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Correlation and Path Coefficient Analysis of Yield Components in Cotton (*Gossypium hirsutum* L.)

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ABSTRACT

Path coefficients were computed to estimate the contribution of individual characters to yield in cotton. The calculated correlations indicate that boll number per plant, sympodial branches had positive and significant correlation with seed cotton yield at genotypic level. Internodal length had negative but significant genotypic correlation. Number of bolls per plant had maximum positive direct effect on seed cotton yield per plant followed by boll weight; whereas, internodal length had maximum negative direct effect on seed cotton yield.

Key Words: Yield; Correlation; Path Coefficient; Cotton

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) occupies a prime position as fibre crop of masses of the world in general and of Pakistan in particular. The sufficient production of cotton for meeting the fibre requirements of the world's exploding population is now universally realized.

Keeping in view the future needs of the country, cotton research needs to be versatile and accelerated to develop more productive cotton genotypes for various agro–ecological production areas of Pakistan. Seed cotton yield is a complex phenomenon entailing several contributing factors which are in turn highly susceptible to environment influence. These factors contribute to seed cotton production both directly and indirectly and the breeder is naturally interested in explaining the extent and type of association of such traits.

Path coefficients have been used to develop selection criteria for complex traits in several crop species (Wright 1921; Dewey & Lu, 1959; Fonseca & Patterson, 1968; Bhatt, 1973; Pandey & Torrie, 1973; Ivanovic & Kang *et al.,* 1983; Rosic, 1985; Gravois *et al.,* 1991; Diz *et al.,* 1994).

The present study with five cotton germplasm lines and their 20 F_1 crosses was conducted to provide information on interrelationships of yield with some important yield components and to partition the observed genotypic correlations into their direct and indirect effects.

MATERIALS AND METHODS

The present study with five cotton varieties and germplasm line i.e NIAB–999, CIM–473, ACALA 1517/C, CRIS–420, FVH–57 along with their all possible F_1 crosses was conducted to provide information on interrelationship of yield with some important yield components. During the summer of 2003, plants were grown in the vicinity of University of Agriculture Faisalabad. The experimental design was a randomized complete block with three replications. The seeds of all the genotypes were dibbled in rows. Plant to plant and row to row distance was 30 and 75 cm, respectively.

Eight plants, free of mechanical damage or obvious defects and with plants on either side with in row, were individually identified. At maturity, data on plant height, boll weight, internodal length, sympodial branches, monopodial branches, boll number per plant and seed cotton yield were collected from individual plants.

The estimates of phenotypic and genotypic correlation coefficient were worked out by using the formulae suggested by Kwon and Torrie (1964). Genotypic correlations were partitioned into path coefficient using the technique outlined by Dewey and Lu (1959). This technique involves partitioning of correlation coefficient to determine direct (unidirectional path–ways ('P') and indirect influence through alternate pathways (Pathway 'P'x correlation coefficient 'r) of various variables over seed cotton yield per plant. Seed cotton yield was considered as the resultant variable and the others as causal variables. Standard error for genotypic correlation was calculated by using the formula given by Reeve (1955) and Robertson (1959). The genotypic correlation was considered significant if its absolute value exceeded the twice of its respective standard value.

Statistically significance of phenotypic correlation coefficients was determined by using "t" test as described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Genotypic and phenotypic correlation coefficient between all possible combinations was estimated (Table I). Results indicate that boll number per plant and sympodial branches had positive and highly significant correlation at genotypic and phenotypic level with seed cotton yield. Boll weight had non–significant correlation at genotypic level but negative and significant correlation at phenotypic level with seed cotton yield. Plant height, internodal length and monopodial branch had negative and highly significant correlation at phenotypic level with seed cotton yield. The correlations reported by Christidis and Harrison (1955), Singh *et al.* (1968), Khan *et al.* (1979) and Tariq *et al.* (1992) also reported similar associations. This indicated that selection for these characters can be effective in the search of high yielding cotton genotypes.

The pathways through which the six yield components operate to produce their genotypic association with seed cotton yield reveal direct and indirect contributions (Table II) and are demonstrated diagrammatically in Fig. 1. The path coefficient analysis showed that direct effect of boll number on seed cotton yield was very high and significant (1.116). The indirect effect through Internodal length (0.096) was positive but not so pronounced. Total correlation coefficient (0.94) between boll number and seed cotton yield was mainly due to its own direct effect which supports the hypothesis of Khan *et al.* (1991) and Azhar *et al.* (1992). However, indirect effects via monopodial branches (–0.066), sympodial branches (–0.05), plant height (–0.0574) and boll weight (–0.096) have some what deluded the direct effect.

The direct effect of monopodial branches on seed cotton yield was positive but not so pronounecd. The indirect effect via boll number was negative and high in magnitude. Total correlation coefficient (–0.60) between monopodial branches and seed cotton yield was mainly due to its effect through boll number per plant (–0.90), which was high and negative. This showed that selection for the character monopodial branches would not be realized in increased seed cotton yield (Kotaiah, 1973).

The direct effect of sympodial branches on seed cotton yield was low and negative. The indirect effect via boll

Table I. Genotypic (G) and phenotypic (P) correlation coefficients among all possible combinations of seven different quantitative characters of upland cotton

Characters		Height	IL	SB	MB	BNP	Plant Yield
Boll weight	G	0.64**	0.62**	-0.49**	0.68**	-0.30**	0.01NS
	P	0.64**	0.62**	-0.47**	0.67**	-0.23*	-0.21*
Plant Height	G		0.93**	-0.71NS	0.85**	-0.82**	-0.64**
	P		0.90**	-0.69**	0.80**	-0.80**	-0.62**
IL	G			-0.91**	0.88**	-0.88**	-0.71**
	P			-0.90**	0.80**	-0.86**	-0.67**
SB	G				-0.87**	0.86**	0.73**
	P				-0.73**	0.85**	0.72**
MB	G					-0.81**	-0.60**
	P					-0.78**	-0.58**
BNP	G						0.94**
	P						0.94**

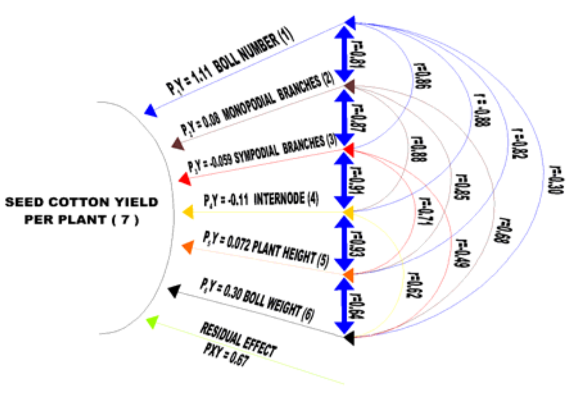
NS, *, ** denotes Non-significance and significance at 5% and 1% respectively; IL= Internodal length; SB= Sympodial branches; MB= Monopodial branches; BNP= Boll number per plant; IL= Internodal length; SB= Sympodial branches; MB= Monopodial branches

Table II. Direct and indirect effects of boll number, monopodial branches, sympodial branches, internodal length, plant height and boll weight on seed cotton yield

Path ways of association	Direct effect (P)	Indirect effects (P x r)	(r)
1. Boll Number			
(a). Direct effect (P_{1Y})	1.116		
(b). Indirect effect via			
Monopodial Branches ($P_{2Y}r_{12}$)		-0.066	
Sympodial Branches ($P_{3Y}r_{13}$)		-0.050	
Internodal length ($P_{4Y}r_{14}$)		0.096	
Height ($P_{5Y}r_{15}$)		-0.0574	
Boll weight ($P_{6Y}r_{16}$)		-0.096	
(c). Total effect			0.94
2. Monopodial Branches			
(a). Direct effect (P_{2Y})	0.082		
(b). Indirect effect via			
Boll number ($P_{1Y}r_{12}$)		-0.90	
Sympodial Branches ($P_{3Y}r_{23}$)		0.051	
Internodal length ($P_{4Y}r_{14}$)		-0.096	
Height ($P_{5Y}r_{15}$)		0.059	
Boll weight ($P_{6Y}r_{16}$)		0.204	
(c). Total effect			-0.60
3. Sympodial Branches			
(a). Direct effect (P_{3Y})	-0.059		
(b). Indirect effect via			
Boll number ($P_{1Y}r_{13}$)		0.955	
Monopodial Branches ($P_{2Y}r_{23}$)		-0.071	
Internodal length ($P_{4Y}r_{34}$)		0.10	
Height ($P_{5Y}r_{35}$)		-0.049	
Boll weight ($P_{6Y}r_{36}$)		-0.146	
(c). Total effect			0.73
4. Internodal length	-0.11		
(a). Direct effect (P_{4Y})			
(b). Indirect effect via			
Boll number ($P_{1Y}r_{14}$)		-0.98	
Monopodial Branches ($P_{2Y}r_{24}$)		0.072	
Sympodial ($P_{4Y}r_{34}$)		0.053	
Height ($P_{5Y}r_{45}$)		0.0651	
Boll weight ($P_{6Y}r_{46}$)		0.187	-0.71
(c). Total effect			
5. Plant height			
(a). Direct effect (P_{5Y})	0.07		
(b). Indirect effect via			
Boll number ($P_{1Y}r_{15}$)		-0.91	
Monopodial Branches ($P_{2Y}r_{25}$)		0.069	
Sympodial ($P_{3Y}r_{35}$)		0.041	
Internodal length ($P_{4Y}r_{45}$)		-0.10	
Boll weight ($P_{6Y}r_{56}$)		0.19	
(c). Total effect			-0.64
6. Boll weight			
(a). Direct effect (P_{6Y})	0.30		
(b). Indirect effect via			
Boll number ($P_{1Y}r_{16}$)		-0.35	
Monopodial Branches ($P_{2Y}r_{26}$)		0.05	
Internodal length ($P_{4Y}r_{36}$)		0.028	
Height ($P_{5Y}r_{46}$)		-0.06	
Sympodial Branches ($P_{6Y}r_{56}$)		0.044	
(c). Total effect			0.01
5. Residual effect (Pxy)			0.67

P= Path Coefficient; (P x r)= Path coefficient; (r)= Correlation coefficient

Fig. 1. Diagrammatic representation of direct and indirect influence of variable on dependent variable



number per plant was positive and very high in magnitude. Total correlation coefficient (0.73) between sympodial branches and seed cotton yield was mainly due to its effect through boll number per plant (0.95), which was high and positive. Hence, the sympodial branches can not be regarded as a reliable source of getting high yields in cotton.

The direct effect of Internodal length was negative but nonsignificant (–0.11). Total correlation coefficient (–0.71), between Internodal length and seed cotton yield was mainly due to its indirect effect through boll number per plant. Therefore selection for lower internodal length cannot be guarantee for high yields in cotton.

The direct effect of the height on the seed cotton yield per plant was positive and low (0.07) which was mainly due to positive effect of boll weight (0.19). The total effect of height on seed cotton yield is negative (–0.64), therefore height cannot be used as criteria of yield improvement in cotton.

The direct effect of boll weight on seed cotton yield was positive (0.30) and pronounced but total genotypic effect of boll weight on yield is negligible (0.01), therefore, boll weight cannot be used as source of yield improvement in cotton. The high residual effect observed in the present studies (Fig. 1) suggest that the path coefficient obtained within the constraint of the construct do not reflect the influences of the second order components.

It is clearly understood from the present study that the character of most influence on seed cotton yield per plant was higher number of bolls per plant.

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