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Research Article

Genetic analysis in Cotton

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Abstract :
Combining ability analysis helps in the evaluation of inbreds interms of their genetic value and in the selection of suitable parents for hybridization. It is also useful technique in identification of superior cross combinations. In the present study, the general combining ability of the 19 parents and specific combining ability of 84 hybrids resynthesised using those parents were estimated through combining ability analysis for yield, yield components and fibre quality parameters in cotton (*Gossypium hirsutum*) using a Line x Tester design. The estimated components of GCA and SCA variances showed preponderance of non additive gene action for the characters studied. This showed the possibilities of improvement of these traits through heterosis breeding. Based on the gca effects the lines TCH 1702, TCH 1726, HSC – 1 – 521 were identified as good combiners for most of the characters. These parents can be used in pedigree breeding for incorporation of desired traits. The hybrid combinations TCH 1705 x HSC – 1 – 521, NARASIMHA x HSC – 1 – 521, TCH 1726 x HSC – 2 – 133, H 97 x HSC – 1 – 521 recorded as the highest specific combiners. These hybrids could be exploited commercially.

Key words:
Combining ability, *Gossypium hirsutum,* non-additive gene action, economic characters

Introduction

Cotton (*Gossypium hirstum*) is one of the important commercial crops of the world and among the fibre crops it is considered as the king of fibres. In India the crop grown in an area of 7.39 million hectares producing 140 lakh bales with a productivity of 322 kg/ha and forms the backbone of Indian Textile Industry. In Tamil Nadu cotton is being grown in an area of 2.25 lakh hectares with a production and productivity of 5.50 lakh bales and 400 kg/ha against the mill consumption of 43 lakh bales. Selection of suitable parents for hybridization and choice of breeding procedure are important for any crop improvement programmes. Knowledge on combining ability is useful for selection of desirable parents for exploitation of hybrid vigour. It elucidates the nature and magnitude of gene action involved in the inheritance of seed cotton yield and its related characters. The present investigation was undertaken to obtain information on general and specific combining ability to identify useful parents and hybrids with respect to yield and yield components and quality characters.

Materials and methods

The experimental material consisted of 84 hybrid combinations obtained from crossing seven varieties as females viz., TCH 1705, MCU 12, H 99, TCH 1702, H 97, NARASIMHA and TCH 1726 with twelve G. hirsutum accessions constituted the testers such as HSC – 1 – 521, HSC – 2 – 133, HSC – 2 – 264, HSC – 1 – 132, LPHS, HT 1, HT 3, HT 4, TCH 1699, BW 9-1-1, BW 12-5-1 and BW 4-1-1. The observations recorded were days to fifty percent flowering, plant height, number of sympodia per plant, number of bolls per plant, boll weight, seed cotton yield, ginning out turn (%), 2.5% percent span length and bundle strength. The parental materials were raised in 4.5 meters length with a spacing of 75 cm x 30 cm between rows and plants respectively during kharif 2005-06. Each of the seven females were crossed with 12 testers in line x tester fashion to produce 84 cross combinations. The hybrids along with parents were raised in randomized block design with three replications with a plot size of 6m rows and spacing of 90x60 cm during winter 2006-07. Biometrical observations on each genotype were made on five randomly chosen plants in each replication and the average was used for analysis. Observations on three fibre quality traits were estimated by High Volume Instrument 900 classic installed at Department of cotton, Centre for Plant Breeding and Genetics, TNAU, Coimbatore. Recorded data for biometric and fibre quality traits were then subjected to appropriate statistical analysis. The general and specific combining ability

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of the parents and hybrids were worked out as per the method out lined by Kempthorne (1957).

Results and discussion

The analysis of variance for biometric (yield and quality) characters showed significant differences among the genotypes for plant height, number of sympodia/plant, number of bolls / plant, boll weight, single plant yield, ginning out turn, 2.5% span length, bundle strength for both parents and hybrids indicated that sufficient variability was present in the experimental materials. The results from combining ability revealed that the differences due to lines were highly significant for characters viz., days to 50% flowering, plant height, number of bolls per plant, single plant yield, 2.5% span length and bundle strength. This indicates that the biometric and fibre quality traits contribute much for genetic diversity among the lines. The SCA variance was greater in magnitude than GCA variance for all the characters studied, indicating the predominance of non additive gene action for all the characters (Table 1). This showed the possibilities of improvement of these traits through heterosis breeding. Shanti and Selvaraj (1995), Mandloi *et al* (1998) reported similar results.

Combining ability assumes greater importance in assessing the genetic potentialities of genotypes. Dhillion (1975) had pointed out that the combining ability gives useful information on the choice of parents' in terms of expected performance of the hybrids and their progenies. Also the parents having high *gca* could be useful for producing transgressive segregants (Jagtap, 1986) . In the present study among the lines TCH 1726 was a good general combiner for yield and yield contributing characters like number of bolls/plant, boll weight, and single plant yield. The parents H 99 and MCU 12 recorded highly significant *gca* for quality contributing characters like 2.5% span length and bundle strength. Among testers HSC -1 – 521 had a highest *gca* effect for number of bolls/plant, single plant yield, and bundle strength. So this parent can be used as good combiner for single plant yield.

The line TCH 1702 recorded high performance and significant gca effect for number of bolls/plant, Boll weight, single plant yield and bundle strength. The estimates of *gca* effects for parents indicated that none of the parents proved to be a good general combiner for all the characters, the parent TCH 1726 exhibited positive significant *gca* effect for plant height, single plant yield and it exhibited high mean performance for these characters. Most of the lines showed positive *gca* effects for the characters it had high *per se* performance also. High mean values remain, as selection index in the choice of parents and the parents possessing high *per se* performance will result in superior hybrids. Therefore the lines TCH 1702 and TCH 1726 can be exploited in hybridization for improving the yield contributing characters through pedigree breeding.

The lines such as TCH 1726, TCH 1705 and Narasimha were the best combiners as female and the testers HT 1, HT 3, and HT 4 were the best combiners for plant height. For seed cotton yield the female TCH 1726, TCH 1702 and H 99 and male BW 4–1– 1, HSC -1 – 132 and HSC – 1 – 521 were best combiner. For number of bolls/plant, as female, TCH 1726, NARASIMHA and H 99 and male line such as BW 4- 1 – 1, HSC – 1 – 132 and HSC – 1 – 521 were observed best combiners (Table 2). Significant high *gca* effects for 2.5% span length were recorded by TCH 1726, MCU 12, BW 12 – 5 – 1 and BW 9-1-1 in that order. For bundle strength MCU 12 and H99 were best combiners among female parent and HSC – 1 – 132, HSC – 2 – 264 and HSC – 1 – 521 among male.

The estimates of *sca* effects indicated that out of 84 crosses, 33 crosses had significant positive *sca* effects for single plant yield/plant. The best cross combination for single plant yield was TCH 1705 X H T1. It was followed by crosses H 97 x BW -9-1-1, NARASIMHA x H SC – 1-521, NARASIMHA x HSC – 2 -133, H 99 x H 74, MCU 12 x H SC – 1 - 132 and TCH 1702 x H 73. The best cross combination for days to 50% flowering was TCH 1702 x H SC – 2-133 followed by H 99 x H T1 recorded significant negative *sca* effects. TCH 1705 x H SC – 1 – 521 was the best combiner for plant height and TCH 1726 x TCH 1699 for number of sympodia / plant. For number of bolls/plant TCH 1705 x H T1 was the best combiner followed by MCU 12 x HSC– 1-132. Nine cross combinations had significant positive *sca* effects for average boll weight in which H 99 x TCH 1699 was the best.Six hybrids had significant positive *sca* effects for ginning % in which NARASIMHA x BW 9-1-1 had highest *sca* effects. The best specific combiners for span length was H 99 x LPHS followed by TCH 1702 x HSC– 1-132 was the best cross combination for bundle strength followed by MCU 12 x HT 3.

When the *sca* effects of the best combiner were compared in relation to *gca* effects of their parents, it was observed that these crosses had at least one parent with high *gca* effects for almost all the characters. The crosses involving high x low general combiner are likely to produce desirable transgressive segregants. El-Ad1 and Miller (1971) obtained transgressive segregants that were better than the original F1.However it was not true in all cases. The parents with low x low *gca* effects resulted into good *sca* effects. (e.g) TCH 1705 x H T1 and H 97 x BW – 9-1-1 for single plant yield

(Table 3). These results are in conforming to Patil and Chopde (1983). The cross NARASIMHA x HSC – 1 – 521 for seed cotton yield involving parents with high x high *gca* effects resulted into high *sca* effect which can be exploited through transgressive segregant . It involved additive type of gene action that could be easily fixable. This type of gene action is highly desirable. The cross combinations such as MCU 12 X LPHS for number of bolls/plant. TCH 1702 x H SC -1-132 for 2.5 per cent span length, TCH 1705 x H T1 and H 97 x BW 9 – 1 – 1 for seed cotton yield involved poor combining parents. The superiority of low x low combinations may be attributed to the genetic diversity of the parents. In the present study, the four hybrids TCH 1705 x H SC – 1 – 521, H 99 x H T4 , H 99 x TCH 1699 , NARASIMHA x H SC – 1 – 521 showed high *per se* performance for yield and quality. In many of the characters, both the parents were not good general combiners. Therefore, crosses in which atleast one parent with of high general combining ability for a particular character is involved could be exploited for breeding with better dependability. The combining ability of parents may be considered as a reliable guide for the prediction of yield potential of a cross. In the present study there are many deviations from the expected behavior of F_1s based on parental performance. Such deviations can be explained to be due to non additive genes like inter allelic interactions (or) due to large number of quantitative genes, determining the characters. (or) the effect of modifier genes. Nevertheless, the role of environment cannot also be completely ruled out, testing of hybrids over locations and years is likely to eliminate such effects and identify useful hybrids either for direct exploitations or pedigree breeding to combine not only the yield and fibre quality but also the resistance traits of the derived lines.

The present study indicated that the parents TCH 1726, HSC -1-52 and H 99 had high *gca* effects for different economic characters can be utilized in conventional breeding programme and the crosses NARASIMHA X H SC – 1-52, TCH 1705 X H SC - 1-521 and TCH 1726 X H SC -2-133 which possessed good *sca* can be exploited for hybrid vigour.

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Table 1. Magnitude of GCA and SCA for different characters

Particulars	GCA	SCA	GCA/SCA
Days to 50% flowering	0.131	0.938	0.139
Plant height (cm)	86.946	157.204	0.553
Number of sympodia/ plant	2.285	15.336	0.148
Number of bolls/plant	3.705	32.051	0.1155
Boll weight (g)	0.017	0.078	0.220
Single plant yield	117.923	839.115	0.1405
Ginning outturn (%)	0.917	3.258	0.282
2.5% Span length (mm)	0.423	0.925	0.457
Bundle strength	0.289	0.846	0.342

Table 2. Estimates of general combining ability (gca) effects of parents for different characters in cotton.

Character/line	Days to 50% flowering	Plant height(cm)	Number of sympodia/plant	Number of bolls Per plant	Boll weight	Single Plant Yield (g)	Ginning Outturn (%)	2.5% span length (mm)	Bundle strength (g/tex)
TCH 1705	-0.193	12.077**	-0.729**	-0.632*	0.012	-2.165**	1.319**	-0.736**	-1.022**
MCU 12	-0.329**	-11.874**	-0.734**	-2.668**	0.143**	-9.09**	0.149	0.731**	0.842**
H 99	0.146	8.693**	0.091	1.652**	0.012	9.199**	0.552	0.462*	0.342*
TCH 1702	0.601**	-6.171**	0.48	-1.933**	-0.229**	11.355**	-2.056**	0.025	0.239
H 97	0.282*	-0.94	0.808**	0.425	-0.229**	-5.773**	-0.662	-1.255**	-0.325*
NARASIMHA	-0.396*	7.698**	-0.373	1.573**	-0.115**	3.626**	0.649	0.145	-0.186
TCH 1726	0.454*	14.671**	0.458	1.584**	0.198**	15.558**	0.049	0.628**	0.109
SE for line	0.115	0.584	0.244	0.312	0.056	0.762	0.358	0.190	0.1593
Tester									
HSC-1-521	-0.236	2.513**	0.013	2.39**	0.264**	16.618**	-0.868	0.272	0.629**
HSC-2-133	-0.374**	-7.054**	-0.968**	-1.29**	0.116	-1.065	-0.801	0.129	0.262
HSC-2-264	0.392**	-7.082**	-0.159	-2.805**	0.126	-8.362**	1.189*	0.477	0.529*
HSC-1-132	-0.274	-7.163**	-0.502	2.154**	0.14	15.687**	-0.42	-0.371	0.738**
LPHS	0.002	-0.258	-0.659*	0.97*	-0.141	5.306**	1.008*	-0.956**	-0.519**
HT 1	-0.122	10.856**	-0.006	-1.269**	-0.212**	-20.32**	-1.03*	-0.456	-0.49
HT 3	0.512**	5.213**	0.851**	-3.216**	-0.008	12.52**	0.499	-0.599*	0.267
HT 4	-0.293	7.656**	-1.059**	-0.802*	-0.055	-6.974**	0.946*	0.21	0.067
TCH 1699	0.735*	-5.539**	1.527**	1.579**	-0.122	5.279**	-0.273	-0.647*	-0.557**
BW 9-1-1	-0.146	-7.568**	0.484	-1.204**	0.107	-5.398**	1.07*	0.701*	-0.333
BW 12-5-1	-0.088	4.232**	0.222	-0.478	-0.165*	-6.763**	-1.535**	0.739**	0.257
BW 4-1-1	-0.108	4.194**	0.256	3.97**	-0.05	18.526**	0.213	0.501	-0.848**
SE for Tester	0.151	0.764	0.319	0.408	0.074	0.955	0.469	0.248	0.208

* - significant at 5% level ** - significant at 1% level

Table 3.Estimation of specific combining ability effects based on mean performance of best crosses

Characters	Top ranking two Hybrids with high *sca* effects and *per se* performance	Mean	*sca* effect	*gca* status of Parents			
				♀		♂	
Days to 50% flowering	TCH 1702 X H SC -2-133	58.67*	-2.054**	0.601**	HighLo	-0.374**	Low
	H 99 X H T1	58.63*	-1.884**	0.146	w	-0.122	Low
Plant height	TCH 1705 X H SC -1-521	166.47	51.25**	12.077**	HighLo	2.513**	High
	TCH 1702 X BW 9 -1-1	137.00	25.923**	-6.171**	w	-7.568	Low
Number of sympodia/ plant bolls	TCH 1726 X TCH 1699	24.40*	2.909**	0.458	Low	1.527**	High
	MCU 12 X LPHS	20.13	2.687**	-0.734**	Low	-0.659	Low
Number of bolls per plant	TCH 1705 X HT1	45.83*	16.40**	-0.632*	Low	-1.269**	Low
	MCU 12 X H SC -1-132	42.5*	11.67**	-2.668**	Low	2.154**	High
Boll weight	H99 X TCH 1699	5.30*	0.716**	0.012	Low	-0.122	Low
	NARASIMHA X HSC-1-521	5.37*	0.525**	-0.115**	Low	0.264**	High
Single plant yield	TCH 1705 X H T1	76.92**	185.98*	-2.165**	Low	-20.32**	Low
	H 97 X BW -9-1-1	50.41**	170.79*	-5.773**	Low	-5.398**	Low
	NARASIMHA X HSC–1- 521	41.64**	193.44*	3.626**	High	16.618**	High
	NARASIMHA X HSC–2-133	46.26**	180.38*	3.626**	High	-1.065	Low
	H 99 X H T4	46.43**	180.21*	9.199**	High	-6.974**	Low
	MCU 12 X HSC-1-132	40.75**	178.9*	-9.09**	Low	15.687**	High
	TCH 1702 X H T3	44.24**	151.91	11.355**	High	-12.52**	Low
Ginning out turn	NARASIMHA X BW 9 -1-1	38.10	4.865**	0.064	Low	1.07*	High
	TCH 1726 X HSC -2-264	36.70	3.984**	0.049	Low	1.189*	High
2.5 per cent span length	H99 X LPHS	33.07*	2.515**	0.462*	HighLo	-0.956**	Low
	TCH 1702 X HSC -1-132	32.97*	2.265**	0.025	w	-0.371	Low
Bundle strength	TCH 1702 X HSC – 1 -132	25.10*	2.604**	0.239	Low	0.738**	High
	MCU12 X HT 3	24.87*	2.239**	0.842**	High	0.267	Low

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