HVI) in ICC mode. The means for all the observed parameters were worked out and were further subjected to analyze the genotypic and phenotypic coefficients of variation, heritability (broad sense) and expected genetic advance as per cent of mean, correlation and path analysis

RESULTS AND DISCUSSION

Variability studies : The analysis of variance (Table. 1) revealed significant differences among the genotypes for all the characters studied indicated that the data generated from the material studied will yield reliable information. The results pertaining to genetic parameters *viz.*, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), broad sense heritability (h^2) and

genetic advance over mean for all the thirteen characters presented in Table 2. High estimate of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were observed for seed cotton yield (33.17 and 31.85%), monopodia (24.81 and 20.84%) and bolls / plant (21.85 and 20.52%). Moderate phenotypic coefficient of variation and moderate genotypic coefficient of variation were observed for seed index (13.04 and 10.41%) and fibre fineness (17.18 and 16.14%). Moderate PCV and low GCV was observed for lint index (11.81 and 8.77%). Low PCV and GCV were observed for plant height (6.60, 4.13%), sympodia / plant (7.01, 5.60%), boll weight (9.78 and 7.57%), ginning percentage (7.83, 6.81%), 2.5 per cent span length (7.96%, 7.63%), uniformity ratio (4.61, 4.44%) and bundle strength (8.80, 8.56%) which indicated that these characters were highly influenced by environmental factors. The phenotypic coefficient of variation which measures total variation was found to be greater than genotypic coefficient of variation for all the characters indicated some degree of environmental influence on the traits. Selection for improvement of such traits may sometimes be misleading. These findings were also supported by Sunanaya *et al.,* (2017), Gnanasekaran *et al.,* (2018), Praveen Sampath Kumar *et al.,* (2019), Deshmukh *et al.,* (2019) and Sangwan *et al.,* (2020).

High heritability value were observed for characters like monopodia (70.57%), sympodia (63.76) and bolls / plant (88.18%), seed index (63.80%), ginning percentage (75.79%), 2.5 per cent span length (91.95%), uniformity ratio (92.75%), bundle strength (94.58%), fibre fineness (88.24%) and seed cotton yield / plant (92.24%). These findings were agreed with earlier findings of Deshmukh *et al.,* (2019). Praveen Sampath Kumar *et al.,* (2019) reported the same finding except fibre fineness. Sangwan *et al.,* (2020) observed the similar findings for monopodia and bolls / plant, seed index, ginning percentage and seed cotton yield / plant. Gnanasekaran *et al.,* (2018) observed the similar findings for 2.5 per cent span length, fibre fineness, bundle strength, and seed cotton yield / plant and Eswari *et al.,* (2017) for bolls / plant, ginning percentage, 2.5 per cent span length, bundle strength and seed cotton yield / plant. This suggested the greater effectiveness of selection and improvement to be expected for these characters. Plant height, boll weight and lint index showed moderate estimates of heritability. These results were in agreement with the results reported by Sunanaya *et al.,* (2017) for plant height; Rama Reddy and Sarma (2014) for boll weight and Praveen Sampath Kumar *et al.,* (2019) for lint index. Heritability estimates along with genetic advance would be more useful in predicting yield under phenotypic selection than heritability estimates alone. If heritability is mainly due to non-additive gene effect, the expected genetic advance would be low, and if there is additive gene effect, a high genetic advance may be expected. In the present investigation high heritability coupled with high genetic advance as percentage over mean was observed for monopodia and (70.57, 36.07), bolls / plant (88.18, 39.69), fibre fineness (88.24, 31.23) and seed cotton yield / plant (92.24, 63.02) indicated the preponderance of additive gene action. Eswari *et al.,* (2017), Sunanaya *et al.*, (2017), Praveen Sampath Kumar *et al.,* (2019), Deshmukh *et al.,* (2020) and Sangwan *et al.,*

Table 1. Analysis of variance for various yield parameters and fibre quality traits in cotton

Source of Variation	Degrees of freedom	Plant height (cm)	Mono-podia/ plant	Sym-podia/ plant	Bolls/ plant	Boll weight	Seed index	Lint index (g)	Ginning (%)	2.5 per cent span length (mm)	Uni-formity ratio (%)	Bundle strength (g/tex)	Fibre fineness (μ)	Seed cotton yield/ plant (g)
Replication	1	12.23	0.19	0.01	0.02	0.55	2.45	1.15	0.80	0.49	-0.03	0.31	0.15	0.00001
Genotypes	66	72.18*	0.24*	1.84*	65.51*	0.34*	2.47*	0.60*	13.97*	9.10*	9.72*	7.01*	0.98*	0.0022*
Error	66	31.49	0.04	0.41	4.11	0.09	0.55	0.18	1.92	0.38	0.37	0.20	0.06	0.0001

Table 2. Genetic components of variance for various yield traits in cotton

Characters	Plant height (cm)	Mono-podia/ plant	Sym-podia/ plant	Bolls/ plant	Boll weight	Seed index	Lint index (g)	Ginning (%)	2.5 per cent span length (mm)	Uni-formity ratio (%)	Bundle strength (g/tex)	Fibre fineness (μ)	Seed cotton yield/ plant (g)
PCV (%)	6.6	24.81	7.01	21.85	9.78	13.04	11.81	7.83	7.96	4.61	8.8	17.18	33.17
GCV (%)	4.13	20.84	5.6	20.52	7.57	10.41	8.77	6.81	7.63	4.44	8.56	16.14	31.85
h^2 (%)	39.24	70.57	63.76	88.18	59.94	63.8	55.1	75.79	91.95	92.75	94.58	88.24	92.24
GA	5.82	0.55	1.39	10.72	0.57	1.62	0.71	4.4	4.12	4.29	3.7	1.31	0.06
GAM (%)	5.33	36.07	9.21	39.69	12.07	17.14	13.41	12.22	15.08	8.81	17.14	31.23	63.02

Table 3. Genotypic and phenotypic correlations of various traits in cotton

Characters	Plant height (cm)	Mono-podia/ plant	Sym-podia/ plant	Bolls/ plant	Boll weight	Seed index	Lint index (g)	Ginning (%)	2.5 per cent span length (mm)	Uni-formity ratio (%)	Bundle strength (g/tex)	Fibre fineness (μ)	Seed cotton yield/ plant (g)
Plant	1.000	0.129	0.683*	0.376*	-0.026	-0.253*	-0.274*	0.036	-0.224*	0.257*	-0.067	0.328*	0.620*
height (cm)		**0.095**	**0.540***	**0.288***	**0.013**	**-0.104**	**-0.110**	**0.011**	**-0.135**	**0.098**	**-0.043**	**0.193**	**0.352***
Monopodia/		1.000	0.258*	0.191	0.169	0.230*	0.432*	0.141	-0.217*	0.104	-0.229*	-0.092	0.210*
plant			**0.142**	**0.153**	**0.168**	**0.104**	**0.248***	**0.134**	**-0.195**	**0.078**	**-0.171**	**-0.031**	**0.177**
Sympodia/plant			1.000	0.293*	-0.063	0.022	-0.115	-0.120	-0.124	0.259*	0.020	0.215*	0.477*
				0.266*	**0.001**	**-0.071**	**-0.144**	**-0.073**	**-0.085**	**0.175**	**0.005**	**0.150**	**0.364***
Bolls/plant				1.000	0.010	-0.143	0.201	0.313*	-0.277*	0.062	-0.204	-0.040	0.872*
					0.022	**-0.072**	**0.137**	**0.219***	**-0.248***	**0.043**	**-0.193**	**-0.012**	**0.783***
Boll weight (g)					1.000	0.594*	0.611*	-0.033	0.123	0.002	0.038	-0.094	-0.022
						0.420*	**0.356***	**-0.089**	**0.090**	**0.004**	**0.036**	**-0.073**	**-0.009**
Seed index						1.000	0.381*	-0.644*	0.245*	-0.165	0.033	-0.084	-0.313*
							0.512*	**-0.551***	**0.195**	**-0.120**	**0.036**	**-0.053**	**-0.221***
Lint index							1.000	0.458*	0.049	0.023	-0.048	-0.173	0.041
								0.428*	**0.032**	**0.024**	**-0.027**	**-0.092**	**0.014**
Ginning (%)								1.000	-0.209	0.192	-0.063	-0.080	0.351*
									-0.185	**0.162**	**-0.060**	**-0.044**	**0.259***
2.5 per cent									1.000	-0.592*	0.796*	0.073	-0.318*
span length (mm)									**-0.543***	**0.733***	**0.041**	**-0.289***	
Uniformity ratio										1.000	-0.037	0.072	0.176
											-0.025	**0.063**	**0.157**
Bundle strength											1.000	-0.060	-0.137
(g/tex)												**-0.055**	**-0.125**
Fibre fineness (μ)												1.000	-0.053
													-0.057
Seed cotton yield/plant (g)												1.000	

* Significant at 5% level. The values in bold are phenotypic correlation

Table 4. Direct effects (diagonal) and indirect effects (off diagonal) of various traits on seed cotton yield at genotypic level

Characters	Plant height (cm)	Mono-podia/ plant	Sym-podia/ plant	Bolls/ plant	Boll weight	Seed index	Lint index (g)	Ginning (%)	2.5 per cent span length (mm)	Uni-formity ratio (%)	Bundle strength (g/tex)	Fibre fineness (µ)	Seed cotton yield/ plant (g)
Plant height (cm)	**0.207**	0.011	0.092	0.280	-0.004	0.079	0.027	-0.001	-0.062	0.042	0.012	-0.061	0.620
Monopodia/ plant	0.027	**0.081**	0.035	0.142	0.029	-0.072	-0.042	-0.005	-0.061	0.017	0.043	0.017	0.210
Sympodia/ plant	0.141	0.021	**0.135**	0.219	-0.011	-0.007	0.011	0.004	-0.034	0.042	-0.004	-0.040	0.477
Bolls/plant	0.078	0.015	0.040	**0.746**	0.002	0.045	-0.020	-0.011	-0.077	0.010	0.038	0.007	0.872
Boll weight (g)	-0.005	0.014	-0.009	0.007	**0.170**	-0.186	-0.060	0.001	0.034	0.000	-0.007	0.018	-0.022
Seed index	-0.052	0.019	0.003	-0.107	0.101	**-0.313**	-0.037	0.023	0.068	-0.027	-0.006	0.016	-0.313
Lint index	-0.057	0.035	-0.016	0.150	0.104	-0.119	**-0.098**	-0.016	0.014	0.004	0.009	0.032	0.041
Ginning (%)	0.008	0.011	-0.016	0.234	-0.006	0.202	-0.045	**-0.036**	-0.058	0.031	0.012	0.015	0.351
2.5 per cent Span length (mm)	-0.046	-0.018	-0.017	-0.207	0.021	-0.077	-0.005	0.008	**0.278**	-0.096	-0.147	-0.014	
Uniformity ratio	0.053	0.008	0.035	0.046	0.000	0.052	-0.002	-0.007	-0.165	**0.162**	0.007	-0.013	0.176
Bundle strength (g/tex)	-0.014	-0.019	0.003	-0.152	0.007	-0.010	0.005	0.002	0.221	-0.006	**-0.185**	0.011	-0.137
Fibre fineness (µ)	0.068	-0.008	0.029	-0.030	-0.016	0.026	0.017	0.003	0.020	0.012	0.011	**-0.186**	-0.053

Residual Effect = 0.2951

(2020) reported high heritability and high genetic advance as percentage of mean for bolls, seed cotton yield / plant and Gnanasekaran *et al.,* 2018 for fibre fineness revealed the influence of additive gene action for these traits. Hence the improvement of these traits can be made through direct phenotypic selection. The traits such as sympodia / plant (63.76, 9.21), and uniformity ratio (92.75, 8.81) in which high heritability accompanied by low genetic advance was recorded indicated the effect of non additive gene action and hence heterosis breeding may be useful for these traits. Such kind of similar results were observed by Santhoshkumar et al., (2012) for sympodia / plant and Deshmukh *et. al.,* (2019) for uniformity ratio.

Correlation studies : Computation of correlation between yield and yield attributing traits is of considerable importance in plant selection. The genotypic and phenotypic correlation co efficient between yield and its components were presented in Table 3. Five traits namely, plant height (0.620), monopodia (0.210), sympodia (0.477) and bolls / plant (0.872) and ginning percentage (0.351) had a significant positive association with seed cotton yield / plant. Hence selection for these traits will help in selecting genotypes with higher seed cotton yield / plant. In earlier studies, same findings for these traits were reported by Asha *et al.,* (2015) for plant height, sympodia and bolls / plant; Sunanaya *et al.,* (2017) for plant height, monopodia, sympodia and bolls / plant; Sangwan *et al.*, (2020) for plant height, monopodia and bolls / plant and ginning percentage. The fibre quality traits studied in the present experiment showed negative and non significant association with seed cotton yield / plant except 2.5 per cent span length which was significant but negative association

Path co efficient studies : The effect of independent character on the dependent is known as direct effect, whereas effect of an independent character on the dependent traits is known as indirect effect. The estimation of path analysis indicated that due emphasis should be given to bolls / plant as this trait showed high direct positive effects on seed cotton yield/ plant (Table 4). The above results are in conformity with reports of Asha *et al.,* (2015) and Pinki *et al.,* (2018) suggesting that the direct contribution of the above character to yield would be highly important for formulating an appropriate selection programme as cotton breeding includes several agronomic and fibre traits, whose association may interfere in the selection process

CONCLUSION

High heritability coupled with high genetic advance as percentage of mean was observed for monopodia and bolls / plant, fibre fineness and seed cotton yield / plant indicating the preponderance of additive gene action in the inheritance of these traits. The improvement of these traits can be made through direct phenotypic selection. The traits such as sympodia / plant and uniformity ratio had high heritability accompanied by low genetic advance indicate the effect of non additive gene action and hence heterosis breeding may be rewarding for improvement of these traits. Correlation analysis revealed that simultaneous selection

based on plant height, monopodia, sympodia and bolls / plant and ginning percentage will bring about breakthrough in cotton yields since these traits had a significant positive association with seed cotton yield / plant. Path analysis revealed that bolls / plant has positive and high direct effect on seed cotton yield / plant. Therefore, a restricted selection model of direct selection for traits *viz.,* bolls / plant is suggested for obtaining yield improvement in cotton.

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