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Research Article

Selection parameters for improving the seed cotton yield and fibre quality traits in American Cotton (*Gossypium hirsutum* L.)

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Abstract :

Information on the influence of different yield components on improvement of yield will be crucial in any selection programme. Four intra-*hirsutum* hybrids *viz*., TCH1452 x MCU5, TCH1628 x Gh493, TCH1628 x MCU5 and SVPR2 x MCU5 were developed by utilizing the five genetically diverse American cotton (*Gossypium hirsutum* L.) genotypes as parents. Observations were recorded on plant height, boll number, boll weight, ginning outturn, lint index, seed index, 2.5% span length, bundle strength, fibre fineness, elongation % and seed cotton yield in F_2 population and correlation of yield and its components were analysed to understand the relative contribution of different yield components in enhancing the yield and fibre quality. Study revealed significant positive association of plant height, sympodia, boll number, boll weight with yield. Span length had highly significant negative association with yield whereas uniformity ratio exhibited both positively and negatively significant association with yield. Associations of fibre fineness, fibre strength and elongation % with seed cotton yield was non-significant. Association of traits *inter se* revealed the positive association of plant height with sympodia, uniformity ratio, 2.5% span length and number of bolls, sympodia with uniformity ratio and boll number, boll weight with uniformity ratio, seed index with ginning %, fibre length with bundle strength, uniformity ratio with micronaire and elongation %. Significant negative correlation of bolls with fibre strength and 2.5% span length, lint index with 2.5% span length and ginning %, fibre length with uniformity ratio and elongation %, micronaire with fibre strength was observed. Information generated on the relationship between yield components, fibre quality and yield in F_2 generation will help the crop breeder in enhancing the efficiency of selection.

Key words:

Intra-*hirsutum,* Yield components, F_2 correlation, *G. hirsutum* L.

Introduction

'White gold' is the popular term assigned to indicate the importance of cotton crop. Cotton (*Gossypium hirsutum* L.) is a predominant commercial fibre crop popular among the farming community due to its higher yield and superior fibre quality. For the past few decades the export of textile products increased steadily, correspondingly textile industry has also grown in faster rate and therefore high yielding superior quality cotton varieties/hybrids have to be bred to promote the export in order to enhance the foreign exchange. Further, recent advances in spinning technology demands better fibre quality with improved fibre length and bundle strength to produce better quality yarn. Hence, the genotypes with high yield and improved fibre properties are needed to be developed to meet the ever-growing demands of textile industries. In any crop, improvement of yield will be the first and foremost objective of plant breeding. Yield is a complex biometrical trait and its genetic analysis is rather difficult. Seed cotton yield is a resultant product of all its component traits and it could be improved by exploiting the positive influence of yield components. Therefore, the information on nature of association of different yield contributing characters generated out of the studies will serve as an effective selection procedure for improving the yield indirectly. Generally, selections of new genotypes are made in F_2 generation and hence estimation of association among the yield components and association of yield contributing traits on seed cotton yield in F_2 generation will provide useful information about the positive influence of different traits on yield and fibre quality. With the above idea, the present investigation was carried out in F_2 generations of five different cross combinations.

Material and methods

Five diverse genotypes of cotton *Gossypium hirsutum L.* exhibiting variability in fibre quality and biometric traits were used as parental material (Table 1) for synthesis of four intra-*hirsutum* F_1 hybrids *viz*., TCH1452 x MCU5, TCH1628 x Gh493, TCH1628 x

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MCU5 and SVPR2 x MCU5. F_1 plants were selfed to obtain F_2 generation of each cross. Seeds harvested from those selected and self pollinated plants constituted the F_2 seed. The F_2 seeds were sown crosswise at a spacing of 75 cm x 30 cm and the population size of 200 plants in each cross combination was maintained with proper care. Data were recorded on plant height (cm), number of bolls per plant, boll weight (g), ginning outturn (%), lint index, seed index and seed cotton yield (g per plant) in the selected 200 plants of F_2 generation. The fibre quality parameters *viz*., 2.5% span length (mm), bundle strength (g/tex), uniformity ratio (%), micronaire and elongation per cent were estimated in selected superior single plants in F_2 population by utilising High Volume instrument 900 Classic. The mean of different traits are furnished in Table 2.

Statistical analysis

The data generated on different traits in F_2 population were used to estimate correlation co-efficients as per the method suggested by Goulden (1959) to find out the relationship between yield and its components. The variance and co-variance values were utilized to calculate the correlation coefficients by applying the following formula.

$$r_{xy} = \frac{\text{Cov. }(x,y)}{\sqrt{V_{(x)}\,V_{(y)}}}$$

Where,

r_{xy} = Correlation co-efficient between character x and y

Cov. (x,y) = Covariance between character x and y

$V_{(x)}$ = Variance of character x and

$V_{(y)}$ = Variance of character y

The significance of correlation co-efficients was tested with reference to the 't' table given by Snedecor and Cochran (1967) at (n-2) degrees of freedom.

Results and Discussion

Association of characters with seed cotton yield

Significant positive association of plant height with yield was observed in SVPR2 x MCU5 and TCH1452 x MCU5 (Table 3). The results obtained by Gunaseelan and Krishnasamy (1987); Sumathi and Nadarajan (1995); Manimaran (1999); Rao *et al*. (2001); Echekwu (2001); Kaushik *et al*. (2003), Ahuja *et al*. (2006) and Ganesan and Raveendran (2007) were also similar. Number of sympodia had the positively significant association with seed cotton yield in TCH1628 x Gh493 (Table 3). Positive association of this trait with yield was observed by Sarwar *et al*. (1984), Shanti and Selvaraj (1993), Larik *et al*. (1999), Manimaran (1999), Rao *et al*. (2001), Kaushik *et al*. (2003) and Ganesan and Raveendran (2007). The crosses, SVPR2 x MCU5, TCH1628 x Gh493 and TCH1628 x MCU5 (Table 3) expressed strong significantly positive correlation between boll number and seed cotton yield. Vijayakumar and Choudhry (1986), Al-Rawi *et al*. (1986), Singh *et al*. (1987), Aher *et al*. (1989), Alam and Islam (1991), Shanti and Selvaraj (1993), Sumathi and Nadarajan (1995), Larik *et al*. (1999), Manimaran (1999), Rao *et al*. (2001), Kaushik *et al*. (2003), Iqbal *et al*. (2006), Ahuja *et al*. (2006) and Ganesan and Raveendran (2007) have also reported similar results from their experiments.

There was a strong positive significant association between boll weight and seed cotton yield in the following crosses viz., TCH1452 x MCU5, TCH1628 x Gh493 and TCH1628 x MCU5. Similar results of positive association between boll weight and seed cotton yield were reported by Vijayakumar and Choudhry (1986), Al-Rawi *et al*. (1986), Singh *et al*. (1987), Alam and Islam (1991), Shanti and Selvaraj (1993), Larik *et al*. (1999), Manimaran (1999), Iqbal *et al*. (2006) and Ganesan and Raveendran (2007). None of the crosses studied expressed neither significant positive nor significant negative correlation of lint index, seed index and ginning outturn with seed cotton yield. However, significant positive correlation of seed index (Nadarajan, 1986), Lint index (Nadarajan, 1986; Larik *et al.*, 1999 and Manimaran, 1999) and ginning outturn (Manimaran, 1999) with seed cotton yield have been reported.

Highly significant negative association of 2.5% span length with yield was observed only in TCH1452 x MCU5 out of four crosses studied. Ahuja *et al*. (2006) have reported similar results. In contrast, positive relationship of this trait with yield has also been reported (Echekwu, 2001). The trait, uniformity ratio exhibited positively significant association (TCH1452 x MCU5) as well as negatively significant (TCH1628 x MCU5) association with seed cotton yield.

Although positive and negative associations of fibre fineness, fibre strength and elongation % with seed cotton yield were observed in the present study, none was found to be significant in any of the crosses studied. Rao *et al*. (2001) and Echekwu (2001) have observed significant positive association of these traits with seed cotton yield.

Association of character *inter se*

Association between plant height and number of sympodial branches/plant was found to be positive and significant in all the crosses studied except TCH1628 x Gh493. In addition, it had positive association with uniformity ratio (TCH1452 x MCU5), 2.5% span length (TCH1628 x MCU5) and number of bolls (TCH1628 x Gh493). Its association with 2.5% span length (TCH1452 x MCU5) was observed to be significantly negative. Similar positive association of plant height with boll number and sympodial number and negative association with halo length have been reported (Sarwar *et al*., 1984; Kaushik *et al*., 2003). However, positive association of this trait with number of sympodia (Echekwu, 2001, Ganesan and Raveendran, 2007 and Basbag and Gencer, 2007); bundle strength (Basbag and Gencer, 2007) and 2.5% span length (Echekwu, 2001) has also been reported.

Sympodia had positive significant association with uniformity ratio in TCH1452 x MCU5, while the cross TCH1628 x GH493 showed positive and significant correlation between sympodia and boll number. It corroborates with the results of Basbag and Gencer (2007). Significant negative correlation of bolls with fibre strength (SVPR2 x MCU5) and 2.5% span length (TCH1452 x MCU5) was noted. On the contrary, positive significant correlation of boll number with fibre length was reported (Jagtap and Kolhe, 1984). Larik *et al.* (1999) reported positive association of this trait with staple length at phenotypic level and strong negative association with staple length at genotypic level.

Boll weight had significant positive relation with uniformity ratio (TCH1452 x MCU5) only whereas its association with all the other traits was observed to be non-significant in this cross. However, the cross *viz*., TCH 1628 x MCU 5 has exhibited significant positive association of boll weight with 2.5% span length and negative association with uniformity ratio. Lint index was observed to have a significant negative association with 2.5% span length (SVPR2 x MCU5) and ginning % (TCH1452 x MCU5, TCH1628 x MCU5). Reports of earlier workers also revealed similar negative association of this trait with fibre length (Jehangir, 1981). Contradictory to the results obtained in the present study, Shanti and Selvaraj (1994) reported significant positive association between lint index and ginning %.

Most crosses (TCH1452 x MCU5, TCH1628 x MCU5) have exhibited significant positive correlation between seed index and ginning %. Seed index had non-significant correlation with all the other characters studied. Correlation of ginning % with other traits was non-significant. Fibre length showed significant negative association with uniformity ratio (TCH1628 x Gh493, TCH1628 x MCU5), elongation % (TCH1628 x MCU5). Its relationship with bundle strength (SVPR2 x MCU5, TCH1452 x MCU5 and TCH1628 x Gh493) was significantly positive. Similar significant negative association of 2.5% span length with uniformity ratio was reported by Ganesan and Raveendran (2007). However, Basbag and Gencer (2007) reported positive associations between fibre length and bundle strength, uniformity ratio and elongation %.

Significant positive correlation was observed between uniformity ratio and micronaire (TCH1628 x Gh493) and uniformity ratio and elongation % (TCH1452 x MCU5 and TCH1628 x Gh493). This is in conformity with the results of Ganesan and Raveendran (2007). Micronaire exhibited significant negative association with fibre strength (TCH1628 x Gh493). Contradictory to the results of present study, reports of Larik *et al*. (1999) revealed the strong positive correlation of fibre fineness with fibre strength. Bundle strength and elongation % were found to show non significant correlation with all the traits studied. Echekwu (2001) reported negative association between bundle strength and micronaire index.

Understanding the relationship between the yield components in F_2 generation will help the crop breeders in identifying the suitable cross combination for selecting the elite single plants of their interest. Information on indirect improvement of seed cotton yield through its correlated traits will have a significant impact in evolving the genotypes with enhanced yield and quality. Information of positive association between the quality traits and yield in a particular cross will serve as a selection index in locating the genotypes with improved yield and enhanced fibre quality which will satisfy the needs of both farmers as well as textile industry.

Based on the study, the single plant selections were made in the F_2 population of a cross *viz*., TCH 1452 x MCU 5 exhibiting positive relationship of boll weight, uniformity ratio with seed cotton yield as the plants selected out of this cross are expected to throw positive impact on the improvement of yield. Similarly, the cross TCH 1628 x Gh 493 exhibiting positive and significant association between plant height and boll weight, sympodial number and boll number, fibre length and bundle strength, uniformity ratio and micronaire and uniformity ratio and elongation % can be well exploited for selecting the segregants with improved fibre quality. As the selection of single plant is to be made right from the F_2 generation of any crop, the crop breeders can use this simple statistical tool to locate the superior genotypes in early segregating generations.

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Table 1. Pedigree and characters of cotton *G. hirsutum* L) genotypes used as a parent for hybridisation.

	Parental genotypes	Pedigree	Special features	Region/ Country
1	SVPR2	Derivative of the cross between TSD22 x JR 36	150-160 days duration, medium staple (25mm), bundle strength (19.9 g/tex), 36.4% ginning	Tamil Nadu/India
2	TCH1452	Multiple cross derivative from (TCH665 x LS149) (TCH665 x TCH21) TCH21 x EECH) (TCH92 x EECH)	Long staple (30.8mm), bundle strength (20.5 g/tex), 31.6% ginning	Tamil Nadu/India
3	TCH1628	Selection from MCU5	Long staple (30.3mm), bundle strength (21.3 g/tex), 32.2% ginning	Tamil Nadu/India
4	Gh493	Uganda	Long staple (29.8mm), bundle strength (20.9 g/tex), 37% ginning	Uganda
5	MCU5	Multiple cross derivative	Extra long staple (32.3mm), bundle strength (22 g/tex), 34% ginning, suitable for 70s count	Tamil Nadu/India

Table 2. Mean performance of cross combinations for different traits in F_2 generation

F_2 crosses	Plant height (cm)	Sympo dia/ plant	Bolls /plant	Boll weight (g)	Ginning outturn (%)	Lint index (g)	Seed index (g)	2.5% span length (mm)	Elonga-tion (%)	Unifor mity ratio	Micro-naire	Bundle strength (g/tex)	Seed cotton yield/ plant (g)
SVPR2xMCU5	92.62	15.14	11.50	5.36	32.56	2.54	5.57	31.20	4.719	47.81	4.15	23.45	61.44
TCH1452xMCU5	92.75	16.45	12.40	3.78	32.74	3.49	7.16	31.80	5.87	48.85	4.10	24.18	46.57
TCH1628xGh493	92.25	16.80	14.50	4.68	33.90	3.12	6.10	30.63	4.93	48.00	3.91	24.43	67.96
TCH1628xMCU5	85.45	17.10	14.00	4.43	34.04	3.47	6.75	30.53	5.28	48.45	4.12	25.5	60.55

Table 3. Correlation co-efficients of yield and yield components in F_2 generation of cross combinations in cotton

Traits	Crosses	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}
x_2	Cross 1	0.920**											
	Cross 2	0.780**											
	Cross 3	0.443											
	Cross 4	0.497**											
x_3	Cross 1	0.415	0.191										
	Cross 2	0.24	0.306										
	Cross 3	0.620**	0.544*										
	Cross 4	0.41	-0.011										
x_4	Cross 1	0.302	0.341	-0.318									
	Cross 2	0.286	0.045	-0.409									
	Cross 3	-0.212	0.201	-0.002									
	Cross 4	0.158	0.258	-0.066									
x_5	Cross 1	0.011	-0.11	-0.137	0.208								
	Cross 2	-0.116	0.067	-0.096	-0.388								
	Cross 3	-0.022	0.138	-0.029	-0.133								
	Cross 4	-0.029	-0.05	-0.082	-0.279								
x_6	Cross 1	-0.198	-0.189	-0.007	-0.299	0.328							
	Cross 2	-0.108	-0.032	-0.109	-0.21	0.159							
	Cross 3	0.133	-0.131	0.207	0.212	0.226							
	Cross 4	0.003	-0.063	-0.217	0.167	-0.092							
x_7	Cross 1	-0.192	-0.117	0.081	-0.402	-0.271	0.818						
	Cross 2	-0.018	-0.065	-0.048	0.056	-0.453*	0.807**						
	Cross 3	0.136	-0.171	0.219	0.298	-0.411	0.79						
	Cross 4	0.0003	-0.026	-0.173	0.262	-0.556*	0.876**						
x_8	Cross 1	0.03	0.261	-0.3	0.07	-0.441*	-0.254	0.021					
	Cross 2	-0.469*	-0.35	-0.499*	-0.174	-0.02	0.062	0.056					
	Cross 3	0.223	0.205	-0.012	0.201	-0.381	-0.097	0.152					
	Cross 4	0.490*	0.037	0.154	0.501*	-0.311	0.046	0.166					

Table 3. Contd..

Traits	Crosses	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}
x_9	Cross 1	-0.001	0.1	0.104	0.03	0.248	-0.074	-0.256	-0.328				
	Cross 2	0.555*	0.555*	-0.185	0.544*	-0.215	0.179	0.302	-0.361				
	Cross 3	-0.378	-0.229	-0.19	-0.041	0.201	-0.31	-0.41	-0.698**				
	Cross 4	-0.395	-0.025	-0.322	-0.461*	0.084	-0.304	-0.265	-0.705**				
x_{10}	Cross 1	-0.007	0.08	-0.317	0.321	0.277	-0.145	-0.334	-0.02	0.338			
	Cross 2	0.085	0.194	0.013	0.01	0.106	0.246	0.163	-0.326	0.206			
	Cross 3	-0.018	0.023	0.18	-0.063	0.174	-0.201	-0.298	-0.711	0.618**			
	Cross 4	-0.404	-0.073	-0.364	0.21	-0.196	-0.251	-0.093	-0.205	0.329			
x_{11}	Cross 1	0.019	0.243	-0.504*	0.218	0.025	-0.174	-0.188	0.479*	0.078	0.119		
	Cross 2	-0.249	0.021	-0.394	-0.049	0.022	0.403	0.342	0.638**	0.083	-0.392		
	Cross 3	0.007	0.022	-0.084	0.105	0.127	-0.115	-0.178	0.485*	-0.159	-0.535*		
	Cross 4	0.141	-0.343	-0.132	0.021	-0.039	0.074	0.08	0.434	-0.154	-0.267		
x_{12}	Cross 1	-0.118	-0.22	0.203	-0.465	0.299	0.391	0.216	-0.392	-0.016	-0.34	-0.371	
	Cross 2	0.428	0.161	-0.034	0.064	-0.248	0.257	0.386	-0.133	0.555*	-0.272	0.098	
	Cross 3	-0.183	0.205	0.304	0.21	-0.04	-0.255	-0.185	-0.358	0.565**	0.375	-0.221	
	Cross 4	-0.258	-0.089	-0.007	-0.179	-0.139	0.044	0.117	-0.468*	0.426	-0.014	-0.353	
x_{13}	Cross 1	0.603**	0.415	0.756**	0.377	0.001	-0.225	-0.208	-0.258	0.145	-0.062	-0.337	-0.137
	Cross 2	0.585**	0.437	0.351	0.683**	-0.418	-0.272	0.013	-0.636**	0.552*	0.124	-0.375	0.094
	Cross 3	0.357	0.567**	0.845**	0.517*	-0.123	0.24	0.317	0.091	-0.156	0.112	-0.025	0.396
	Cross 4	0.443	0.14	0.815**	0.510*	-0.228	-0.129	-0.031	0.44	-0.555*	-0.179	-0.114	-0.094

* and ** - significant at 5% and 1% respectively

x_1 – Plant Height; x_2 – Sympodia/plant; x_3 –Bolls/plant; x_4 – Boll weight/boll; x_5 – Lint index; x_6 – Seed Index; x_7 –Ginning outturn; x_8 – 2.5% span length; x_9 – Uniformity Ratio; x_{10} – Micronaire; x_{11} – Bundle strength; x_{12} – Elongation %; x_{13} – Seed cotton yield/plant

Cross 1:SVPR2 x MCU5; Cross 2:TCH1452 x MCU5; Cross 3:TCH1628 x Gh493; Cross 4:TCH1628 x MCU5