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Heterosis and combining ability studies in upland cotton for fibre characters

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ABSTRACT

The present investigation was undertaken to identify best parents and hybrids and also to study the genetic potential of thirteen *Gossypium hirsutum* lines in evolving superior fibre quality genotypes coupled with jassid resistance. The study indicated the predominance of non-additive gene effects for 2.5 per cent span length, uniformity ratio, micronaire, bundle strength and elongation percentage. The genotypes SVPR 3, B 1007 and MCU 5 for 2.5 per cent span length, SVPR 3, Laxmi, DHY 286 for uniformity ratio, SVPR 3 for micronaire value, Laxmi, B 1007, KC 2 and MCU 5 for bundle strength, SVPR 3, Khandwa 2 for elongation percentage would serve as good general combiners. The jassid resistant lines DHY 286 and KC 2 were observed as good general combiners for uniformity ratio and bundle strength, respectively. The tester MCU 5 was a good general combiner for 2.5% span length and bundle strength. By hybridizing the resistant lines with MCU 5, favorable gene combinations could be accomplished for the above fibre quality traits. Further, the resistant hybrids KC 2 x MCU 7 for 2.5% span length, SVPR 3 x MCU 12 for uniformity ratio and elongation percentage, SRT 1 x MCU 5 for 2.5% span length and bundle strength showed significant positive specific combining ability effects. Hence the above hybrids can be used in breeding programmes for improving the fibre quality traits coupled with jassid resistance.

Keywords: Cotton, heterosis, combining ability, fibre quality, jassid resistance

INTRODUCTION

Selection of parents for hybridization is an important aspect in all crop improvement programmes and, the performance of varieties over a large number of yield trials may give an idea of their relative superiority. Therefore, proper choice of parents based on their combining ability is an important pre-requisite. The studies intended to determine the combining ability also simultaneously measure the nature and the magnitude of gene action. The degree of economic heterosis should be considered superior if any of the F_1 hybrids performs better than the best commercial variety. This estimate in a real sense, decides whether the hybrid is worth exploiting or not. The present investigation was undertaken to identify best parents and hybrids and also to study the genetic potential of thirteen *Gossypium hirsutum* lines in evolving superior fibre quality genotypes coupled with jassid resistance.

MATERIALS AND METHODS

The material consisted of ten *Gossypium hirsutum* lines and three standard varieties viz.,

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MCU 5, MCU 7 and MCU 12 as testers. The resulting 30 F_1s and 13 parents were grown in a randomized block design with 3 replications at the Department of Cotton, TNAU,Coimbatore. The parents and F_1s were grown in a single row of 6 m length with a spacing of 75 x 30 cm. Observations were recorded on five competitive plants selected at random for five characters viz.,2.5% span length, uniformity ratio, micronaire, bundle strength and elongation percentage. The kapas samples were pooled from the five sample plants, ginned and the lint obtained was assessed for the above five characters. The characters were estimated by using High Volume instrument 900 classic installed at Cotton Breeding Station, Centre for Plant Breeding & Genetics, TNAU, Coimbatore. The mean data were subjected to a line x tester analysis and combining ability effects and variances were estimated using the model suggested by Kempthorne (1957). The above lines, testers and the resulting thirty hybrids were screened for jassid resistance under artificial conditions (ICCC, 1960). The resistant parents and hybrids were discussed for their combining ability and heterosis for fibre characters coupled with resistance.

RESULTS AND DISCUSSION

Analysis of variance

The analysis of variance revealed significant differences among parents for all characters except for micronaire value (Table 1). Variance due to lines was highly significant for the characters 2.5 per cent span length, uniformity ratio and bundle strength. Variance due to testers was highly significant for 2.5% span length, uniformity ratio and bundle strength. The variance due to interaction effect of lines and testers was significant for all characters except for micronaire value and elongation percentage. The variance due to SCA was larger than the variance of GCA for all the traits.

Heterosis

The estimates of heterosis over standard check (MCU 12) are presented in Table 2. Two out of 30 crosses showed significant positive heterosis for uniformity ratio and it ranged from 9.66 to 8.97. For 2.5% span length and micronaire, none of the hybrids showed significant positive heterosis. The hybrids

Table 1 . Analysis of variance for fibre quality

Source	df	2.5% Span Length	Uniformity ratio	Micronaire	Bundle Strength	Elongation percentage
Hybrids	29	7.31**	8.56**	0.187	4.16**	1.03
Parents	12	16.61**	9.30**	0.299	4.20**	2.24**
Parents Vs Crosses	1	11.96**	57.25**	0.0079	0.033	0.228
Lines	9	5.66**	12.23**	0.339	8.14**	1.36
Testers	2	27.81**	6.74**	0.035	5.59**	1.39
Lines x Testers	18	5.86**	6.92*	0.127	2.01**	0.835
Error	58	1.92	2.88	0.108	1.00	0.350
GCA		0.557	0.131	0.003	0.248	0.027
SCA		2.34	1.71	0.004	0.776	0.182
GCA/SCA		0.24	0.08	0.75	0.32	0.15

* Significant at 5% level ** Significant at 1% level

Table 2. Standard Heterosis for fibre characters

Particulars	2.5% span Length (mm)	Uniformity ratio	Micronaire	Bundle strength (g/tex)	Elongation percentage
KC 2 x MCU 5	-12.50**	0.00	-16.67*	-6.16	-17.49**
KC 2 x MCU 7	-6.30	-1.38	-1.59	-3.72	-20.63**
KC 2 x MCU 12	-8.61*	-1.38	-10.32	-2.87	-21.52**
SVPR 2 x MCU 5	-11.55**	0.00	-7.94	-10.17**	-11.66
SVPR 2 x MCU 7	-15.02**	-3.45	-16.67*	-11.03**	-15.25*
SVPR 2 x MCU 12	-7.35*	-1.38	-6.35	- 8.74*	-12.56
SVPR 3 x MCU 5	-11.13**	0.00	-5.56	- 5.01	-23.32**
SVPR 3 x MCU 7	-17.54**	-1.38	-5.56	-15.62**	-8.52
SVPR 3 x MCU 12	-17.23**	4.83	-3.17	-9.74**	1.35
SRT 1 x MCU 5	1.53	-9.66**	-10.32	-3.58	-30.04**
SRT 1 x MCU 7	-10.71**	-4.14	-8.73	-11.46**	-19.28**
SRT 1 x MCU 12	-16.39**	-6.21*	-11.11	-18.62**	-17.04**
Laxmi x MCU 5	-7.98*	-2.07	-25.40**	0.86	-30.49**
Laxmi x MCU 7	-20.69**	8.97**	-14.29*	- 6.16	-7.62
Laxmi x MCU 12	-8.09*	-4.14	-25.40**	0.14	-21.08**-
Stoneville x MCU 5	-8.61*	-4.14	-9.52	- 9.17*	24.66**
Stoneville x MCU 7	-16.28**	0.00	-16.67*	- 7.59*	-10.76
Stoneville x MCU 12	-6.72	-2.76	-9.52	- 8.60*	10.49
DHY 286 x MCU 5	-3.99	0.00	-19.05**	- 1.58	21.23*
DHY 286 x MCU 7	-16.60**	6.21*	-11.90	- 8.02*	-9.42
DHY 286 x MCU 12	-5.15	-1.38	-12.70*	- 5.87	1.85
Khandwa 2 x MCU 5	-12.82**	-2.76	-5.56	-13.32**	31.51**
Khandwa 2 x MCU 7	-12.50**	-4.14	-15.87*	-12.89**-	-13.45*
Khandwa 2 x MCU 12	-11.55**	-0.69	-10.32	15.19**-	23.46**
Badnawar 1 x MCU 5	-11.55**	0.00	-4.76	14.04**	33.56**
Badnawar 1 x MCU 7	-12.39**	-2.307	-12.70*	-12.46**	-24.66**
Badnawar 1 x MCU 12	-8.40*	-1.38	-3.97	-11.32**	- 1.23
B 1007 x MCU 5	-3.15	-2.07	-11.90	1.86	7.53
B 1007 x MCU 7	-11.76**	-1.38	-17.46**	- 6.16	-26.91**
B 1007 x MCU 12	-3.89	-4.14	-12.70*	- 8.02*	0.62

* Significant at 5% level ** Significant at 1% level

Khandwa 2 x MCU 12 and Badnawar 1 x MCU 7 showed significant positive heterosis. For bundle strength and the value ranged from 18.62 to 15.19. The hybrids Stoneville x MCU 5, DHY 286 x MCU 5, Khandwa 2 x MCU 5, Khandwa 2 x MCU 12 and Badnawar 1 x MCU 5 showed significant positive standard heterosis. Hence, for the improvement of the fibre quality traits, the above crosses can be exploited.

Combining ability effects

The general combining ability effects (gca) of the parents and specific combining ability effects (sca) of the hybrids are presented in Tables 3 and 4. The *sca* variance was greater than the *gca* variance for all the five traits in this study, indicating the predominance of non additive gene action. This signifies the scope for exploitation of heterosis for the above traits. Predominance of non-additive gene action for

Table 3. General combining ability effects

Particulars	2.5% span length	Uniformity Ratio	Micronaire	Bundle strength	Elongation percentage
Lines					
KC 2	0.44	0.23	0.08	0.91*	-0.11
SVPR 2	-0.25	-0.10	0.05	-0.43	0.39
SVPR 3	1.50**	1.23*	0.28*	-0.46	0.61**
SRT 1	0.53	-2.54**	0.06	-0.72*	-0.27
Laxmi	-0.55	1.12*	-0.43**	1.49**	-0.10
Stoneville	0.00	-0.43	-0.02	-0.07	0.00
DHY 286	0.62	1.46**	-0.13	0.69	-0.02
Khandwa 2	-0.56	-0.54	0.04	-1.32**	0.44*
Badnawar 1	-0.08	0.12	0.18	-1.04**	-0.25
B 1007	1.35**	-0.54	-0.11	0.94	-0.70
CD (5%)	0.97	1.05	0.23	0.71	0.43
CD (1%)	1.29	1.39	0.31	0.94	0.57
Testers					
MCU 5	0.72**	-0.32	-0.01	0.49*	-0.22
MCU 7	-1.09**	0.54	-0.03	-0.32	0.21
MCU12	0.38	- 0.22	0.04	-0.17	0.02
CD (5%)	0.52	0.57	0.11	0.37	0.23
CD (1%)	0.68	0.76	0.15	0.49	0.31

* Significant at 5% level ** Significant at 1% level

fibre quality was reported by many workers (Lather, 1985; Rajan *et al.,* 1999; Xin and Ming, 1998 and Zia Ul Islam *et al.*, 2001).
High mean values remain as a main selection index in the choice of parents and Gilburt (1958) pointed out that the parents with high *per se* performance will result in superior hybrids. Combining ability is another parameter used for selection of parents which furnishes useful information in terms of expected performance of their hybrids and their progenies, when the characters are under the control of non-additive genes. Many workers have followed this method to analyze critically the parents for their ability to transfer their potential to their progeny (Shanthi and Raveendran, 1999; Kowsalya *et al.,* 1999 and Tomar and Singh, 1992).

From the present investigation it is inferred that SVPR 3, B 1007 and MCU 5 for 2.5 % span length, SVPR 3, Laxmi, DHY 286 for uniformity ratio, SVPR 3 for micronaire value, Laxmi, B 1007, KC 2 and MCU 5 for bundle strength, SVPR 3, Khandwa 2 for elongation percentage would serve as good general combiners. It was further revealed that the resistant variety, Stoneville had a significantly negative *gca* effect for important fibre characters. *Per se* performance of this parent was also poor in most of the characters and may therefore be precluded from the crossing programme.

Among the resistant parents, DHY 286 was found to possess more favourable genes for 2.5% span length as seen from the positive and significant *gca* effects. The highly resistant parent KC 2 was observed as a good general combiner for bundle strength. So, this parent can be used in breeding programme for improving the above fibre quality traits

Table 4. Specific Combining ability effects of crosses

Particulars	2.5% span length (mm)	Uniformity ratio	Micronaire	Bundle strength (g/tex)	Elongation percentage
KC 2 x MCU 5	-1.78*	0.77	-0.29	-0.94	0.40
KC 2 x MCU 7	1.99*	-0.77	0.36	0.44	-0.26
KC 2 x MCU 12	-0.21	0.00	-0.07	0.49	-0.14
SVPR 2 x MCU 5	-0.79	1.10	0.11	-0.54	0.33
SVPR 2 x MCU 7	-0.08	1.43	-0.24	0.07	-0.36
SVPR 2 x MCU 12	0.38	0.33	0.13	0.46	0.03
SVPR 3 x MCU 5	0.61	-0.23	-0.02	0.70	-0.75**
SVPR 3 x MCU 7	0.38	-1.77	0.00	-0.96	-0.08
SVPR 3 x MCU 12	-0.99	2.00*	0.03	0.26	0.84*
SRT 1 x MCU 5	2.26**	-1.12	0.00	1.29*	-0.37
SRT 1 x MCU 7	0.51	0.68	0.08	0.26	0.00
SRT 1 x MCU 12	-2.77**	0.44	-0.08	-1.55*	0.36
Laxmi x MCU 5	0.64	-1.12	-0.15	0.11	-0.58
Laxmi x MCU 7	-1.58	3.34**	0.34	-0.71	0.69
Laxmi x MCU 12	0.94	-2.22	-0.19	0.61	-0.12
Stoneville x MCU 5	-0.10	-0.57	0.11	-0.66	-0.24
Stoneville x MCU 7	-0.73	0.57	-0.17	0.52	0.36
Stoneville x MCU 12	0.83	0.00	0.06	0.14	-0.12
DHY 286 x MCU 5	0.74	-0.46	-0.18	0.34	0.08
DHY 286 x MCU 7	-1.45	1.68	0.14	-0.35	0.48
DHY 286 x MCU 12	0.71	-1.22	0.04	0.01	-0.56
Khandwa 2 x MCU 5	-0.88	0.21	0.22	-0.38	0.12
Khandwa 2 x MCU 7	1.03	-1.32	-0.19	0.53	-0.27
Khandwa 2 x MCU 12	-0.15	1.11	-0.03	-0.15	0.15
Badnawar 1 x MCU 5	-0.96	0.88	0.11	-0.82	0.91*
Badnawar 1 x MCU 7	0.58	-0.99	-0.20	0.35	-0.42
Badnawar 1 x MCU 12	0.38	0.11	0.10	0.47	-0.49
B 1007 x MCU 5	0.27	0.54	0.10	0.90	0.09
B 1007 x MCU 7	-0.65	0.01	-1.12	-0.16	-0.14
B 1007 x MCU 12	0.38	-0.56	0.02	-0.74	0.05
CD (5%)	1.69	1.82	0.41	1.23	0.75
CD (1%)	2.24	2.42	0.55	1.63	1.00

* Significant at 5% level ** Significant at 1% level

coupled with resistance. The resistant parent DHY 286 appeared to be a good general combiner for uniformity ratio. Another resistant parent Khandwa 2 was a good general combiner for elongation percentage. The tester MCU 5 was a good general combiner for 2.5% span length and bundle strength. It may be concluded that by hybridizing the resistant genotypes with MCU 5, favourable gene recombinations could be accomplished for the above quality traits.

The hybrid DHY x MCU 5, in addition to jassid resistance is having high *per se* performance for 2.5 % span length, uniformity ratio, micronaire value and bundle strength. So, for breeding for quality traits, coupled with resistance DHY 286 x MCU 5 is found to be the best hybrid.

Further, the resistant hybrid KC 2 x MCU 7 showed significant positive *sca* effects for 2.5% span length. Resistant hybrid SVPR 3 x MCU 12 had positive *sca* effects for uniformity ratio and elongation percentage. The hybrid SRT 1 x MCU 5 in addition to jassid resistance possesses high significant positive *sca* effects for 2.5% span length and bundle strength. This hybrid also ranked first in *per se* performance for 2.5% span length. So, this hybrid can be used in breeding programme for improving resistance with increased span length.

The resistant hybrid B 1007 x MCU 12 also had high mean performance for 2.5% span length and ginning out-turn. The estimates of *gca* (additive) effects for parents indicated that none of the parents proved to be all round good general combiner for all the characters. Under such situations where additive and non-additive variances are important, recurrent selection approach would be appropriate for rapid improvement of fibre quality traits. From the present investigation it was inferred that, the above resistant parents and hybrids with good fibre quality can be used in breeding programme for improving the fibre quality traits coupled with jassid resistance.

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