COMBINING ABILITY ANALYSIS FOR YIELD AND ITS COMPONENT CHARACTERS IN COTTON (*Gossypium hirsutum* L.)

SOLANKI, H. V., *MEHTA, D. R. AND RATHOD, V. B.

DEPARTMENT OF GENETICS AND PLANT BREEDING
JUNAGADH AGRICULTURAL UNIVERSITY
JUNAGADH - 362 001, GUJARAT, INDIA

E-mail: drmehta@jau.in

ABSTRACT

A line x tester mating design for combining ability analysis was carried out for seed cotton yield per plant and its component traits in upland cotton. The analysis of variance for combining ability indicated the preponderance of additive gene action for boll weight, ginning percentage, seed index and lint index and non-additive gene action for number of sympodia per plant, number of bolls per plant, seed cotton yield per plant and lint yield per plant. Among lines, GBHV 170, GJHV 460, BS 27 and H 1316 and among testers, 76 IH 20 and G.cot-12 were the good general combiners for seed yield and some other important traits. Two crosses namely, G.cot-12 x H 1316 and 76 IH 20 x GBHV 170 were the best specific cross combinations to exploit non-fixable components for seed cotton yield per plant. Crosses showing high sca effects for seed cotton yield also possessed high sca effects for important yield attributes and were involved with good x good, average x poor, average x average or poor x average general combiners.

KEY WORDS: Combining ability, cotton, gca, line x tester analysis, sca

INTRODUCTION

Cotton is one of the most important commercial cash crops of India, playing a key role in national economy. In cotton, the high yielding parents may not necessarily be able to transmit their superiority to the progenies in crosses. Information on gene action and combining ability helps in the choice of suitable parents for hybridization programme for developing superior hybrids, so as to exploit hybrid vigour and/or building genotypes to be used in further breeding programmes. Therefore, the present investigation has been undertaken to determine combining ability analysis for seed cotton yield and its component characters through line x tester mating design.

MATERIALS AND METHODS

Five diverse male parents (G.cot-18, G.cot-12, LRA 5166, BC 68-2, 76 IH 20) and ten lines (MR 786, GISV 254, GTHV 95/145, GBHV 148, GJHV 503, GBHV 170.C, BS 27, BS 279, H 1316, GJHV 460) were used to generate fifty cross combinations by using line x tester mating design. These fifty crosses along with fifteen parents and one check (G. Cot. Hy. 12) were grown in randomized block design with three replications. One row of each hybrid and parent was sown at spacing of 120 x 45 cm during *kharif* 2010-11 at Cotton Research Station, Junagadh Agricultural University, Junagadh, Gujarat. Five randomly selected plants were chosen from each row to record observations on seed cotton yield and its seven contributing traits. The combining ability analysis was worked out as per the method suggested by Kempthorne (1957).

RESULTS AND DISCUSSION

Analysis of variance for combining ability (Table 1) revealed that the mean squares due to lines, testers as well as lines x testers were highly significant for all the characters (except variance due to testers for number of sympodia per plant, when tested against respective error mean square) indicating the importance of both additive and non-additive genetic variances in the expression of these characters. The results are in accordance with the findings of Kaushik *et al.* (2006), Pratap *et al.* (2006), Basbag *et al.* (2007), Bhaskaran and Ravikesavan (2008), Panhwar *et al.* (2008), Patel *et al.* (2009), Yashavantha *et al.* (2009) and Singh *et al.* (2010). The components of genetic variance estimated from the results indicated that the magnitude of variance due to lines (σ^2l) was higher than those of testers (σ^2t) for all the characters except boll weight and seed index. The magnitude of variance due to lines x testers (σ^2lt) was also higher than those of lines and testers for number of sympodia per plant, number of bolls per plant, seed cotton yield per plant and lint yield per plant. Estimates of σ^2gca and σ^2sca revealed that the magnitude of gca variances were higher than those due to sca variances for boll weight, ginning percentage, seed index and lint index, suggesting involvement of additive gene action in the inheritance of these four characters. The results are in accordance with the findings of Sakhare *et al.* (2005), Patel *et al.* (2007) and Palve (2009). On the other hand, for number of sympodia per plant, number of bolls per plant, seed cotton yield per plant and lint yield per plant, sca variances were higher than gca variances, which indicated greater role of non-additive gene action in the control of these four characters. The results are in accordance with the findings of Rauf *et al.* (2005), Ashokkumar and Ravikesavan (2010), Senthilkumar *et al.* (2010) and Jatoi *et al.* (2011). This was also confirmed by the ratio of σ^2sca/ σ^2gca respective groups of traits.

The estimates of gca effects (Table 2) revealed that among lines, GBHV 170 was good general combiner for seed cotton yield per plant, number of sympodia per plant, number of bolls per plant, lint yield per plant, ginning percentage and lint index, while BS 27 was good general combiner for seed cotton yield per plant, lint yield per plant, ginning percentage, seed index and lint index. Similarly, GJHV 460 was good general combiner for seed cotton yield per plant, number of bolls per plant and lint yield per plant, while H 1316 was good general combiner for seed cotton yield per plant, number of sympodia per plant and number of bolls per plant. Among testers, 76 IH 20 was good general combiner for seed cotton yield per plant, number of bolls per plant, lint yield per plant, seed index and lint index, while G.cot-12 was good general combiner for seed cotton yield per plant, seed index and lint index. It was also observed that two parents namely GBHV 170 and BS 27 were good general combiners for seed cotton yield per plant and were also good general combiners for some of yield contributing characters. Besides these, rest of the parents were also good general combiners for at least two or three component traits. This would help in construction of a suitable selection index for breeding productive genotypes. High general combining ability effects mostly contribute additive gene effect or additive x additive interaction (Griffing, 1956a and 1956b) and represent fixable portion of genetic variation. In view of this, GBHV 170, BS 27, H 1316 and GJHV 460 offer the best possibilities of exploitation for the development of improved lines with enhanced yielding ability in cotton. Among lines *viz.,* GBHV 170, BS 27, H 1316 and GJHV 460 which showed high gca effects for two or three traits and also possessed high *per se* performance for most of characters are worth considering in future breeding programme and also to select desirable transgressive segregants from segregating population for seed cotton yield per plant and its component characters. Similar findings have also been reported by Kumar *et al.* (2005), Rauf *et al.* (2005), Sakhare *et al.* (2005), Bhaskaran and Ravikesavan (2008) and Yashavantha *et al.* (2009).

The estimate of sca effects (Table 3) revealed that none of the crosses was consistently superior for all the characters. The highest yielding hybrid G.cot-12 x H 1316 (253.93 g) had also registered highest, significant and positive sca effect for seed cotton yield per plant (69.74). This could be due to good x good general combiner parents. This cross also showed desirable and high sca effect for number of bolls per plant, lint yield per plant and ginning percentage. Similar situation of good x good general combiner was also observed in the cross combination 76 IH 20 x GBHV 170 that recorded significant and positive sca effect (43.46) for seed cotton yield per plant. On the other hand, three cross combinations *viz.*, BC 68-2 x GISV 254, LRA 5166 x GJHV 503 and G.cot-18 x GTHV 95/145 had also high and desirable sca effect for seed cotton yield per plant, which was due to average x poor, average x average and poor x average general combiner parents, respectively. This indicated the presence of epistatic interaction and such deviation could be attributed to the genetic diversity in the form of heterozygous loci. This could also be an indication of gene dispersion and genetic interaction between favorable alleles contributed by both the parents. Such combinations could be utilized for intermating segregants in F_2 or F_3 generations and simultaneous selection for desirable plant type.

While considering component traits like number of sympodia per plant, thirteen crosses showed significant and positive sca effect with range of -8.36 to 6.92. The highest, significant and positive sca effect was reported by G.cot-18 x GISV 254 (6.92) (Table 3). Likewise, for number of bolls per plant and boll weight, fifteen and seven crosses showed significant and positive sca effect with range of -13.60 to 18.42 and -0.51 to 0.46, respectively. The highest, significant and positive sca effect for number of bolls per plant and boll weight was reported by LRA 5166 x GJHV 503(18.42) and 76 IH 20 x H 1316 (0.46), respectively. The extent of sca effects for lint yield per plant ranged from -18.86 to 28.87 and eleven hybrids showed significant and positive sca effects. The cross G.cot-12 x H 1316 showed highest, significant and positive sca effect for lint yield per plant. The cross combination, BC 68-2 x GBHV 148 (1.64) exhibited highest, significant and positive sca effect for ginning percentage, which ranged from -1.17 to 1.64. For seed index and lint index, sca effect ranged from -1.14 to 1.18 and -0.66 to 0.71, respectively. The cross combination BC 68-2 x GBHV 170 (1.18) showed highest, significant and positive sca effect for both seed index and lint index.

CONCLUSION

On the basis of *per se* performance and combining ability estimates involved in the expression of seed cotton yield and its components, two crosses namely G.cot-12 x H 1316 and 76 IH 20 x GBHV 170 appeared to be most suitable for exploitation in practical plant breeding programme in cotton. Both additive and non-additive gene effects being important, bi-parental mating as well as mating of selected plants in early segregating generations should be attempted in developing potential populations having optimum levels of homozygosity and heterozygosity. Further, transgressive segregants could be isolated by alternate intermating and selfing.

REFERENCES

Ashokkumar, K. and Ravikesavan, R. (2010). Combining ability estimates for yield and fiber quality traits in Line x Tester crosses of upland cotton (*Gossypium hirsutum* L.). *Int. J. Biol.*, **2** (1): 26-29

Basbag, S., Ekinci, R. and Gencer, O. (2007). Combining ability and heterosis for earliness characters in L x T population of *Gossypium hirsutum* L. *Hereditas*, **144**: 185-190.

Bhaskaran, S. and Ravikesavan, R. (2008). Combining ability analysis of yield related traits and fibre quality traits in cotton. *J. Cotton Res. Dev*., **22** (1) 23-27.

Griffing, B. (1956a). Concept of general and specific combining ability in relation to diallel crossing systems. *Aust.J. Biol. Sci*., **9**: 463-493.

Griffing, B. (1956b). A generalized treatment of the use of diallel cross in quantitative inheritance. *Heredity*, **10:** 31-50.

Jatoi. W. A., Baloch. M. J., Veesar. N. F. and Panhwar. S. A. (2011). Combining ability estimates from Line x Tester analysis for yield and yield components in upland cotton genotypes. *J. Agric. Res.*, **49** (2): 165-172.

Kaushik, S. K., Kapoor, C. J. and Singh, J (2006). Combining ability analysis in upland cotton (*Gossypium hirsutum* L.). *National. J. Plant Improv.*, **8** (1): 32-38.

Kempthorne, O. (1957). An Introduction to Genetic Statistics. John Willey and Sons. New York.

Kumar, M., Chhabra, B. S., Kumar, R., Lather, P. S. and Sangwan, R. S. (2005).Combining ability studies for seed cotton yield and fiber quality characters in *Gossypium hirsutum* L. *J. Cotton Res. Dev.*,**19** (2): 157-160.

Palve, S. M. (2009). Heterosis and combining ability for fibre properties in upland cotton (*Gossypium hirsutum* L.). *Indian J. Agric. Sci.*, **79** (9): 732-734.

Panhwar, S. A., Baloch, M. J., Jatoi, W. A. and Majeedano, M. S. (2008). Combining ability estimation from L x T matting design in upland cotton. *Proc. Pakistan Acad. Sci.*, **45** (2): 69-74.

Patel, A. D., Patel, U. G. and Kumar, V. (2009). Diallel analysis for combining ability for seed cotton yield and its component traits in upland cotton (*Gossypium hirsutum*). *J. Cotton. Res. Dev*., **23** (2): 222-225.

Patel, K. G., Patel, R. B., Patel, M. I. and Kumar, V. (2007). Genetics of yield, fibre quality and their implication in breeding of inter-specific cross derivatives of cotton. *J. Cotton Res. Dev.,* **21** (2): 153-157.

Pratap, L. K., Reddy, C. V., Reddy, K. V. S. and Rao, P. C. (2006). Combining ability for yield component traits in cotton. *Andhra Agric. J*., **53** (3&4): 152- 156.

Rauf, S., Khan, T. M. and Nazir, S. (2005). Combining Ability and Heterosis in *Gossypium hirsutum* L. *Int. J. Agri. Biol.*, **7** (1): 109-113.

Sakhare, B. A., Wandhare, M. R., Ladole, M. Y. and Wakode, M. M. (2005). Combining ability studies in diploid cotton. *J. Cotton. Res. Dev.*, **19** (1): 52-54.

Senthilkumar, R., Ravikesavan, R., Punitha, D. and Rajarathinam, S. (2010). Genetic analysis in cotton.

Electronic J. Pl. Breed., **1** (4): 846-851.

Singh S., Singh V. V. and Choudhary (2010). Combining ability for oil content, yield components and fibre quality traits in cotton (*G. hirsutum L.*) using 8 x 8 diallel mating design. *Tropical and Subtropical Agroecosystems*, **12**: 161-166.

Yashavantha, K. J., Patil, R., Patil, S. S. and Katageri, I.S. (2009). Genetical studies of yield components, seed oil and fibre quality traits in cotton (*G. hirsutum* L.) *Karnataka J. Agri. Sci*., **22** (3): 160-162.

Table 1 : Analysis of variance for combining ability and variance components for different characters in cotton

Source	d.f.	Number of Sympodia Per Plant	Number of Bolls Per Plant	Boll Weight (g)	Seed Cotton Yield Per Plant (g)	Lint Yield Per Plant (g)	Ginning Percentage	Seed Index (%)	Lint Index (%)
Replications	2	0.010	72.308**	0.127	1077.910*	127.381	0.342	0.245	0.056
Lines	9	1.615**	539.383*+	0.856**++	6126.782*	1097.571*	20.704**++	3.064**++	3.395**++
Testers	4	6.284**++	660.591*+	3.603**++	3860.791*	379.606*	7.915**++	12.014**++	3.489**++
Lines x Testers	36	1.115**	243.950**	0.237**	3561.516**	541.434**	1.695**	0.917**	0.392**
Error	98	0.064	13.497	0.063	344.820	47.742	0.413	0.168	0.080
				Variance Components					
σ^2l		12.978	35.059	0.053	385.464	69.987	1.353	0.193	0.221
σ^2t		-0.012	21.570	0.118	117.199	11.062	0.250	0.395	0.114
σ^2lt		21.735	76.817	0.058	1072.232	164.564	0.427	0.250	0.104
σ^2gca		4.318	26.066	0.096	206.621	30.704	0.618	0.328	0.149
σ^2sca		21.735	76.817	0.058	1072.232	164.564	0.427	0.250	0.104
σ^2sca/ σ^2gca		5.033	2.947	0.604	5.189	5.360	0.691	0.762	0.698
				Per Cent Contribution					
Lines		41.861	29.820	25.128	27.737	31.980	66.786	25.381	52.115
Testers		0.264	16.232	47.016	7.768	4.916	11.348	44.227	23.806
Lines x Testers		57.875	53.948	27.855	64.495	63.104	21.866	30.392	24.078

, ** Significant at 5 per cent and 1 per cent levels of significance, respectively when tested against error mean square

+,++ Significant at per cent and 1 per cent levels of significance, respectively when tested against lines x testers interaction mean square

Table 2 : Estimates of gca effects of 15 parents for different characters in cotton

Sr. No.	Parents	Number of Sympodia Per Plant	Number of Bolls Per Plant	Boll Weight (g)	Seed Cotton Yield Per Plant (g)	Lint Yield Per Plant (g)	Ginning Percentage	Seed Index (%)	Lint Index (%)
Lines									
1	MR 786	-5.325**	-9.551**	0.184**	-23.121**	-7.149**	1.427**	0.563**	0.657**
2	GISV 254	-0.152	-6.631**	-0.236**	-33.435**	-13.699**	-0.907**	-0.041	-0.241**
3	GTHV 95/145	0.195	2.542**	-0.184**	-6.060	-4.521*	-1.193**	-0.465**	-0.523**
4	GBHV 148	1.608**	-1.858	-0.279**	-19.058**	-8.042**	-0.387*	-0.279**	-0.265**
5	GJHV 503	4.275**	3.715**	-0.130*	3.747	-0.661	-1.440**	-0.103	-0.361**
6	GBHV 170	3.195**	7.515**	0.087	28.870**	14.575**	1.913**	-0.127	0.310**
7	BS 27	-2.999**	-2.578**	0.375**	11.936*	6.642**	1.133**	0.675**	0.680**
8	BS 279	-5.765**	-4.165**	0.360**	4.225	2.120	0.460**	0.620**	0.480**
9	H 1316	4.541**	2.069*	-0.056	10.337*	2.582	-0.860**	-0.449**	-0.445**
10	GJHV 460	-0.272	8.942**	-0.121	22.561**	8.154**	-0.147	-0.397**	-0.293**
$SE(g_i) \pm$		**0.460**	**0.949**	**0.065**	**4.795**	**1.784**	**0.166**	**0.106**	**0.073**
$SE(g_i\text{-}g_j)\pm$		**0.651**	**1.341**	**0.092**	**6.781**	**2.523**	**0.235**	**0.150**	**0.103**
Testers									
1	G.cot-18	-0.292	-3.731**	-0.133**	-17.644**	-5.351**	0.760**	-0.276**	-0.015
2	G.cot-12	-0.019	-5.115**	0.497**	7.096*	2.045	-0.240*	0.644**	0.352**
3	LRA-5166	0.501	6.255**	-0.455**	-3.059	-0.585	0.263*	-0.965**	-0.562**
4	BC 68-2	-0.192	-0.365	0.094*	1.747	-0.276	-0.540*	0.335**	0.107*
5	76 IH 20	0.001	2.955**	-0.003	11.861**	4.169**	-0.243*	0.261**	0.118*
$SE(g_i) \pm$		**0.325**	**0.671**	**0.046**	**3.390**	**1.261**	**0.117**	**0.075**	**0.051**
$SE(g_i\text{-}g_j) \pm$		**0.460**	**0.949**	**0.065**	**4.795**	**1.784**	**0.166**	**0.106**	**0.073**

, ** Significant at 5 per cent and 1 per cent levels of significance, respectively.

Table 3: Estimates of sca effects for various characters in five selected crosses of cotton

Characters	Range of SCA	Best Five Cross Combinations	SCA Effect	No. of Significant Crosses in Desirable Direction
Number of Sympodia Per Plant	-8.36 to 6.92	G.cot-18 x GISV 254	6.92	13
		76 IH 20 x BS 27	6.50	
		LRA 5166 x BS 279	6.40	
		LRA 5166 x GBHV 170	5.98	
		G.cot-12 x GTHV 95/145	5.96	
Number of Bolls Per Plant	-13.60 to 18.42	LRA 5166 x GJHV 503	18.42	15
		76 IH 20 x GBHV 170	18.39	
		G.cot-12 x H 1316	16.27	
		BC 68-2 X GISV 254	12.19	
		G.cot-12 x BS 279	9.21	
Boll Weight (g)	-0.51 to 0.46	76 IH 20 x H 1316	0.46	7
		BC 68-2 X GISV 254	0.43	
		LRA 5166 x GJHV 503	0.38	
		G.cot-18 x GTHV 95/145	0.34	
		LRA 5166 X GJHV 460	0.34	
Seed Cotton Yield Per Plant (g)	-50.72 to 69.74	G.cot-12 x H 1316	69.74	11
		BC 68-2 x GISV 254	66.86	
		LRA 5166 X GJHV 503	66.06	
		76 IH 20 x GBHV 170	43.46	
		G.cot-18 x GTHV 95/145	42.11	
Lint Yield Per Plant (g)	-18.86 to 28.87	G.cot-12 x H 1316	28.87	11
		LRA 5166 x GJHV 503	26.92	
		BC 68-2 X GISV 254	23.71	
		G.cot-18 x GTHV 95/145	17.26	
		76 IH 20 X BS 27	16.86	
Ginning Percentage	-1.17 to 1.64	BC 68-2 x GBHV 148	1.64	7
		G.cot-12 x GBHV 170	1.61	
		G.cot-12 x H 1316	1.01	
		LRA 5166 X GISV 254	0.99	
		76 IH 20 x GISV 254	0.90	
Seed Index (%)	-1.14 to 1.18	BC 68-2 x GBHV 170	1.18	9
		BC 68-2 X GISV 254	0.81	
		LRA 5166 X GTHV 95/145	0.77	
		76 IH 20 X BS 279	0.77	
		76 IH 20 X H 1316	0.71	
Lint Index (%)	-0.66 to 0.71	BC 68-2 x GBHV 170	0.71	7
		LRA 5166 X GTHV 95/145	0.56	
		76 IH 20 X BS 279	0.49	
		G.cot-12 x BS 27	0.47	
		76 IH 20 X H 1316	0.47	

, ** Significant at 5 per cent and 1 per cent levels of significance, respectively.

[MS received: December 02, 2013] *[MS accepted: December 21, 2013]*