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Combining Ability Studies Involving New Hirsutum Lines in Cotton (*Gossypium hirsutum* L.)

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ABSTRACT

Combining ability analysis using line × tester design was conducted during *kharif* 2008-09 on 48 hybrids produced by crossing 8 lines and 6 testers. Among lines, RAH 22 and RAH 44 while, tester RAH 143 showed positively significant *gca* effects for seed cotton yield plant^{-1} and six yield contributing characters. All the characters studied were controlled predominantly by non-additive gene action. Among the cross combinations RAH 63 × RAH 141, RAH 44 × RAH 141, RAH 15 × RAH 183, RAH 24 × RAH 162, RAH 24 × RAH 183 and RAH 52 × RAH 143 exhibited higher *per se* performance and significant positive *sca* effects for seed cotton yield plant^{-1}.

Key words : Cotton, Line ×Tester Analysis, General and Specific Combining Ability

Cotton (*Gossypium hirsutum* L.), the king of apparel fibres, with more than twenty utilities and by-products has become a highly agro-industrial crop (Ashok Kumar and Ravikesavan, 2008). Knowledge on combining ability is useful for selection of desirable parents for exploitation of hybrids and transgressive expressions.

MATERIAL AND METHODS

The experimental material for the present investigation comprised 48 hybrids derived from crossing 8 lines with 6 testers which are intra-hirsutum lines developed from heterotic pools of segregating generations of multiple crosses. These 48 hybrids were grown at Agricultural College Farm, Bapatla, Andhra Pradesh during *kharif* 2008-09. The experiment was laid out in a randomized block design with two replications with inter- and intra-row spacing of 120cm × 60cm. Recommended agronomic practices and need based plant protection measures were followed. Data on plant height, days to 50% flowering, number of monopodia plant^{-1}, number of sympodia plant^{-1}, number of bolls plant^{-1}, boll weight, seed index, lint index, ginning out-turn, 2.5% span length, micronaire value, bundle strength, uniformity ratio, fibre elongation, lint yield plant^{-1} and seed cotton yield plant^{-1} were recorded.

The data were subjected to combining ability analysis following Kempthorne (1957). The ratio of GCA/SCA was worked out for each character to find out the predominance of additive / non-additive gene action.

RESULTS AND DISCUSSION

The analysis variance (Table 1) revealed highly significant differences among hybrids for all the characters, indicating considerable genetic diversity among the parents selected except, for fibre elongation (%) in lines whereas, for micronaire value, bundle strength, uniformity ratio and fibre elongation in testers.

The GCA : SCA ratio was less than unity for seed cotton yield plant^{-1} suggesting that the trait was governed predominantly by non-additive component (Table 1). Similar results were obtained by Ahuja and Tuteja (2003), Mohammad Ilyas *et al.* (2007), Ashok Kumar and Ravikesavan (2008), Kalpande *et al.* (2008).

Combing ability studies revealed that lines RAH 22 and RAH 44 and the tester RAH 143 showed high *gca* effect for seed cotton yield plant^{-1} (Table 2). The line RAH 22 also showed high *gca* effect for boll weight, seed index, 2.5% span length, micronaire value and lint yield plant^{-1}. The other line RAH 44 showed high *gca* effect for plant height, number of sympodia plant^{-1}, number of bolls plant^{-1}, seed index, lint index and lint yield plant^{-1}. Whereas the tester RAH 143 showed high *gca* effect for number of bolls plant^{-1}, seed index, lint index, ginning out turn and lint yield plant^{-1}. For earliness the line RAH 36 and the tester RAH 112 showed desirable *gca* effects in desired direction.

Among the crosses RAH 63 × RAH 141, RAH 44 × RAH 141, RAH 15 × RAH 183, RAH 24 × RAH 162, RAH 24 × RAH 183 and RAH 52 × RAH 143

Table 1. Analysis of variance for combining ability and estimates of genetic components of variance and proportional contribution of lines, testers and line x tester interaction to total variance for seed cotton yield plant^{-1} and yield components in cotton (*Gossypium hirsutum* L.)

Source of variation	d.f	Plant height	Days to 50% flowering	No. of monopodia plant^{-1}	No. of sympodia plant^{-1}	No. of bolls plant^{-1}	Boll weight	Seed index	Lint index
Replications	1	30.0	0.1	0.1	1.4	43.2	0.01	0.8	0.1
Crosses	47	455.9**	8.0**	0.7*	13.9**	169.5**	0.1**	4.5**	1.1**
Line effect	7	876.3**	7.0**	0.6*	18.4**	226.6**	0.2**	3.1**	1.2**
Tester effect	5	76.8	7.3**	1.4**	11.1**	201.1**	0.1**	4.3**	1.4**
Line X tester effect	35	426.0**	8.3**	0.6*	13.3**	153.6**	0.1	4.8**	1.1**
Error	47	79.6	1.2	0.06	3.7	32.0	0.0	0.6	0.0
σ^2gca		0.7	-0.007	0.002	0.01	0.38	0.00	-0.007	0.001
σ^2sca		173.1**	3.5**	0.2	4.8*	60.7**	0.06	2.07	0.51
σ^2gca/σ^2sca		0.004	-0.001	0.008	0.002	0.006	0.004	-0.003	0.002
Contribution of									
Line (%)		28.6	13.0	13.8	19.7	19.9	21.3	10.3	15.3
Tester (%)		1.7	9.7	21.5	8.5	12.6	9.8	10.2	13.1
Line x tester (%)		69.5	77.2	64.5	71.7	67.4	68.7	79.3	71.4

Ginning out turn	2.5% span length	Micronaire value	Baundle strength	Uniformity ratio	Fibre elongation	Lint yield plant^{-1}	Seed cotton yield plant^{-1}
2.1	3.3	0.01	2.5	6.7	0.04	234.6	536.2
4.8**	11.0**	0.3	1.7*	13.6**	0.03	288.5**	2024.9**
7.8**	13.8**	1.1**	2.13*	24.1**	0.05	314.4**	2176.5**
1.8**	4.3**	0.07	0.9	3.0	0.04	372.2**	2543.7**
4.7**	11.3**	0.2	1.8*	13.1**	0.03	271.3**	1920.5**
0.4	1.0	0.0	0.8	2.9	0.00	56.4	393.2
0.003	-0.008	0.002	-0.001	0.01	0.00	0.4	2.4
2.1**	5.1**	0.07	0.4**	5.1**	0.005	107.4**	763.6**
0.001	-0.001	0.03	-0.002	0.002	0.01	0.003	0.003
24.0	18.7	49.7	17.8	26.6	21.7	16.2	16.0
4.0	4.2	2.2	5.8	2.3	11.4	13.7	13.3
71.9	76.9	48.0	76.3	71.3	66.8	70.0	70.6

*, ** = Significant at 5% and 1% level, respectively.

Table 2. Estimates of general combining ability (*gca*) effects of lines and testers for seed cotton yield plant^{-1} and yield components in cotton (*Gossypium hirsutum L.*)

Plant height	Days to 50% flowering	No. of monopodia plant^{-1}	No. of bolls plant^{-1}	Boll weight	Seed index	Lint index
Lines						
L2(-5.81*) L3(-5.91*) L4(17.09**) L5(7.29**) L6(-9.07**)	L3(-1.04**) L4(1.38**) L8(0.71*)	L1(-0.48**) L4(0.16*) L5(-0.17*) L6(0.27**)	L4(8.10**) L7(-4.61**) L8(-5.00**)	L1(0.13*) L3(-0.15**) L4(-0.21**) L7(0.24**)	L1(0.49*) L2(-0.70**) L4(0.92**)	L2(-0.38**) L3(-0.22*) L4(0.58**) L5(0.21*) L7(-0.29**)
Testers						
—	T1(-0.83**) T4(1.04**)	T1(-0.46**) T2(-00.18**) T3(0.14*) T4(0.40**) T6(0.15*)	T1(-3.33*) T3(-3.71*) T4(5.36**)	T1(-0.16**) T2(0.10*) T3(0.12**)	T1(-0.70**) T4(0.56**) T5(0.44*) T6(-0.56**)	T1(-0.35**) T2(0.17*) T4(0.30**) T5(0.28**) T6(-0.36**)

Ginning outturn	2.5% span length	Micronaire value	Uniformity ratio	Lint yield plant^{-1}	Seed cotton yield plant^{-1}
Lines					
L1(-0.57**) L4(0.57**) L5(1.48**) L6(0.55**) L7(-0.60**) L8(-0.98**)	L1(1.70**) L3(0.67*) L4(-0.86**) L5(-1.67**) L6(-0.69**) L7(0.64*)	L1(0.30**) L2(0.40**) L4(-0.21**) L5(0.22**) L6(-0.21**) L7(-0.48**) L8(-0.17**)	L2(1.66**) L6(1.72**) L7(-2.41**) L8(-1.20*)	L1(5.03*) L3(-4.74*) L4(7.03**) L8(-8.49**)	L1(16.70**) L4(17.59**) L8(-19.62**)
Testers					
T4(0.47**) T6(-0.57**)	T1(-0.63*) T2(0.86**)	—-	—-	T1(-7.59**) T4(6.76**)	T1(-20.82**) T4(16.64**)

NOTE: L1=RAH 22, L2= RAH 19, L3= RAH 36, L4= RAH 44, L5= RAH 15, L6= RAH 24, L7=RAH 63 and L8= RAH 52 are lines and T1= RAH 112, T2=RAH 116, T3= RAH 162, T4=RAH 143, T5=RAH 183 and T6= RAH 141 are testers.

*, ** = Significant at 5% and 1% level, respectively.

Table 3. Estimates of specific combining ability (*sca*) effects of five promising crosses for seed cotton yield plant^{-1} and yield components in cotton (*Gossypium hirsutum* L.)

Plant height	Days to 50% flowering	No. of monopodia plant^{-1}	No. of sympodia plant^{-1}	No. of bolls plant^{-1}	Boll weight	Seed index	Lint index
2XA (20.08**)	3XA (3.17**)	3XA (0.64**)	5XE (3.26*)	5XE (11.05**)	1XD (0.31*)	3XB (1.83**)	1XA (0.87**)
3XA (26.82**)	3XB (3.42**)	5XA (1.14**)	6XC (4.26**)	6XC (16.98**)	2XA (0.45**)	5XD (1.93**)	5XE (0.98**)
4XD (16.89*)	5XA (2.58**)	6XC (0.84**)	6XE (3.73**)	6XE (10.28*)	4XC (0.38**)	6XC (2.64**)	6XC (0.99**)
7XB (15.70*)	6XC (2.08*)	6XD (0.73**)	7XF (5.07**)	7XF (21.21**)	5XF (0.34**)	6XE (1.95**)	6XE (0.93**)
8XC (27.86**)	7XF (2.21*)	7XC (0.57**)	8XD (4.17**)	8XD (14.79**)	8XF (0.33*)	7XF (1.85**)	8XD (1.09**)

Ginning out turn	2.5% span length	Micronaire value	Bundle strength	Uniformity ratio	Fibre elongation	Lint yield plant^{-1}	Seed cotton yield plant^{-1}
1XB (1.95**)	1XC (3.49**)	1XE (0.42*)	2XB (-1.72*)	1XD (2.79*)	5XD (-0.23*)	5XE (13.93*)	5XD (0.86**)
3XF (3.66**)	2XF (3.66**)	2XF (0.38*)	2XD (1.74*)	4XA (2.91*)	5XF (0.22*)	6XC (19.34**)	5XE (0.98**)
6XB (1.92**)	3XD (2.68**)	3XD (0.52*)	5XD (-1.56*)	4XE (3.11*)	7XB (0.25*)	6XE (13.82*)	6XC (0.99**)
7XA (2.40**)	7XB (5.29**)	5XC (0.46*)	5XF (1.81**)	5XD (3.44**)	7XF (-0.23*)	7XF (22.32**)	6XE (0.93**)
8XC (2.11**)	8XE (2.45**)	6XB (0.46*)	7XB (2.12**)	7XD (2.80*)		8XD (24.14**)	8XD (1.09**)

NOTE: 1=RAH 22, 2= RAH 19, 3=RAH 36, 4= RAH 44, 5=RAH 15, 6= RAH 24, 7= RAH 63 and 8=RAH 52 are lines whereas, A=RAH 112, B=RAH 116, C=RAH162, D=RAH 143, E=RAH 183 and F=RAH 141are testers respectively.

*, ** = Significant at 5% and 1% level, respectively.

exhibited significant positive *sca* effect and high *per se* performance for seed cotton yield plant^{-1} (Table 3). The highest significant positive *sca* effect was recorded by RAH 63 × RAH 141(65.27) for seed cotton yield plant^{-1}.

Out of the 48 crosses studied, the cross RAH 52 × RAH 162 (27.86) showed highest *sca* effect for plant height, whereas the cross RAH 36 × RAH 141 (-3.71) recorded highest significant negative *sca* effect for days to 50% flowering. While, the cross RAH 63 × RAH 141 exhibited highest significant positive *sca* effect of 5.07 and 21.21 for number of sympodia plant^{-1} and number of bolls plant^{-1}, respectively.

The cross RAH 19 × RAH 112 (0.45) exhibited high *sca* effect for boll weight whereas, the cross RAH 24 × RAH 162 (2.64) exhibited highest significant positive *sca* effect for seed index. The cross RAH 52 × RAH 143 (1.09) displayed highest *sca* effect for lint index. The cross, RAH 36 × RAH 141 (3.66) recorded highest *sca* effects for ginning out-turn. For 2.5% span length, the cross RAH 63 × RAH 116 (5.29) recorded highest *sca* effect.

The combing ability analysis disclosed that all the traits in general are predominantly controlled by non-additive gene action. The present study indicated the scope of developing hybrids with high seed cotton yield plant^{-1} and desired fibre qualities through heterosis breeding.

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