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Nikhil PG
University of Agricultural Sciences, Raichur, Karnataka, India

JM Nidagundi
University of Agricultural Sciences, Raichur, Karnataka, India

Anusha Hugar A
University of Agricultural Sciences, Raichur, Karnataka, India

Correspondence
Nikhil PG
University of Agricultural Sciences, Raichur, Karnataka, India

Correlation and path analysis studies of yield and fibre quality traits in cotton (*Gossypium hirsutum* L.)

Nikhil PG, JM Nidagundi and Anusha Hugar A

Abstract
Correlation and path coefficient analysis was performed for fifteen quantitative traits of yield and fibre quality for ninety six diverse genotypes. The association analysis revealed significant positive correlation for seed cotton yield per plant with number of monopodia, number of bolls per plant, boll weight and lint index at phenotypic level. The path analysis indicated that boll weight and number of bolls per plant had highest direct effect on seed cotton yield per plant, whereas traits like plant height, UHML, fibre strength and lint index had direct negative effect on yield revealing that due weightage should be given in selection process with more number of bolls per plant and more boll weight and can be considered as principal yield determining components.

Keywords: Cotton, correlation, path analysis, yield and fibre quality

Introduction

Cotton (*Gossypium hirsutum* L.) also renowned as "White Gold" belongs to family Malvaceae is grown mainly in the tropics and sub-tropics as the most important fibre cum food crop. Cotton improvement programmes across the world have always responded to the needs of the growers and industry and strived to combine high yield and good fibre quality. In India, development of high yielding cotton varieties with superior fibre quality is a fundamental objective of many cotton improvement programmes. Hence the objective of the present study is to explore the association between various yield and fibre quality traits to facilitate indirect selection in cotton (Angadi *et al*., 2016) [3].

In plant breeding correlation studies pave the way for a better understanding of the association prevailing between highly heritable characters with most economic characters and give better understanding of the contribution of each trait in building up the genetic make-up of the crop (Jawahar and Patil, 2017) [10]. Since, seed cotton yield and fibre quality traits are complex quantitative characters, direct selection may not be a reliable approach as these traits are influenced by environmental factors. So it is important for breeders to know more about direct and indirect correlation among the different traits while selecting plants for breeding.

Path coefficient analysis provides an effective aid in selection as it parts the correlation into direct and indirect components. So it's important to know more about the traits which contribute to the yield and their direct and indirect association to successfully design an effective breeding program. It is helpful in the procedure of selection and empowers the breeders to select a genotype on the basis of two or more traits simultaneously (Salahuddin *et al.*, 2010) [18, 19].

The present research was conducted on ninety six different *Gossypium hirsutum* accessions to study the correlation and path coefficient analysis of fifteen yield, yield attributing and fibre quality traits to find the principal yield determining components and to use these traits as selection criteria for seed cotton yield improvement.

Material and methods

Ninety six germplasm lines of *Gossypium hirsutum* cotton including forty seven diverse lines (45 IC and 2 EC lines) from Central Institute for Cotton Research (CICR), Nagpur and forty nine advanced breeding lines indigenously bred and developed in Main Agricultural Research Station (MARS), Raichur were evaluated for the study, along with two checks SUJAY (SCS-793) and BGDS-1063 identified and released from AICRP on cotton, MARS, Raichur. The genotypes were grown in two rows of 6 m length with 75 cm x 30 cm spacing at Main Agricultural Research Station field, Raichur during *Kharif* season of 2017-18 using augmented design. Recommended package of practices and plant protection measures were adapted to raise a good crop.

At maturity, five random plants were selected from each genotype and observations were recorded for fifteen traits viz., plant height (cm), number of monopodia per plant, number of sympodia per plant, sympodial length at ground level (cm), sympodial length at fifty per cent plant height (cm), inter-nodal distance (cm), number of bolls per plant, boll weight (g), upper half mean length (mm), fibre strength (g/tex), micronaire value (µg/inch), ginning out turn (%), seed index (g), lint index and seed cotton yield per plant (g). The lint samples obtained by ginning 100 grams of each seed cotton of all ninety six samples along with the two checks were then subjected to quality evaluation at Quality Evaluation Unit (QEU), Mahyco, Jalna, Maharashtra.
Simple correlations among various traits were calculated using the formula given by Singh and Narayanan (1993). Path coefficient analysis (Dewey and Lu, 1959) was carried out to decipher the direct and indirect effects of yield attributing and fibre quality traits on seed cotton yield.

Results and discussions

Correlation Analysis: The phenotypic correlation of seed cotton yield with various component traits in this population are presented in Table 1. At phenotypic level, seed cotton yield per plant has shown significant positive correlation with number of monopodia per plant (0.592), number of bolls per plant (0.665), boll weight (0.818) and lint index (0.232) followed by non-significant positive correlation with micronaire (0.191), ginning outturn (0.172) and seed index (0.160). These results were in agreement with the findings of Khan *et al.* (2010) [11], Alkuddsi *et al.* (2013) [2], Farooq *et al.* (2014) [8], Reddy *et al.* (2015) [14], Memon *et al.* (2017) [13] and many others. On the contrary, reports on negative association of seed cotton yield with boll weight and micronaire was given by Pujer *et al*. (2014) [16].

Table 1: Phenotypic correlation among 15 yield, yield attributing and fibre quality traits in 98 cotton (*Gossypium hirsutum* L.) genotypes

	PH	**NM**	**NS**	**SLG**	**SLFPH**	**IND**	**NBP**	**BW**	**UHML**	**FS**	**MIC**	**GOT**	**SI**	**LI**	**SCYP**
PH	1.000	-0.063	0.522**	0.551**	0.505**	0.279**	0.156	0.096	-0.107	0.034	0.097	-0.142	0.115	-0.072	-0.040
NM		1.000	-0.093	-0.053	-0.059	-0.057	0.533**	0.437**	-0.011	-0.019	0.131	0.082	-0.010	0.061	0.592**
NS			1.000	0.244*	0.090	-0.015	-0.020	-0.094	0.108	-0.026	0.036	-0.068	0.161	0.026	-0.018
SLG				1.000	0.665**	0.199*	0.101	-0.090	-0.084	-0.027	0.064	-0.180	0.010	-0.153	-0.056
SLFPH					1.000	0.287**	0.172	-0.019	-0.210	0.025	-0.008	-0.009	-0.061	-0.046	-0.010
INL						1.000	0.218*	-0.148	-0.109	0.206*	-0.273	-0.117	-0.176	-0.221*	-0.111
NBP							1.000	0.438**	-0.206*	0.034	0.141	0.025	-0.056	-0.029	0.655**
BW								1.000	-0.259*	-0.114	0.212*	0.231*	0.106	0.249*	0.818**
UHML									1.000	0.227*	-0.210	-0.208*	0.016	-0.176	-0.219*
FS										1.000	-0.196	-0.201*	0.065	-0.148	-0.142
MIC											1.000	0.404**	-0.025	0.350**	0.191
GOT												1.000	-0.166	0.779**	0.172
SI													1.000	0.477**	0.160
LI														1.000	0.232*

*** Significant at 5% (p = 0.05) ** Significant at 1% (p = 0.01)**
PH- Plant height (cm) **NM**- Number of monopodia **NS**- Number of sympodia **SLG**- Sympodial length at ground level (cm)
SLFPH- Sympodial length at 50% plant height (cm) **INL**- Inter nodal length(cm) **NBP**- Number of bolls per plant **BW**- Boll weight (g)
UHML- Upper half mean length (cm) **FS**- Fibre strength (g/tex) **MIC**- Micronaire (µg/inch) **GOT**- Ginning outturn (%) **SI**- Seed index (g) **LI**- Lint index (g) **SCYP**- Seed cotton yield per plant (g)

Seed cotton yield per plant has recorded a significant negative phenotypic correlation with UHML (-0.219). The traits, plant height (-0.040), number of sympodia per plant (-0.018), sympodial length at ground level (-0.056), sympodial length at fifty per cent of plant height (-0.010), inter-nodal length (-0.111) and fibre strength (-0.142) have shown non-significant negative correlation at phenotypic level. Similar results were observed by Dahiphale *et al*. (2015) [6] and Khokher *et al.* (2017) [12]. Ashok and Ravikesavan (2010) [5] and Farooq *et al.* (2014) [8] also observed negative correlation between seed cotton yield and fibre strength. On the contrary, positive interrelation of UHML, fibre strength, plant height and sympodial branches with seed cotton yield per plant was reported by Pradeep *et al*. (2014) [15], Asha *et al*. (2015) [4] and Irfan *et al.* (2018) [9]. Also, Pradeep *et al*. (2014) [15], Pujer *et al*. (2014) [16], Abdullah *et al.* (2016) and Memon *et al.* (2017) [13] observed positive associations of seed cotton yield per plant with plant height.

Path coefficient analysis

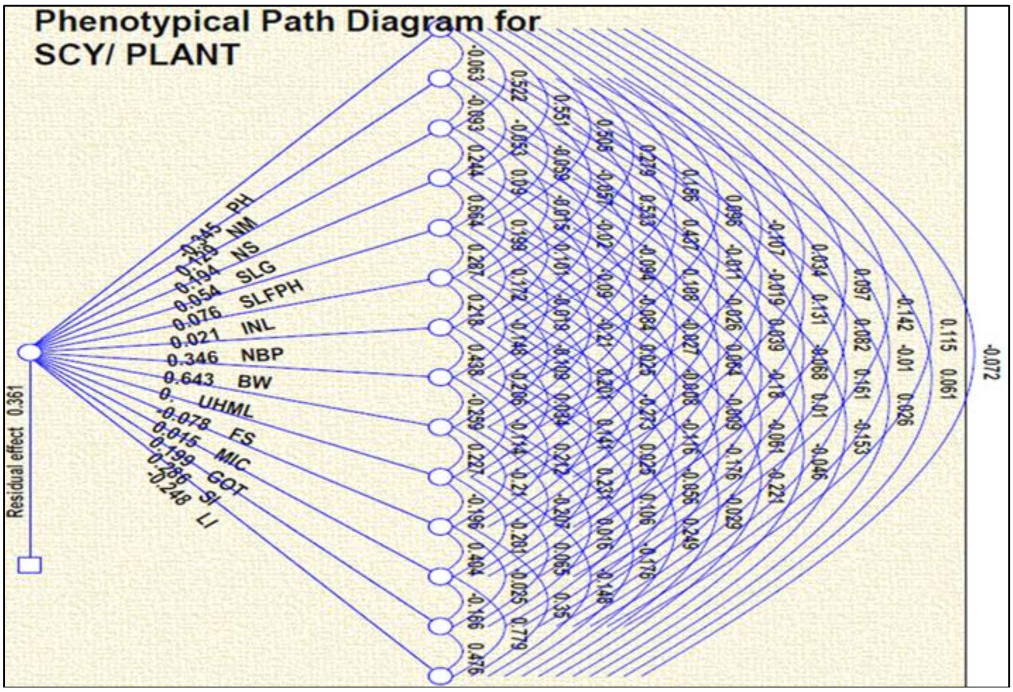
The estimate of direct and indirect effects of different yield attributing traits and fibre quality traits on seed cotton yield per plant was worked out through path analysis at phenotypic level and along with their phenotypic correlation is presented in Table 2. The phenotypical path diagram for seed cotton yield per plant is given in Figure 1. The path analysis indicated that boll weight (0.6431) and number of bolls per plant (0.3460) had highest direct effect on seed cotton yield per plant. Similar results were reported by Shazia *et al*. (2010) [19], Pujer *et al*. (2014) [16], Asha *et al*. (2015) [4], Reddy *et al*. (2015) [17], Angadi *et al*. (2016) [3] and Irfan *et al.* (2018) [9]. Whereas traits like plant height (-0.3449), UHML (-0.0001), fibre strength (-0.0781) and lint index (-0.2479) had negative direct effect on yield. The direct effects of all other component traits on seed cotton yield were positive but low.

Table 2. Phenotypic path analysis for 15 yield, yield attributing and fibre quality traits in 98 cotton (*Gossypium hirsutum* L.) genotypes

	PH	NM	NS	SLG	SLFPH	IND	NBP	BW	UHML	FS	MIC	GOT	SI	LI	SCYP
PH	-0.3449	0.0216	-0.1798	-0.1896	-0.1739	-0.0961	-0.0536	-0.0331	0.0368	-0.0117	-0.0334	0.0489	-0.0397	0.0247	-0.0403
NM	-0.0082	0.1289	-0.0122	-0.0070	-0.0077	-0.0074	0.0699	0.0573	-0.0014	-0.0025	0.0172	0.0108	-0.0013	0.0079	0.5918**
NS	0.1015	-0.0181	0.1941	0.0475	0.0174	-0.0028	-0.0039	-0.0183	0.0210	-0.0050	0.0076	-0.0132	0.0313	0.0051	-0.0176
SLG	0.0295	-0.0028	0.0131	0.0539	0.0355	0.0107	0.0054	-0.0048	-0.0045	-0.0015	0.0034	-0.0096	0.0005	-0.0082	-0.0560
SLFPH	0.0384	-0.0045	0.0068	0.0505	0.0760	0.0218	0.0131	-0.0015	-0.0160	0.0019	-0.0006	-0.0007	-0.0047	-0.0035	-0.0096
IND	0.0062	-0.0013	-0.0003	0.0045	0.0064	0.0215	0.0049	-0.0033	-0.0024	0.0045	-0.0061	-0.0026	-0.0039	-0.0049	-0.1112
NBP	0.0531	0.1815	-0.0068	0.0345	0.0586	0.0743	0.3460	0.1492	-0.0703	0.0115	0.0481	0.0086	-0.0191	-0.0099	0.6552**
BW	0.0621	0.2822	-0.0609	-0.0579	-0.0124	-0.0957	0.2827	0.6431	-0.1672	-0.0736	0.1369	0.1489	0.0687	0.1608	0.8180**
UHML	0.0002	0.0000	-0.0002	0.0001	0.0003	0.0002	0.0003	0.0004	-0.0001	-0.0004	0.0003	0.0003	0.0000	0.0003	-0.2193*
FS	-0.0026	0.0014	0.0020	0.0021	-0.0019	-0.0155	-0.0026	0.0088	-0.0175	-0.0781	0.0150	0.0155	-0.0050	0.0114	-0.1415
MIC	0.0015	0.0020	0.0006	0.0010	-0.0001	-0.0042	0.0022	0.0032	-0.0032	-0.0030	0.0146	0.0062	-0.0004	0.0054	0.1906
GOT	-0.0275	0.0159	-0.0131	-0.0349	-0.0017	-0.0225	0.0049	0.0446	-0.0401	-0.0389	0.0781	0.1995	-0.0322	0.1506	0.1715
SI	0.0324	-0.0028	0.0452	0.0028	-0.0172	-0.0495	-0.0157	0.0299	0.0045	0.0182	-0.0069	-0.0467	0.2863	0.1338	0.1600
LI	0.0173	-0.0146	-0.0064	0.0370	0.0111	0.0533	0.0070	-0.0601	0.0425	0.0358	-0.0844	-0.1881	-0.1151	-0.2479	0.2319*

Residual effect = 0.3606* Significant at 5% (p = 0.05) ** Significant at 1% (p = 0.01)

PH- Plant height (cm) **NM**- Number of monopodia **NS**- Number of sympodia **SLG**- Sympodial length at ground level (cm)
SLFPH- Sympodial length at 50% plant height (cm) **INL**- Inter nodal length(cm) **NBP**- Number of bolls per plant **BW**- Boll weight (g)
UHML- Upper half mean length (cm) **FS**- Fibre strength (g/tex) **MIC**- Micronaire (µg/inch) **GOT**- Ginning outturn (%) **SI**- Seed index (g) **LI**- Lint index (g) **SCYP**- Seed cotton yield per plant (g)



The positive indirect effect of boll weight with seed cotton yield per plant was highest through number of bolls per plant, followed by number of monopodia, lint index, ginning outturn and micronaire value, whereas that of number of bolls per plant was *via.*, number of monopodia, boll weight, inter-nodal distance, sympodial length at fifty per cent of plant height and plant height. Neelima *et al.* (2008) [14] indicated that bolls per plant through boll weight and lint index, exerted high positive indirect effects on seed cotton yield. Vinodhana *et al*. (2013) [21] reported that boll weight exerted positive effects on seed cotton yield per plant through seed index, lint index, fibre length, ginning percentage and fibre strength. The indirect effects of all other component traits were negligible.

As a concluding remark, seed cotton yield per plant showed strong and positive association as well as positive direct effects on the yield contributing characters *viz*., number of bolls per plant, boll weight, seed index, ginning outturn, number of monopodia per plant and micronaire. Thus during future breeding programmes, these parameters should be given thrust while making selection as they were major attributes of the seed cotton yield.

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