International Journal of Chemical Studies 2019; 7(6): 1118-1122

International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(6): 1118-1122

Received: 16-09-2019
Accepted: 18-10-2019

UU Vaghela
Department of Genetics and Plant Breeding, NMCA, NAU, Navsari, Gujarat, India

GO Faldu
Main Cotton Research Station Athwa Farm, NAU, Surat, Gujarat, India

RJ Panchal
Department of Genetics and Plant Breeding, NMCA, NAU, Navsari, Gujarat, India

KN Patel
Department of Genetics and Plant Breeding, College of Agriculture, JAU, Junagadh, Gujarat, India

Corresponding Author:
UU Vaghela
Department of Genetics and Plant Breeding, NMCA, NAU, Navsari, Gujarat, India

Determination of combining ability for seed cotton yield and its attributes in American cotton (*Gossypium hirsutum* L.)

UU Vaghela, GO Faldu, RJ Panchal and KN Patel

Abstract
The prime objective of this study was to the estimate the general combining ability of the parents and specific combining ability of hybrids for the development of high yielding cultivars in cotton (*Gossypium hirsutum* L.). A line x tester analysis was carried out by using four lines and eight testers and their resulting 32 hybrids during 2018-19 in randomized block design with three replications. Whereas, both GCA and SCA variances were found significant for days to 50% flowering, sympodia per plant and bolls per plant, which indicated that both additive as well as non-additive types of gene actions were important in the inheritance of these traits. The estimates of GCA effects of parents indicated that the GSHV 199 and CPD 1602 were good general combiner. The top five crosses of seed cotton yield, which showed positive and significant SCA effects *viz.*,GSIV 298 x RAH 1071, GSIV 298 x RHC 1217 (1.07), GSHV 199 x RHC 1217 (-0.04), GISV 319 x PBH 42 (-0.09) and GSHV 199 x RHC 1217 (0.66) and involved the combinations of either goodx good, good x poor, average x good, average x average and poor x poor general combining parents.

Keywords: Cotton, general and specific combining ability, line x tester, gene action

Introduction

Cotton (*Gossypium hirsutum* L.) is the "King of fiber" and has a proud place among the cash crop exercising significance influence on economics and social affairs. Cotton contributed by the genus *Gossypium* in the family Malvaceae. The *Gossypium* species were domesticated in both the old and new world. India has the unique distinction of being the only country where all the cultivated species and some of their hybrid combinations are commercially grown. Cotton possessing great importance as a multipurpose crop like fiber, oil, and protein yielding crop of global significance and that supplies five basic products seed, lint, oil, hulls and linters. Cotton is undoubtedly the backbone of textile industry and contributing nearly 65% of raw materials for textile industry. India, China, United States, Pakistan, Australia, Brazil, Turkey and Greece are the major cotton growing countries which accounts for nearly 90 per cent of total global production. Cotton breeders mainly emphasized on to develop cultivars in early maturity, high yield and good fiber quality traits. Knowledge of combining ability plays an important role in selection of parents for exploitation of hybrid and transgressive expression. Combining ability studies also explain nature and magnitude of gene action. Generally, the selection of parents based on combining ability as well as the *per se* performance but in the presence of non-additive gene action *per se* performance may not produce desirable hybrids. In this context combining ability play important role for parental selection. Line xtester analysis is the simplest method for identification of parents and hybrids by gca and sca, respectively and further evaluate heterotic effect for direct exploitation or whether isolate transgressive sergeant from subsequent generation.

Materials and Methods

The present investigation was carried out to exploit information about combining ability of parents and hybrids at Main Cotton Research Station, Navsari Agricultural University, Surat during year 2018-19. The experimental materials comprised of 45 diverse genotypes of cotton including four female parents *viz.*, GSHV 191, GSHV 199, GISV 298 and GISV 319 as well as eight male parents *viz.*, CPD 1602, SIMA 5, RAH 1071, RHC 1217, PBH 42, HS 298, F 2453 and BGDS 1033 of *Gossypium hirsutum* L. and their resultant 32 crosses (line x tester) along with GN. Cot. Hy-14 as standard check. Thirty two hybrids were obtained during 2017- 18 at Main Cotton Research Station, Navsari Agricultural University, Surat using four females and eight diverse pollinators in a line x tester mating design. The hybrid (F_1) seeds were produced by Dock's (1934) method. Flower buds of proper size about to open next morning were emasculated during late afternoon (after 3 pm). For emasculation, first bracts were removed. Then the petals together with the androecium whorl along with the anther sacs were gently removed by smoothly cutting with the thumb nail, without damaging the stigma, style and ovary. The emasculated flowers were kept covered over night with paper bag. On next morning (between 9 to 11 am) pollens of the desired male flowers were dusted on the stigma of the emasculated flowers and covered with white paper bag. One plant of each parent was also selfed to obtain selfed parental seeds to be used for final evaluation. All the F_1's and selfed seeds of parents were stored properly in seed packets for sowing in the next season. The experiment was laid out in randomized block design with three replications. Each plot consisted of single row of 5.4 m length spaced at 1.20 m apart. Plant to plant distance was 45 cm. One guard row was planted on both sides of the experiments. All recommended packages of practices were adopted for raising a successful and healthy crop. Five random competitive representative plants, excluding border plant, of each genotype in each replication were selected to record the observation for various characters *viz.*, days to 50% flowering, sympodia per plant, bolls per plant, boll weight (g), seed cotton yield per plant (g) and ginning percentage. The average value of data from these plants was computed and used for statistical analysis.

Results and Discussion

The concept of combining ability is becoming increasingly important in plant breeding, its provides guidelines for an early assessment of the relative breeding worth of the parental material. Utilizing this technique, the breeder can choose the best general combining parents as well as specific cross combinations for further exploitation. The GCA is attributed to additive genetic effects which are theoretically fixable. On the other hand, SCA attributed to non-additive gene action may be due to dominance, additive x dominance and dominance x dominance or higher order gene interaction and is unfixable.

Analysis of variance

Analysis of variance for combining ability for all the characters was presented in Table 1. According to the line x tester analysis proposed by Kempthorne (1957) [8]. Combining ability is a prerequisite to choice of parents and also illustrate the nature and magnitude of gene action involved in the inheritance. If lines x testers interaction component were significant, the mean squares due to lines and testers were further tested against their respective interaction mean squares.

The estimated variances due to line σ^2_l and due to testers σ^2_t were non-significant for all the trait except days to 50% flowering. The estimates of σ^2gca were significant for all the traits except boll weight (g), seed cotton yield per plant(g) and ginning percentage. The significant values for gca variances were also noted by Rajamani *et al.* (2014) [14] for boll weight, seed cotton yield and ginning outturn; Sawarkar *et al.* (2014) [16] for days to 50 per cent flowering; Dave *et al.*, (2015) [4] for days to 50% flowering, plant height, sympodia per plant, bolls per plant, boll weight(g), seed cotton yield per plant(g) and ginning outturn; Reddy *et al.* (2017) [15] for days to 50% flowering, plant height, sympodia per plant, bolls per plant and boll weight(g). The estimates of σ^2sca were significant for days to 50% flowering, sympodia per plant, bolls per plant, boll weight(g) and seed cotton yield per plant(g). The ratio of σ^2gca /σ^2sca revealed that all the characters manifested values less than unity. The estimates of components of variances (GCA and SCA) and their ratio (σ^2gac/σ^2sca) indicated that both additive and non-additive variances were important in inheritance of those traits. However, the variance due to GCA were higher in magnitude than their respective SCA variances for ginning percentage. Almost similar results have been reported by Patel *et al.* (2007) [10], Bhaskaren and Ravikesavan (2008) [2], Preethaand Raveendran (2008) [13], Patil *et al.* (2011) [12], Rajamani *et al.* (2014) [14], Usharani *et al.* (2016) [17] and Kumar *et al.* (2015) [9].

Griffing (1956) [7] and Carnahan *et al*. (1960) [3] suggested that GCA could include both additive effects as well as additive x additive interactions. Several earlier workers, Bhandari (1978) [1] and Patel and Mehta (1985) [11] reported the equal importance of GCA and SCA variances signifying the importance of both additive and non-additive types of gene action. Preponderance of additive type of gene effect for ginning percentage suggested directional selection for isolating better homozygous lines from the segregating population for these trait. In view of this situation, breeding procedure which exploits both additive as well as non-additive genetic effects need to be adopted for making yield improvement in such materials. Under such circumstances, recurrent selection procedure seems to be the most appropriate breeding method.

General combining ability (GCA) and Specific combining ability (SCA) effects

The GCA and SCA effects of parents and their crosses for different yield contributing traits were presented in Table 2 and Table 3, respectively. The combining ability provides useful information for the choice of parents in terms of expected performance of the hybrids and progenies (Dhillon, 1975) [5]. Combining ability also useful in deciding breeding methodology aiming at exploitation of fixable (additive) and none fixable (non-additive) genetic variances.

Days to 50% flowering

Earliness being a desirable character, hence parents with significant and negative GCA effects were preferred for imparting earliness in their hybrids and their progenies were considered as good combiners. Two line *viz.*, GSHV 199 (-0.88) and GISV 298 (-1.51) and two testers *viz.*, F 2453 (-1.51) and BGDS 1033 (-1.17) showed significant and negative GCA effect for days to 50% flowering. A perusal of SCA effects estimation of days to 50% flowering for hybrid ranged between -3.74 (GISV 319 x CPD 1602) to 3.51 (GSHV 191 x CPD 1602). Out of 32 hybrids, four hybrids showed negative and significant SCA value.

Sympodia per plant

The magnitude of GCA effects, two lines *viz.*, GISV 298 (0.68) and GISV 319 (0.47) and three testers *viz.*, PBH 42 (1.06), PD 1602 (0.89) and F 2453 (0.72) were good general combiners as they exhibited positive and significant gca effect. The SCA effect varied from -2.39 (GISV 298 x CPD 1602) to 2.22 (GSHV 199 x F 2453). Eight hybrids showed positive and significant SCA effects for number of sympodia per plant.

Bolls per plant

One line *viz.*, GISV 319 (2.39) as well as one tester *viz.*, CPD 1602 (3.18) were identified as good general combiners as they expressed significant positive GCA effect for bolls per plant. The variation in SCA effects for the number of bolls per plant was observed between -6.68 (GISV 298 x HS 298) to 7.06 (GISV 298 x PBH 42). Two hybrids showed significant and positive SCA effect.

Boll weight (g)

The estimation of GCA effects of parent revealed that two testers *i.e.*, RHC 1217 (0.194) and HS 298 (0.33), while none of the female parents were found to be good general combiner for boll weight in desirable direction. An examination of SCA effects ranged from -0.76 (GISV 298 x PBH 42) to 0.56 (GISV 298 x HS 298) and only two hybrids GISV 298 x HS 298 (0.56) and GSHV 199 x BGDS 1033 (0.44) exhibited positive and significant.

Seed cotton yield per plant (g)

Seed cotton yield per plant is a desirable and important yield contributing characters in cotton. The estimates of GCA effects revealed that among lines none of lines showed significant and positive GCA effect and in case of testers, the one tester CPD 1602 (8.87) identified as good general combiner in desirable direction. In case of SCA effect, it ranged between -26.28 (GISV 319 x RHC 1217) to 19.18 (GISV 298 x RAH 1071) and two hybrids GISV 298 x RAH 1071 (19.18) and GISV 298 x RHC 1217 (16.15) showed positive and significant SCA effects for seed cotton yield per plant.

Ginning percentage

For ginning percentage, the spectrum of difference in GCA effects ranged from -0.88 (F 2453) to 1.22 (RAH 1071). None of the line displayed significant and positive GCA effect for ginning percentage. Among testers, only one tester RAH 1071 (1.22) exhibited significant and positive gca effect. The spectrum of difference in SCA effects ranged from -1.89 (GSHV 199 x PBH 42) to 1.35 (GSHV 199 x RHC 1217). None of the hybrid showed positive and significant SCA effect for ginning percentage.

Table 1: Mean sum of square for combining ability and variance components for different characters in *G. hirsutum* L.

Source of variation	Df	Days to 50% flowering	Sympodia per plant	Bolls per plant	Boll weight (g)	Seed cotton yield per plant (g)	Ginning percentage
Replications	2	1.82	1.12	29.65	0.26	93.46	0.25
Crosses	31	21.23**	6.70**	53.15**	0.38	492.28**	3.78
Line effect	3	70.84*	13.56	132.90	0.17	671.39	10.99*
Tester effect	7	19.60	7.39	48.04	0.40	406.97	4.30
Line x Tester effect	21	14.68**	5.49**	43.47**	0.39	495.13**	2.58
Error	62	3.44	0.71	14.66	0.07	192.18	3.07
σ^2l		2.81*	0.53	4.91	0.01	20.47	0.33
σ^2m		1.36*	0.55	2.75	0.02	18.92	0.12
σ^2gca		2.33**	0.53**	4.19**	0.01	19.95	0.26
σ^2sca		3.81**	1.56**	9.48**	0.10**	105.06**	-0.08
σ^2gca/σ^2sca		0.61	0.34	0.44	0.10	0.18	-2.98

* and ** indicates significance at 5% and 1% levels of probability, respectively

Table 2: General combining ability effect of parents for different characters in *G. hirsutum* L.

Sr. No.	Parents	Days to 50% flowering	Sympodia per plant	Bolls per plant	Boll weight (g)	Seed cotton yield per plant (g)	Ginning percentage
1	GSHV 191	2.40**	-0.18	-1.06	0.06	1.06	-0.71*
2	GSHV 199	-0.88*	-0.97**	-2.77**	0.03	-7.67**	-0.43
3	GISV 298	-1.51**	0.68**	1.43	0.03	4.29	0.60
4	GISV 319	-0.01	0.47*	2.39**	-0.12*	2.32	0.55
	SE (g_i)	0.36	0.18	0.79	0.05	2.73	0.34
1	CPD 1602	1.99**	0.89**	3.18**	-0.12	8.87*	-0.02
2	SIMA 5	0.90	-0.68**	-1.47	-0.01	-3.25	0.03
3	RAH 1071	-0.76	-0.43	1.10	-0.08	2.79	1.22*
4	RHC 1217	-1.01	-1.02**	-1.06	0.19*	5.45	0.02
5	PBH 42	1.07*	1.06**	1.68	-0.19*	-2.59	-0.10
6	HS 298	0.49	-0.27	-3.22**	0.33**	-6.33	0.17
7	F 2453	-1.51**	0.72**	-0.22	0.04	2.60	-0.88
8	BGDS 1033	-1.17*	-0.27	0.02	-0.15	7.53	-0.44
	SE (g_j)	0.52	0.25	1.11	0.08	3.87	0.48

* and ** indicates significance at 5% and 1% levels of probability, respectively

Table 3: Specific combining ability effect of crosses for different characters in *G. hirsutum* L.

Sr. No.	Crosses	Days to 50% flowering	Sympodia per plant	Bolls per plant	Boll weight (g)	Seed cotton yield per plant (g)	Ginning percentage
1	GSHV 191 x CPD 1602	3.51**	0.60	-1.27	0.21	5.83	-0.59
2	GSHV 191 x SIMA 5	1.92	2.18**	0.72	-0.13	-1.56	-0.24
3	GSHV 191 x RAH 1071	0.26	-0.06	-3.18	-0.01	-14.76	0.70
4	GSHV 191 x RHC 1217	0.51	0.18	-0.68	-0.09	-4.06	-0.09
5	GSHV 191 x PBH 42	-3.24**	-0.56	-2.10	0.29	1.33	-0.07
6	GSHV 191 x HS 298	-2.32*	-0.22	2.81	-0.35	6.24	-0.84
7	GSHV 191 x F 2453	-0.32	-1.22*	1.14	0.20	1.78	0.74
8	GSHV 191 x BGDS 1033	-0.32	-0.89	2.56	-0.12	5.19	0.40
9	GSHV 199 x CPD 1602	3.13**	2.06**	-1.56	0.01	-13.52	0.02
10	GSHV 199 x SIMA 5	-0.44	-2.35**	0.43	0.24	7.72	0.15
11	GSHV 199 x RAH 1071	-0.78	0.72	5.18*	-0.34*	1.94	0.55
12	GSHV 199 x RHC 1217	-1.85	-1.02	2.68	0.12	14.19	1.35
13	GSHV 199 x PBH 42	2.38*	-0.77	-5.39*	0.16	-6.17	-1.89
14	GSHV 199 x HS 298	-1.69	-0.43	1.52	-0.46**	3.71	-0.42
15	GSHV 199 x F 2453	-0.69	2.22**	0.18	-0.16	-13.44	0.07
16	GSHV 199 x BGDS 1033	-0.03	-0.43	-3.06	0.44**	5.57	0.17
17	GISV 298 x CPD 1602	-2.90**	-2.39**	4.22	-0.33*	4.31	0.01
18	GISV 298 x SIMA 5	-0.49	-0.14	-4.77*	-0.09	-18.96*	-0.96

* and ** indicates significance at 5% and 1% levels of probability, respectively

Sr. No.	Crosses	Days to 50% flowering	Sympodia per plant	Bolls per plant	Boll weight (g)	Seed cotton yield per plant (g)	Ginning percentage
19	GISV 298 x RAH 1071	-1.15	0.27	2.64	0.28	19.18*	-0.76
20	GISV 298 x RHC 1217	-0.90	0.18	-0.18	0.30	16.15*	0.12
21	GISV 298 x PBH 42	1.67	0.77	7.06**	-0.76**	-6.91	0.65
22	GISV 298 x HS 298	2.26*	1.10*	-6.68**	0.56**	-12.10	1.22
23	GISV 298 x F 2453	1.26	-1.22*	-1.02	0.30	2.00	0.13
24	GISV 298 x BGDS 1033	0.26	1.43**	-1.27	-0.26	-3.67	-0.41
25	GISV 319 x CPD 1602	-3.74**	0.89**	-1.39	0.11	3.37	0.55
26	GISV 319 x SIMA 5	-0.99	-0.68**	3.60	-0.01	12.80	1.05
27	GISV 319 x RAH 1071	1.67	-0.43	-4.64*	0.07	-6.36	-0.49
28	GISV 319 x RHC 1217	2.26*	-1.02**	-1.81	-0.33*	-26.28**	-1.36
29	GISV 319 x PBH 42	-0.82	1.06**	0.43	0.30	11.75	1.31
30	GISV 319 x HS 298	1.76	-0.27	2.35	0.25	2.14	0.04
31	GISV 319 x F 2453	-0.24	0.72**	-0.31	-0.34*	9.66	-0.95
32	GISV 319 x BGDS 1033	0.09	-0.27	1.77	-0.05	-7.09	-0.16
	SE(S_{ij})	1.03	0.51	2.23	0.16	7.74	0.97

* and ** indicates significance at 5% and 1% levels of probability, respectively

References

1. Bhandari DR. Line x Tester analysis of combining ability and its interaction with environment in American cotton *G. hirsutum* L. Madras Agric. J. 1978; 65:218-225.
2. Bhaskaren S, Ravikesavan R. Combining ability analysis of yield related traits and fiber quality traits in cotton. J Cotton Res. Dev. 2008; 22(1):23-27.
3. Carnahan HL, Horin AW, Graumeum HO, Keur WR, Devis RL, Eling LJ, Hanson. General versus specific combining ability in alfalfa for seedling vigour and full growth habit in year of establishment. Agron. J. 1960; 52:511-516.
4. Dave PB, Patel BN, Patel PC, Patel MP, Patel NA. Study of combining ability analysis and gene action for seed cotton yield and its agronomic traits in upland cotton. J cotton Res. Dev. 2015; 29(2):212-217.
5. Dhillion BS. The application of partial diallel crosses in plant breeding- A review. Crop improve. 1975; 2:1-7.
6. Doak CC, Beasley. A new technique in cotton hybridizing. J Hered. 1934; 25:201-204.
7. Griffing B. Concept of general and specific combining ability in relation to diallel crossing system. Aust. J Biol. Sci. 1956; 9:463-493.
8. Kempthorne O. An introduction to genetical statistics. John Wiley and Sons. Inc. New York, 1957.
9. Kumar A, Nirania KS, Chhavikant, Bankar AH. Combing ability for seed cotton yield and attributing traits in American cotton (*Gossypium hirsutum* L.). J Pharma. and Phyto. 2014-2015; 6(6):376-378.
10. Patel KG, Patel RB, Patel MI, Kumar V. An introgression- A new tool for quality and yield improvement in diploid cotton heterosis and combining ability. J Cotton Res. Dev. 2007; 21(2):143-147.
11. Patel UG, Mehta NP. Studies on heterosis, combining ability and stability of performance in cotton (*G. herbaceum* L.). Unpublished Ph.D. thesis submitted to G.A.U., S K Nagar, 1985.
12. Patil SA, Naik MR, Chougule GR, Pathak VD, Patil AB. Combining ability analysis for yield and fibre quality traits in upland cotton (*Gossypium hirsutum* L.). J Cotton Res. Dev. 2011; 25(2):171-175.
13. Preetha S, Raveendran TS. Combining ability and heterosis for yield and fibre quality traits in line x tester crosses of upland cotton. Int. J Pl. Br. and Gen. 2008; 2(2):64-74.
14. Rajanami S, Gopinath M, Reddy KHP. Combining ability for seed cotton yield and fiber characters in upland cotton (*G. hirsutum* L.). J cotton Res. Dev. 2014; 28(2):207-210.
15. Reddy KB, Reddy VC, Ahmed L, Naidu TCM, Srinivasrao V. Combining ability analysis for seed cotton

yield and quality traits in upland cotton (*Gossypium hirsutum* L.) El. J Pl. Br. 2017; 8(1):142-152.
16. Sewarkar M, Solanke A, Mhasal GS, Deshmukh SB. Combining ability and heterosis for seed cotton yield, its components and quality traits in *Gossypium hirsutum* L. Indian J Agric. Res. 2014; 49(2):154-159.
17. Usharani CV, Manjula SM, Patil SS. Estimating combining ability through line x tester analysis in upland cotton. Res. Environ. Life Sci. 2016; 9(5):628-633.