J. Farm Sci., 33(3): (306-309) 2020

RESEARCH PAPER

Combining ability studies for seed cotton yield and fibre quality traits for varietal and hybrid development in cotton (*Gossypium hirsutum* L.)

A. ANUSHA HUGAR[1], J. M. NIDAGUNDI[1], L. N. YOGESH, MUNISWAMY[2], A. C. HOSAMANI[2] AND J. R. PATIL[3]

[1]Department of Genetics and Plant Breeding, [2]Department of Agricultural Entomology and
[3]Department of Crop Physiology, College of Agriculture, Raichur
University of Agricultural Sciences, Raichur - 584 104, Karnataka, India
E-mail: annu555anush@gmail.com

(Received: September, 2019 ; Accepted: August, 2020)

Abstract: The present investigation was carried out with a vision to study the combining ability for important productivity and fibre quality traits of cotton. Fifty five hybrids generated through Griffing's half diallel method were evaluated along with eleven parents and two checks RAHH 455 and SHH 818 in 2017-18 at the Main Agricultural Research Station, Raichur. SCS-PL-03 expressed significant gca effects and could be used to exploit varietal development with respect to seed cotton yield. SCS-PL-12 was identified as parent having significant gca effects with respect to UHML. The performance of the hybrids in the present study could be expected on the basis of the average performance of the parental inbred lines.

Key words: Cotton, General combining ability, Specific combining ability, Yield

Introduction

Cotton is essentially produced for its fibre, which is universally used as a textile raw material. Cotton is an important commodity in the world economy. Cotton plays an important role in the Indian economy as the country's textile industry is predominantly cotton based. India is one of the largest producers as well as exporters of cotton yarn. Relative magnitude of genetic variance and combining ability estimates are important and fundamental parameters to shape the genetic framework of crop like cotton. Such type of exploration could prove an indispensable approach to the cotton breeders in the screening of better parental combinations for further enhancement.

The genetic variability concluded in the analysis for each character was partitioned into its components *i.e.* general and specific combining ability as defined by Sprague and Tatum (1942) who stated that gca effects were due to additive type of gene action but sca effects were due to genes which are non-additive (dominant or epistatic) in nature. Combining ability also helps in assessing the gene action involved in controlling components of yield. General combining ability (GCA) variances reflect the additive gene action while Specific combining ability (SCA) variances reflect the non-additive gene action. It helps in the selection of superior parents to develop superior hybrids and exploits the genetic variability (Inamullah *et al.,* 2006).

Selection of appropriate parents is essential as genetic variation is required to develop superior varieties with unique genetic makeup. The motive of this research was to estimate the gca and sca effects for seed cotton yield, its components and fibre quality traits among eleven genotypes and fifty five hybrids to determine appropriate parents and crosses for the investigated traits.

Material and methods

Varietal genotypes with proven productivity and quality features were selected as parents to constitute an 11 × 11 half diallel in the study (Table 1). The half diallel generated fifty five credible hybrids that were evaluated in *kharif* 2018 along with the parental genotypes and checks RAHH 455 and SHH 818 at the Main Agriculture Research Station, Raichur. The same were planted in a randomised complete block design with four rows of six meters each in two replications. Spacing of 90 cm between rows and 60cm between plants was maintained.

For each genotype and its cross combinations, data were recorded on five randomly selected plants per replication for eight important traits *viz.,* seed cotton yield (kg/ha), lint yield (kg/ha), ginning outturn (%), boll weight (g), bolls per plant, UHML (mm), bundle strength (g/tex) and micronaire (µg/inch). Quality parameters were analyzed by High Volume Instrument (HVI). Statistical analysis was carried out by using the mean values over five sample plants (Indostat Statistical Software Package; Indostat Pvt. Ltd., Hyderabad, India).

Results and discussion

Combining ability effects

General and specific combining ability effects were estimated for eleven parents and the fifty five hybrids of diallel cross.

Seed cotton yield (kg/ha): One parent expressed significant positive GCA effects. Eleven crosses exhibited significant sca effects of them eight expressed in positive direction and the remaining three in negative direction. Presence of both significant GCA and SCA effects indicates the role of additive and non-additive gene action.

Lint yield (kg/ha): Three parents expressed significant positive GCA effects of them two parents in positive direction and one parent in negative direction. Seven crosses showed significant positive SCA effects and five crosses exhibited the same in negative direction. Presence of both significant

Table 1. Parental genotypes used in 11×11 half diallel set of crosses

Sl. No.	Parent	Features
1	SCS-PL-01	A tall and robust genotype with high productivity features and having moderate fibre quality parameters derived from intra-hirsutum cross GSHV-99/307 × PUSA 9127.
2	SCS-PL-02	Medium robust hirsutum genotype derived from an intra-hirsutum cross involving GSH99/303 × CCH 510 known to exhibit high fibre strength and fibre length.
3	SCS-PL-18	A stabilized line derived from a cross involving parents PUSA 9127 × NDLH 761 exhibiting open plant type and possessing an ability to yield consistently desirable fibre quality features.
4	SCS-PL-3	A hirsutum line derived from a cross involving two parents ARB 904 × CSH 2572 coming from North zone and south zone respectively exhibiting wide adaptability and high yield.
5	SCS-PL-04	An intra hirsutum derivative involving parents HAG 1055 (high productivity and high fibre strength) and CPD 803 (genotype with high productivity and quality features).
6	SCS-PL-10	An intra hirsutum cross derivative involving the parental lines CCH 510 from Coimbatore (high productivity with consistent fibre strength) and GMR5 from the south zone (high productivity and high strength from the central zone)
7	SCS-PL-12	A high productivity parental line derived from the hirsutum parents namely GSHV99/307 and NDLH761 known to possess robust plant type and bigger boll size.
8	SCS-PL-51	A hirsutum genotype contributed by CICR Coimbatore in AICRP trials exhibiting high fibre strength
9	SCS-PL-59	A *Gossypium hirsutum* line selection from a variable population of BS-59 contributed by Bhavanipatna research station, Orissa known to exhibit high productivity features.
10	SCS-PL-60	A *Gossypium hirsutum* line developed from a intra-hirsutum cross involving NDLH 761 and CCH 510 known to exhibit high productivity features
11	SCS-PL-61	An intra hirsutum cross derivative involving wide adaptability genotype MCU5VT and CCH 510 known to possess desirable quality features

Table 2. Estimates of general combining ability (GCA) effects for different quantitative traits

Parents	Seed cotton yield (kg/ha)	Lint yield (kg/ha)	Ginning outturn	Boll weight (g)	Bolls/ plant	UHML	Fibre strength (g/tex)	Micronaire (µg/inch)
SCS-PL-01	44.874	21.633	0.364	-0.12	-0.579	-0.599*	0.01	(-0.148)**
SCS-PL-02	-37.762	-33.152**	-0.846	-0.006	-0.341	-0.189	-0.074	0.329**
SCS-PL-18	69.643	24.499**	-0.004	0.339**	-0.102	0.134	-0.014	0.175**
SCS-PL-03	148.538**	26.775**	-0.855	-0.01	-0.417	0.129	0.195	(-0.152)**
SCS-PL-04	57.551	3.197	-0.632	-0.053	-0.479	0.291	-0.118	0.14**
SCS-PL-10	-37.784	3.893	0.794	0.057	0.906	-0.112	-0.085	-0.056
SCS-PL-12	-5.912	14.731	0.651	0.117	0.529	0.438*	0.291	(-0.106)**
SCS-PL-51	-25.05	-21.637	-0.7	(-0.212**)	0.09	0.155	0.104	(-0.133)**
SCS-PL-59	-56.913	-18.402	0.055	0.089	0.298	0.023	0.106	-0.098
SCS-PL-60	-86.425	-15.748	0.578	0.005	0.121	-0.148	-0.047	0.094
SCS-PL-61	-70.759	-5.788	0.595	(-0.206) **	-0.025	-0.121	-0.369	-0.044
Gi<> 0 at 95 %	119.294	54.052	1.473	0.167	1.266	0.395	0.390	0.11
Gi<> 0 at 99 %	169.680	76.881	2.096	0.237	1.801	0.562	0.554	0.156
Gi—Gj at 95 %	176.942	80.171	2.185	0.247	1.878	0.586	0.578	0.163
Gi—Gj at 99 %	251.676	114.033	3.108	0.352	2.671	0.834	0.822	0.232

GCA and SCA effects indicates the role of additive and non-additive gene action.

Ginning outturn (%): Although none of the parents expressed significant GCA effects seven crosses expressed significant positive SCA effects. Presence of SCA effects implies the presence of non-additive gene action in the population under study for the trait.

Bolls/plant: One parent expressed significant positive GCA effect for the trait and four crosses expressed significant positive SCA effects. Presence of both significant GCA and SCA effects indicates the role of additive and non-additive gene action.

Boll weight (g): For the trait boll weight one parent expressed significant positive GCA effects and two parents expressed the same in negative direction. None of the crosses showed significant SCA effects indicating that the trait is governed by additive gene action.

UHML (mm): Two parents expressed significant GCA effects one in positive direction and the other in negative direction. Three crosses showed significant SCA effects of which two were in positive direction and one in negative direction. Presence of both significant GCA and SCA effects indicates the role of additive and non-additive gene action.

Table 3. Estimates of specific combining ability (SCA) effects for different quantitative traits

Parents	Seed cotton yield (kg/ha)	Lint yield (kg/ha)	Ginning outturn	Boll weight (g)	Bolls/ plant	UHML	Bundle strength (g/tex)	Micronaire (µg/inch)
SCS-PL-01 × SCS-PL-02	(-272.148)*	(-65.014)	1.089	-0.574	0.048	0.202	-0.761	(-0.483)*
SCS-PL-01 × SCS-PL-18	(-259.427)*	(-98.995)	-0.653	-1.713	(-0.162)	0.244	1.603*	(-0.529)**
SCS-PL-01 × SCS-PL-03	38.338	-44.646	-2.076	4.303*	0.177	-0.851	-0.216	0.148
SCS-PL-01 × SCS-PL-04	310.92*	42.697	-2.32	-0.236	0.155	-0.773	1.283*	(-0.044)
SCS-PL-01 × SCS-PL-10	76.425	-27.984	-1.167	-2.121	(-0.120)	0.1	0.309	(-0.598)**
SCS-PL-01 × SCS-PL-12	320.343*	84.268*	-1.186	-1.344	-0.014	0.31	-0.417	0.052
SCS-PL-01 × SCS-PL-51	252.701*	52.681	-0.652	3.795*	0.179	-0.367	-0.439	-0.071
SCS-PL-01 × SCS-PL-59	-88.136	-39.539	-1.585	-1.513	0.139	0.455	-0.702	0.244
SCS-PL-01 × SCS-PL-60	455.256*	118.927*	2.149*	0.364	-0.273	0.226	-0.299	0.152
SCS-PL-01 × SCS-PL-61	90.33	98.342*	-2.383	1.31	0.449	0.289	0.228	0.64*
SCS-PL-02 × SCS-PL-18	227.268*	11.094	0.789	-1.451	0.019	0.585	-0.238	-0.156
SCS-PL-02 × SCS-PL-03	83.903	49.549	0.74	-0.336	-0.177	0.19	0.538	0.021
SCS-PL-02 × SCS-PL-04	117.64	54.616	-1.601	2.726	0.201	-0.593	-0.133	0.179
SCS-PL-02 × SCS-PL-10	77.805	-9.175	1.508	0.341	0.141	-0.825	-0.477	0.375*
SCS-PL-02 × SCS-PL-12	-28.156	28.243	0.314	-0.482	-0.248	0.115	-1.168	-0.175
SCS-PL-02 × SCS-PL-51	112.061	31.72	-4.457	-0.044	0.24	1.418*	-0.54	-0.198
SCS-PL-02 × SCS-PL-59	-196.641	-166.139*	-0.28	3.649	0.29	0.681	-0.098	0.367*
SCS-PL-02 × SCS-PL-60	143.107	48.836	-1.396	-1.974	0.199	0.801	0.635	-0.025
SCS-PL-02 × SCS-PL-61	147.385	24.881	0.656	-3.428	-0.13	-0.5	-0.623	0.313
SCS-PL-18 × SCS-PL-03	-187.986	-38.052	-0.092	-0.574	-0.237	-0.218	0.427	0.375
SCS-PL-18 × SCS-PL-04	58.016	14.575	-1.808	(-0.713)	-0.081	1.084	-0.404	-0.267
SCS-PL-18 × SCS-PL-10	331.71*	67.814	-1.95	3.103	0.31	0.277	-0.358	-0.021
SCS-PL-18 × SCS-PL-12	260.099*	36.956	3.911*	0.879	0.272	0.172	-0.239	0.129
SCS-PL-18 × SCS-PL-51	275.017*	201.434**	3.911*	-0.682	0.485	0.01	0.199	-0.044
SCS-PL-18 × SCS-PL-59	152.074	84.719	1.176	-0.09	0.035	0.033	0.362	-0.179
SCS-PL-18 × SCS-PL-60	-68.923	-14.67	1.176	2.987	0.174	-0.602	-0.371	0.179
SCS-PL-18 × SCS-PL-61	18.355	-7.56	0.288	-1.167	0.065	-0.568	(-1.293)*	0.617**
SCS-PL-03 × SCS-PL-04	130.036	-5.365	-0.144	-2.697	0.251	-1.546 *	0.302	0.21
SCS-PL-03 × SCS-PL-10	-135.224	(-113.841*)	-1.681	-2.182	0.37	1.237	-0.332	-0.094
SCS-PL-03 × SCS-PL-12	(-207.846)*	(-115.269*)	-2.188	2.595	0.261	0.337	-0.323	0.256
SCS-PL-03 × SCS-PL-51	77.732	87.694	2.413	2.533	-0.046	-0.24	-0.58	-0.117
SCS-PL-03 × SCS-PL-59	6.735	82.584	3.278*	0.526	0.264	-0.577	1.143	0.098
SCS-PL-03 × SCS-PL-60	-97.028	(-124.37*)	-4.141	2.203	0.248	-0.212	0.305	(-0.594)**
SCS-PL-03 × SCS-PL-61	190.221	(101.92*)	1.243	0.749	0.194	0.157	0.368	0.094
SCS-PL-04 × SCS-PL-10	(-227.412)*	5.847	3.43*	3.979	0.158	0.92	-0.588	-0.087
SCS-PL-04 × SCS-PL-12	282.041*	105.579*	0.213	-1.344	0.039	0.165	0.906	0.313
SCS-PL-04 × SCS-PL-51	-68.901	70.656	3.909*	-0.305	-0.348	0.088	-0.832	0.54**
SCS-PL-04 × SCS-PL-59	263.752*	37.057	-1.871	-2.213	0.292	0.455	-0.349	0.056
SCS-PL-04 × SCS-PL-60	-98.636	(-123.477*)	-3.754	3.364	0.106	0.706	0.824	-0.237
SCS-PL-04 × SCS-PL-61	2.378	61.937	2.304	1.51	0.377	-0.701	(-1.349)*	0.402
SCS-PL-10 × SCS-PL-12	-187.034	-24.127	1.948	-2.628	-0.061	-0.832	-0.273	0.21
SCS-PL-10 × SCS-PL-51	89.659	68.66	1.574	-1.19	0.142	-0.049	1.32*	(-0.113)
SCS-PL-10 × SCS-PL-59	58.756	58.416	1.643	2.303	-0.633	-0.527	0.318	0.352*
SCS-PL-10 × SCS-PL-60	174.029	28.982	-1.450	1.579	-0.109	0.009	-0.41	-0.04
SCS-PL-10 × SCS-PL-61	-27.498	-48.424	-1.566	5.026*	0.057	-0.528	1.273*	(-0.102)
SCS-PL-12 × SCS-PL-51	51.212	7.148	-0.208	4.487*	0.353	1.531*	1.194	0.037
SCS-PL-12 × SCS-PL-59	-42.785	-46.362	-1.303	0.279	0.982	-0.712	-0.308	0.002
SCS-PL-12 × SCS-PL-60	55.022	155.464*	5.543*	1.856	-0.219	0.289	0.519	-0.090
SCS-PL-12 × SCS-PL-61	81.026	57.839	1.322	1.203	-0.263	-0.313	-0.353	0.048
SCS-PL-51 × SCS-PL-59	-51.297	4.901	0.968	2.018	-0.284	0.052	0.359	-0.021
SCS-PL-51 × SCS-PL-60	(-247.52)*	-44.734	2.094	-1.005	0.025	-1.208	0.137	0.087
SCS-PL-51 × SCS-PL-61	10.074	23.481	1.043	-1.659	0.261	0.155	0.459	-0.325
SCS-PL-59 × SCS-PL-60	167.883	57.372	-0.071	1.787	-0.076	1.069	-0.030	0.002
SCS-PL-59 × SCS-PL-61	-34.524	-79.763	-2.587	-0.967	-0.089	1.073	-0.628	-0.310
SCS-PL-60 × SCS-PL-61	-141.561	-2.818	2.304	-1.29	0.159	-0.107	-0.745	0.248

Contd...

Sij at 95%	376.2	170.455	4.646	3.993	0.526	1.247	1.229	0.346
Sij at 99%	500.999	227.001	6.187	5.317	0.700	1.660	1.637	0.461
Sij-Sik at 95%	551.522	249.892	6.811	5.853	0.771	1.827	1.802	0.508
Sij-Sik at 99%	734.482	332.79	9.071	7.795	1.026	2.434	2.399	0.676
Sij-Skl at 95%	528.042	239.253	6.521	5.604	0.738	1.750	1.725	0.486
Sij-Skl at 99%	703.213	318.623	8.685	7.463	0.983	2.330	2.297	0.648

Table 4. Combining ability variance for different quantitative traits

Source of variation	DF	Bolls/plant	Boll weight (g)	Ginning outturn	Seed cotton yield (kg/ha)	Lint yield kg/ha)	(UHML (mm)	Bundle strength (g/tex)	Micronaire (µg/inch)
GCA	10	2.7*	0.31 ***	5.479*	66911.81**	5479.18*	1.013*	0.40*	0.33*
SCA	55	6.309**	0.11	6.41	45099.27**	8110.02**	0.51	0.55*	0.10
Error	65	4.62	0.08	6.25	40990.38	8415.14	0.45	0.44	0.04

Micronaire (µg/inch): Three parents expressed significant GCA effects in positive direction and three of them expressed the same in negative direction. Six crosses expressed significant positive SCA effects and four of them expressed significant negative SCA effects. Presence of both significant GCA and SCA effects indicates the role of additive and non-additive gene action.

Bundle strength (g/tex): None of the parents expressed significant GCA effects among the eleven parents. In terms of the SCA, four crosses showed significant positive SCA effects and two of them showed significant negative SCA effects. Presence of both significant GCA and SCA effects indicates the role of additive and non-additive gene action.

Combining ability variance

The particulars of analysis of variance for combining ability of 11x11 diallel set of crosses evaluated are furnished in Table 4.

The results for combining ability are in accordance with Ahuja and Tuteja (2000), Reddy (2001), Karande *et al*. (2004), Deosarkar *et al.* (2009), Usharani *et al.* (2015).The variance due to GCA was found significant for most of the characters under study indicating that the genes are controlled in additive fashion. However variance due to SCA was found significant for seed cotton yield, lint yield, number of bolls and bundle strength indicating the prevalence of dominant and epistatic gene effects.

References

Ahuja S L and Tuteja O P, 2000, Variability and association analysis for chemical components imparting resistance to *Gossypium hirsutum* L., *Journal of Cotton Research and Development*, 14(1): 19-22.

Deosarkar D B, Jadhav D S and Patil S G, 2009, Combining ability studies for yield and quality traits in cotton (*Gossypium hirsutum* L.). *Journal of Cotton Research and Development.*, 23(2): 183-187.

Inamullah, Ahmed H, Muhammad F, Sirajuddin, Hassan G, Gul R, 2006, Evaluation of heterotic and heterobeltiotic potential of wheat genotype for improved yield. *Pakistan Journal of Botany*, 38: 1159-1168.

Karande S S, Wandhare M R, Ladole M Y, Waode M M and Meshram L D, 2004, Heterosis and combining ability studies in interspecific diploid cotton hybrids for fibre quality parameters. *International Symposium on Strategies for Sustainable Cotton Production - A Global Vision.* Crop Improvement1, 23rd-25th November, 2004, University of Agricultural Sciences, Dharwad, Karnataka, India.

Reddy A N, 2001, Heterosis, combining ability and stability analysis of hybrids for yield and yield components in cotton (*Gossypium hirsutum* L.). *Ph. D. Thesis*, Acharya N. G. Ranga Agricultural University, Rajendranagar, Hyderabad.

Sprague G F and Tatum L A, 1942, General and specific combining ability in single crosses in corn, *American Society of Agronomy*, 34: 923-932.

Usharani K, Vindhiyavarman S P, Amalabalu P and Boopathi N M, 2015, Heterosis studies for fibre quality traits in diallel crosses of upland cotton (*Gossypium hirsutum* L.). *The Bioscan*, 10(2): 793-799.