Studies on Genetic Variability, Correlation and Path Coefficient Analysis in Cotton (*Gossypium hirsutum* L.)

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ABSTRACT: The present investigation was conducted to elicit information on extent of genotypic and phenotypic variability, genotypic coefficient of variance and phenotypic coefficient of variance, heritability and genetic advance. Besides, these parameters, correlation coefficient and path analysis were also studied for seed yield and its component traits in seventeen diverse genotypes of Cotton (Gossypium hirsutum L.). The analysis of variance revealed significant differences among the genotypes for all the characters studied. The high genotypic and phenotypic coefficient of variation observed for number of bolls per plant, monopodia per plant and plant height. High heritability coupled with high genetic advance as percent of mean were exhibited by number of bolls per plant, monopodia per plant, plant height, seed cotton yield, sympodia per plant, plant stand and lint kg/ha. However, seed index and fibre length recorded high heritability with moderate genetic advance. Seed cotton yield was found positive and significantly correlated with GOT %, lint kg/ha and number of bolls per plant. Number of bolls per plant exhibited the highest magnitude of direct effects on seed cotton yield, followed by GOT %, plant height, plant stand, fibre length and seed index. The results of this study might be capable in the selection criteria in further studies in order to increase the selection efficiency.

Key words: Gossypium hirsutum L., Correlation, genetic variability, heritability, path analysis

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is currently the leading plant fibre crop worldwide and is grown commercially in the temperate and tropical regions of more than 50 countries. It is fibre, oil and protein yielding crops plays a crucial role in the economy of India. For multiple use of lint and byproducts cotton is also referred as "White gold". Cotton area in India was 111.42 lakh ha having production of 339.10 lakh bales with productivity 517 kg/ha (Anonymous, 2011). The genetic information on broad sense heritability and genetic advance are very important to predict the behavior of the parents to be utilized in breeding programme for selecting high yielding cultivars (Larik *et al.*, 1997). The correlation coefficient determines simple relations among the traits, so it doesn't determines always decisive results about determination of plant selection criteria (Cakmakci *et al.*, 1998). Path coefficient analysis as to correlation coefficient gives more detailed information on the relations so it is commonly used by researchers in plant breeding to determine seed cotton yield and

seed cotton yield criteria relations (Williams *et al.*, 1990).

MATERIALS AND METHODS

The study was conducted in Cotton Research Scheme, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *Kharif* 2010. Seventeen cotton genotypes *viz.*, NH 630, AKH 2008-2, AKH 2006-1, CNH 1111, AKH 9916, CNH 13, CNH 2001, RHC 0688, DTS 121, PKV Rajat, CNH 1110, AKH 2005, CIHS 15, AKH 28-2-2 along with three checks i.e. AKH 8828, NH 615, Ankur 651 Bt were planted in randomized block design with two replications. Uniform spacing of 60 x 30 cm except Ankur 651 Bt (60 x 60 cm) and all the recommended field operations were carried out. In each replications five competitive plants were randomly selected and observations were recorded on eleven traits *viz.*, plant stand, days to first flowering, plant height, monopodia per plant, sympodia per plant, GOT %, lint kg/ha, number of bolls per plant, fibre length, seed index and seed cotton yield. Analysis of variance was carried out

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statistically utilizing the mean values. Heritability (h^2), expected genetic advance and genetic gain in the broad sense was calculated according to formula suggested by Johnson *et al.* (1955). Genotypic and phenotypic correlation coefficients were estimated as per method proposed by Singh and Chaudhari (1977). Path coefficient analysis was done according to procedure suggested by Diwey and Lu (1959).

RESULTS AND DISCUSSION

Mean Performance

Mean values (Table 1) for the plant stand was ranged from 33.00 (Ankur 651 Bt) to 70.00 (NH 630). In respect of days to first flowering, the range was observed from 50 days to 58 days. The genotypes AKH 2006-1 and CNH 13 (50 days) was found early in flowering. In case of plant height, maximum plant height was observed by AKH 2005 (105.50 cm) followed by Ankur 651 Bt (101 cm) and NH 615 (97.50 cm). For the character monopodia per plant, the fifteen genotypes had recorded lowest number of monopodia per plant (01). The sympodia per plant was ranged from 05 (CNH 1111) to 11 (CNH 13, AKH 2005 and AKH 28-2-2). In respect of fibre characters, the highest GOT % was recorded by AKH 9916 (36.95 %) even as the range was from 33.21% to 36.95%. The highest value for lint kg/ha was exhibited by Ankur 651 Bt (291 kg/ha). For the character number of bolls per plant, the genotype Ankur 651 Bt (12) had recorded highest number of bolls per plant. The mean range (21.75 mm to 29 mm) was observed for fibre length. The genotype NH 630 had recorded maximum (29 mm) fibre length. The values of seed index among genotypes were ranged from 6.40 g to 9.00 g. The highest seed cotton yield was recorded by Ankur 651 Bt (816 kg/ha) followed by NH 630 (754 kg/ha) and NH 615 (715 kg/ha).

Genotypic coefficient variance and phenotypic coefficient variance

The analysis of variance revealed significant differences among the genotypes for all the characters studied indicating presence of high degree of variability. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) showed substantial amount of genetic variability for the characters studied (Table 2). These findings are in accordance with Efrem *et al.,* (2010), Batool *et al.,* (2010) and Bolek *et al.* (2010) who reported significant genetic variability among cultivars for fiber quality traits and seed cotton yield. The estimates of GCV

ranged from 2.73 to 43.13. The highest GCV estimated for the character number of bolls per plant (43.13) followed by monopodia per plant (28.94), plant height (21.28 cm) and sympodia per plant (19.85). At the same time the estimates of PCV ranged from 3.49 to 44.49. The maximum PCV was recorded for number of bolls per plant (44.49) followed by monopodia per plant (31.20), plant height (23.84) and sympodia per plant (22.89). Soomro *et al.* (2005) observed significant differences for bolls per plant, yield and other yield attributes. Khan *et al.* (2009) observed the highest phenotypic and genotypic variances for plant height and seed cotton yield per plant. Efrem *et al.* (2010), Bolek *et al.* (2010) and Elango *et al.* (2012) reported significant genetic variability among cultivars for seed cotton yield. The moderate to least amount of variations were observed for lint kg/ha, seed cotton yield, plant stand, seed index, fibre length, days to first flowering and GOT %.

Heritability study

High heritability accompanied with high genetic advance as percent of mean indicates that most likely the heritability is due to additive gene effects and selection may be effective. High heritability coupled with high genetic advance as percent of mean were observed for number of bolls per plant (94.00/ 110.38%), monopodia per plant (86.00/70.87%), plant height (79.70/50.17%), seed cotton yield (75.40/ 34.78%), sympodia per plant (75.20/45.44%), plant stand (70.10/26.90%) and lint kg/ha (69.80/36.08%). High heritability accompanied with moderate genetic advance as percent of mean indicated by seed index (63.90/17.41%) and fibre length (32.20/10.79%). Similar findings were also reported by Roy (2006), Khan *et al.* (2009) and Elango *et al.* (2012). High heritability accompanied with low genetic advance as percent of mean were observed for GOT % (61.10/ 5.64%) and days to first flower (37.70/5.71%). Similar suggestions were given by Sharma and Tyagi (1990, 1991).

Genotypic and phenotypic correlation coefficient

Genotypic correlations had higher magnitude than corresponding phenotypic correlations for all the characters under study (Table 3). This indicated that there was inherent association among the characters. Seed cotton yield was found significant positively associated with GOT % at genotypic level and number of bolls per plant at both and genotypic and phenotypic level indicating that these attributes are predominant and may contribute considerably

towards higher seed cotton yield. However, plant stand showed negative correlation. Among yield components, plant stand registered positive and significant association with fibre length at genotypic level. Similarly, days to first flower had significant and positive association with GOT % at genotypic and phenotypic levels. Plant height revealed positive and significant correlations with sympodia per plant at genotypic and phenotypic levels. Sympodia per plant showed negative and significant association with GOT %, fibre length and seed index at genotypic level. Conversely the GOT % had positive and significant association with lint kg/ha at genotypic and phenotypic levels, while the character lint kg per ha had positive and significant association with number of bolls per plant at both levels whereas seed cotton yield at phenotypic levels. Number of bolls per plant showed positive and significant correlations with seed cotton yield at both levels. The phenotypic correlation coefficients for lint kg/ha and number of bolls per plant had revealed positive and significant association with seed cotton yield per plant. These findings are accordance with Ahmad *et al.* (2008), Tamilselvam *et al.* (2013) and Alkuddsi *et al.* (2013).

Path coefficient analysis

Path coefficient analysis revealed that number of bolls per plant (2.246) exhibited the highest magnitude of direct effects on seed cotton yield, followed by GOT % (1.218) and plant height (1.058) in Table 4 and Fig 1. These results were in agreement with Thanki and Sawargaonkar (2010) and Vinodhana *et al.* (2013).

Table 1
Mean performance of genotypes for various characters of cotton

Sr. No.	Genotypes	Plant stand	Days to first flower	Plant height (cm)	Monop odia/ plant	Sympo dia/ plant	GOT %	Lint Kg/ha.	No. of bolls/ plant	Fibre length (mm)	Seed index (gm)	Seed cotton yield/ha
1	AKH 8828 (C)	68	52	58.00	2	7	35.50	196	4	26.50	8.0	553
2	NH 630	70	54	75.50	1	7	36.66	276	8	29.00	7.2	754
3	AKH 2008-2	65	51	72.50	1	8	35.36	181	4	22.50	6.7	517
4	AKH 2006-1	64	50	64.50	1	7	33.76	178	4	26.00	8.0	528
5	CNH 1111	68	53	39.00	1	5	35.63	226	5	27.75	7.1	679
6	AKH 9916	69	55	60.00	1	6	36.95	258	6	22.00	9.0	705
7	CNH 13	66	50	96.00	1	11	34.12	169	3	21.75	7.2	500
8	CNH 2001	64	57	75.50	1	8	33.93	182	4	24.75	6.8	536
9	RHC 0688	66	52	91.50	1	9	33.21	214	6	25.50	7.2	629
10	DTS 121	68	55	94.00	1	9	34.06	195	4	25.50	8.0	573
11	NH 615 (C)	69	54	97.50	1	8	35.12	248	5	24.00	6.4	715
12	PKV Rajat	68	58	88.50	1	10	36.06	211	4	24.00	6.5	585
13	CNH 1110	69	56	86.00	1	9	36.32	259	4	27.75	6.8	708
14	AKH 2005	66	54	105.50	2	11	34.71	208	5	22.00	7.2	584
15	CIHS 15	65	55	92.50	1	8	35.40	182	3	23.00	7.2	501
16	AKH 28-2-2	64	56	93.00	1	11	35.48	190	4	23.00	7.0	517
17	ANKUR 651 Bt (C)	33	52	101.00	1	10	35.15	291	12	22.00	7.4	816
	SE +	2.97	1.40	5.07	0.07	0.55	0.44	13.39	0.31	1.47	0.26	76.16
	CD @ 5 %	8.57	4.05	14.60	0.21	1.60	1.27	38.57	0.90	4.26	0.75	227.89

Table 2
Variability parameters in cotton

Characters	Range	Mean	Variance		Coefficient of variation		Heritabili-tybs (%)	G.A. as % of mean
			Genotypic	Phenotypic	Genotypic	Phenotypic		
Plant stand	33.00 to 70.00	64.82	62.29	88.88	12.17	14.54	70.10	26.90
Days to first flower	50.00 to 58.00	53.76	3.58	9.52	3.52	5.73	37.70	5.71
Plant height (cm)	58.00 to 105.50	81.79	303.19	380.33	21.28	23.84	79.70	50.17
Monopodia/ plant	1.00 to 02.00	1.11	0.10	0.12	28.94	31.20	86.00	70.87
Sympodia/ plant	5.00 to 11.00	8.47	2.82	3.76	19.85	22.89	75.20	45.44
GOT %	33.21 to 36.95	35.14	0.92	1.51	2.73	3.49	61.10	5.64
Lint Kg/ha.	169.00 to 291.00	215.52	1243.08	1781.00	16.35	19.58	69.80	36.08
No. of bolls/ plant	3.00 to 12.00	5.00	4.65	4.94	43.13	44.49	94.00	110.38
Fibre length (mm)	21.75 to 29.00	24.52	3.12	9.68	7.20	12.69	32.20	10.79
Seed index	6.40 to 9.00	7.27	0.36	0.56	8.25	10.31	63.90	17.41
Seed cotton yield/ha	500 to 816	611.76	17752.31	23548.13	15.17	17.47	75.40	34.78

Table 3
Genotypic and phenotypic correlation coefficient in cotton for different traits

Characters		Plant stand	Days to first flower	Plant height (cm)	Monopodia/ plant	Sympodia/ plant	GOT %	Lint Kg/ha.	No. of bolls/ plant	Fibre length (mm)	Seed index	Seed cotton yield
Plant stand	G	1.00	0.309	-0.344*	0.114	-0.316	0.114	-0.428**	-0.783**	0.602**	0.010	-0.394*
	P	1.00	0.160	-0.236	0.070	-0.253	0.174	-0.202	-0.659**	0.171	-0.056	-0.323
Days to first flower	G		1.00	0.165	-0.139	0.147	0.453**	0.093	-0.148	-0.138	-0.223	0.050
	P		1.00	0.169	-0.107	0.089	0.339*	0.229	-0.151	0.215	-0.257	0.130
Plant height(cm)	G			1.00	0.007	0.927**	-0.355*	-0.013	0.132	-0.667**	-0.388*	0.035
	P			1.00	-0.014	0.767**	-0.193	0.104	0.098	-0.324	-0.319	0.051
Monopodia/ plant	G				1.00	0.123	-0.002	-0.141	-0.092	-0.050	0.190	-0.178
	P				1.00	0.095	-0.028	-0.126	-0.076	-0.043	0.181	-0.124
Sympodia/ plant	G					1.00	-0.369*	-0.235	-0.026	-0.796**	-0.441**	-0.201
	P					1.00	-0.199	-0.106	0.006	-0.271	-0.252	-0.173
GOT %	G						1.00	0.622**	0.212	0.201	0.070	0.525**
	P						1.00	0.478**	0.136	0.073	0.060	0.329
Lint Kg/ha.	G							1.00	0.867**	0.333	0.111	1.108
	P							1.00	0.678**	0.136	-0.007	0.813**
No. of bolls/ plant	G								1.00	0.001	0.148	0.886**
	P								1.00	-0.029	0.106	0.700**
Fibre length(mm)	G									1.00	-0.108	0.206
	P									1.00	0.009	0.273
Seed index	G										1.00	0.069
	P										1.00	0.038

Table 4
Path coefficient analysis showing direct and indirect effects of ten casual variables on seed cotton yield

Characters	Plant stand	Days to first flower	Plant height (cm)	Monopodia/plant	Sympodia/plant	GOT %	Lint Kg/ha.	No. of bolls/plant	Fibre length (mm)	Seed index	Correlation with Seed cotton yield
Plant stand	**0.685**	0.212	-0.236	0.078	-0.217	0.078	-0.293	-0.537	0.412	0.007	-0.394
Days to first flower	-0.097	**-0.315**	-0.052	0.044	-0.046	-0.142	-0.029	0.046	0.043	0.070	0.050
Plant height (cm)	-0.364	0.175	**1.058**	0.007	0.981	-0.375	-0.032	0.140	-0.706	-0.410	0.035
Monopodia / plant	-0.031	0.038	-0.002	**-0.274**	-0.033	0.0008	0.038	0.025	0.013	-0.052	-0.178
Sympodia / plant	0.097	-0.045	-0.284	-0.037	**-0.306**	0.113	0.072	0.008	0.244	0.135	-0.201
GOT %	0.140	0.552	-0.432	-0.003	-0.450	**1.218**	0.758	0.258	0.245	0.086	0.525
Lint Kg/ha.	0.652	-0.142	0.047	0.214	0.358	-0.947	**-1.522**	-1.320	-0.507	-0.170	1.108
No. of bolls/ plant	-1.760	-0.332	0.297	-0.207	-0.058	0.476	1.948	**2.246**	0.004	0.333	0.886
Fibre length (mm)	0.282	-0.064	-0.313	-0.023	-0.374	0.094	0.156	0.009	**0.469**	-0.051	0.206
Seed index	0.001	-0.027	-0.047	0.023	-0.053	0.008	0.013	0.018	-0.013	**0.121**	0.069

Figures in bold letters indicate the direct effects, **Residual effect = 0.3018**
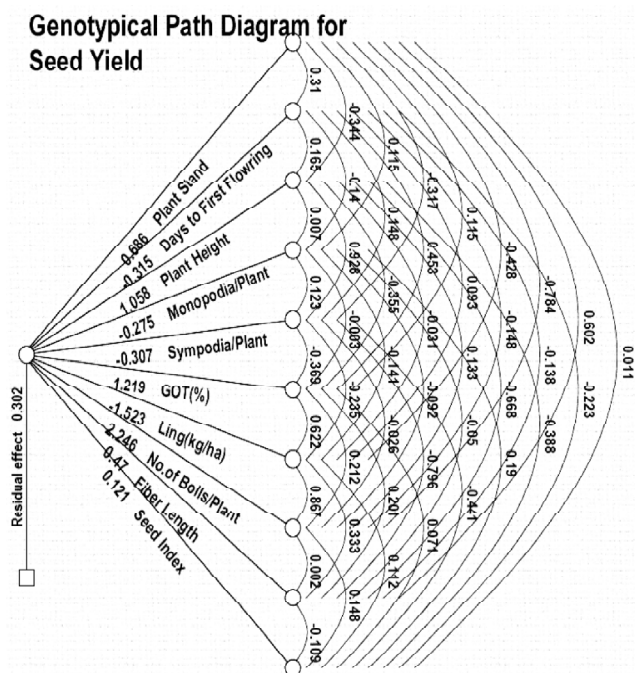
Figure 1: Path coefficient diagram showing direct and indirect effects of attributing traits on seed cotton yield

Plant stand had negative correlation with seed cotton yield (rg =-0.394). Its positive direct effect was (0.685). This character showed positive indirect effects for days to first flower (0.212), monopodia pr plant (0.078), GOT % (0.078), fibre legth (0.412) and seed index (0.007).

Negative direct effect was found in days to first flower (-0.315), whereas it had positive association (rg = 0.050) with seed cotton yield. Positive indirect effects were noticed for monopodia per plant (0.044), number of bolls per plant (0.046), fibre length (0.043) and seed index (0.070). Positive association was noticed for plant height (0.035) with seed cotton yield and it revealed positive direct effect (1.058), this character indirectly contributed to the seed cotton yield via positive path values of days to first flower (0.175), monopodia per plant (0.007), sympodia per plant (0.981) and number of bolls per plant (0.140). The trait monopodia per plant showed negative correlation (-0.178) with seed cotton yield, its direct effect was also registered negative with path values (-0.274). This character indirectly contributed mainly via positive path values of days to first flower (0.038), GOT % (0.0008), lint kg/ha (0.038), number of bolls per plant (0.025) and fibre length (0.013) towards seed cotton yield.

Sympodia per plant revealed negative association (-0.201) with seed cotton yield. It had negative direct effect (-0.306) on seed cotton yield. This character indirectly influenced to the seed cotton yield via plant stand (0.097), GOT % (0.113), lint kg / ha (0.072), number of bolls per plant (0.008), fibre length (0.244) and seed index (0.135). The character GOT % showed positive and significant correlation (0.525) with seed cotton yield, while it had positive direct effect (1.218) on seed cotton yield, this character indirectly contributed positive effect via plant stand (0.140), days to first flower (0.552), lint kg/ha (0.758), number of bolls per plant (0.258), fibre length (0.245) and seed index (0.086). Negative direct effect was found in lint kg/ha (-1.522), whereas it had positive association (rg = 1.108) with seed cotton yield. Positive indirect effects were noticed for plant stand (0.652), plant height (0.047), monopodia per plant (0.214) and sympodia per plant (0.358). Positive association was noticed for number of bolls per plant (0.886) with seed cotton yield and it revealed positive direct effect (2.246). This character indirectly contributed to the seed cotton yield via positive path values of plant height (0.297), GOT % (0.476), lint kg/ha (1.948), fibre length (0.004) and seed index (0.333). Fibre length showed significant and positive correlation (0.206) with seed cotton yield. Its direct effect was also registered positive path value (0.469). This character indirectly contributed mainly via plant stand (0.282), GOT % (0.094), lint kg/ ha (0.156) and number of bolls per plant (0.009) towards seed cotton yield. Positive association was noticed for seed index (-0.069) with seed cotton yield and it revealed positive direct effect (0.121). This character indirectly contributed to the seed cotton yield via positive path values of plant stand (0.001), monopodia per plant (0.023), GOT % (0.008), lint kg/ha (0.013) and number of bolls per plant (0.018). It was in accordance with Elango *et al.* (2012), Alkuddsi *et al.* (2013) and Vinodhana *et al.* (2013) for direct and indirect effects of various characters on seed cotton yield.

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