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General and Specific Combining Ability for Some Important Fiber Quality Traits in Intra-Specific Upland Cotton Hybrids

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Abstract: *The objective of this study was to investigate the general combining ability (GCA) of parents and specific combining ability (SCA) of hybrids and also the genetic behaviourof the populations obtained by 10x10 half diallel. The forty-five F1 intra-specific hybrids and ten parents were planted in a randomized block design with two replications in 2012. The general combining ability (GCA) effects of the parents and the specific combining ability (SCA) effects of the hybrids as well as the gene action were estimated by using the half diallel analysis. All the fibre quality traits indicated that GCA variance was greater than SCA variance for all traits expect for 2.5% span length and uniformity ratio indicating the preponderance of non-additive variance and GSHV-99/307 for Micronaire, H-1462 for Fibre strength, Elongation (%) and Fibre strength to length ratio, are the best parent cotton cultivars having the good (GCA) general combining abilities in positive direction and PUSA 9127 for 2.5% Span length in negative direction. It was also found that CCH 510 x H 1462 for 2.5% Span length, BS 2170 x TSH 0250 for Micronaire, hybrid combinations was the most promising crosses with the highest specific combining ability in positive direction and CCH -510 x BS -277 for 2.5% Span length and CCH- 510 x H -1462 for Uniformity ratio (%) in negative direction.*

Keywords: *General combining ability, 2.5% span Length, specific combining ability.*

INTRODUCTION

Cotton is used in many different areas having economical importance. Most of the breeding programs of cotton to increase fibre quality parameters that are important in textile industry. For this purpose the most important step is to select suitable parents. Since fibre quality traits are quantitively inherited, a simple genetic model having several genetic parameters needs a lot of work to solve complex relationships to successful breeding. Combining ability analysis, to compare the performance of lines in hybrid combinations is used in breeding programs and allow estimation of different genetic parameters.

In previous studies in cotton, (1) used the terms of general (GCA) and specific combining ability (SCA) to designate the average performance of parents and hybrid combinations. Combining ability analysis is an important tool for selection of desirable parents together with the information regarding nature and magnitude of gene effects controlling both quantitative and qualitative traits. GCA effects reflects performance of parental lines in combination with all other lines, so parents with the highest GCA effects should have greater impact on trait improvement and it may be possible utilize additive variance through natural selection.

The success of the hybridization program depends on the ability of the parents having greater potential in hybridization to yield desirable segregants or recombinants (2). Fibre elongation had approximately equal additive and dominance genetic effects while strength exhibited primarily additive genetic effects (3). The micronaire, fibre strength, fibre length, uniformity index, short-fibre index, fibre elongation showed additive effects (4). To determine combining abilities of parents and to select appropriate parents and crosses the half diallel analysis has been widely used by plant breeder. Superior combining parents were identified on the basis of combining abilities and subsequently used in the breeding program with good results. Thus, the main objective of this experiment was to identify the parents and their crosses, on the basis of their general

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and specific combining abilities for fibre quality properties.

MATERIALS AND METHODS

Ten parents which were genetically diverse agro-climatic zones i ., All India Coordinated Cotton Improvement Projects trails namely GSHV-99/307, Pusa-9127, ARB-904, Surabhi, CCH-510, BS-277, BS-2170, H-1462,TSH-0250 and TCH-1728 and one commercial cotton va-rieties (*Gossypium hirsutum* L.) namely Bunny and their forty five F1 hybrids.

Ten parents were crossed using a half diallel mating design in 2011-12. Ten parents and their forty-five F1 hy-brids were planted in a randomized block design with two replications at the Agri-cultural Research station, Siruguppa in 2012-13. Each plot contained two rows, of 6.0 m length at planting and the distance between and within the rows spacing were 90cm x 60 cm, respectively. The seed cotton sample of 300 g was collected from each treatment in each replication. The samples were ginned and 100 g lint represented a fibre sample. Fibre properties measurements were made on High Volume Instrument, popularly known as HVI at the Quality Evaluation at Central Institute for Research on Cotton Technology (CIRCOT), Main Station, Mumbai.

RESULTS AND DISCUSSION

The analysis of variance of the investigated characters in the population is presented in Table 1. Mean squares for genotypes were found to be highly significant for the 2.5% span length and Micronaire characters under study, indicating considerable genetic diversity for quality traits, hence later analysis for combining ability was possible. The total genetic variability was partitioned to general combining ability and specific combining ability.

Table 1
Analysis of variance for genotypes and combining ability for fiber quality properties in half diallel cross of cotton

Source of variation	*df*	*2.5% span length*	*Uniformity ratio (%)*	*Micronaire (µg/inch)*	*Fibrestrength (g/t)*	*Elongation (%)*	*Strength to length ratio*
Replicates	1	0.25	28.50**	0.72**	6.19	1.12	102.15
Treatments	54	3.24*	2.97	0.20**	2.38	0.27	34.73
Parents	9	3.84*	3.76	0.21*	5.072**	0.18	50.76
Hybrids	44	3.19*	2.73	0.20**	1.88	0.30	32.16
Parent Vs Hybrids	1	0.06	6.34	0.07	0.25	0.10	3.91
Error	54	1.85	2.71	0.08	1.81	0.34	25.70
Total	109	2.53	3.07	0.14	2.14	0.31	30.88
GCA	9	0.87	0.77	0.19**	1.93 *	0.22	30.81*
SCA	45	1.77*	1.63	0.08**	1.04	0.12	14.68
GCA/SCA		0.49	0.47	2.33	1.85	1.84	2.10
Error	54	0.93	1.36	0.04	0.91	0.17	12.85

*, ** Significant at 5% and 1% levels, respectively

Mean squares of general combining ability (GCA) were found significant for Micronaire, Fibre strength and Strength to length ratio, revealing the important role of additive gene effects, but not for Uniformity ratio and Elongation (%). Specific combining ability (SCA) was found significant for the 2.5% span length and Micronaire, revealing that non-additive gene ef-fects, as dominant or epistatic are important (Table. 1)

The general combining ability (GCA) effects were higher than specific combining ability (SCA) effects for the Micronaire, Fibre strength, Elongation (%) and Strength to length ratiowhich indicated that additive gene action is prevailing with dominant or epistatic for the expression of these traits.

Mean squares of the specific combining ability (SCA) were found to be highly significant for 2.5% span length andUniformity ratio (%), revealing important role and non-additive gene effects. The results are in agreement with the previous studies of (2), (5) and (6).

General combining ability effects were presented in Table 2. As regards the estimates for general combining abil-ity (GCA) effects, for Micronaire only one parent showed significant GCA effects, negative GCA effects for Micronaire was predicted for BS-2170 and TSH -0250. Posi-tive GCA effects for fibre strength, elongation (%) and strength to length ratio were predicted for only parent H-1462. Although crosses with this parent showed reduced these characteristics.

Table 2
Predicted general combining ability effects (GCA) for fibre properties of ten parents.

Parents	*2.5% span length*	*Uniformity ratio (%)*	*Micronaire (µg/inch)*	*Fibrestrength (g/t)*	*Elongation (%)*	*Strength to length ratio*
GSHV 99/307	-0.14	0.00	0.25**	-0.16	-0.05	-0.27
Pusa 9127	0.35	0.38	0.09	0.21	-0.17	-0.27
ARB 904	-0.13	0.42	-0.08	0.28	0.04	1.23
Surabhi	0.44	-0.17	0.03	-0.17	-0.04	-1.77
CCH 510	0.29	0.00	0.01	0.00	-0.18	-0.77
BS 277	-0.21	0.21	0.08	-0.40	0.11	-0.77
BS 2170	0.08	-0.17	-0.18**	-0.51	-0.14	-1.85
H 1462	-0.22	-0.25	-0.02	0.73**	0.22*	3.23**
TSH 0250	-0.33	-0.13	-0.12*	-0.38	0.09	-0.52
TCH 1728	-0.13	-0.29	-0.06	0.41	0.11	1.73
Parental mean	28.40	51.50	3.50	21.70	5.70	0.77
$CD_{(gi)}$ @ 5 %	0.53	0.64	0.11	0.52	0.22	1.97
CD gi – gj @ 5%	0.79	0.95	0.16	0.77	0.34	2.93

*, ** Significant at 5% and 1% levels, respectively

Specific combining ability effects of the hybrids for fiber quality properties are presented in Table 3.

Table 3
Predicted specific combining ability effects (SCA) for fiber properties of hybrids.

Character / *Crosses*	*2.5% span length*	*Uniformity ratio (%)*	*Micronaire*	*Fibre strength (g/t)*	*Elongation (%)*	*Strength/ Length ratio*
GSHV 99 x PUSA 9127	-0.14	0.22	-0.25	-0.26	0.10	-0.67
GSHV 99/307 x ARB 904	-0.46	-0.83	0.22	-1.22	-0.27	-2.67
GSHV 99/307 x Surabhi	-0.45	-0.70	0.14	0.66	0.11	3.33
GSHV 99/307 x CCH 510	0.58	-0.24	0.36	0.52	0.11	0.33
GSHV 99/307 x BS 277	0.49	2.38	-0.38	-0.70	-1.01	-3.17
GSHV 99/307 x BS 2170	-0.19	0.34	-0.41	1.59	0.23	5.83
GSHV 99/307 x H 1462	-0.53	-0.41	-0.06	0.06	0.21	1.33
GSHV 99/307 x TSH 0250	0.78	0.22	0.30	0.59	0.38	0.33
GSHV99/ 307 x TCH 1728	-1.15	1.67	-0.08	-0.63	-0.18	0.83
Pusa 9127 x ARB 904	-1.81	0.26	-0.09	-1.48	-0.20	-0.67
Pusa 9127 x Surabhi	0.22	-0.12	-0.18	0.10	-0.03	-0.17
Pusa 9127 x CCH 510	-1.07	-0.99	0.23	-0.77	0.04	-0.17
Pusa 9127 x BS 277	0.36	-0.03	0.20	-1.59	-0.42	-6.17
Pusa 9127 x BS 2170	1.05	0.05	-0.31	-0.04	0.31	-2.67
Pusa 9127 x H 1462	-0.36	-0.12	0.22	0.09	0.25	1.33
Pusa 9127 x TSH 0250	-1.12	-0.74	0.38	-0.23	0.11	1.92
Pusa 9127 x TCH 1728	-1.05	-0.12	0.45	0.60	0.29	4.92
ARB 904 x Surabhi	1.42	-0.16	-0.08	0.88	0.63	-0.58
ARB 904 x CCH 510	-0.84	0.92	0.10	-0.38	-0.04	0.92
ARB 904 x BS 277	-0.70	2.26	-0.12	1.96	-0.85	8.42
ARB 904 x BS 2170	1.90	0.05	0.06	0.85	0.36	-2.08
ARB 904 x H 1462	-0.33	-0.16	0.16	-1.03	-0.29	-2.67
Mean	29.0	52.0	3.71	21.7	5.5	0.75
CD (Sij-Sik) at 5%	2.61	3.16	0.53	2.58	1.12	9.73
CD (Sij-Skl) at 5%	2.49	3.01	0.51	2.46	1.07	9.28
ARB 904 x TSH 0250	2.34	-0.03	-0.23	1.10	0.13	-2.67
ARB 904 x TCH 1728	0.31	-0.58	-0.31	1.08	0.12	2.83
Surabhi x CCH 510	1.70	-0.49	-0.12	1.08	-0.05	-1.17
Surabhi x BS- 277	0.44	-1.16	0.06	-1.54	0.09	-6.17
Surabhi x BS -2170	-1.95	2.63	0.14	0.20	0.25	6.33
Surabhi x H 1462	0.21	1.01	0.00	-0.98	-0.25	-4.08
Surabhi x TSH 0250	0.64	-0.78	0.12	-0.46	-0.21	-3.42
Surabhi x TCH 1728	1.00	-0.16	-0.42	-0.28	-0.09	-3.42
CCH 510 x BS -277	-2.73**	2.30	-0.05	-0.25	-0.20	6.58
CCH 510 x BS -2170	0.66	0.88	0.29	0.75	0.33	0.58

contd. table 3

Character Crosses	2.5% span length	Uniformity ratio (%)	Micronaire	Fibre strength (g/t)	Elongation (%)	Strength/ Length ratio
CCH 510 x H 1462	2.65**	-3.28**	-0.33	1.13	0.07	-2.92
CCH 510 x TSH 0250	1.31	0.01	-0.15	1.57	-0.07	2.08
CCH 510 x TCH 1728	-0.73	0.38	-0.14	0.29	0.38	2.67
BS 277 x BS 2170	-0.49	-1.03	0.04	-0.41	-0.43	-0.42
BS 277 x H 1462	0.44	0.88	-0.20	0.19	0.22	-0.67
BS 277 x TSH 0250	0.25	-0.49	-0.08	0.12	-0.70	-0.17
BS 277 x TCH 1728	0.73	-0.53	0.34	-1.00	-0.02	-5.67
BS 2170 x H 1462	0.07	-0.95	0.38	-1.90	0.01	-6.67
BS 2170 x TSH 0250	-2.09	1.38	0.61**	-1.27	-0.44	0.83
BS 2170 x TCH 1728	0.66	-0.83	-0.21	-0.08	-0.03	-2.17
H 1462 x TSH 0250	-1.43	2.55	-0.20	-0.71	-0.14	0.92
H 1462 x TCH 1728	-2.23	-0.37	0.48	0.05	0.26	7.33
TSH 0250 x TCH 1728	2.13	0.01	-0.36	0.76	0.29	-2.42
Mean	29.0	52.0	3.71	21.7	5.5	0.75
CD (Sij-Sik) at 5%	2.61	3.16	0.53	2.58	1.12	9.73
CD (Sij-Skl) at 5%	2.49	3.01	0.51	2.46	1.07	9.28

Based on the results of SCA effects for hybrids BS 2170 x TSH 0250 for Micronaire was found to be the best specific combinations in Contrast, Significant and negative specific combining ability effects for Uniformity ratio (%) observed in CCH 510 x H 1462 only one crosses of the forty five cross com-binations, as these seem to be desirable for further improvement propose.

CONCLUSIONS

In this study significant additive genetic effects was observed for Micronaire, Fibre strength, and Strength to length ratio, on the other hand, non-additive genetic effects were observed for 2.5% span length and Uniformity ratio (%), Therefore, selection in advanced generations may be more appropri-ate for characters under non-additive genetic effects, but early generation's selection may be more appropriate for characters under additive genetic effects, because effective selection in early generations of segregating material can be achieved when additive genetic effects are substantial and environmental effects are low.

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