Environment & Ecology 27 (3) : 989—993, 2009
 ISSN 0970-0420

Genetic Variability, Character Association and Path Coefficient Analysis in Upland Cotton (*Gossypium hirsutum* L.) under Rainfed Condition

RAVI KUMAR PATNAIK AND PARSHURAM SIAL

Regional Research & Technology Transfer Station, Orissa University of Agriculture & Technology Bhawanipatna 766001,Kalahandi, Orissa, India

Abstract

A biometrical investigation on 14 intra hirsutum hybrids of upland cotton with 14 yield attributing traits was carried out to study the genetic variability, character association and path analysis. Significant genotypic differences existed among the genotypes for all the characters studied. High PCV, GCV, heritability and genetic gain were recorded in boll weight (g), no. of seeds per boll, fiber fineness (mic), seed cotton yield (q/ha) and seed cotton yield per plant (g). Significant correlation between seed cotton yield and number of sympodia per plant and number of bolls per plant both at genotypic and phenotypic level, indicated scope for improving seed cotton yield through simultaneous selection. Path analysis further supported and high lighted the importance of number of bolls per plant and sympodia per plant in yield improvement.

Key words : *Gossypium hirsutum*, Genetic variability, Character association, Path analysis.

Seed cotton yield in upland cotton is a complex character, governed by a large number of quantitative characters, which are especially important for selecting a genotype. Application of biometrical techniques has lead to the greater understanding of genetics of quantitative characters and found to be extremely useful for systematic genetic analysis and planning of sound breeding program. For this, a thorough knowledge of the nature and magnitude of genetic variability and association of characters in a group, is essential for the selection of genotypes. However, direct selection based on correlations may not be effective. When there are many characters influencing one another, it is necessary to split the total correlation coefficient into direct and indirect effects on a given character. Based on importance of these aspects, an attempt was made in upland cotton for estimating genetic variability, character association and path analysis for yield and its contributing characters for effective selection of genotypes.

Methods

Fourteen diverse intra hirsutum hybrids of upland cotton were evaluated in a randomized complete block design with three replications in *kharif* of 2004-05 at Regional Research and Technology Transfer station, (OUAT), Bhawanipatna, Kalahandi, Orissa. Each hybrid was sown in four rows of 6.3 m each with the spacing of 90 cm between rows and 90 cm be-

Table 1. Analysis of variance for 14 characters of 14 intra-hirsutum hybrids of uplands cotton under rain fed condition.

	Characters	Mean sum of square Replication (2)	Genotype (13)	Error (26)
1	Boll weight (g)	0.070	0.677**	0.065
2	No. of sympodia/plant	0.671	11.362**	1.885
3	No. of bolls/plant	2.258	73.556**	4.065
4	No. of monopodia/plant	2.207	0.166**	0.111
5	No. of seeds/boll	0.662	33.125**	0.744
6	No. of seeds/locule	0.044	1.596**	0.146
7	No. of locules/boll	0.034	0.119**	0.037
8	2.5% staple length (mm)	0.028	15.557**	0.005
9	Fiber fineness (mic)	0.007	0.046**	0.008
10	Fiber strength (g/tex)	0.000	4.613**	0.007
11	Strength/length	0.001	0.013**	0.001
12	50% boll bursting (days)	2.656	101.159**	1.257
13	Seed cotton yield (q/ha)	0.331	17.676**	0.122
14	Seed cotton yield per plant (g)	2.492	232.496**	0.670

Table 2. Estimates of parameters of genetic variability, heritability and genetic advance for various characters in 14 intra-hirsutum hybrids of upland cotton under rainfed condition.

	Characters	Phenotypic range	Mean ± SE	PCV (%)	GCV (%)	GCV/ PCV	Herita-bility (h2%)	Genetic advance	GAM (% mean)
1	Boll weight (g)	3.56–5.43	4.46+0.21	11.63	10.13	0.87	75.90	0.81	18.16
2	No. of sympodia/plant	14.20–21.67	19.27+1.12	11.66	9.22	0.79	62.60	2.90	15.05
3	No. of bolls/plant	31.70–49.73	42.05+1.65	12.41	11.44	0.92	85.10	9.14	21.74
4	No. of monopodia/plant	1.67–2.47	2.10+0.27	17.09	6.39	0.37	14.00	0.10	4.77
5	No. of seeds/boll	23.20–35.27	28.05+0.56	12.01	11.76	0.98	95.80	6.65	23.71
6	No. of seeds/locule	5.80–8.40	6.99+0.31	11.36	9.95	0.88	76.80	1.26	18.03
7	No. of locules/boll	3.60–4.40	4.01+0.16	6.34	4.12	0.65	42.20	0.22	5.49
8	2.5% staple length (mm)	25.10–32.53	27.73+0.06	8.21	8.21	1.00	99.90	4.69	16.91
9	Fiber fineness (mic.)	3.40–5.07	4.35+0.07	10.79	10.59	0.98	96.30	0.93	21.38
10	Fiber strength (g/tex)	18.10–22.53	20.56+0.07	6.04	6.03	0.99	99.60	2.55	12.40
11	Strength/length	0.63–0.83	0.75+0.01	8.68	8.67	0.99	99.60	0.13	17.33
12	50% boll bursting (days)	110.00–130.00	117.79+0.92	4.99	4.90	0.98	96.40	11.67	9.91
13	Seed cotton yield (q/ha)	15.00–23.48	19.44+0.29	12.57	12.44	0.99	98.00	4.93	25.36
14	Seed cotton yield per plant (g)	53.55–83.64	69.75+0.67	12.68	12.63	0.99	99.10	18.07	25.91

tween plants. Recommended package of practices and plant protection measures were given when needed. Observations were taken on plot basis for days to 50% boll bursting and seed cotton yield (q/ha). Ten randomly selected plants in each entry were taken for recording data on number of sympodia per plant, number of bolls per plant, number of monopodia per plant and seed cotton yield per plant (g). Data on boll weight (g), number of seeds per boll, number of seeds per locule and number of locules per boll were recorded by taking 10 bolls from the selected plants. The fiber quality parameter like 2.5% staple length (mm), fiber fineness (mic), fiber strength (g/tex) and strength/length were recorded from the testing report of CIRCOT, Mumbai.

Analysis of variance from 2004-05 crop season data, was performed following the standard procedures described by Singh and Chaudhury (1). The phenotypic and genotype coefficients of variability were computed according to the method suggested by Burton (2). Heritability (broad sense) and genetic advance were estimated following Johnson et al. (3). The phenotypic and genotypic correlations were calculated based on the methods of Al-Jibouri et al. (4).

Table 3. Estimate of genotypic (rg) and phenotypic (rg) correlation coefficient for different characters of intra-hirsutum hybrids in upland cotton under rainfed condition.

	Characters	Boll weight 1	Sympodia/ plant 2	Bolls/ plants 3	Monopodia/ plant 4	Seeds/boll 5	Seeds/locule 6	Locules/boll 7
1	rp	1.000	-0.040	0.109	-0.207	0.186	0.089	0.181
	rg	1.000	-0.049	0.166	-0.591	0.222	0.165	0.147
2	rp		1.000	0.790**	0.007	0.153	0.107	-0.076
	rg		1.000	0.988**	-0.106	0.253	0.378	-0.046
3	rp			1.000	-0.073	0.201	0.264	-0.108
	rg			1.000	-0.270	0.233	0.331	-0.149
4	rp				1.000	0.010	0.093	-0.405
	rg				1.000	-0.074	0.395	-0.590
5	rp					1.000	0.829**	0.358
	rg					1.000	0.947**	0.574
6	rp						1.000	0.067
	rg						1.000	0.025

Table 3. Continued.

Characters		Boll weight 1	Sympodia/ plant 2	Bolls/ plants 3	Monopodia/ plant 4	Seeds/boll 5	Seeds/locule 6	Locules/boll 7
7	rp							1.000
	rg							1.000
8	rp							
	rg							
9	rp							
	rg							
10	rp							
	rg							
11	rp							
	rg							
12	rp							
	rg							
13	rp							
	rg							
14	rp							
	rg							

Table 3. Continued.

Characters		2.5% staple length 8	Fiber fineness 9	Fiber strength 10	Strength/ length 11	50% Boll bursting 12	Seed cotton (q/ha) 13	Seed cotton yield/plant 14
1	rp	-0.217	-0.406	-0.151	0.085	-0.414	0.196	0.191
	rg	-0.248	-0.452	-0.179	0.992	-0.489	0.207	0.216
2	rp	-0.041	0.285	-0.316	-0.190	-0.094	0.802**	0.821**
	rg	-0.051	0.432	-0.295	-0.130	-0.115	0.919**	0.917**
3	rp	-0.075	0.221	-0.366	-0.191	-0.229	0.933**	0.938**
	rg	-0.085	0.250	-0.402	-0.208	0.253	0.962**	0.964**
4	rp	0.299	0.058	0.137	-0.198	0.150	0.087	-0.085
	rg	0.780	0.049	0.408	-0.503	-0.386	-0.219	-0.262
5	rp	-0.222	0.169	0.319	0.431	0.154	0.271	0.269
	rg	-0.222	0.181	0.324	0.439	0.158	0.284	0.280
6	rp	-0.041	0.070	0.344	0.276	0.139	0.346	0.323
	rg	-0.048	0.028	0.394	0.312	0.148	0.389	0.385
7	rp	-0.351	0.257	-0.005	0.328	0.072	-0.081	-0.085
	rg	-0.535	0.418	-0.006	0.515	0.094	-0.179	0.147
8	rp	1.000	-0.050	0.212	-0.733**	0.159	-0.055	-0.053
	rg	1.000	-0.052	0.213	-0.733**	0.162	-0.056	-0.054
9	rp		1.000	0.084	0.115	0.214	0.166	0.192
	rg		1.000	0.089	0.120	0.221	0.171	0.200
10	rp			1.000	0.504	0.713	-0.365	-0.385
	rg			1.000	0.504	0.728	0.372	-0.387
11	rp				1.000	0.357	-0.211	-0.227
	rg				1.000	0.363	-0.215	-0.227
12	rp					1.000	-0.292	-0.312
	rg					1.000	-0.294	-0.316
13	rp						1.000	0.994**
	rg						1.000	0.998**
14	rp							1.000
	rg							1.000

Path coefficient analysis was carried out with genotypic correlations following Dewey and Lu (5).

Results and Discussion

The analysis of variance revealed significant dif-

Table 4. Direct and indirect effects of path coefficients based on genotypic correlation with seed cotton yield per plant in upland cotton under rainfed condition.

Characters	1	2	3	4	5	6	7	8	9	10	11	12	Genotypic correlation with SCY/plant
1	-0.351	-0.006	0.183	0.013	0.069	-0.076	0.055	0.605	0.209	-0.471	-0.272	0.258	0.216
2	0.007	0.289	0.996	0.005	0.079	-0.074	-0.073	0.125	-0.095	-0.938	0.580	0.061	0.917**
3	-0.058	0.315	0.997	0.008	0.072	-0.153	-0.107	0.206	-0.113	-0.953	0.617	0.133	0.964**
4	0.208	-0.060	-0.407	-0.022	-0.023	-0.182	-0.223	-0.997	-0.277	0.971	0.988	-0.194	-0.262
5	0.019	0.043	0.119	-0.001	0.037	0.119	-0.013	0.111	0.010	0.122	-0.284	-0.026	0.280
6	0.009	0.073	-0.007	0.031	0.031	0.144	-0.002	0.020	0.004	0.131	-0.182	-0.012	0.385
7	0.018	-0.022	0.030	0.013	0.013	0.010	-0.035	0.175	0.015	-0.002	-0.217	-0.068	-0.147
8	-0.022	-0.012	-0.022	-0.008	-0.008	-0.006	-0.012	-0.498	-0.003	0.081	0.483	-0.014	-0.054
9	-0.041	0.081	-0.004	0.006	0.006	0.010	-0.009	0.025	0.057	0.032	-0.076	-0.019	0.200
10	-0.015	-0.090	-0.010	0.012	0.012	0.050	0.000	-0.106	0.005	0.382	-0.333	-0.063	-0.387
11	0.009	-0.054	0.015	0.015	0.015	0.040	-0.012	0.365	0.007	0.192	-0.660	-0.032	-0.227
12	-0.042	-0.027	0.011	0.006	0.006	0.020	-0.003	-0.079	0.012	0.272	-0.236	-0.089	-0.316
			R=0.0585										

ferences among the hybrids for all the 14 characters under study (Table 1). The GCV was comparatively high for seed cotton yield (12.44%), seed cotton yield per plant (12.63%), number of seeds per boll (11.76%), number of bolls per plant (11.44%) and boll weight (10.13%) (Table 2). Moderate values of GCV, was observed for no. of seeds per locule (9.95%), number of sympodia per plant (9.22%), fiber strength/length ratio (8.67%), 2.5% fiber length (8.21%), number of monopodia per plant (6.39%) and fiber strength (6.03%), while this value was comparatively low for rest of the traits. Low GCV/PCV ratio of number of monopodia per plant (0.37) and number of locules/boll (0.65) indicated that these characters were highly influenced by environmental factors. High GCV / PVC ratio was recorded for rest of characters.

High heritability value was recorded for seed cotton yield per plant (99.10%), seed cotton yield per hectare (98.00), 2.5% fiber length (99.90), fiber strength (99.60%), fiber fineness (96.30%), strength/length ratio (99.60%), days to 50% boll bursting (96.40%), number of seeds per boll (95.80%), number of bolls per plant (85.10%), number of seeds per locule (76.80%) and boll weight (75.90%) which indicated that selection was effective for these traits. These findings are in agreement with Rao and Reddy (6), Joshi et al. (7) and Samba Murty and Chamundeswari (8).

High heritability coupled with high genetic advance as per cent of mean was recorded for seed cotton yield (q/ha), seed cotton yield per plant (g), fiber fineness (mic), number of seeds/boll, number of bolls/plant and boll weight (g) under rainfed condition, revealing the influence of additive gene action for these traits. Hence the improvement of these traits can be made through direct phenotypic selection. High heritability coupled with low genetic advance as per cent of mean was recorded for 2.5% of fiber length (mm), fiber strength (g/tex), strength/length ratio and days to 50% boll bursting indicating the effect of non-additive gene action like heterosis breeding may be tried for improvement of these traits.

The genotypic and phenotypic correlation coefficients were worked out to assess their strength and direction (Table 3). The genotypic correlation coefficients were similar in direction but higher in magnitude than phenotypic correlation coefficients revealing the influence of environment. Seed cotton yield was found to be positively and significantly associated with number of sympodia per plant and number of bolls per plant both at phenotypic and genotypic level. Similar relationship has been reported by Neelam and potduke (9), Samba Murty and Chamundeswari (8). Similarly, positive and significant correlations both at phenotypic and genotypic level were recorded for number of bolls per plant with number of sympodia per plant; number of seeds per boll with number of seeds per locule and days to 50% boll bursting with fiber strength, whereas significant nega-

Table 5. Direct and indirect effects of path coefficients based on genotypic correlation with seed cotton yield per plant in upland cotton under rainfed condition.

Characters	1	2	3	4	5	6	7	8	9	10	11	12	Genotypic correlation with SCY/plant
1	-0.378	-0.005	0.185	0.028	0.058	-0.064	0.055	0.642	0.223	-0.488	-0.288	0.239	0.207
2	0.007	0.268	0.906	0.010	0.067	-0.148	-0.018	0.133	-0.208	-0.976	0.620	0.560	0.919**
3	-0.063	0.291	0.912	0.017	0.061	-0.129	-0.056	0.218	-0.121	-0.995	0.652	0.124	0.962**
4	0.223	-0.055	-0.412	-0.047	-0.020	-0.154	-0.223	0.915	-0.023	0.912	0.975	-0.180	-0.219
5	0.084	0.086	0.259	0.004	0.263	-0.370	0.217	0.585	-0.087	0.082	-0.976	-0.077	0.284
6	-0.062	0.101	0.680	-0.019	0.250	-0.390	0.009	0.123	-0.014	0.974	-0.878	-0.073	0.389
7	-0.055	-0.012	-0.166	0.028	0.151	-0.010	0.378	0.983	-0.201	-0.017	-0.992	-0.046	-0.179
8	0.094	-0.014	-0.094	-0.037	-0.060	0.019	-0.202	-0.984	0.025	0.580	0.997	-0.079	-0.056
9	0.175	0.116	0.278	-0.002	0.048	-0.011	0.158	0.135	-0.782	0.242	-0.376	-0.108	0.171
10	0.068	-0.006	0.046	-0.019	0.085	-0.154	-0.002	-0.049	-0.043	0.973	-0.977	-0.356	0.372
11	-0.035	-0.063	-0.232	0.012	-0.024	0.064	0.001	0.272	0.002	0.143	-0.495	-0.025	-0.215
12	-0.041	-0.026	-0.141	-0.009	-0.009	0.032	0.000	-0.059	0.004	0.203	-0.177	0.069	-0.294

tive correlation was noted between 2.5% staple length and fiber strength/length ratio. The genotypic correlation with seed cotton yield was further partitioned into direct and indirect effects to establish the cause and effect relationship among the yield and its component characters (Table 4). Path analysis revealed that the significant and positive association of seed cotton yield per hectare and per plant with number of bolls per plant was due to high positive direct effect of number of bolls per plant (Table 5). It was also found that the significant and positive association of seed cotton yield per hectare and per plant with number of sympodia per plant was due to high indirect effect of number of boll per plant. Similar findings were earlier reported by Samba Murty and Chamundeswari (8), Althaher and Singh (10) and Kowsalya and Raveendran (11).

Thus, from these studies it can be inferred that number of bolls per plant, number sympodia per plant and seed cotton yield per plant had greater influenced on seed cotton yield (q/ha). In the cotton improvement program, due emphasis could be given to these four traits while selecting high yielding lines of cotton.

References

1. Singh R. K. and B. D. Chaudhury. 1985. Biometrical methods in quantitative genetic analysis. Kalyani Publ., New Delhi, India.
2. Burton G. W. 1952. Quantitative inheritance in grasses. Proc. 6th Int. Grassl. Cong. 1 : 277—283.
3. Johnson H. W., H. F. Robinson and R. E. Comstock. 1955. Estimates of genetic and environmental variability in soybean. Agron. J. 47 : 314—318.
4. AI-Jibouri H. A., P. A. Miller and H. F. Robinson. 1558. Genotypic and environmental variances and covariances in an upland cotton cross of inter specific origin. Agron. J. 50 : 633—636.
5. Dewey D. R. and K. H. Lu. 1959. Correlation and Pth coefficient analysis of crested wheat grass seed production. Agron. J. 51 : 515—518.
6. Rao G. N. and M. S. S. Reddy. 2001. Studies on heritability and variability for yield and its components in cotton (*Gossypium hirsutum* L.) J. Cott. Res. Dev. 15 : 84—86.
7. Joshi H. J., P. K. Chovatia and D. R. Metha. 2006. Genetic variability, character association and component analysis in upland cotton. Indian J. Agric. Res. 40 : 302—305.
8. Samba Murty J. S. V. and N. Chamundeswari. 2006. Yield component analysis in introgressed lines of upland cotton (*Gossypium hirsutum* L.) J. Cott. Res. Dev. 20 : 1—4.
9. Neelam G. D. and N. R. Potduke. 2002. Studies on variability and correlations in upland cotton for yield and its components. J. Indian. Soc. Cott. Improv. 16 : 148—151.
10. Althaher A. F. and R. P. Singh. 2003. Yield component analysis in upland cotton (*Gossypium hirsutum* L.) J. Indian Soc. Cott. Improv. 28 : 151—157.
11. Kowsalya R. A. and T. S. Raveendran. 1996. Genetic variability and D_2 analysis in upland cotton. Crop Res. 12 : 36—42.