RESEARCH ARTICLE

SABRAO Journal
of Breeding and Genetics
46 (2) 313-318, 2014

COMBINING ABILITY STUDIES FOR YIELD AND FIBRE QUALITY TRAITS IN UPLAND COTTON (*Gossypium hirsutum* L.)

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SUMMARY

Identification parents with yield as well as good fiber quality traits are essential for development hybrids in cotton. . Combining ability is a powerful tool to discriminate between good and poor general combiners and for choosing appropriate parental lines to produce superior hybrids. Combining ability studies were carried out in cotton seed yield and fibre quality traits by utilizing 7 lines, 8 testers and their 56 hybrids obtained by line x tester analysis. The *gca* variance was greater than to *sca* variance for ginning percentage, 2.5% span length, micronaire value and seed cotton yield indicating the predominance of additive gene action whereas, uniformity ratio and bundle strength were predominantly under control of non-additive gene action. Parents Galama, CPD 420, BC 68-2, HAG 1055, LRA 5166 and LK 861 were found to be good general combiners for yield and at least one of the fiber quality traits. The crosses NA 1325 x L 604 and NA 1325 x 4084 were identified as good specific combiners for seed cotton yield and whereas the crosses IC 357063 x L 761, IC 357063 x LRA 5166, CPD 420 x L 761 and IC 357063 x JK 344 exhibited significant *sca* effects for fiber quality traits in desirable direction.

Keywords: Cotton, combining ability, cotton seed yield, fiber quality traits

Manuscript received: November 4, 2013; Decision on manuscript: February 5, 2014; Manuscript accepted: July 11, 2014.

Communicating Editor: Naqib Ullah Khan

INTRODUCTION

Cotton is one of the most important commercial crops and forms the back bone of Indian textile industry. Ever since the man chose various crops for his sartorial needs, cotton has reigned as king of apparel fibers due to its easy wear quality. Both cotton lint yield and fiber quality are equally important in cotton. Fiber quality variables should be given due importance in any cotton improvement program. Selection of parents with good fiber quality traits is essential to develop hybrids with superior fiber properties. Combining ability is a powerful tool to discriminate between good and poor general combiners and for choosing appropriate parental lines to produce superior hybrids. Earlier studies showed that variation in seed cotton yield and its components were controlled by genes acting additively and non-additively. Lukange *et al.* (2007) revealed additive gene action for fiber strength and micronaire value and non-additive gene action for fiber length. Non-additive gene action for fiber quality traits including fiber length, fiber strength and micronaire value have been reported by Ahuja and Dhayal (2007). The objective of present study was to elucidate information on nature of gene action for the fiber quality traits and also to find out the combining ability of cotton genotypes and hybrids.

MATERIALS AND METHODS

Seven lines (CPD 420, Galama, NA 1325, L 389, IC 357063, BC 68-2 and AKH 9331) and 8 testers (HAG 1055, LK 861, L 604, JK 344, 4084, IC 356932, LRA 5166 and L 761) were crossed in a line x tester mating design during *kharif*, 2006. The experimental material consisted of 56 resultant hybrids were evaluated along with their parents in randomized block design with 3 replications during *kharif*, 2007. Data recorded on ginning percentage, 2.5% span length, uniformity ratio, micronaire value, bundle strength and seed cotton yield per plant. The data were analyzed for combining ability by following the method of Kempthorne (1957) by using the WINDOSTAT advanced biometric statistical package, Indostat services, Hyderabad 500016(http://www.windostat.org/).

RESULTS AND DISCUSSION

The analysis of variance for combining ability (Table 1) revealed significant differences among the treatments for all the characters in the study indicating the presence of wide variability for all the traits. Parents and crosses showed significant differences for all the traits. However, both lines and testers differed significantly for all the characters except for bundle strength and seed cotton yield in case of testers. The proportion of mean sum of squares due to lines were greater than due to testers for ginning percentage, 2.5% span length, micronaire value, bundle strength and seed cotton yield per plant, whereas, it was *vice versa* for uniformity ratio. The mean sum of squares due to interaction of line x tester was significant for ginning percentage, uniformity ratio, bundle strength and seed cotton yield per plant. The *gca* variance was greater than to *sca* variance for ginning percentage, 2.5% span length, micronaire value and seed cotton yield indicating the predominance of additive gene action whereas, uniformity ratio and bundle strength were predominantly under control of non-additive gene action as indicated by higher magnitude of *sca* variance than *gca* variance. These findings are in accordance with the results of Rauf *et al.* (2006) and Ilyas *et al.* (2007).

Table 1. Analysis of variance (mean squares) for combining ability for cotton seed yield and fiber quality traits in cotton.

Source of variation	D.F	Ginning percentage	2.5 % Span Length	Uniformity ratio	Micronaire value	Bundle strength	Seed Cotton Yield/ plant
Replications	2	11.67**	5.64**	3.90**	0.05	1.24	538.33
Treatments	70	13.10**	11.94**	13.98**	0.31**	2.64**	3314.23**
Parents	14	18.95**	19.67**	21.3**	0.58**	2.41**	2379.46**
Parents vs. crosses	1	28.74**	32.14**	7.7	0.21	10.34**	9348.04**
Crosses	55	11.32**	9.60**	12.2**	0.25**	2.56**	3442.46**
Lines	6	49.79**	44.40**	25.4**	1.35**	9.09**	11007.24**
Testers	7	28.76**	29.97**	45.7**	0.44**	2.86	3115.51
Lines x Testers	42	2.92*	1.23	4.76**	0.06	1.58*	2416.27**
Error	140	1.85	0.93	2.45	0.09	1.06	227.9
Total	212	5.66	4.61	6.27	0.16	1.59	1249.9
σ2 *gca*	1.67	1.61	1.47	0.04	0.22	303.71	1.67
σ2 *sca*	0.36	0.1	0.77	0.08	0.17	729.46	0.36
σ2 *gca* / σ2 *sca*	4.63	16.1	1.9	0.5	1.29	0.42	4.63

**, * = Significant at $P \leq 0.01$ and $P \leq 0.05$

Table 2. General combining ability (*gca*) effects of parents for yield and fibre quality traits in cotton.

Parents	Ginning percentage	2.5% span Length	Uniformity ratio	Micro-naire value	Bundle strength	Seed cotton yield/plant
Lines						
CPD 420	-0.07	1.10**	-0.17	-0.11	-0.33	20.02**
Galama	-1.39**	1.90**	-0.99**	-0.33**	0.56**	23.21**
NA 1325	0.48	-0.26	-0.63	0.11	-1.06**	12.86**
L 389	0.57*	1.05**	-1.28**	-0.10	0.02	-11.76**
IC 357063	-1.51**	-0.89**	1.36**	0.31**	0.44*	-32.57**
BC 68-2	-0.75**	-1.68**	0.90**	-0.16*	0.67**	7.88*
AKH 9331	2.67**	-1.22**	0.80*	0.27**	-0.31	-19.65**
SE(g_i)	0.28	0.20	0.32	0.06	0.21	3.08
Testers						
HAG 1055	0.81**	0.42*	-0.62	0.05	-0.26	9.40**
LK 861	-1.07**	0.98**	-1.16**	-0.21**	0.11	14.14**
L 604	-0.85**	-0.36	1.63**	-0.13*	0.56*	-2.49
JK 344	0.77*	-1.38**	0.68*	-0.07	0.10	-14.85**
4084	1.77**	-2.17**	2.51**	0.23**	-0.72**	-7.17*
IC 356932	-1.79**	0.79**	-1.82**	-0.07	0.16	-6.15
LRA 5166	0.01	0.75**	-0.68	0.06	0.08	17.86**
L 761	0.36	0.97**	-0.55	0.14*	-0.03	-10.74**
SE(g_j)	0.30	0.21	0.34	0.06	0.22	3.29

**, * = Significant at $P \leq 0.01$ and $P \leq 0.05$

However, contradictory results were reported by Karademir and Gencer (2010) (additive gene action for ginning percentage and non-additive gene action for seed cotton yield and uniformity ratio), Saravanan *et al.* (2010) (non-additive gene action for all fiber quality traits) and Karademir *et al.* (2009) (non-additive gene action for seed cotton yield, uniformity ratio and ginning percentage).

The general combining ability effects of the lines and testers for seed cotton yield and fiber quality characters are presented in Table 2. Among the lines Galama and CPD 420 exhibited desirable and significant *gca* effects for seed cotton yield and 2.5% span length, whereas the line IC 357063 recorded positive significant *gca* effects for uniformity ratio, micronaire value and bundle strength. The line BC 68-2, recorded positive and significant *gca* effects for seed cotton yield, uniformity ratio, and bundle strength. Among the testers, LRA 5166 and LK 861 were found to be good general combiners for seed cotton yield and 2.5% span length, HAG 1055 for yield, ginning percentage and 2.5% span length, while tester 4084 recorded significant *gca* effects for ginning percentage, uniformity ratio and micronaire value. The parents having high *gca* effects for fibre quality traits could be useful in quality improvement breeding programs by practicing early generation selections, since the *gca* effect was due to additive gene action and was fixable.

The specific combining ability effects were estimated for all the 56 hybrids for 6 characters. Superior crosses with high *sca* effects and their *per se* performance are given in Table 3.

Table 3. Superior crosses with high *sca* effects and their per *se* performance and *gca* effects of parents for seed cotton yield and fibre quality traits in cotton.

Character	Cross	Mean	*sca* effect	*gca* effect		*gca* status
				Female Parent	Male parent	
Ginning percentage	IC 357063 x L 761	34.88	1.98*	-1.51**	0.36	low x average
	AKH 9331 x LRA 5166	38.55	1.83*	2.67**	0.01	high x average
	NA 1325 x LK 861	35.15	1.69*	0.48	-1.07**	average x low
2.5% span length	IC 357063 x LRA 5166	29.49	1.24*	-0.89**	0.75**	low x high
Uniformity ratio	CPD 420 x L 761	49.93	2.81**	-0.17	-0.55	average x average
	CPD 420 x 4084	52.07	1.88*	-0.17	2.51**	average x high
	IC 357063 x L 761	50.47	1.81*	1.36**	-0.55	high x average
Micronaire value	IC 357063 x JK 344	4.58	0.34*	0.31**	-0.07	high x average
Seed cotton yield/ plant	NA1325 x L 604	218.57	63.4**	12.8**	-2.49	high x average
	NA 1325 x 4084	204.25	53. 8**	12.8**	-7.17*	high x low
	AKH 9331 x HAG 1055	182.95	48.4**	-19.6**	9.40**	low x high
	IC 357063 x JK 344	135.20	37.8**	-32.5**	-14.85**	low x low
	BC 68-2 x HAG 1055	195.20	33.2**	7.88*	9.40**	high x high

**, * = Significant at $P \leq 0.01$ and $P \leq 0.05$

With regard to ginning percentage significant positive *sca* effects observed in 3 hybrids *viz.*, IC 357063 x L 761, AKH 9331 x LRA 5166 and NA 1325 x LK 861 involved parents of low x average, high x average and average x low combiners respectively indicating the presence of genetic diversity among the parents. For the trait 2.5% span length the cross IC 357063 x LRA 5166 exhibited significant positive *sca* effects where parents involved are low x high combiners.

High *sca* effect in this combination might be due to possibility of interaction between positive alleles of good combiner with negative alleles of poor combiner. The crosses CPD 420 x L 761 (average x average), CPD 420 x 4084 (average x high) and IC 357063 x L 761 (high x average) were found to be best specific combiners for uniformity ratio. Presence of at least 1 parent with high *gca* effects indicating that a high general combiner in the cross combination might result in good specific combination. For the trait micronaire value the only cross, IC 357063 x JK 344 (high x average) exhibited significant positive *sca* effect, whereas in case of bundle strength none of the crosses exhibited significant positive *sca* effect. Even though good general combiners are observed for bundle strength, none of them produced a hybrid combination with significant good *sca* effects which might be due to cancellation effects of its alleles.

Highest *sca* effects for seed cotton yield per plant were observed in crosses NA 1325 x L 604 (high x average), NA 1325 x 4084 (high x 4 low), AKH 9331 x HAG 1055 (low x high), IC 357063 x JK 344 (low x low) and BC 68-2 x HAG 1055 (high x high). Almost all types of combinations produced superior hybrids for seed cotton yield per plant. Neelima *et al.* (2004) and Rauf *et al.* (2006) reported high *sca* effects for the characters were either due to high x high, high x average, high x low, average x high, average x average, average x low, low x high, low x average or low x low combining parents. The ideal specific combination should be the one where high magnitude of *sca* in addition to high *gca* in both or at least one of the parents is present. High *sca* effects resulted due to average x average general combiners may expected to throw high yielding segregants in later generations and could be exploited for isolating superior genotypes (Bhatade *et al.* 1992). Nevertheless, lines with good estimates are part of the superior hybrids. The crosses involving both good combiners are expected to produce desirable segregants in the subsequent generations (Gururajan and Basu 1992). However, parents with high x high *gca* effects were reported by Narisireddy and Satyanarayana (2004) and De Aguiar *et al.* (2007).

The overall perusal of *sca* effects of different characters in present investigation reveals that *sca* effects and *per se* performance of the crosses were not closely related, which indicates that the hybrids with high *per se* performance need not be the one with high *sca* effects. So the cross combinations may be selected either on the basis of *sca* or mean performance or in combination. Several workers found that, hybrids with superior fibre quality traits were not good in seed cotton yield and *vice versa* (Dheva *et al.,* 2002 and Ahuja and Dhayal, 2007). Hence, high yielding hybrids with acceptable levels of fiber quality traits should be given importance for selection of hybrids.

This study indicated that the parents Galama, CPD 420, BC 68-2, LK 861 and LRA 5166 which had high *gca* effects for cotton seed yield and one or other fiber quality traits can be utilized in crop improvement program. The crosses NA1325 X L 604, NA 1325 X 4084, IC 357063 X LRA 5166, CPD 420 X L 761, IC 357063 X JK 344 and IC 357063 X L 761 with high *sca* effects for cotton seed yield and fiber quality traits are can be exploited for hybrid vigor. Most of the fiber quality traits were found to be controlled by additive gene action, therefore early generation selections may be appropriate for the improvement fiber quality traits in cotton.

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