Combining ability and Heterosis for yield traits in Cotton (*Gossypium hirsutum* L.)

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Abstract: The ratio between gca and *sca* variances estimated from 9 lines, 6 testers and their 54 hybrids obtained by line x tester mating design indicated the predominance of non-additive gene action for all the yield traits *viz.*, days to first flowering, plant height, number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight, seed cotton yield per plant and number of locules per boll. Identification of superior heterotic hybrids is mostly done based on the high *per se* performance, high *sca* effect associated with heterotic effect (standard heterosis). The following hybrids *viz.*, TCH 1452 x Halden, MCU 12 x MCU 5, KC 2 x MCU 5, KC 2 x EC 35556, MCU 12 x Hancock and TCH 1452 x Uganda -8-9 were considered as superior and worth studying further.

Key words : Cotton, Line x tester mating design, Combining ability, Heterosis, Yield characters.

Introduction

Cotton is one of the most important commercial crop in 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 breeding programmes. Accordingly, the present investigation has been undertaken to determine combining ability and heterosis for seed cotton yield and its component traits through line x tester mating design.

Materials and Methods

The materials consist of nine lines *viz.*, MCU 12 (L1), Surabhi (L2), SVPR 2 (L3), KC 2 (L4), TCH 1569 (L5) , TCH 1002 (L6), TCH 1452 (L7), TCH 1628 (L8), TCH 1218 (L9) and six testers *viz.*, Halden 4 (T1), CTI-30-10-Delta express (T2), EC 35556 (T3),

Hancock (T4), Uganda-8-9 (T5), MCU 5 (T6) and their hybrids. Both the parents and their hybrids were raised in randomized block design with three replications in Cotton Breeding Station, Tamil Nadu Agricultural University, Coimbatore-641003 by adopting the spacing of 75 cm x 60 cm. Data were recorded from 5 plants per replication for 8 yield characters *viz.*, days to first flowering, plant height, number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight, seed cotton yield per plant and number of locules per boll. The data were analysed based on the line x tester mating design for combining ability effects (Kempthorne,1957).

Results and discussion

The results from combining ability revealed that the differences due to lines were highly significant for the characters plant height, number of monopodia per plant, number of bolls per plant and seed cotton yield per plant and testers were highly significant for characters plant

height and number of monopodia per plant. The line x tester interaction differences was highly significant for all the characters. The magnitude of *sca* variances was higher than *gca* variances for all the characters which indicated the predominant action of non- additive genes, which signals the selection to be postponed to later generations. It also stress the need for choosing appropriate breeding techniques to sieve the materials to screen out superior genotypes (Panse,1942).

In this study, the *gca* effects for seed cotton yield per plant was positive and significant for parent MCU 12, Surabhi and SVPR 2 for plant height, KC 2 for days to first flowering, number of bolls per plant and seed cotton yield. TCH 1569 for days to first flowering. Among the testers, Halden-4 recorded high order of mean performance and *gca* effect for number of locules per boll. MCU 5 revealed significant high mean performance and *gca* effect for boll weight and seed cotton yield per plant. Chawla and Gupta (1982) stated that all parents with high mean performances as well as high *gca* could produce transgressive segregants in the F$_2$ as well as in later generations. Hence, considering the parameters, *per se* performance and *gca* effects together for yield contributing characters, parents LI (MCU 12), L2 (Surabhi), L3 (SVPR 2), L4 (KC 2), L5 (TCH 1569), Tl (Halden - 4) and T6 (MCU 5) were considered as superior and worth studying further (Table 1).

The hybrid KC 2 x EC 35556 exhibited superior *sca* effects for five characters *viz.* plant height (high x medium), number of bolls per plant (high x low), boll weight (medium x high), seed cotton yield per plant (high x low) and number of locules per boll (high x low). The hybrid TCH 1002 x MCU 5 revealed high *sca* effects for five characters like days to first flowering (medium x medium), plant height (low x medium), number of sympodia

per plant (medium x high), boll weight (low x high) and seed cotton yield per plant (low x high). This was followed by hybrid TCH 1569 x EC 35556 for four characters *viz.*, days to first flowering (high x medium), plant height (low x low), number of monopodia per plant (high x low) and number of bolls per plant (low x low). TCH 1569 x Hancock for four characters *viz.* plant height (low x low), number of sympodia per plant (medium x medium), boll weight (low x low) and seed cotton yield per plant (low x low). The hybrid TCH 1002 x CTI-30-10- Delta express showed significant *sca* effect for four characters *viz.* plant height (low x high), number of bolls per plant (low x low), seed cotton yield per plant (low x medium) and number of locules per boll (low x medium) and hybrid TCH 1452 x EC 35556 stood for characters like plant height (high x low), number of sympodia per plant (high x low), number of bolls per plant (medium x low/and number of locules per boll (low x low), exhibited significant and desirable *sca* effects. However, the remaining hybrids were found to be superior for various characters, while some possessed high *sca* effects for one or more characters, other had low *sca* values (Table 2). Hybrids which involve high x high *gca* are expected to release desirable segregants in subsequent generations (Gururajan and Basu, 1992). High x low *gca* with significant *sca* effect are likely to produce desirable transgressive segregants (Gururajan and Basu, 1992 ; Kalsy and Garg, 1980). High x average, Average x average *gca* effects may be expected to throw high yielding segregants in later generations and could be exploited for isolating superior genotypes (Bhatade *et al.* 1992).

Negative heterosis for days to first flowering is a desirable feature as it confers earliness. Hybrid SVPR 2 x EC 35556 recorded the highest negative heterosis for days to first flowering. Hybrid TCH 1452 x Halden 4 recorded maximum heterosis for plant height. Hybrid TCH

Table 1. Estimates of *gca* effects for different characters

Particulars	Days to first flowering	Plant height	Number of monopodia per plant	Number of sympodia per plant	Number of bolls per plant	Boll weight weight	Seed cotton yield per plant	Number of locules per bolls
Lines								
L1	1.58**	-1.61**	-0.13*	0.37	-0.00	0.35**	5.86**	-0.04
L2	1.58**	3.99**	-0.20**	-0.65*	0.27	-0.18**	-2.01**	-0.01
L3	-0.31	5.15	0.21**	0.08	-0.07	-0.36**	-6.27**	0.02
L4	-2.59**	1.31*	0.17**	0.18	3.66**	-0.04	11.26**	0.26**
L5	-2.75**	-3.17**	-0.28**	0.55	-1.12**	-0.02	-3.74**	0.00
L6	0.86	-4.00**	0.14**	0.38	-0.73**	-0.12**	-4.29**	-0.08**
L7	-0.31	7.45**	-0.05	1.31**	-0.05	0.03	0.34	-0.16**
L8	1.69**	-7.96**	0.09	-0.82**	-0.12	-0.30	-0.88	-0.07**
L9	0.25	-1.16*	0.05	-1.40**	-1.84**	0.37**	-0.28	0.08**
SE	0.5782	0.5685	0.0536	0.3135	0.1766	0.0272	0.6678	0.027
Tester								
T1	-0.16	0.40	-0.10*	-0.60*	0.67**	0.08**	3.53**	0.05*
T2	-0.60	7.36**	0.02	0.52*	-0.47**	0.04	-0.67	-0.00
T3	0.88	-3.78**	0.28**	-1.06**	-1.27**	0.07**	-2.64**	-0.06**
T4	0.06	-7.16**	-0.10*	-0.50	-0.33*	-0.10**	-2.90**	0.01
T5	-0.98*	2.45**	0.06	1.12**	0.71**	-0.17**	-1.00	0.01
T6	0.80	0.74	-0.17**	0.52*	0.69**	0.09**	3.67**	-0.02
SE	0.4721	0.4642	0.0437	0.2559	0.1442	0.0222	0.5452	0.0221

** significant at 1% level
* significant at 5% level

Table 2. Estimates of *sca* effects for different characters

Particulars	Days to first flowering	Plant height	Number of monopodia per plant	Number of sympodia per plant	Number of bolls per plant	Boll weight	Seed cotton yield per plant	Number of locules per bolls
L1XT4	1.05	-9.13**	0.06	-0.13	-0.39	0.44**	5.91**	0.21**
L1XT5	-3.25*	-0.54	-0.16	-2.69**	4.06**	-0.31**	7.66**	0.28**
L1XT6	-0.02	10.88**	0.09	1.29	0.02	0.46**	8.40**	-0.02
L2XT2	1.72	1.32	0.18	-0.19	1.71**	0.42**	12.56**	0.26**
L3XT3	-7.54**	1.72	-0.16	3.60**	1.44**	0.64*	15.08**	-0.03
L3XT5	-0.02	-9.39**	0.06	-1.64*	-0.07	0.30**	5.18**	-0.01
L4XT1	1.44	1.61	0.04	0.72	0.37	0.20**	5.34**	-0.27**
L4XT2	0.22	1.53	-0.47**	-1.42	-0.09	0.33**	5.88**	-0.13
L4XT3	1.07	3.14*	0.48**	-1.24	3.04**	0.38**	17.82**	0.19**
L5XT1	1.94	2.24	0.31*	-0.31	1.19**	0.06	4.84**	0.07
L5XT4	-1.28	4.47**	0.04	1.82*	-0.04	0.24**	3.81*	-0.03
L6XT2	-2.56	5.89**	0.23	0	1.77**	-0.05	4.59**	0.23**
L6XT6	-3.30*	3.12*	-0.11	2.05**	0.21	0.34**	6.46**	0.06
L7XT1	0.49	11.76**	-0.25	3.10**	-0.58	0.63**	8.88**	-0.16*
L8XT1	-0.84	-5.08**	0.14	-1.70*	0.69	0.32**	8.16**	-0.09
L8XT4	-0.06	12.40**	-0.13	-0.32	3.71**	-0.17*	8.19**	0.36**
L9XT5	1.09	-2.95*	-0.11	-1.1	0.3	0.23**	5.53**	0.08
L9XT6	-0.69	-4.25**	0.18	0.03	2.37**	-0.18**	5.46**	0.12
SE	1.42	1.39	0.13	0.77	0.43	0.07	1.64	0.07

Note: only hybrids which are positively significant for yield are given

Table 3. Expression of standard heterosis (percentage) for different characters

Hybrids	Days to first flowering	Plant height	Number of monopodia per plant	Number of sympodia per plant	Number of bolls per plant	Boll weight	Seed cotton yield per plant	Number of locules per bolls
L1XT4	2.33	-21.58**	50.00	16.18**	5.93	5.18*	11.40**	-0.35
L1XT5	-5.12*	-2.61	16.67	10.62	42.29**	-17.09**	17.97**	1.40
L1XT6	1.86	7.50**	33.33	30.41**	15.42**	10.91**	27.71**	-7.24**
L2XT2	2.33	10.28**	131.67	15.79**	20.70**	-6.00*	13.20**	1.48
L3XT3	-11.16**	0.3	300.00*	32.94**	11.41**	-4.36	6.51	-7.07**
L3XT5	-3.26	-4.78*	300.00*	15.01*	14.54**	-20.00**	-8.35*	-4.71*
L4XT1	-3.26	0.54	191.67	19.40**	41.85**	-7.18**	31.68**	-4.19
L4XT2	-5.58*	7.71**	0.00	13.45*	31.28**	-4.64	25.08**	-1.83
L4XT3	-2.33	-2.22	600.00**	5.26	46.70**	-2.45	43.02**	5.06*
L5XT1	-2.79	-3.47	100.00	15.59**	15.64**	-10.27**	3.76	-1.75
L5XT4	-6.98**	-9.03**	-33.33	28.65**	0.88	-10.45**	-9.68*	-5.58*
L6XT2	-4.65	6.72**	333.33**	22.90**	14.54**	-17.27**	-5.25	-1.40
L6XT6	-3.72	-3.07	66.67	34.89**	11.87**	-5.27*	5.92	-6.20*
L7XT1	-1.4	17.50**	-66.67	39.96**	11.01**	6.73**	18.39**	-12.13**
L8XT1	-0.47	-16.10**	200.00	-0.58	18.94**	-3.36	14.89**	-7.94**
L8XT4	0.93	-5.76**	66.67	8.09	32.27**	-21.82**	3.36	2.62
L9XT5	-0.93	-4.66*	133.33	9.55	5.29	-1.91	3.07	-0.61
L9XT6	-0.93	-7.79**	166.67	12.67*	18.79**	-6.18*	11.35**	-0.44
SE	1.8643	1.9052	0.2451	1.0158	0.5929	0.0891	2.3117	0.0918

** significant at 1% level * significant at 5% level Note: only hybrids which are positively significant for *sca* effects for yield are given

1452 x Uganda-8-9 revealed high standard heterosis for number of sympodia per plant. Highest positive heterosis for number of bolls per plant was recorded in hybrid KC 2 x EC 35556. For boll weight, the hybrid MCU 12 x MCU 5 recorded highest positive standard heterosis. Hybrid KC 2 x EC 35556 recorded highest positive heterosis for the character seed cotton yield per plant. For number of locules per boll, hybrid Surabhi x Halden-4 recorded highest positive standard heterosis. Out of the 54 hybrids studied, heterotic effect for all the characters was not expressed in a single hybrid combination, different hybrids had heterosis for different characters (Table 3).

Based on the standard heterosis the hybrid MCU 12 x MCU 5 was the best for the traits plant height, number of sympodia per plant, number of bolls per plant, boll weight and seed cotton yield per plant. It was followed by the hybrids viz., KC 2 x CTI-30-10-Delta express, KC 2 x 35556, KC 2 x Hancock, KC 2 x MCU 5 and TCH 1452 x Halden-4 which possessed desirable performance.

Identification of superior heterotic hybrids is mostly done based on the high *per se* performance, high *sca* effect associated with heterotic effect. If all these parameters are associated for the expression of the character it will be a boon to the breeder to screen such parental combination to exploit them for a successful heterotic breeding. By considering this the following hybrids viz., TCH 1452 x Halden, MCU 12 x MCU 5, KC 2 x MCU 5, KC 2 x EC 35556, MCU 12 x Hancock and TCH 1452 x Uganda -8-9 were considered as superior and worth studying further.

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