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HETEROSIS AND COMBINING ABILITY ANALYSIS FOR SEED QUALITY TRAITS IN *GOSYYPIUM HIRSUTUML*

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The ratio between GCA and SCA variances estimated from 14 parents and their 40 hybrids indicated the predominance of non additive gene action for all the seven characters studied. The line MCU 5 was a positive general combiner for seed oil,seed protein,seed cotton yeild and mean halo length.MCU-9 had negative GCA for total phenol,tannin and gossypol.The best four hybrids identified in this study were MCU-7=X Acala Q/6-1,MCU-5 x ELS 481,MCU-5 x Glandless Acala and LRA 5166 x Deltapine.These hybrid combination had high mean for seed cotton yield,seed oil,seed protein content,high positive sca,and high positive heterosis over the mid parent.

KEYWORDS : Seed oil,Seed protein,Total Phenol,Tannin,and Gossypol

Selection of parents for hybridzation 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 stimultaneously measure the nature and the magnitude of gene action. The present study was undertaken to estimate the general and specific combining ability effects and variance through sib analysis so that an appropriate breeding strategy for improving the seed quality traits for cotton can be formulated.

MATERIALS AND METTHODS

The material for the study consisted of 14 parental genotypes and their 40 hybrids of cotton.Forty F_1 crosses were synthesised during summer 1995 by utilising four adapted varieties as female lines and 10 genetic accessions, varying widely in genetic make-up, as male testers.The parents and their hybrids were evaluated in a randomised block design with three replications during Kharif 1996.Each entry was sown in a row of 20 dibbles at a spacing of 75X30cm.Three mature and fully burst bolls from middle portion of the five random plants were picked and ginned to get

Table 1. Analysis of variance for different characteristics

Source	DF	Mean squares						
		seed oil	seed protein	total phenol	tannin	gossypol	seed cotton yield	Mean halo length
Replications	2	0.1708	0.3563	0.414	0.413	0.0038	4.73	5.26
Lines	3	9.11**	3.17*	346.29**	3.13*	1.01	100.4**	18.66**
Testers	9	8.48**	15.07**	57.16**	7.18**	0.7146	118.35*	15.38**
Line x Testers	27	9.62**	15.41**	38.11**	2.95**	0.8802	392.15**	8.38**
Error	78	0.0264	0.0573	0.0339	0.0371	0.041	3.46	4.41
GCA		-0.0391	-0.2993	7.79	0.1053	-0.0008	-13.46	0.4115
SCA		3.12	4.52	28.27	1.18	0.2871	102.63	2.15
GCA / SCA		-0.0125	-0.0662	0.2756	0.0892	-0.0028	-0.1312	0.1914

Table 2. Effects of general combining ability of the parents for different characters

Parents	Seed oil (%)	Seed protein (%)	Total phenol (mg / g of sample)	Tannin (mg/g of sample)	Gossypol (mg/g of sample)	Seed cotton yield (g/plant)	Mean halo length (mm)
Lines							
MCU 9	-0.28**	-0.30**	-4.61**	-0.40**	-0.22**	0.23	0.39
MCU 5	-0.28**	-0.13**	-0.51**	0.40**	0.01	-1.07**	-0.89**
MCU 7	0.83**	0.46**	2.40**	0.01	-0.02	2.48**	0.89**
LRA 5166	-0.27**	-0.03	2.72**	0.01	0.23**	-1.64**	-0.38
Testers							
Acala Q 6-1	1.44**	-1.18**	-2.53**	-0.64**	0.21**	2.64**	0.21
ISC 78	0.78**	C 45**	-1.64**	0.43**	-0.18**	-1.24**	1.75**
Deltapine	-0.91**	-0.36**	4.38**	-0.37**	0.11**	2.87**	-0.55
Saudi Arabia	-0.99**	-1.18**	-0.85**	-0.89**	-0.35**	1.93**	0.31
Alagodenlas Brenas	-0.29**	2.35**	-0.98**	-0.18**	0.17**	-1.79**	0.47
Okra leaf Acala	0.32**	-0.08	-0.22**	-0.58**	0.30**	-6.37**	1.13**
Mc Namara Wine sap	0.54**	0.39**	0.84**	0.21**	0.06	-3.55**	0.10
ELS 470	-1.00**	0.19**	-0.99**	-0.25**	-0.34**	2.73**	-2.00**
ELS 481	0.49	-1.36**	3.14**	0.51**	-0.20**	0.78	0.50
Glandless Acala	-0.39	0.79**	-1.16**	1.77**	0.22**	1.99**	-1.51**
SE of lines	0.02	0.03	0.03	-0.40**	-0.02	0.25	0.29
SE of testers	0.04	0.06	0.04	0.40**	0.03	0.44	0.50

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

a composite sample of seeds. For recording seed traits, seed oil (%), seed protein (%),total phenol (mg/g of sample), tannin content (mg/g of sample),and gossypol (mg/g of sample),acid delinted seeds of crossed bolls (F_1) were used and for seed cotton yield (g/plant) and halo length (mm),five F_1 plants in all the three replication were utilised. For the estimation of seed traits,seeds from each genotype were mixed thoroughly and divided into three lots to represent the three replications.The data were analysed based on the method outlined by Kempthorne (1957).Heterosis was worked out as percentage over the mid and better parental values of the respective crosses.

RESULTS AND DISCUSSION

The analysis of variance indicated that the parent *vs* hybrid component was significant for all the characters indicating the validity of comparison of parental and hybrid expression in respect of the genotypes under study.The components of variance due to lines,testers and lines x testers were significant for all the characters except gossypol content (Table 1). The information

Table 3. Specific combining ability effects and heterosis for different characters in some important cross combinations

(1A)

Hybrids	Characters											
	Seed oil			Seed protein			Total phenol			Tannin		
	sca effects	di	dii	sca effects	di	dii	sca effects	di	dii	sca effects	di	dii
1	2	3	4	5	6	7	8	9	10	11	12	13
MCU 9 x Acala Q 6-1	2.41**	24.02**	19.95**	1.88**	50.23**	36.21**	0.85**	-55.24**	-59.28**	0.32**	-6.70	-4.47
MCU 9 x ISC 78	-0.06	9.67**	6.92*	1.63**	61.56**	50.77**	0.03	-54.29**	-58.55**	-1.74**	-50.89**	57.34**
MCU 9 x Deltapine	-0.23**	3.74	-0.86	1.92**	71.10**	70.69**	-4.76**	-39.55**	-47.84**	1.70**	75.56**	96.37**
MCU 9 x Alagodenl as Brenas	-1.51**	-1.47	-3.61	1.37**	48.87**	26.05**	2.75**	-28.06**	-28.83**	0.05	-0.55	-3.93
MCU 9 x ELS 481	-3.02**	-3.06	-6.68*	-0.30**	31.28**	13.21**	-3.21**	-46.10**	-47.19**	-1.05**	-16.74**	-20.47**
MCU 9 x Glandless Acala	0.09	5.63*	2.64	-0.99**	47.79**	35.08**	1.17**	-36.07**	-44.31**	0.16*	7.19*	23.99**
MCU 7 x Acala Q 6-1	-1.86**	9.53**	9.30**	-0.07	25.69**	22.27**	0.29**	10.41**	-12.21**	-0.66**	2.79	-15.98**
MCU 7 x	-0.16*	13.27**	12.10**	1.78**	43.02**	34.99**	-0.18*	16.69**	-6.98**	0.85**	24.57**	13.36**

on nature of generation canalso be drawn from GCA/SCA variance. The results are discussed charecterwise.

Seed Oil: Seed oil was predominantly under the control of dominance genetic system,the ratio of GCA/SCA being less than unity. This suggests that seed oil can be improved by heterosis breeding.Earlier report by Dani *et al.*(1984)also indicates the performance of dominance component. The line MCU 5 was a general combiner while, six out of 10 testers,Acala Q/6-1,JSC 78, Alagodenlas Brenas,Okra leaf Acala,Mc Namara Wine Sap and ELS 481 showed positive gca effects (Table 2). Although as many as 19 hybrids had positive SCA effects, the combination MCU 5 x ELS 481,combining high mean performance, high heterotic expression,positive combining parents is the best for future exploitation.

Seed Protein: Seed protein was found to be predominantly under the control of the non-additive genetic system as seen from the

(1B)

Hybrids	Gossypol			Seed cotton yield			Mean halo length		
	sca effects	di	dii	sca effects	di	dii	sca effects	di	dii
MCU 9 x Acala Q 6-1	-0.12*	-21.00**	-33.12**	3.91**	63.68**	46.08**	1.97*	18.56**	10.40*
MCU 9 x ISO 78	1.29**	5.56	-23.22**	5.36**	88.29**	77.87**	-0.69	2.38	-2.72
MCU 9 x Deltapine	0.59**	-60.91**	-70.10**	-11.20**	64.16**	35.51**	1.27	-3.19	-11.56*
MCU 9 x Alagocenlas Brenas	-0.02	0.12	-0.92	8.79**	76.60**	66.78**	1.52	16.87**	11.19
MCU 9 x ELS 48	-0.20**	-64.42**	-75.14**	-0.89	51.19**	40.64**	0.79	9.63	8.84
MCU 9 x Glandless Acala	-0.35**	-45.74**	-59.44**	4.05**	75.03**	66.59**	-0.96	-0.12	-3.80
MCU - x Acala Q 6-1	-0.17**	-32.90**	-39.92**	18.70**	110.70**	82.13**	-2.69*	8.96	7.26
MCU - x ISO 78	-0.25**	-61.82**	-65.07**	4.80**	88.75**	84.77**	-1.35	4.37	-8.56

proportion of the SCA variance than GCA. Hiremath (1993) encountered such situation. Only one line and five testers,MCU 5,ISC 78, Alagodenlats Brenas Mc Namara Wine Sap, ELS 470 and Glandless Acala possessed positive GCA. All the hybrids except one,MCU 7 x Acala Q 6-1 exhibited significant positive and sca of hybrids suggesting the involvement of epistatic genes. The hybrids MCU 9 x Acala Q 6-1, MCU 9 x ISC 78, MCU 9 x Deltapine MCU 9 x Alagodenlas Brenas, MCU 7 x ISC 78, MCU 7 x Alagodenlas Brenas, MCU 7 x Okraleaf Acala, MCU 5 x Mc Namara Wine sap MCU 5 x Glandless Acala. LRA5166 x Deltapine, LRA 5166 x McNamara Wine Sap and LRA 5166 x ELS 470 can be considered as important in view of their high mean seed protein, positive sca and positive heterotic expression over their mid and better parents (Table-3)

Total Phenol: Total phenol is under the control of non additive genes. MCU 7, MCU 9, Acala Q/6-1,ISC 78,/ Saudi Arabia Alagodenlas Brenas Okra leaf Acala,ELS 470, Glandless Acala are the parents exhibiting negative gca. A total of 20 hybrids showed negative sca values. All these combinations also had very low total phenol. On the other land crosses involving LRA 5166 which is high phenol parent,exhibited high levels of total phenol content (Table 3). All the hybrids involving MCU 9 as female parent exhibited negative heterosis on both mid parental and better parental basis. It would be desirable to select a negative general combiner and negatively heterotic hybrids

1-A

1	2	3	4	5	6	7	8	9	10	11	12	13
MCU 7 x Saudi Arabia	1.54**	9.94**	6.06*	-0.23*	22.80**	21.68**	-2.60**	-20.05**	-41.60**	-1.86**	-34.06**	-45.95**
MCU 7 x Alagodenlas Brenas	0.57**	11.35**	9.82**	1.13**	32.34**	25.83**	1.78**	35.09**	0.93	0.32**	5.39	-13.13**
MCU 7 x Okra leaf Acala	0.42**	21.68**	15.01**	2.00**	26.61**	20.11**	0.30**	59.82**	37.33**	-0.45**	-46.39**	-40.08**
MCU 7 x Glandless Acala	0.28**	10.41**	9.63**	0.23*	35.38**	30.56**	3.39**	81.81**	50.14**	0.05	2.87*	-12.98**
MCU 5 x ISO 78	-0.31**	18.22**	16.30**	-0.48**	28.10**	14.63**	-1.22**	51.74**	13.34**	-1.10*	-36.24**	-42.38
MCU 5 x Okra -leaf Acala	-1.05**	20.73**	14.77**	1.62**	20.27**	19.75	2.21**	151.18**	100.57**	-0.54**	-56.91**	-52.86**
MCU 5 x Mc Namara wine sap	2.68**	33.78**	32.70**	3.77**	28.60**	28.26**	1.52**	93.36	48.45**	0.06	-20.96**	-22.05**
MCU 5 x ELS 470	-0.86**	0.92	-6.49*	-3.08**	14.23**	5.35**	-0.64**	64.73**	21.34**	-0.24*	-44.73**	-39.05**
MCU 5 x	4.30**	39.33**	38.86**	0.33**	14.61**	11.40**	9.25**	214.04**	117.56**	1.42**	40.19**	14.85**

involving these parents so that progenies with good oil quality can be develope

Tannin **:** The tannin content is under the control of dominant genetic system as seen from the larger magnitute of SCA as compared to that of GCA. Hiremath (1993) studied the different generation of the crosses and found the preponderance of dominant gene action which corresponded to the present findings. Only one line and six teste Acala Q 6/1, Deltapine, Saudi Arabia, Alagodenlas Brenas, Okra leaf Acala and ELS 470 had significant *gca* effects, only five, MCU 9 X ELS 481, MCU 7 X Saudi Arabia, MCU 5 x ISC 78, MCU 5 x Okra leaf Acala and MCU 5 x ELS 470 are important crosses as they combined low tannin content, high sed cotton yield, negative *sca* and negative heterotic expression over their mid and better pasrnets (Table 3).

Gossypol **:** A negative association between all the characters with gosspyol was evident in the present study. Hence the breeding programme should be carefully drawn up to get a low gossypol genotype so that the quality of the seed is not affected. For this character dominance genes had

1-B

Hybrids									
MCU 7 x Saudi Arabia	-0.01	-47.96**	-55.07**	27.74**	182.85**	180.40**	1.72*	23.09**	18.44**
MCU 7 x Alagodenlas Brenas	0.11*	-11.11**	-30.68**	-5.76**	30.28**	18.89**	-0.04	16.99**	12.64*
MCU 7 x Okra leaf Acala	0.09	-18.35**	-26.32**	-1.25	28.58**	16.26**	1.74*	20.49**	11.21*
MCU 7 x Glandless Acala	0.08	-33.86**	-37.08**	-9.69**	30.93**	20.39**	-1.16	3.62	-1.45
MCU 5 x ISO 78	-0.35**	-65.78**	-69.33**	-11.88**	57.39**	48.68**	1.91*	12.12*	6.65
MCU 5 x Okra leaf Acala	-0.93**	-62.51**	-65.46**	2.88**	44.40**	21.92**	-1.00	7.14	6.36
MCU 5 x Mc Namara wine sap	0.07	-24.40**	-34.81**	3.31**	58.17**	24.83**	0.46	0.93	10.02
MCU 5 x ELS 470	-0.46**	-73.85**	-75.12**	4.41**	73.91**	34.04**	1.22	-9.70	19.83**
MCU 5 x ELS 481	0.54**	-39.93**	-49.16**	10.99**	116.59**	81.99**	-0.21	7.82	6.92

primary influence as observed from the higher SCA than GCA. Earlier investigation of Singh *et al* (1991) also showed the involvement of non additive genes in the inheritance of gossypol content. Among the parents, MCU 9, ISC 78, Saudi Arabia, ELS 470 ELS 481 possessed negative GCA effects. Only six hybrids exhibitng low mean gossypol content, negative SCA effects and negative mid and better parental heterosis with increased seed cotton yield are identified to be important.

Seed Cotton Yield : The seed cotton yield is under the control of non additive genetic system, SCA being larger than that of GCA. Report on dominant gene control was made by Hiremath (1993). Among the 40 hybrids, 30 had high yield level. One line and six testers were general combiners in the positive direction. Four hybrids MCU 7 X Acola Q/6-1, MCU 5 x ELS 481, MCU 5 x Glandless Acala and LRA 5166 x Deltapine can be considered to be the most dependable crosses as they combined high yield, high positive sca, and high positive heterotic expression over the mid parent. The four hybrids also exceed mean seed oil and sed protein contents. These hybrids will be useful as intra *hirsutum* hybrids with good oil

1-A

1	2	3	4	5	6	7	8	9	10	11	12	13
MCU 5 x Glandless Acala	-1.24**	9.24**	7.82**	1.67**	34.40**	22.72**	-1.39**	66.01**	27.94**	-0.14	-9.14**	22.12**
LRA 5166 x Deltapine	-0.12	10.50**	9.36**	2.43**	48.69**	29.60**	8.16**	156.88**	115.40**	-0.13	15.16*	27.80*
LRA 5166 x Mc Namara wine sap	-1.66**	10.55**	9.78**	1.27**	23.51**	19.18**	1.46**	54.16**	31.04**	-0.70**	-21.81**	-37.86**
LRA 5166 x ELS 470	0.26**	2.43	-6.40*	2.57**	37.99**	32.00**	-2.04**	-2.68	-12.79**	0.32**	-18.03**	-39.53**
LRA 5166 x ELS 481	0.87**	11.81**	9.78**	-1.12**	12.43**	11.29**	-3.17**	-2.18	-3.54*	-1.00**	-0.12	-5.23

di = relative heterosis
dii = heterobeltiosis
* Significant at 5% level
** Significant at 1% level

quality. The presence of parallelism between high mean and positive heterosis in many hybrids in the present study, reveals the simple nature of the inheritance of this importnat character and support direct exploitation of these hybrids.

1-B

Hybrids									
MCU 5 x Glandless Acala	0.05	-34.41**	-38.93**	13.74**	137.11**	103.29**	0.94	8.12	4.02
LRA 5166 x Deltapine	0.03	-32.00**	-33.76**	22.37**	245.29**	220.82**	-0.49	-10.39*	-18.59**
LRA 5166 x Mc Nomara wine sap	0.59**	3.38	-15.53**	-1.21	32.94**	3.34	1.73*	10.84*	9.40
LRA 5166 x ELS 470	0.44**	-34.17**	-35.18**	2.62**	58.31**	20.26**	0.69	-14.43**	-24.5
LRA 5166 x ELS 481	-0.60	-70.89**	-73.93**	1.07	70.52**	40.90**	-1.34	0.45	0.34

Mean halo length : Halo length was predominantly under the control of dominant genetic system, the ratio of GCA / SCA being 0.1914 suggesting that halo length can be improved by heterosis breeding (Table 1). Duhoon et al (1983) inferred the predominance of partial dominance in the genetic control of this character. The genotypes MCU 5, ISC 78 and Okra leaf Acala were positive general combiners which can be used for future breeding work. Although, four hybrids had positive sca effects, the combination MCU 5 x ISC 78 is the best because both of its parents are general combiners and the hybrid was having high mean performance and positive peterotic expression.

Thus, the studies indicated that seed characters, yield and quailty parameters are under non additive genetic system and MCU 7 x Acala Q 6-1, MCU 5 x ELS 481, MCU 5 x Glandless Acala and LRA 5166 x Deltapine are the best crosses identified for future plant breeding programme.

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PHENOTYPIC STABILITY FOR GRAIN YIELD AND ITS COMPONENT TRAITS IN SORGHUM

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ABSTRACT

Sixty hybrids of sorghum were evaluated in four environment and stability parameters were studied for pánicle yield per panicle. The genotypes showed significiant differences interaction was significant for all the characters except 100 grain weight. The hybrids 205 A x MR 750, 56 A x TNS 79, 73 A x TNS 88, 26 A x MR 750 and 111 A x 881 could be recommended for wider cultivation since they recorded superior mean, stability and average responsiveness for yeild and yeild component characters.

KEY WORDS : Sorghum,Hybrids, Stability, G x E interaction

Sorghum (*Sorghum bicolor* (L.) moench) is next in Tamilnadu. It is widely grown under different edaphic and environmental conditions and it is known to exhibit a high degree of genotype-environment interactions. But sorghum improvement has been limited in target areas with highly unpredicated environments. The main reason is the poor performance of the hybrids or varieties to the great difference among environmental conditions. Blum (1988) discussed limitation in using hybrid per se as a selection criterian based upon the large effect of environments. Hence,there is a need to develop hybrids with stability in performance over a wide range of environmental conditions.For this,information on stability of newly developed culture and behaviour of hybrids under different environments is quite important. The present study