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Genetic inter-relationship of yield and yield component traits in upland cotton (*Gossypium hirsutum* L.)

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Abstract
Study of association of the yield contributing characters paves way in any selection programme targeted towards yield improvement. Eleven intra *hirsutum* F_4 populations were raised in winter rainfed condition in Cotton Research Station, Veppanthattai during the year 2018-19. Single plants were selected based on biometrical traits *viz*., seed cotton yield, plant height, number of monopodial branches per plant, number of sympodial branches per plant, number of bolls per plant. Among the crosses, three crosses *viz.*, TCH 1705-152 x KC3, African I-2 x TCH 1705 and African I -2 x COD 5-1-2 in which number of plants selected were higher were used to study the inter-relationship. The results revealed that invariably, in all three crosses it was observed that no. of bolls had significant positive association with seed cotton yield. Path analysis revealed the highest positive direct effects for plant height and number of bolls per plant in majority of crosses. The positive indirect effect for seed cotton yield was observed for number of bolls per plant. Selection for these traits would be useful in selection programme under rainfed conditions.

Keywords: Cotton, inter-relationship, correlation, path analysis, *G. hirsutum* L

Introduction
Cotton is considered as one of the important cash crop and supplies raw material to the textile industries. Cotton is grown in an area of 122.35 lakh hectares in India with an annual production of 377 lakh bales. American cotton or upland cotton (*G. hirsutum* L.) covers major area of Cotton. In Tamil Nadu, major area of cotton is under rainfed condition cultivated in area of 0.83 lakh hectares with a share of 56.6 per cent of total area with a production of 1,58,520 bales. In order to increase the productivity in cotton, high yielding varieties / hybrids are need to be developed. Systematic crop breeding programs aims to manipulate the yield components to increase the seed cotton yield. In this context, the association analysis was carried out to study the interrelationship and between seed cotton yield and other yield contributing characters in the F_4 segregating population for selection of superior genotypes under rainfed condition.

Materials and Methods
The present study was conducted at Cotton Research Station, Veppanthattai, Tamil Nadu Agricultural University, Tamil Nadu, India during 2018-19.
The F_4 populations of three crosses were studied to identify the inter-relationship and to advance superior plant progenies suitable for rainfed conditions. Three crosses *viz.*, TCH 1705-152 x KC3, African I-2 x TCH 1705 and African I -2 x COD 5-1-2 were selected for association analysis as the number of single plant progenies of these crosses were higher for studying association analysis. Biometrical characters *viz.*, plant height (cm), number of monopodial branches per plant, number of sympodial branches per plant, number of bolls per plant and single plant yield (g) were recorded in each generation on single plant basis for advancement. The data from single plants were used to estimate correlation co-efficient as per the method suggested by Goulden (1959) [4] to find out the relationship between yield and its components. The significance of correlation co- efficient was tested with reference to the 't' table given by Snedecor and Cochran (1967) [8].

Results and Discussion
Single plant seed cotton yield ranged from 120.2 g to 248.4 g in the cross TCH 1705-152 x KC3, 122.3 g to 215.7 g in African I-2 x TCH 1705 and 148.8 g to 184.1 in the cross African I -2 x COD 5-1-2 (Table 1). The highest mean seed cotton yield was observed in TCH 1705-152 x KC3 followed by African I-2 x TCH 1705 and African I -2 x COD 5-1-2.

The amount of contribution and of various quantitative traits on yield can be studied from correlation analysis. Estimates of correlation coefficients for five quantitative traits in F_5 generation of cotton are given in the Table 2.

Significant positive association of the seed cotton yield with plant height (r = 0.573) was observed in the cross TCH 1705-152 x KC3 while non-significant negative, and positive associations were observed in African I-2 x TCH 1705 and African I -2 x COD 5-1-2, respectively. In all cross combinations studied, significant positive association between plant height and number of sympodial branches per plant was observed (Ganesan and Raveendran, 2010, Santoshkumar Pujer *et al*. 2014, Sunayana *et al.* 2017 and Khokhar *et al.* 2017) [3, 9, 10, 5]. Significant positive correlation was observed for number of monopodial branches per plant with number of bolls per plant in two crosses *viz*., African I-2 x TCH 1705 (r=0.545) and African I -2 x COD 5-1-2 (r=0.587) (Bharathikumar, 2020) [2]. Among F_4 progenies of the cross African I -2 x COD 5-1-2, number of sympodial branches per plant had significant and positive association on number of bolls per plant (r = 580) and seed cotton yield (r=616) (Muhammed Iqbal, (2006) [7], Ganesan and Raveendran, (2010) [3], Tulasi *et al.* 2012 [11], Santoshkumar Pujer *et al.* 2014 [9], Bayyapu Reddy *et al.* 2015 [1], Sunayana *et al.* 2017 [10] and Monisha *et al.* 2018) [6]. Invariably, in all three crosses it was observed that no. of bolls had significant positive association with seed cotton yield.

Portioning of the total correlation coefficient into direct and indirect effects for seed cotton yield per plant was studied. Number of bolls per plant had direct effect on seed cotton yield (0.219, 0.312 and 0.321). In indirect effects, plant height showed positive indirect effect on number of bolls per plant (0.091, 0.047 and 0.080). Number of monopodial branches per plant had positive indirect effect of values 0.187, 0.069 and 0.078 for the plant height, number of sympodial branches per plant and number of bolls per plant, respectively in the cross TCH 1705-152 x KC3. Number of sympodial branches per plant and number of bolls per plant recorded indirect effects of 0.590 and 0.219 on plant height in the cross TCH 1705-152 x KC3. Highest positive indirect effect (0.624) was recorded for number of sympodial branches per plant on plant height in the cross African -I - 2 x COD - 5-1-2 (Santoshkumar Pujer *et al.* 2014) [9]. Hence selection by increasing the plant height will increase the number of sympodial branches per plant and number of bolls per plant (Tulasi et al. 2102 and Santoshkumar Pujer *et al*. 2014) [11, 9]. The residual values were 0.71, 0.88 and 0.73 indicating other characters are also contributing to yield.

Table 1: Mean, range of variability for yield and component traits of F_4 progenies in cotton

Cross combination	Plant height (cm)	No. of monopodia per plant	No. of sympodia per plant	No. of bolls per plant	Single plant yield (g)
TCH 1705-152 x KC3	155.8 (125-165)	3.3 (2 - 4)	31.8 (30 – 32)	61.2 (57 - 65)	178.9 (120.2 - 248.4)
African I-2 x TCH 1705	163.8 (155-175)	2.33 (1 - 3)	38.6 (24 - 40)	54.2 (45 - 72)	166.5 (122.3 – 215.7)
African -I - 2 x COD - 5-1-2	138.6 (135-143)	2.3 (1 - 3)	27.6 (26 – 28)	46.8 (42 - 50)	164.6 (148.8 - 184.1)

Range is given in parenthesis

Table 2: Correlation Coefficient for Seed cotton yield and yield components in F_4 generation in cotton

Character	Cross	PHT	MONO	SYM	BOLLS	YIELD
PHT	Cross 1	1.000	0.234	0.578*	0.293	0.573*
	Cross 2		-0.089	0.561*	0.311	-0.043
	Cross3		0.128	0.538*	0.198	0.265
Mono	Cross 1		1.000	-0.99	0.205	0.079
	Cross 2			-0.112	0.545*	0.290
	Cross 3			-0.182	0.587*	0.194
SYM	Cross 1			1.000	0.132	0.215
	Cross 2				-0.012	-0.054
	Cross 3				0.580*	0.616*
BOLLS	Cross 1				1.000	0.605*
	Cross 2					0.539*
	Cross 3					0.517*

Cross 1- TCH 1705-152 x KC3; Cross 2- African I-2 x TCH 1705; Cross 3 - African -I - 2 x COD - 5-1-2. PHT-Plant height, MONO –No. of monopodial branches/plant, SYM - No. of sympodial branches per plant, BOLLS- No. of bolls/plant and YIELD - seed cotton yield/ per plant

Table 3: Direct and indirect effects of various characters on cotton yield in F_4 generation

Character	Cross	PHT	MONO	SYM	BOLLS	Correlation YIELD
PHT	Cross 1	0.132	-0.042	-0.298	0.091	0.573*
	Cross 2	-0.106	-0.026	0.059	0.047	-0.043
	Cross 3	0.115	-0.031	0.064	0.080	0.265
MONO	Cross 1	0.187	-0.211	0.069	0.078	0.079
	Cross 2	0.011	0.281	-0.011	0.107	0.290
	Cross 3	0.124	0.197	-0.021	0.145	0.194
SYM	Cross 1	0.590	0.044	-0.432	0.049	0.215
	Cross 2	-0.056	-0.047	0.096	-0.011	-0.054
	Cross 3	0.624	0.032	0.084	-0.024	0.616*

BOLLS	Cross 1	0.219	-0.098	-0.063	0.219	0.605*
	Cross 2	-0.039	0.104	-0.009	0.312	0.539*
	Cross 3	0.193	0.228	0.054	0.321	0.517*

Direct effect values are given in bold
Residue value - TCH 1705-152 x KC3 = 0.71; Residue value - African I-2 x TCH 1705 = 0.88; Residue value - African -I - 2 x COD - 5-1-2 = 0.73

Cross 1- TCH 1705-152 x KC3; Cross 2- African I-2 x TCH 1705; Cross 3 - African -I - 2 x COD - 5-1-2. PHT-Plant height, MONO –No. of monopodial branches/plant, SYM - No. of sympodial branches per plant, BOLLS- No. of bolls/plant and YIELD - seed cotton yield/ per plant

Conclusion

It has been concluded from the present study that the number of bolls per plant, number of sympodial branches per plant followed by number of monopodial branches per plant and plant height should be given importance due to its association with yield, in the selection programme to get higher seed cotton yield.

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