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Research Article

Combining ability analysis for yield and fibre quality parameters in intraspecific hybrids of *G. hirsutum* L.

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Abstract
Four genetically diverse jassid resistant varieties *viz*., SRT 1, Khandwa 2, KC 2 and SVPR 3 (Females i.e lines) were crossed with three standard varieties *viz.,* MCU 5, MCU 7 and MCU 12 (male parents i.e., testers) in line x tester fashion for estimation in combining ability effects of twelve economic characters including fibre quality traits like 2.5% span length, bundle strength, fibre fineness, uniformity ratio and elongation percentage. Non-additive type of gene action was found relatively more important for all the characters. The jassid resistant parent KC 2 was a good combiner for boll weight, lint index, seed index and bundle strength besides seed cotton yield. While the parents SRT 1 and MCU 5 were found to be good general combiner for 2.5 per cent span length. On the basis of *sca* effects the combinations KC 2 x MCU 5, KC 2 x MCU 12 and Khandwa 2 x MCU 5 were the best hybrids for combining high yield, quality and jassid resistance.

Key words: *Gossypium hirsutum*, line x tester, combining ability effects, intraspecific hybrids

Introduction

Cotton often known as King among the fibres, is the principal raw material of the cotton textile industry of India. About 190 million people in the third world derive their income from cotton growing and processing. The economy of many countries depends on production, processing, utilization and export of cotton. In addition, cotton is also a predominant food and feed crop being the second best potential source of plant proteins after soybean, and the fifth best oil producing plant after soybean, palm tree, colza and sunflower (Texier 1993).

In the recent years cotton production is stagnant in many countries due to several biotic constraints particularly due to insect pests. Bollworms and sucking pests are the two major groups, which cause considerable damage to the crop leading to severe loss in yield and fibre quality. Among the sucking pests of cotton, jassids (*Amrasca bigutulla bigutulla*) is the most serious causing irreparable damage such as reddening, stunting, delayed maturity and lowered productivity and fibre quality. Loss in lint and seed yield has been estimated as 20–35% by sucking pests alone (Parnel *et al.* 1949). In the present situation it is impossible to raise a good crop without pest control in cotton and for which a major quantum of insecticides manufactured are used. In spite of colossal use of insecticides, complete pest control is not achieved, besides which the indiscriminate use of pesticides by cotton farmers has also resulted in increase in the cost of production, development of resistance to insecticides in major pests, resurgence of secondary pests and elimination of natural enemies in cotton ecosystem. Hence, there is a need for continuous development of new strategies to meet the emerging challenges in pest scenario of cotton. One of the viable and cost effective approaches is to develop cultivars that possess built-in resistance to insect pests. Insect resistant cultivars are compatible with other strategies of integrated, pest management practices, besides being sustainable and ecofriendly. Keeping this in view, the present study was undertaken to determining the combining ability effects of jassid resistance lines for yield and its fibre quality traits.

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Materials and Methods

The experimental materials for the present investigation consisted of a line x tester set of four diverse jassid resistance lines *viz.,* SRT 1, Khandwa 2, KC 2 and SVPR3 and three testers *viz.,* MCU 5,

MCU 7 and MCU 12. Crossing was done by following the conventional hand emasculation and pollination method developed by Doak (1934). The resulting 12 F_1 hybrids along with their seven parents were raised in a randomized block design with three replications at Department of Cotton, Centre for Plant Breeding and Genetics, TNAU, Coimbatore. Each progeny in a replication consisted of two rows of 6.0 m length, with a spacing of 90 x 45 cm between and within the rows. The data were recorded on five randomly selected parents in each replication on various component characters and mean values were used for statistical analysis. The line x tester analysis was carried out for determining the combining ability effects according to the method out lined by Kempthrone (1957).

Results And Discussions

The analysis of variance revealed significant variability among parents for all the characters. Variance due to lines was highly significant for three characters, boll weight, seed index and uniformity ratio and significant for lint index. Variance due to testers was highly significant for number of boll per plant, boll weight, seed cotton yield per plant and uniformity ratio. The variance due to interaction effect of lines and testers was significant for all the characters except for boll weight and uniformity ratio. The variance due to SCA was larger than the GCA variance for all the characters except uniformity ratio in which the SCA was lower than GCA and for the boll weight the variance of CGA was almost equal to variance of SCA.

In genetic analysis it is presumed that GCA variance reflects additive gene action and SCA variance corresponds with non additive gene action. If additive variance is greater the chance of fixing superior genotypes will be greater and also earlier. If dominant and epistatic interactions predominate, heterosis breeding can be adopted for either direct exploitation of crosses or for obtaining superior genotypes through inbreeding and selection in later generations. The SCA variance was greater than the GCA variance for all thirteen characters and indicated the predominance of non additive gene action which can be improved by heterosis breeding programmes. This findings support earlier observations of Shanthi and Selvaraj (1995); Punitha and Raveendran (1999); Punitha *et al* (1999) for yield and quality characters, Singh and Chahal (1974) and Singh *et al.* (1974) for bolls per plant, boll weight and seed cotton yield per plant.

The *per se* performance was considered as the first important selection index in the choice of parents and the parents with high *per se* performance will result in superior hybrids (Gilbert, 1958). However combining ability is a more dependable parameter used for selection of parents, which furnishes useful information in terms of expected performance of their hybrids and their progenies particularly when the characters are under the control of non additive genes. Many workers have followed this method to analyse 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).

In the present study, the parents KC 2, MCU 5 and MCU 12 were found to be good general combiners besides high mean *per se* for single plant yield. Hence these can be used in recombination breeding to obtain more favourable gene recombinations for seed cotton yield. Nadarajan and Elangovan (1982) and Kowsalya (1994) reported good general combining parents for yield in many studies. Among the three parents KC 2 also combines high degree of jassid resistance, which is the most desirable feature in resistance and productivity in cotton.

The parent KC 2 was a good general combiner for boll weight, lint index, seed index and bundle strength besides seed cotton yield. Regarding number of bolls per plant SVPR 3 and MCU 12 were good general combiners with high mean performance The parents SRT 1 and MCU 5 were found to be good general combiner for 2.5 per cent span length and also had higher mean performance than other parents for this character. The parents MCU 5, MCU 12, SVPR 3 and KC 2 can be used as best parents for improvement of yield and associated characters.

Among the twelve hybrids, SRT 1 x MCU 7, Khandwa 2 x MCU 5 and KC 2 x MCU 12 showed positive and significant *sca e*ffect for seed cotton yield. Out of these, KC 2 x MCU 12 ranked first for yield and both the parents of this hybrid were also found to possess high *gca* effect. This cross is the best for exploitation of developing high yield with resistant genotypes. The hybrid SRT 1 x MCU 7 had positive significant *sca* effect for yield. However, both the parents of this hybrid were not good general combiners. Evidently the influence of epistatic mechanism should have contributed to the positive yield expression and the cross should be cautiously followed up for deriving useful lines. Yield is

interplay of component characters. In this respect, the resistant hybrid KC 2 x MCU 12 which had high significant positive *sca* effect for yield was also a good combiner for number of sympodia per plant, number of bolls per plant which are important components of yield and ginning outturn and 2.5 per cent span length which are desirable quality characters. So in resistant breeding programme for incorporation of jassid resistance among all the hybrids, KC 2 x MCU 12 is the most important. The cross SRT 1 x MCU 5 showed high *sca* effect for bundle strength. As fibre strength is an important fibre quality parameter in the modern spinning machineries, a double crossing programme of KC 2 x MCU 12 and SRT 1 x MCU 5 would yield excellent genotypes for all characters. Multiple crossing programmes was also suggested by Singh and Chahal (1974), Singh *et al.* (1974) for bolls per plant, boll weight and seed cotton yield per plant and Meredith and Bridge (1972) for fibre fineness.

Combining ability studies disclosed that the parent KC 2 is an ideal plant for improving the yield, number of bolls per plant, lint index, seed index and bundle strength. The best hybrids identified in this study KC 2 x MUC 5, KC 2 x MCU 12 and Khandwa 2 x MCU 5 combined high yield and fibre quality and jassid resistance and deserve further evaluation.

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Table 1. Analysis of variance for combining ability

Source	df	No. of symp-odia / plant	No. of bolls / plant	Boll Weight (g)	Seed cotton yield / plant	Lint index	Seed index	Ginn-ing outturn	2.5% span length (mm)	Unifor-Mity ratio	Fibre Fineness	Bundle strength (g/tex)	Fibre elongation percentage
Cross	11	15.27**	20.85**	0.09**	371.30**	0.23**	0.64**	2.56**	9.51**	3.97*	0.17**	6.37**	0.25*
Lines	3	28.74	14.34	0.15**	76.21	0.47*	1.78**	4.39	8.14	4.78**	0.21	5.72	0.16
Testers	2	16.03**	75.35**	0.26**	1656.21**	0.15	0.04	1.38	18.21	12.33**	0.24	7.21	0.03
Lines x Testers	6	8.28**	5.93**	0.02	90.54**	0.14**	0.27**	2.04**	7.29**	0.78	0.13*	6.43**	0.37**
Parents	6	13.2**	24.03**	0.16**	584.56**	0.32**	1.41**	10.07**	11.97**	8.97**	0.55**	5.06**	1.01**
Parents Vs Crosses	1	10.44**	24.97**	0.26**	357.88**	1.12**	0.28**	16.72**	9.87**	4.70	0.00	0.02	0.22
Error	36	0.18	0.29	0.01	5.73	0.01	0.01	0.16	0.34	1.45	1.77	0.38	0.11
GCA		0.31	0.64	0.01	12.11	0.01	0.02	0.03	0.09	0.14	0.01	-0.01	-0.01
SCA		2.69	2.57	0.01	28.55	0.04	0.08	0.65	2.33	-0.39	0.03	1.96	0.09
GCA/SCA		0.12	0.25	1.00	0.42	0.25	0.25	0.05	0.04	-0.25	0.33	-0.01	-0.11

* - Significant at 5% level ** - Significant at 1% lev

Table 2. Mean performance of different characters in *Gossypium hirsutum* parents

Characters	LINES				TESTERS			Mean	SE	CD (5%)
	SRT 1	Khandwa 2	KC 2	SVPR 3	MCU 5	MCU 7	MCU 12			
No. of sympodia	21.27	19.07	17.67	16.80	20.73	22.07	21.87	19.92	0.35	0.69
No. of bolls/plant	21.27	18.93	17.87	15.73	23.20	15.30	19.07	18.77	0.31	0.88
Boll weight (g)	3.61	3.37	3.11	3.23	3.80	3.45	3.49	3.44	0.05	0.14
Seed cotton yield/plant (g)	78.00	65.69	55.96	53.67	88.64	49.81	64.71	65.21	1.38	3.92
Lint index (g)	4.94	4.10	4.64	4.10	4.80	4.40	4.60	4.51	0.05	0.13
Seed index (g)	8.62	7.72	8.47	7.66	8.44	9.19	9.50	8.51	0.08	0.22
Ginning outturn (%)	35.34	36.43	37.22	34.22	35.75	33.18	32.01	34.91	0.23	0.66
2.5% span length (mm)	24.93	24.93	26.13	28.27	29.63	26.17	29.33	27.06	0.33	0.95
Uniformity ratio(%)	49.33	46.00	45.67	44.67	44.33	46.67	44.67	45.90	0.69	1.97
Fibre fineness (mic)	3.33	3.60	4.03	2.93	2.87	3.03	3.00	3.26	0.13	0.36
Bundle strength (g/tex)	19.37	19.20	20.93	21.9.	21.47	18.73	21.43	20.44	0.36	1.01
Fibre Elongation percentage	5.60	4.80	5.53	4.50	4.20	5.23	4.30	4.88	0.19	0.53

Table 3. Mean performance of different characters in *Gossypium hirsutum* hybrids

Hybrids	No. of Symp-odia	No. of bolls/ plant	Boll weight (g)	Seed Cotton yield/ plant (g)	Lint index (g)	Seed index (g)	Ginning out-turn (%)	2.5% span length (mm)	Unifo-rmity ratio (%)	Fibre fine-ness (mic)	Bundle strength (g/tex)	Fibre Elonga-tion percen-tage
SRT 1 x MCU 5	18.73	20.73	3.55	72.56	4.51	8.69	35.09	30.57	46.33	3.33	22.60	5.16
SRT 1 x MCU 7	18.60	18.73	3.36	61.62	4.55	9.21	34.58	25.93	45.67	3.60	19.40	4.43
SRT 1 x MCU 12	18.33	20.80	3.58	73.02	4.99	9.23	35.99	25.57	45.00	3.33	17.77	5.00
Khandwa 2 x MCU 5	19.40	19.33	3.91	74.29	4.86	8.22	37.21	25.90	47.33	3.13	19.00	4.80
Khandwa 2 x MCU 7	21.40	16.40	3.42	55.29	4.78	8.41	36.41	24.77	46.67	3.27	19.80	4.97
Khandwa 2 x MCU 12	19.80	19.8	3.70	71.54	5.09	8.58	37.15	27.03	44.33	3.07	20.13	4.77
KC 2 x MCU 5	18.73	20.27	3.82	75.12	5.11	9.31	35.81	26.17	47.33	3.77	21.70	4.60
KC 2 x MCU 7	23.07	16.40	3.54	56.09	4.85	9.17	35.23	25.10	48.00	3.17	21.13	4.63
KC 2 x MCU 12	24.73	24.47	3.73	89.45	5.22	8.61	37.13	28.03	46.00	3.07	21.47	4.50
SVPR 3 x MCU 5	21.27	22.47	3.52	77.36	4.77	8.35	36.52	26.57	47.67	3.20	21.80	4.23
SVPR 3 x MCU 7	21.40	18.07	3.33	55.35	4.56	8.10	36.37	23.67	47.67	3.20	18.87	5.17
SVPR 3 x MCU 12	24.27	24.20	3.46	83.18	4.31	8.05	34.87	25.03	46.00	2.90	21.13	4.77
Mean	**20.81**	**20.14**	**3.58**	**70.40**	**4.80**	**8.66**	**36.03**	**26.19**	**46.50**	**3.25**	**20.40**	**4.75**
SE	0.35	0.32	0.05	1.38	0.05	0.08	0.23	0.33	0.69	0.13	0.36	0.18
CD (5%)	0.69	0.89	0.15	3.93	0.14	0.23	0.66	0.95	1.97	0.36	1.01	0.53

Table 4. General combining ability effects of parents

Characters	LINES					TESTERS			
	SRT 1	Khandwa 2	KC 2	SVPR 3	CD (5%)	MCU 5	MCU 7	MCU 12	CD (5%)
No.of sympodia	-2.26**	-0.61**	1.37**	1.50**	0.34	-1.28**	0.31*	0.97**	0.37
No. of bolls/plant	-0.05	-1.63**	0.24	1.44**	0.47	0.56**	-2.74**	2.18**	0.51
Boll weight (g)	-0.08**	0.10**	0.12**	-0.14**	0.06	0.12**	-0.16**	0.04	0.06
Seed cotton yield/plant (g)	-1.34	-3.36**	3.14**	1.56*	1.74	4.43**	-13.32**	8.89**	1.87
Lint index (g)	-0.12**	0.11**	0.26**	-0.25**	0.06	0.01	-0.12**	0.10**	0.07
Seed index (g)	0.38**	-0.26**	0.37**	-0.49**	0.08	-0.02	0.06	-0.04	0.09
Ginning outturn (%)	-0.81**	0.89**	0.03	-0.11	0.24	0.13	-0.38**	0.26**	0.25
2.5% span length (mm)	1.16**	-0.29	0.24	-1.11**	0.43	1.11**	-1.33**	0.22	0.46
Uniformity ratio (%)	-0.83	-0.39	0.61	0.61	1.09	0.67	0.5	-1.17**	1.18
Fibre fineness (mic)	0.17*	-0.1	0.08	-0.15	0.17	0.11	0.06	-0.16*	0.19
Bundle strength (g/tex)	-0.48	-0.76**	1.03**	0.20	0.58	0.87**	-0.60*	-0.27	0.63
Fibre Elongation percentage	0.11	0.09	-0.17	-0.03	0.25	-0.05	0.05	0.01	0.26

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

Table 5. Specific combining ability effects of hybrids

Characters	No. of symp-odia	No. of bolls/ plant	Boll weight (g)	Seed cotton yield / plant (g))	Lint index (g)	Seed Index (g)	Ginning out-turn (%)	2.5% span length (mm)	Uniformity ratio (%)	Fibre fineness (mic)	Bundle strength (g/tex)	Fibre elongation percentage
SRT 1 x MCU 5	1.46**	0.08	-0.07	-0.93	-0.19 **	-0.33 **	-0.26	2.11 **	-0.00	-0.19	1.80 **	0.35
SRT 1 x MCU 7	-0.26	1.38**	0.03	5.87 **	-0.01	0.11	-0.26	-0.09	-0.50	0.12	0.08	-0.48*
SRT 1 x MCU 12	-1.19**	-1.47**	0.04	-4.94 **	0.20 **	0.23 **	0.51 **	-2.01 **	0.50	0.07	-1.88 **	0.13
Khandwa 2 x MCU 5	0.48	0.26	0.11 *	2.82 *	-0.06	-0.17 *	0.16	-1.11 **	0.56	-0.13	-1.52 **	0.01
Khandwa 2 x MCU 7	0.89**	0.63	-0.09 *	1.57	-0.02	-0.05	-0.13	0.19	0.06	0.06	0.76	0.07
Khandwa 2 x MCU 12	-1.37**	-0.89*	-0.02	-4.39 **	0.08	0.22 **	-0.03	0.91 **	-0.61	0.07	0.76	-0.08
KC 2 x MCU 5	-2.17**	-0.67	0.00	-2.86 *	0.04	0.30 **	-0.38 *	-1.37 **	-0.44	0.33 *	-0.61	0.08
KC 2 x MCU 7	0.58*	-1.24**	0.00	-4.14 **	-0.10	0.08	-0.44 *	-0.01	0.39	-0.22	0.30	0.01
KC 2 x MCU 12	1.58**	1.91**	-0.00	7.00 **	0.06	-0.37 **	0.82 **	1.38 **	0.06	-0.11	0.31	-0.08
SVPR 3 x MCU 5	0.23	0.33	-0.04	0.97	0.21 **	0.20 **	0.47 *	0.37	-0.11	-0.01	0.32	-0.43*
SVPR 3 x MCU 7	-1.22**	-0.77*	0.06	-3.30 *	0.13 *	-0.13 *	0.83 **	-0.09	0.06	0.04	-1.13 *	0.40*
SVPR 3 x MCU 12	0.98**	0.44	-0.01	2.32	-0.34 **	-0.07	-1.31 **	-0.28	0.06	-0.04	0.81	0.04
CD (5%)	0.45	0.22	0.07	2.29	0.08	0.11	0.31	0.56	1.45	0.23	0.77	0.33

* - Significant at 5% level ** - Significant at 1% leve