# Correlation and Path Analysis Studies in Cotton (*Gossypium hirsutum* L.)

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## ABSTRACT

The study was undertaken with an objective to study the correlation and path analysis studies for seed yield and yield traits in cotton genotypes during *kharif,* 2012-13 at Agricultural College Farm, Bapatla, Andhra Pradesh. Correlation and path coefficient analyses together indicated that plant height, number of sympodia per plant, number of bolls per plant, lint index, bundle strength, fibre elongation and micronaire had significant positive direct effects on seed cotton yield per plant indicating the existence of true relationship between these characters and their exploitation in selection programmes

**Key words :** Cotton, Correlation, Path analysis.

Cotton is an important fibre crop of global importance which is grown in tropical and subtropical regions of more than 60 countries of the world. Despite threat from synthetic fibre or manmade fibre, cotton retains its reputation as "Queen of the fibre plants". For multiple uses of lint and by-products, cotton is also referred to as "white gold". It is the most important commercial crop contributing nearly 65 per cent of the total raw material needs of the textile industry in our country as well as earning foreign exchange for the country. There are four cultivated species in cotton and India is the only country in world to cultivate these four species. Among the four species, *G. hisutum* is highly cultivated for its yield and fibre characteristics.

Yield is a complex and polygenes controlled trait where improvement is not possible with simple selection and the environmental role in the expression is very huge. Hence, direct selection for yield is not effective and needs a technique where other parameters are selected based on which the yield improvement can be achieved. Correlation studies provide the cause and effect relationship between various yield traits and determine the component traits through which selection can be made for improvement in yield. Path analysis allows partitioning the correlation into direct and indirect effects in order to perceive the most influencing characters to be utilized in the selection criteria in cotton breeding programmes.

## MATERIAL AND METHODS

The experiment was conducted during 2012-13 *kharif* at Agricultural College Farm, Bapatla. The experimental material consisted of 60 genotypes. The experiment was laid in a randomized block design with three replications. Each plot consisted of two rows each of 6 m length with a spacing of 120 X 60 cm. Observations recorded on ten randomly selected plants for the following parameters plant height (cm), days to 50% flowering, number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight (g), seed index (g), lint index (g), ginning out-turn (%), bundle strength (g/tex), fibre elongation (%), uniformity ratio, micronaire ($10^{-6}$g/in), and seed cotton yield per plant (g). The data was statically analysed to estimate the genotypic and phenotypic correlation suggested by Folconer (1964) and path analysis as per Wright (1921) and Dewey and Lu (1964).

## RESULTS AND DISCUSSION

In general, the genotypic values are more than the phenotypic values for correlation coefficients indicating the true relationship among the traits. The correlation of yield and yield component characters are presented in Table-1. Seed cotton yield per plant showed significant positive association with plant height (0.2743** and 0.3409), days to 50% flowering (0.1888* and 0.2524**), number of monopodia per plant (0.1578*

Table 1. Phenotypic (above diagonal) and genotypic (below diagonal) correlation of 15 characters in 60 cotton (*Gossypium hirsutum* L.) genotypes.

| Character | Plant height (cm) | Days to 50% flowering | No.of monopodia per plant | No.of sympodia per plant | No.of bolls per plant | Boll weight (g) | Seed index (g) |
|---|---|---|---|---|---|---|---|
| Plant height (cm) | 1.0000 | 0.5222** | 0.5191** | 0.4181** | 0.2076** | 0.0320 | 0.0381 |
| Days to 50% flowering | 0.6594** | 1.0000 | 0.5335** | 0.3504** | -0.1320 | 0.2653** | 0.0449 |
| No.of monopodia per plant | 0.6950** | 0.6086** | 1.0000 | 0.2825** | -0.0136 | 0.1444 | 0.1091 |
| No.of sympodia per plant | 0.6637** | 0.4850** | 0.4562** | 1.0000 | 0.2948** | 0.1813* | 0.1314 |
| No.of bolls per plant | 0.2539** | -0.1207 | -0.0080 | 0.4324** | 1.0000 | -0.3409** | -0.1807* |
| Boll weight (g) | 0.0276 | 0.3070** | 0.1738* | 0.2366** | -0.3951** | 1.0000 | 0.3244** |
| Seed index (g) | 0.0624 | 0.0668 | 0.1874* | 0.1728* | -0.2758** | 0.4014** | 1.0000 |
| Lint index (g) | -0.0099 | -0.1528* | 0.1017 | 0.1928** | 0.1349 | 0.0994 | 0.7288** |
| Ginning out-turn (%) | -0.0437 | -0.2029** | 0.0044 | 0.0669 | 0.5680** | -0.2803** | -0.2094** |
| 2.5 % span length (mm) | -0.3575** | -0.1938** | -0.0614 | -0.0131 | -0.2372** | 0.0675 | 0.3530** |
| Bundle strength (g/tex) | 0.2284** | 0.1834* | 0.0829 | 0.4638** | 0.1879* | 0.4054** | 0.2425** |
| Fibre elongation (%) | 0.2306** | 0.3585** | 0.2146** | 0.4221** | 0.2008** | 0.1295 | 0.1488* |
| Uniformity ratio | -0.0086 | 0.0603 | -0.0713 | 0.1595* | 0.0769 | 0.0940 | -0.1326 |
| Micronaire ($10^{-6}$ g Inch$^{-1}$ ) | 0.2403** | 0.3282** | 0.2069** | 0.3496** | 0.2110** | 0.2877** | -0.0409 |
| Seed cotton yield per plant | 0.3409** | 0.2524** | 0.1963** | 0.6857** | 0.5838** | 0.5166** | 0.0972 |

Table 1 cont....

| Character | Lint index (g) | Ginning out-turn (%) | 2.5 % span length (mm) | Bundle strength (g/tex) | Fibre elongation (%) | Uniformity ratio | Micronaire ($10^{-6}$ g Inch$^{-1}$ ) | Seed cotton yield per plant |
|---|---|---|---|---|---|---|---|---|
| Plant height (cm) | -0.0150 | -0.0363 | -0.2639** | 0.1774* | 0.1763* | -0.0078 | 0.1858* | 0.2743** |
| Days to 50% flowering | -0.1126 | -0.1084 | -0.1581* | 0.1424 | 0.2594** | 0.0602 | 0.2951** | 0.1888* |
| No.of monopodia per plant | 0.0858 | -0.0025 | -0.0366 | 0.0781 | 0.1909* | -0.0651 | 0.1893* | 0.1578* |
| No.of sympodia per plant | 0.1263 | -0.0215 | -0.0462 | 0.3106** | 0.1367 | 0.1136 | 0.2455** | 0.4506** |
| No.of bolls per plant | 0.1200 | 0.3500** | -0.1979** | 0.1674* | 0.1482* | 0.0682 | 0.1597* | 0.5962** |
| Boll weight (g) | 0.1023 | -0.1976** | 0.0567 | 0.3653** | 0.1146 | 0.0802 | 0.2562** | 0.4834** |
| Seed index (g) | 0.6210** | -0.3703** | 0.2680** | 0.1659* | 0.1104 | -0.1039 | -0.0291 | 0.0874 |
| Lint index (g) | 1.0000 | 0.3896** | 0.0816 | 0.1856* | -0.0003 | 0.0425 | 0.0307 | 0.2111** |
| Ginning out-turn (%) | 0.5138** | 1.0000 | -0.2257** | 0.0483 | -0.0471 | 0.1797* | 0.0939 | 0.1813* |
| 2.5 % span length (mm) | 0.1060 | -0.3034** | 1.0000 | 0.0726 | 0.0901 | 0.0646 | -0.2238** | -0.1650* |
| Bundle strength (g/tex) | 0.2030** | -0.0028 | 0.1337 | 1.0000 | 0.3291** | 0.2614** | 0.2771** | 0.4822** |
| Fibre elongation (%) | -0.0082 | -0.0265 | 0.0265 | 0.4106** | 1.0000 | 0.1081 | 0.1991** | 0.2710** |
| Uniformity ratio | 0.0392 | 0.2681** | 0.0807 | 0.2947** | 0.1177 | 1.0000 | 0.1007 | 0.1363 |
| Micronaire ($10^{-6}$ g Inch$^{-1}$ ) | 0.0516 | 0.1712* | -0.2552** | 0.3267** | 0.2760** | 0.1180 | 1.0000 | 0.3761** |
| Seed cotton yield per plant | 0.2230** | 0.3004** | -0.1844* | 0.5787** | 0.4041** | 0.1681* | 0.4807** | 1.0000 |

(Upper diagonal represents phenotypic correlation and lower diagonal represents genotypic correlation)
* = Significance at 5% level,      ** = Significance at 1% level,

Table 2.  Direct and indirect effects (Phenotypic) of yield components on seed cotton yield in 60
genotypes of cotton (*Gossypium hirsutum* L.).

| Character | Plant height (cm) | Days to 50% flowering | No.of monopodia per plant | No.of sympodia per plant | No.of bolls per plant | Boll weight (g) | Seed index (g) |
|---|---|---|---|---|---|---|---|
| Plant height (cm) | **0.1061** | 0.0699 | 0.0737 | 0.0704 | 0.0269 | 0.0029 | 0.0066 |
| Days to 50% flowering | 0.0235 | **0.0357** | 0.0217 | 0.0173 | -0.0043 | 0.0109 | 0.0024 |
| No.of monopodia per plant | -0.0632 | -0.0554 | **-0.0910** | -0.0415 | 0.0007 | -0.0158 | -0.0170 |
| No.of sympodia per plant | 0.0483 | 0.0353 | 0.0332 | **0.0728** | 0.0315 | 0.0172 | 0.0126 |
| No.of bolls per plant | 0.1935 | -0.0920 | -0.0061 | 0.3296 | **0.7622** | -0.3012 | -0.2102 |
| Boll weight (g) | 0.0229 | 0.2552 | 0.1445 | 0.1967 | -0.3285 | **0.8314** | 0.3337 |
| Seed index (g) | 0.0029 | 0.0031 | 0.0087 | 0.0080 | -0.0128 | 0.0186 | **0.0463** |
| Lint index (g) | 0.0010 | 0.0155 | -0.0103 | -0.0195 | -0.0137 | -0.0101 | -0.0738 |
| Ginning out-turn % | -0.0086 | -0.0399 | 0.0009 | 0.0131 | 0.1116 | -0.0551 | -0.0411 |
| 2.5 % span length (mm) | -0.0106 | -0.0058 | -0.0018 | -0.0004 | -0.0070 | 0.0020 | 0.0105 |
| Bundle strength (g/Tex) | 0.0067 | 0.0054 | 0.0024 | 0.0136 | 0.0055 | 0.0119 | 0.0071 |
| Fibre elongation (%) | 0.0204 | 0.0317 | 0.0190 | 0.0373 | 0.0177 | 0.0114 | 0.0131 |
| Uniformity ratio | 0.0004 | -0.0031 | 0.0036 | -0.0081 | -0.0039 | -0.0048 | 0.0067 |
| Micronaire ($10^{-6}$ g Inch$^{-1}$) | -0.0024 | -0.0033 | -0.0021 | -0.0035 | -0.0021 | -0.0029 | 0.0004 |
| Seed cotton yield per plant | 0.3409** | 0.2524** | 0.1963** | 0.6857** | 0.5838** | 0.5166** | 0.0972 |

Table 3 cont....

| Character | Lint index (g) | Ginning out-turn (%) | 2.5 % span length (mm) | Bundle strength (g/tex) | Fibre elongation (%) | Uniformity ratio | Micronaire ($10^{-6}$ g Inch$^{-1}$) |
|---|---|---|---|---|---|---|---|
| Plant height (cm) | -0.0011 | -0.0046 | -0.0379 | 0.0242 | 0.0245 | -0.0009 | 0.0255 |
| Days to 50% flowering | -0.0054 | -0.0072 | -0.0069 | 0.0065 | 0.0128 | 0.0022 | 0.0117 |
| No.of monopodia  per plant | -0.0093 | -0.0004 | 0.0056 | -0.0075 | -0.0195 | 0.0065 | -0.0188 |
| No.of sympodia per plant | 0.0140 | 0.0049 | -0.0010 | 0.0337 | 0.0307 | 0.0116 | 0.0254 |
| No.of bolls per plant | 0.1028 | 0.4329 | -0.1808 | 0.1432 | 0.1531 | 0.0586 | 0.1608 |
| Boll weight (g) | 0.0827 | -0.2330 | 0.0561 | 0.3371 | 0.1076 | 0.0782 | 0.2392 |
| Seed index (g) | 0.0337 | -0.0097 | 0.0163 | 0.0112 | 0.0069 | -0.0061 | -0.0019 |
| Lint index (g) | **-0.1013** | -0.0521 | -0.0107 | -0.0206 | 0.0008 | -0.0040 | -0.0052 |
| Ginning out-turn (%) | 0.1010 | **0.1965** | -0.0596 | -0.0005 | -0.0052 | 0.0527 | 0.0336 |
| 2.5 % span length (mm) | 0.0032 | -0.0090 | **0.0297** | 0.0040 | 0.0008 | 0.0024 | -0.0076 |
| Bundle strength (g/tex) | 0.0060 | -0.0001 | 0.0039 | **0.0294** | 0.0121 | 0.0087 | 0.0096 |
| Fibre elongation (%) | -0.0007 | -0.0023 | 0.0023 | 0.0363 | **0.0883** | 0.0104 | 0.0244 |
| Uniformity ratio | -0.0020 | -0.0136 | -0.0041 | -0.0150 | -0.0060 | **-0.0509** | -0.0060 |
| Micronaire ($10^{-6}$ g Inch$^{-1}$) | -0.0005 | -0.0017 | 0.0026 | -0.0033 | -0.0028 | -0.0012 | **-0.0101** |
| Seed cotton yield per plant | **0.2230**** | **0.3004**** | **-0.1844*** | **0.5787**** | **0.4041**** | **0.1681*** | **0.4807**** |

 *=significant at 5%level**=significant at 1%level, Bold and diagonal values indicate direct effects,
Residual effect = SQRT (1-1.0264)

Table 3. Direct and indirect effects (Genotypic) of yield components on seed cotton yield in 60 genotypes of cotton (*Gossypium hirsutum* L.).

| Character | Plant height (cm) | Days to 50% flowering | No.of monopodia per plant | No.of sympodia per plant | No.of bolls per plant | Boll weight (g) | Seed index (g) |
|---|---|---|---|---|---|---|---|
| Plant height (cm) | **0.1061** | 0.0699 | 0.0737 | 0.0704 | 0.0269 | 0.0029 | 0.0066 |
| Days to 50% flowering | 0.0235 | **0.0357** | 0.0217 | 0.0173 | -0.0043 | 0.0109 | 0.0024 |
| No.of monopodia per plant | -0.0632 | -0.0554 | **-0.0910** | -0.0415 | 0.0007 | -0.0158 | -0.0170 |
| No.of sympodia per plant | 0.0483 | 0.0353 | 0.0332 | **0.0728** | 0.0315 | 0.0172 | 0.0126 |
| No.of bolls per plant | 0.1935 | -0.0920 | -0.0061 | 0.3296 | **0.7622** | -0.3012 | -0.2102 |
| Boll weight (g) | 0.0229 | 0.2552 | 0.1445 | 0.1967 | -0.3285 | **0.8314** | 0.3337 |
| Seed index (g) | 0.0029 | 0.0031 | 0.0087 | 0.0080 | -0.0128 | 0.0186 | **0.0463** |
| Lint index (g) | 0.0010 | 0.0155 | -0.0103 | -0.0195 | -0.0137 | -0.0101 | -0.0738 |
| Ginning out-turn % | -0.0086 | -0.0399 | 0.0009 | 0.0131 | 0.1116 | -0.0551 | -0.0411 |
| 2.5 % span length (mm) | -0.0106 | -0.0058 | -0.0018 | -0.0004 | -0.0070 | 0.0020 | 0.0105 |
| Bundle strength (g/Tex) | 0.0067 | 0.0054 | 0.0024 | 0.0136 | 0.0055 | 0.0119 | 0.0071 |
| Fibre elongation (%) | 0.0204 | 0.0317 | 0.0190 | 0.0373 | 0.0177 | 0.0114 | 0.0131 |
| Uniformity ratio | 0.0004 | -0.0031 | 0.0036 | -0.0081 | -0.0039 | -0.0048 | 0.0067 |
| Micronaire ($10^{-6}$ g Inch$^{-1}$) | -0.0024 | -0.0033 | -0.0021 | -0.0035 | -0.0021 | -0.0029 | 0.0004 |
| Seed cotton yield per plant | 0.3409** | 0.2524** | 0.1963** | 0.6857** | 0.5838** | 0.5166** | 0.0972 |

Table 3 cont....

| Character | Lint index (g) | Ginning out-turn (%) | 2.5 % span length (mm) | Bundle strength (g/tex) | Fibre elongation (%) | Uniformity ratio | Micronaire ($10^{-6}$ g Inch$^{-1}$) |
|---|---|---|---|---|---|---|---|
| Plant height (cm) | -0.0011 | -0.0046 | -0.0379 | 0.0242 | 0.0245 | -0.0009 | 0.0255 |
| Days to 50% flowering | -0.0054 | -0.0072 | -0.0069 | 0.0065 | 0.0128 | 0.0022 | 0.0117 |
| No.of monopodia per plant | -0.0093 | -0.0004 | 0.0056 | -0.0075 | -0.0195 | 0.0065 | -0.0188 |
| No.of sympodia per plant | 0.0140 | 0.0049 | -0.0010 | 0.0337 | 0.0307 | 0.0116 | 0.0254 |
| No.of bolls per plant | 0.1028 | 0.4329 | -0.1808 | 0.1432 | 0.1531 | 0.0586 | 0.1608 |
| Boll weight (g) | 0.0827 | -0.2330 | 0.0561 | 0.3371 | 0.1076 | 0.0782 | 0.2392 |
| Seed index (g) | 0.0337 | -0.0097 | 0.0163 | 0.0112 | 0.0069 | -0.0061 | -0.0019 |
| Lint index (g) | **-0.1013** | -0.0521 | -0.0107 | -0.0206 | 0.0008 | -0.0040 | -0.0052 |
| Ginning out-turn (%) | 0.1010 | **0.1965** | -0.0596 | -0.0005 | -0.0052 | 0.0527 | 0.0336 |
| 2.5 % span length (mm) | 0.0032 | -0.0090 | **0.0297** | 0.0040 | 0.0008 | 0.0024 | -0.0076 |
| Bundle strength (g/tex) | 0.0060 | -0.0001 | 0.0039 | **0.0294** | 0.0121 | 0.0087 | 0.0096 |
| Fibre elongation (%) | -0.0007 | -0.0023 | 0.0023 | 0.0363 | **0.0883** | 0.0104 | 0.0244 |
| Uniformity ratio | -0.0020 | -0.0136 | -0.0041 | -0.0150 | -0.0060 | **-0.0509** | -0.0060 |
| Micronaire ($10^{-6}$ g Inch$^{-1}$) | -0.0005 | -0.0017 | 0.0026 | -0.0033 | -0.0028 | -0.0012 | **-0.0101** |
| Seed cotton yield per plant | 0.2230** | 0.3004** | -0.1844* | 0.5787** | 0.4041** | 0.1681* | 0.4807** |

*=significant at 5%level**=significant at 1%level, Bold and diagonal values indicate direct effects, Residual effect = SQRT (1-1.0264)

and 0.1963**), number of sympodia per plant (0.4506** and 0.6857**), number of bolls per plant (0.5962** and 5838**), boll weight (0.4834** and 0.5166**), lint index (0.2111* and 0.2230**), ginning out-turn (0.1813* and 0.3004**), bundle strength (0. 4822** and 0.5787**), fibre elongation (0.2710** and 0. 4041**) and micronaire (0.3761** and 0.4807**) at both phenotypic and genotypic levels indicating simultaneous improvement of these characters will be possible with seed cotton yield per plant. This trait also showed significant negative association with 2.5% span length (-0.1651** and -0.1844**) both at phenotypic and genotypic levels indicating selection for this trait will lead to antagonistic effect on 2.5% span length. This trait showed positive significant association with uniformity ratio at genotypic level only indicating the masking effect of environment. Asha *et al.* (2015), Paramjit and Buttar (2013) and Tulasi *et al.* (2012) also reported similar results in their studies in cotton.

The correlation studies clearly indicated that, plant height, days to 50% flowering, number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight, lint index, ginning out turn, bundle strength, fibre elongation and micronaire exerted significant positive association with   seed cotton yield per plant and can be exploited in breeding programme for simultaneous improvement of seed cotton yield along with these traits.

The direct and indirect effects of different yield component traits on seed cotton yield were worked out through path analysis at phenotypic and genotypic levels and are presented in Tables- 2 and 3.The phenotypic values are lower compared to the genotypic values indicating the existence of true relationship among the traits and the lesser role of environment in the expression of the traits. The Phenotypic path analysis indicated that plant height (0.0163), days to 50% flowering (0.0829), number of sympodia per plant (0.0253), number of bolls per plant (0.8051), boll weight (0.7261)), lint index (0.1184), bundle strength (0.0484), fibre elongation (0.0392) and micronaire (0.0002) had positive direct effects on seed cotton yield per plant indicating the importance of these characters in the improvement of seed cotton yield per plant (Asha *et al.*, 2015; Kumari *et al.,* 2013 and Tulasi *et al.*, 2012) while,

seed index  (-0.1028), number of monopodia per plant (-0.0079), ginning out-turn   (-0.0355), 2,5% span length (-0.0250), uniformity ratio (-0.0097) had negative direct effects on seed cotton yield per plant indicating their role in reducing the yield when they are favoured (Harith *et al.*, 2013 and Paramjit and Buttar, 2013)

In plant breeding, it is very difficult to have complete knowledge of all component traits of yield. The residual effect permits precise explanation about the pattern of interaction of other possible components of yield.  Residual effect measures the role of the possible independent variables which were not included in the study on the dependent variable. In the present study, the residual effect observed was 0.3039 at phenotypic and sqrt (1-1.0264) at genotypic levels, which explains the importance of some other characters which were not included in the present study. Based on the results of path analysis, the present study revealed that major emphasis should be laid on selection process with more plant height, more number of sympodia per plant, with more number of big sized bolls and have lint index and there should be economic balance among these traits to get higher seed cotton yield per plant.

The correlation and path coefficient analyses together indicated that plant height, number of sympodia per plant, number of bolls per plant, lint index, bundle strength, fibre elongation and micronaire had significant association and positive direct effects on seed cotton yield per plant indicating the existence of true relationship between these characters and their exploitation in selection programmes.

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