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# Character association and path coefficient analysis for yield and component traits in upland cotton (G*ossypium hirsutum* L.)

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**ABSTRACT :** Correlation and path coefficient analysis for yield and yield contributing characters in upland cotton were carried with 55 genotypes of cotton for 17 characters. Correlation studies showed that seed cotton yield/plant was significantly and positively correlated with plant height, bolls/plant, boll weight, 2.5 per cent span length, bundle strength and lint yield/plant at both phenotypic and genotypic levels. Pathanalysis revealed high positive direct effect of bolls/plant, boll weight and lint yield/plant on seed cotton yield/plant. Selection based on these characters would improve seed cotton yield. Due weightage should be given in selection process with more bolls/plant and more boll weight and there should be economic balance among these traits to get higher seed cotton yield/plant.

**Key words:** Character association, path analysis, upland cotton, yield

Cotton (*Gossypium hirsutum* L.), is an important commercial crop of the country. It is an important natural fibre crop of global importance and widely referred as "White Gold". In India, cotton is being grown over an area of 126.55 lakh ha with an annual production of 400 lakh bales (1 bale=170 kgs of lint) with a productivity of 537 kg/ha (Anonymous, 2015). Yield is a polygenically inherited character resulting from multiplicative interaction of its contributing characters. Yield is highly influenced by the environment, hence selection based on yield alone may limit the progress, where as the yield component characters are less complex in inheritance and are influenced by the environment to a lesser extent. Both the correlation and path coefficient analysis form a basis for selection and also helps in understanding those yield components affecting yield improvement through the study of their direct and indirect effects.

The present study was conducted during *kharif,* 2013-2014 at Regional Agricultural Research Station, Lam Farm, Guntur, in randomized block design with 55 genotypes (45 $F_1$s and 10 parents) with 3 replications following 120 x 60 cm spacing. Recommended doses of fertilizers 120 N, 60 $P_2O_5$ and 40 $K_2O$ kg/ha were applied in split doses. Each plot consisted of 3 rows of 6 m length and observations were recorded on 5 randomly selected plants from each genotype/replication for 17 characters *viz.,* plant height (cm), monopodia, sympodia and bolls/plant, boll weight (g), chlorophyll content (mg/g fresh weight), seed index (g), lint index (g), seed cotton yield/plant (g) and lint yield/plant (g). Days to 50 per cent flowering, ginning outturn (%), 2.5 per cent span length (mm), micronaire value ($10^{-6}$g/inch), bundle strength (g/tex), uniformity ratio and elongation (%) were recorded on plot basis. The fibre quality parameters were studied at Central Institute for Research on Cotton Technology (CIRCOT), RARS, Lam, Guntur, Andhra Pradesh. The data was statistically analysed to estimate genotypic and phenotypic correlation coefficients and path coefficient

analysis.

The correlation coefficient provided a reliable measure of association among the characters and help to differentiate vital associates useful in breeding from those of the non vital ones.The analysis of variance indicated significant differences among the genotypes for all the characters. Genotypic correlation coefficients in general were higher than phenotypic correlation coefficients (Table 1.). Seed cotton yield/plant was significantly and positively correlated with plant height, bolls/plant, boll weight, 2.5 per cent span length, bundle strength and lint yield/plant at both phenotypic and genotypic levels indicates that improvement in yield is possible through simultaneous selection for these component characters under hybridization programmes in cotton.. Similar results were reported by Kumari Vinodhana *et al.,* (2013) and Rumesh Ranjan *et al.,* (2014).

Significant and positive correlations at both the levels were also observed between component characters themselves like that of days to 50 per cent flowering with no. of sympodia/plant, 2.5 per cent span length, bundle strength and uniformity ratio Rumesh Ranjan *et al.,* (2014), plant height with monopodia, sympodia and bolls/plant, uniformity ratio and lint yield/plant (Kumari Vinodhana *et al.,* 2013 and Chitti *et al.,* 2014), sympodia/plant with no. of bolls/plant (Rajamani *et al.,* 2013), bolls/plant with lint yield/plant, boll weight with 2.5 per cent span length and bundle strength (Kumari Vinodhana *et al.,* 2013 and Santosh Kumar *et al.*, 2014), seed index with lint index (Kumari Vinodhana *et al.,* 2013 and Pujer *et al.,* 2014), lint index with ginning outturn and micronaire value (Rajanna *et al.*, 2011 and Rajamani *et al.,* 2013), ginning outturn with bundle strength, uniformity ratio, elongation percentage and lint yield/plant, 2.5 per cent span length with bundle strength (Kumari Vinodhana *et al.,* 2013 and Pujer *et al.,* 2014), micronaire value with uniformity ratio and elongation per cent, uniformity ratio with elongation per cent.

The correlation coefficient estimates mostly indicated inter relationship of different characters but it did not furnish information on cause and effect. Under such situation path analysis helps the breeder to identify the index of selection. Path coefficient analysis was done in order to study the direct and indirect effects of individual component characters on the dependent variable *i.e.*, seed cotton yield/plant. Study of path coefficients enable the breeders to concentrate on the variables which show high direct effect on seed cotton yield. The genotypic and phenotypic correlation coefficients of seed cotton yield with other yield and fibre quality traits was further partitioned into direct and indirect effects and the results were presented in Table 2 and 3.

The component of residual effect of path analysis in yield and fibre quality traits is 0.0986 at genotypic level and 0.3159 at phenotypic level. The lower residual effect indicated that the characters chosen for path analysis were adequate and appropriate.

Path coefficient analysis indicated that bolls/plant, boll weight and lint yield/plant had shown direct positive effect on seed cotton yield/plant at both phenotypic and genotypic levels. These results are in conformity with the findings of Kumari Vinodhana *et al.,* (2013) and Rumesh Ranjan *et al.,* (2014) and Pujer *et al.,* (2014).

The indirect positive effect on seed cotton yield/plant at both phenotypic and genotypic levels by days to 50 per cent flowering with lint yield/plant, plant height with bolls /plant and lint yield/plant, sympodia/plant with bolls/plant and lint yield/plant, bolls/plant with boll weight

**Table 1.** Phenotypic (above diagonal) and genotypic (below diagonal) correlation coefficients for seed yield and yield traits of cotton at RARS, Lam

| Character | Days to 50 per cent flowering | Plant height | Mono-podia/ plant | Symp-odia/ plant | Bolls/ plant | Boll weight | Chloro-phyll content | Seed index | Lint index | Ginning out turn | 2.5 per cent span length | Micro-naire value | Budnle strength | Unifo-rmity ratio | Elong-ation | Lint yield/ plant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days to 50 per cent flowering | — | 0.0289 | 0.0549 | 0.1922* | -0.103 | -0.1196 | 0.1178 | -0.0694 | -0.1892* | -0.1492 | 0.1881* | -0.0445 | 0.3831** | 0.1295 | 0.1947** | -0.2185** |
| Plant height | 0.0183 | — | 0.1600* | 0.2448** | 0.3512** | 0.0158 | -0.1656* | 0.0593 | 0.0181 | -0.0146 | -0.2096** | 0.0364 | -0.0533 | 0.2003** | 0.1448 | 0.1590* |
| Monopodia/plant | 0.1643* | 0.2433** | — | -0.0509 | 0.0507 | -0.1517 | -0.0962 | 0.0655 | 0.0425 | -0.0488 | -0.1294 | 0.0646 | 0.0135 | 0.0967 | 0.1124 | -0.0964 |
| Sympodia/plant | 0.3738** | 0.3726** | -0.2239** | — | 0.2034** | -0.0352 | 0.0193 | -0.0987 | -0.0585 | 0.0357 | -0.0676 | 0.0196 | -0.0828 | 0.1349 | -0.0671 | 0.1610* |
| Bolls/plant | -0.1417 | 0.4635** | 0.1235 | 0.3146** | — | 0.0414 | -0.1767* | -0.0305 | 0.026 | 0.0953 | -0.0982 | 0.0508 | -0.0784 | 0.0868 | 0.1051 | 0.5861** |
| Boll weight | -0.1149 | 0.0385 | -0.4433** | -0.093 | 0.0362 | — | 0.0015 | 0.0087 | -0.1089 | -0.1212 | 0.3368** | -0.2100** | 0.2622** | -0.1590* | -0.1176 | 0.6411** |
| Chlorophyll content | 0.2713** | -0.3368** | -0.1284 | 0.4485** | -0.1892* | -0.0662 | —- | -0.1943* | -0.2180** | -0.0254 | 0.0682 | -0.0353 | 0.0444 | 0.0713 | -0.005 | -0.1052 |
| Seed index | -0.0743 | 0.0738 | 0.2186** | -0.1602* | -0.0112 | 0.0114 | -0.4319** | — | 0.6548** | -0.4541** | 0.2630** | 0.0362 | 0.1106 | -0.4007** | -0.1464 | -0.2163** |
| Lint index | -0.2161** | 0.042 | 0.2122** | -0.1277 | 0.0014 | -0.1441 | -0.4597** | 0.6928** | — | 0.3654** | -0.1148 | 0.2968** | -0.1864* | -0.0949 | 0.0457 | 0.1226 |
| Ginning outturn | -0.1821* | 0.0043 | -0.0687 | 0.0317 | 0.0527 | -0.1759* | 0.0046 | -0.4902** | 0.2783** | — | -0.4702** | 0.2897** | -0.3632** | 0.3812** | 0.2429** | 0.4232** |
| 2.5 per cent span length | 0.2309** | -0.3389** | -0.2548** | -0.1235 | -0.1271 | 0.4264** | 0.1326 | 0.3080** | -0.123 | -0.5789** | — | -0.5846** | 0.6581** | -0.4892** | -0.3022** | -0.0397 |
| Micronaire value | -0.044 | 0.0498 | 0.1728* | 0.0588 | 0.0721 | -0.2854** | -0.0786 | 0.0343 | 0.3158** | 0.3236** | -0.6443** | — | -0.4472** | 0.4104** | 0.3738** | 0.0133 |
| Budnle strength | 0.4498** | -0.0842 | 0.0701 | -0.0519 | -0.1432 | 0.3606** | 0.0038 | 0.1615* | -0.2170** | -0.4944** | 0.8230** | -0.5122** | — | -0.2554** | 0.0443 | -0.0453 |
| Uniformity ratio | 0.1785* | 0.2905** | 0.1066 | 0.2147** | 0.0845 | -0.1795* | 0.1819* | -0.4850** | -0.1122 | 0.5195** | -0.6680** | 0.4938** | -0.3151** | — | 0.4254** | 0.1027 |
| Elongation | 0.2844** | 0.3205** | 0.3776** | 0.0159 | 0.0851 | -0.0886 | -0.1021 | -0.2051** | 0.0865 | 0.3927** | -0.4607** | 0.6282** | 0.0738 | 0.7201** | — | 0.0465 |
| Lint yield/plant | -0.2537** | 0.2431** | -0.2901** | 0.2180** | 0.6024** | 0.6119** | -0.2012** | -0.2309** | 0.068 | 0.3997** | -0.0436 | -0.004 | -0.0824 | 0.1681* | 0.124 | — |
| Seed cotton yield/plant (P) | **-0.1432** | **0.1756*** | **-0.0763** | **0.1157** | **0.5825**** | **0.7677**** | **-0.1116** | **-0.0145** | **-0.0644** | **-0.0332** | **0.1953*** | **-0.1322** | **0.1590*** | **-0.0865** | **-0.0458** | **0.8208**** |
| Seed cotton yield/plant (G) | **-0.1712*** | **0.3259**** | **-0.3189**** | **0.1067** | **0.6456**** | **0.8394**** | **-0.1316** | **0.0022** | **-0.116** | **-0.1091** | **0.2879**** | **-0.2058**** | **0.2235**** | **-0.0723** | **-0.0152** | **0.8812**** |

*significant at 5% level **significant at 1% level

**Table 2.** Direct and indirect effects (phenotypic) of yield components on seed cotton yield of cotton at RARS, Lam

| Character | Days to 50 per cent flowering | Plant height | Mono-podia/ plant | Symp-odia/ plant | Bolls/ plant | Boll weight | Chloro-phyll content | Seed index | Lint index | Ginning out turn | 2.5 per cent span length | Micro-naire value | Budnle strength | Unifo-rmity ratio | Elong-ation | Lint yield/ plant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days to 50 per cent flowering | **0.0045** | 0.0001 | 0.0002 | 0.0009 | -0.0005 | -0.0005 | 0.0005 | -0.0003 | -0.0008 | -0.0007 | 0.0008 | -0.0002 | 0.0017 | 0.0006 | 0.0009 | -0.001 |
| Plant height | -0.0012 | **-0.0406** | -0.0065 | -0.0099 | -0.0143 | -0.0006 | 0.0067 | -0.0024 | -0.0007 | 0.0006 | 0.0085 | -0.0015 | 0.0022 | -0.0081 | -0.0059 | -0.0065 |
| Monopodia/plant | 0.0009 | 0.0025 | **0.0155** | -0.0008 | 0.0008 | -0.0024 | -0.0015 | 0.001 | 0.0007 | -0.0008 | -0.002 | 0.001 | 0.0002 | 0.0015 | 0.0017 | -0.0015 |
| Sympodia/plant | 0.0054 | 0.0069 | -0.0014 | **0.0281** | 0.0057 | -0.001 | 0.0005 | -0.0028 | -0.0016 | 0.001 | -0.0019 | 0.0005 | -0.0023 | 0.0038 | -0.0019 | 0.0045 |
| Bolls/plant | -0.0447 | 0.1524 | 0.022 | 0.0883 | **0.4339** | 0.018 | -0.0767 | -0.0132 | 0.0113 | 0.0414 | -0.0426 | 0.022 | -0.034 | 0.0377 | 0.0456 | 0.2543 |
| Boll weight | -0.0704 | 0.0093 | -0.0893 | -0.0207 | 0.0243 | **0.5884** | 0.0009 | 0.0051 | -0.0641 | -0.0713 | 0.1982 | -0.1236 | 0.1543 | -0.0936 | -0.0692 | 0.3773 |
| Chlorophyll content | -0.0021 | 0.003 | 0.0018 | -0.0004 | 0.0032 | 0 | **-0.0182** | 0.0035 | 0.004 | 0.0005 | -0.0012 | 0.0006 | -0.0008 | -0.0013 | 0.0001 | 0.0019 |
| Seed index | -0.0094 | 0.008 | 0.0088 | -0.0133 | -0.0041 | 0.0012 | -0.0262 | **0.1347** | 0.0882 | -0.0612 | 0.0354 | 0.0049 | 0.0149 | -0.054 | -0.0197 | -0.0291 |
| Lint index | 0.0256 | -0.0025 | -0.0058 | 0.0079 | -0.0035 | 0.0148 | 0.0295 | -0.0887 | **-0.1355** | -0.0495 | 0.0156 | -0.0402 | 0.0253 | 0.0129 | -0.0062 | -0.0166 |
| Ginning outturn | -0.0019 | -0.0002 | -0.0006 | 0.0005 | 0.0012 | -0.0016 | -0.0003 | -0.0058 | 0.0047 | **0.0129** | -0.0061 | 0.0037 | -0.0047 | 0.0049 | 0.0031 | 0.0054 |
| 2.5 per cent span length | -0.0055 | 0.0061 | 0.0038 | 0.002 | 0.0029 | -0.0098 | -0.002 | -0.0076 | 0.0033 | 0.0137 | **-0.0291** | 0.017 | -0.0191 | 0.0142 | 0.0088 | 0.0012 |
| Micronaire value | -0.0002 | 0.0002 | 0.0003 | 0.0001 | 0.0003 | -0.001 | -0.0002 | 0.0002 | 0.0015 | 0.0014 | -0.0029 | **0.005** | -0.0022 | 0.002 | 0.0019 | 0.0001 |
| Budnle strength | 0.0113 | -0.0016 | 0.0004 | -0.0024 | -0.0023 | 0.0078 | 0.0013 | 0.0033 | -0.0055 | -0.0107 | 0.0195 | -0.0132 | **0.0296** | -0.0076 | 0.0013 | -0.0013 |
| Uniformity ratio | -0.0026 | -0.004 | -0.0019 | -0.0027 | -0.0017 | 0.0032 | -0.0014 | 0.008 | 0.0019 | -0.0076 | 0.0098 | -0.0082 | 0.0051 | **-0.02** | -0.0085 | -0.002 |
| Elongation | -0.0017 | -0.0013 | -0.001 | 0.0006 | -0.0009 | 0.001 | 0 | 0.0013 | -0.0004 | -0.0021 | 0.0026 | -0.0033 | -0.0004 | -0.0037 | **-0.0087** | -0.0004 |
| Lint yield/plant | -0.0513 | 0.0373 | -0.0226 | 0.0378 | 0.1375 | 0.1504 | -0.0247 | -0.0507 | 0.0288 | 0.0993 | -0.0093 | 0.0031 | -0.0106 | 0.0241 | 0.0109 | **0.2346** |
| Seed cotton yield/plant | **-0.1432** | **0.1756** | **-0.0763** | **0.1157** | **0.5825** | **0.7677** | **-0.1116** | **-0.0145** | **-0.0644** | **-0.0332** | **0.1953** | **-0.1322** | **0.159** | **-0.0865** | **-0.0458** | **0.8208** |

Residual effect = 0.3159 *Significant at 5% level **Significant at 1% level Bold and diagonal values indicate direct effects

**Table 3.** Direct and indirect effects (Genotypic) of yield components on seed cotton yield of cotton at RARS, Lam

| Character | Days to 50 per cent flowering | Plant height | Mono-podia/ plant | Symp-odia/ plant | Bolls/ plant | Boll weight | Chloro-phyll content | Seed index | Lint index | Ginning out turn | 2.5 per cent span length | Micro-naire value | Budnle strength | Unifo-rmity ratio | Elong-ation | Lint yield/ plant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days to 50 per cent flowering | **0.0696** | 0.0013 | 0.0114 | 0.026 | -0.0099 | -0.008 | 0.0189 | -0.0052 | -0.015 | -0.0127 | 0.0161 | -0.0031 | 0.0313 | 0.0124 | 0.0198 | -0.0176 |
| Plant height | 0.0018 | **0.0969** | 0.0236 | 0.0361 | 0.0449 | 0.0037 | -0.0326 | 0.0071 | 0.0041 | 0.0004 | -0.0328 | 0.0048 | -0.0082 | 0.0281 | 0.031 | 0.0235 |
| Monopodia/plant | -0.0211 | -0.0312 | **-0.1283** | 0.0287 | -0.0158 | 0.0569 | 0.1448 | -0.028 | -0.0272 | 0.0088 | 0.0327 | -0.0222 | -0.009 | -0.0137 | -0.0484 | 0.0372 |
| Sympodia/plant | -0.0658 | -0.0656 | 0.0394 | **-0.1761** | -0.0554 | 0.0164 | -0.079 | 0.0282 | 0.0225 | -0.0056 | 0.0218 | -0.0104 | 0.0091 | -0.0378 | -0.0028 | -0.0384 |
| Bolls/plant | -0.0512 | 0.1676 | 0.0447 | 0.1138 | **0.3617** | 0.0131 | -0.0684 | -0.0041 | 0.0005 | 0.0191 | -0.046 | 0.0261 | -0.0518 | 0.0306 | 0.0308 | 0.2179 |
| Boll weight | -0.0435 | 0.0146 | -0.168 | -0.0352 | 0.0137 | **0.379** | -0.0251 | 0.0043 | -0.0546 | -0.0666 | 0.1616 | -0.1082 | 0.1366 | -0.068 | -0.0336 | 0.2319 |
| Chlorophyll content | 0.0066 | -0.0081 | -0.0273 | 0.0108 | -0.0046 | -0.0016 | **0.0242** | -0.0104 | -0.0111 | 0.0001 | 0.0032 | -0.0019 | 0.0001 | 0.0044 | -0.0025 | -0.0049 |
| Seed index | 0.0062 | -0.0061 | -0.0182 | 0.0133 | 0.0009 | -0.0009 | 0.0359 | **-0.083** | -0.0575 | 0.0407 | -0.0256 | -0.0029 | -0.0134 | 0.0403 | 0.017 | 0.0192 |
| Lint index | -0.0203 | 0.0039 | 0.0199 | -0.012 | 0.0001 | -0.0135 | -0.0431 | 0.065 | **0.0938** | 0.0261 | -0.0115 | 0.0296 | -0.0203 | -0.0105 | 0.0081 | 0.0064 |
| Ginning outturn | 0.0661 | -0.0015 | 0.0249 | -0.0115 | -0.0191 | 0.0638 | -0.0017 | 0.1778 | -0.101 | **-0.3628** | 0.21 | -0.1174 | 0.1794 | -0.1884 | -0.1424 | -0.145 |
| 2.5 per cent span length | 0.0102 | -0.0149 | -0.0112 | -0.0054 | -0.0056 | 0.0188 | 0.0058 | 0.0136 | -0.0054 | -0.0255 | **0.044** | -0.0284 | 0.0362 | -0.0294 | -0.0203 | -0.0019 |
| Micronaire value | 0.0035 | -0.0039 | -0.0137 | -0.0047 | -0.0057 | 0.0226 | 0.0062 | -0.0027 | -0.025 | -0.0257 | 0.0511 | **-0.0793** | 0.0406 | -0.0392 | -0.0498 | 0.0003 |
| Budnle strength | -0.0312 | 0.0058 | -0.0049 | 0.0036 | 0.0099 | -0.025 | -0.0003 | -0.0112 | 0.0151 | 0.0343 | -0.0571 | 0.0356 | **-0.0694** | 0.0219 | -0.0051 | 0.0057 |
| Uniformity ratio | 0.0012 | 0.002 | 0.0007 | 0.0015 | 0.0006 | -0.0013 | 0.0013 | -0.0034 | -0.0008 | 0.0036 | -0.0047 | 0.0035 | -0.0022 | **0.007** | 0.005 | 0.0012 |
| Elongation | 0.0319 | 0.0359 | 0.0423 | 0.0018 | 0.0095 | -0.0099 | -0.0114 | -0.023 | 0.0097 | 0.044 | -0.0516 | 0.0704 | 0.0083 | 0.0807 | **0.112** | 0.0139 |
| Lint yield/plant | -0.1349 | 0.1293 | -0.1543 | 0.1159 | 0.3204 | 0.3254 | -0.107 | -0.1228 | 0.0362 | 0.2126 | -0.0232 | -0.0021 | -0.0438 | 0.0894 | 0.0659 | **0.5318** |
| Seed cotton yield/plant | **-0.1712** | **0.3259** | **-0.3189** | **0.1067** | **0.6456** | **0.8394** | **-0.1316** | **0.0022** | **-0.116** | **-0.1091** | **0.2879** | **-0.2058** | **0.2235** | **-0.0723** | **-0.0152** | **0.8812** |

RESIDUAL EFFECT = 0.0986 * Significant at 5% level **Significant at 1% level, Bold and diagonal values indicate direct effects

and lint yield/plant, boll weight and lint index with bolls/plant, ginning outturn with bolls/plant and lint yield/plant, 2.5 per cent span length and bundle strength with boll weight, uniformity ratio and elongation percentage with bolls/plant, lint yield/plant with bolls/plant and boll weight was observed.

Selection for high seed cotton yield seems to be possible through bolls/plant, boll weight and lint yield/plant as they exerted high positive direct effect as well as had significant and positive association with seed cotton yield/plant.

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