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RESEARCH ARTICLE

Study of combining ability analysis for seed cotton yield, yield contributing and fibre quality traits in *Desi* cotton (*Gossypium arboreum* L.)

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SUMMARY

The present investigation entitled study on heterosis and combining ability for yield, its components and fibre characters in *Desi* cotton (*Gossypium arboreum* L.) was undertaken to estimate general combining ability effects (GCA) of the parents and specific combining ability effects (SCA) of the crosses. The experimental material comprised of 24 F_1 hybrids obtained by crossing 6 lines with 4 testers in line x tester mating system. Sum total of 36 treatments consisting of 24 crosses, 10 parents and two checks were sown in Randomized Complete Block Design. The analysis of variance for combining ability revealed significant general combining ability effects (GCA) and specific combining ability effects (SCA) for all the traits. Among ten parental lines, most of the lines were found to be best general combiner, which had significant general combining ability (GCA) effect for seed cotton yield and its contributing characters including fibre quality traits. Parents PA 778, PAIG 62 and PA 832 among lines, while NDLA 3047 among testers were good general combiners for seed cotton yield per plant. For number of bolls per plant the lines PA 832, PA 778 and PAIG 62 were good general combiners, while in testers NDLA 3047 and JLA 0716 were found good general combiners. The parents PA 832 and ARBAS 1401 recorded significant general combining ability effects (GCA) for 2.5% span length. Out of twenty four crosses, the cross PA 832 x NDLA 3047 was found to have good specific combining ability effects, which had significant SCA effects for days to 50 per cent flowering, days to maturity, number of bolls per plant, number of sympodia per plant and seed cotton yield per plant. The cross PA 785 x ARBAS 1401 had good specific combining ability effects (SCA) for plant height and uniformity ratio. Whereas, cross PA 807 x NDLA 3047 recorded high general combining ability effects (GCA) for boll weight; PA 778 x ARBAS 1401 for lint index; PA 800 x CNA 1013 for seed index; PAIG 62 x CNA 1013 for 2.5 per cent span length; PA 778 x JLA 0716 for fibre fineness (micronaire) and fibre strength and PA 807 x ARBAS 1401 for ginning outturn.

Key Words : General combining ability (GCA), Specific combining ability, Cotton (SCA), Yield

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Cotton, the king of fibres, occupies a pre-eminent position as a commercial crop in India. Cotton also known as 'white gold' as it is preferred by farmers as cash crop beside other field crops. It is grown commercially in the temperate and tropical regions of more than 70 countries. India is perhaps the first country to make use of cotton. Cotton, the 'white gold' enjoys a pre-eminent status among all cash crops in the country. It is grown commercially in the temperate and tropical regions of more than 70 countries. Specific areas of production include countries such as China, USA, India, Pakistan, Uzbekistan, Turkey, Australia, Greece, Brazil, Egypt etc. Genetic improvement in *Desi* cotton could be gained either through selection or exploitation of specific hybrid. Therefore, more emphasis should be given to increase the seed cotton yield per unit area by developing hybrids with short stature, big boll size, longer staple length with sustained yield in multiple environments. To achieve such desirable characteristics in a new cultivar, proper breeding strategies should be followed. There is an urgent need to promote those cottons that could come closer in quality to the most sought by modern textile mills.

For development of superior and heterotic hybrids in cotton, it is essential to utilize large number of available germplasm. In the context of quality assessment, high volume instrument testing is universally accepted by the industry and is becoming a requirement, enabling cotton to be marketed more directly on textile mill needs rather than the traditional grade, staple and micronaire. This has contributed to the development and acceptance of high quality hybrids and varieties.

Line x tester analysis provides a systematic approach for selection of appropriate parents on the basis of general combining ability effects (GCA) and superior crosses on the basis of specific combining ability effects (SCA). Combining ability describes the breeding value of parental lines to produce hybrids. Sprague and Tatum (1942) used the terms general combining ability (GCA) to designate the average performance of a line in hybrid combinations and specific combining ability (SCA) as deviation in performance of a cross combination from that predicted on the basis of the general combining abilities of the parents involved in the cross. In order to choose appropriate parents for hybridization as well as specific crosses, it is essential to determine the combining abilitiy of parents and specific combining ability (SCA) of cross combinations by using line x tester analysis. The method has been widely used by plant breeders. This method was applied to improve self and cross-pollinated crop plants.

MATERIAL AND METHODS

The present investigation was undertaken to study of combining for seed cotton yield, yield contributing and fibre quality traits in *Desi* Cotton (*Gossypium arboreum* L.). Twenty four hybrid combinations derived by crossing 6 *Arboreum* lines with 4 testers and their ten parents along with 2 checks were tested at Cotton Research Station, Mahboob Baugh farm, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *Kharif* season of 2016-17. The mean values of all the treatments for the characters under study were worked out. Standard error and critical difference at 1 and 5 per cent level of significance were calculated by using the formula (Panse and Sukhatme, 1967). The general combining ability effects of female lines and testers while the specific combining ability effects of crosse combinations were worked out. The test of significance of different genotypes was done according to the procedure given by Kempthorne (1957). The nature of gene action involved in the expression of various quantitative traits is also revealed.

RESULTS AND DISCUSSION

It was observed that the crosses showing high heterosis and high per se performance involved the parents possessing either high x high, high x low and low x low general combining ability effects of parents indicating importance of non additive genetic variance. The analysis of variance for combining ability is presented in Table 1. The combining ability analysis gives useful information regarding selection of parents based on performance of their hybrids. While specific combing ability helps in selection of specific cross combination. The general combining ability effects of lines are presented in Table 2, while general combining ability effects of testers are presented in Table 3, respectively. Among parents, the line PA785, PAIG 62, PA 807, while in male parents NDLA 3047 ARBAS 1401 showed negative significant general combining ability effects (GCA) for days to 50 per cent flowering. In case of number of sympodia per plant female parents PA 778 and PAIG 62, while in male parents NDLA 3047 and JLA 0716 exhibited positive significant general combining ability effects (GCA). Similar result were observed by Jatoi *et al.* (2011). For number of bolls significantly

Table 1 : Analysis of variance for combining ability for different characters

Source	d.f.	Days to 50% flowering	No. of sympodia/ plant	No. of boll/ plant	Boll weight (g)	Plant height (cm)	Days to maturity	Seed cotton yield/ plant (g)	Lint index	Seed index (g)
Replications	1	0.333	0.175	0.020	0.000	2.613	0.040	0.013	0.008	0.086
Crosses	23	8.855**	5.664**	10.460**	0.032**	1033.327**	12.144**	63.027**	0.359**	1.214**
Females	5	3.933	5.376	11.102	0.017	1197.679	16.087	81.419	0.708	3.638**
Males	3	2.833	4.170	8.594	0.018	108.407	7.489	60.168	0.344	0.413
M x F	15	11.700**	6.059**	10.620**	0.040**	1163.527**	11.760**	57.468**	0.246**	0.567**
Error	23	0.144	0.084	0.083	0.005	8.557	0.042	0.162	0.032	0.017

* and ** indicate significance of values at P=0.05 and 0.01, respectively.

Table 2 : Estimates of general combining ability (GCA) for lines

Parents	Days to 50% flowering	No. of sympodia/ plant	No. of bolls/ plant	Boll weight (g)	Plant height (cm)	Days to maturity	Seed cotton yield/plant (g)	Lint index	Seed index (g)
PA 832	0.20	-0.86**	1.65**	-0.02	14.30**	0.56**	3.20**	-0.12	-0.015
PA 785	-0.79**	-0.14	-1.22**	-0.01	1.65	-1.08**	-3.69**	0.05	0.03
PA 800	0.95**	-0.15	-0.44**	-0.07**	14.02**	1.81**	-2.06**	-0.44**	-0.69**
PA 807	-0.29*	-0.78**	-1.22**	0.05	-9.73**	0.01	-2.71**	-0.10	-0.79**
PA 778	0.58**	1.13**	0.97**	0.02	-14.84**	0.83**	3.48**	0.42**	0.93**
PAIG 62	-0.66*	0.81**	0.25*	0.04	-5.40**	-2.13**	1.78**	0.19**	0.53**
S.E.(Gi)	0.134	0.102	0.101	0.025	1.034	0.073	0.142	0.063	0.046
S.E.(Gi-Gj)	0.190	0.145	0.144	0.035	1.462	0.103	0.201	0.090	0.066
CD @5%	0.277	0.212	0.210	0.052	2.139	0.151	0.294	0.131	0.096
CD @1%	0.377	0.288	0.286	0.070	2.903	0.205	0.399	0.178	0.131

* and ** indicate significance of values at P=0.05 and 0.01, respectively.

Table 3 : Estimates of general combining ability (GCA) of testers

Parents	Days to 50% flowering	No. of sympodia/ plant	No. of bolls/ plant	Boll weight (g)	Plant height (cm)	Days to maturity	Seed cotton yield/ plant (g)	Lint index	Seed index (g)
NDLA 3047	-0.50**	0.49**	1.04**	-0.03	3.12**	-0.32**	3.26**	-0.02	0.033
JLA 0716	0.41**	0.44**	0.29**	0.04*	-4.02**	1.08**	-0.50**	-0.09	0.22**
ARBAS 1401	-0.33**	-0.20*	-0.85**	0.02	1.02	-0.76**	-1.76**	0.24**	-0.02
CNA 1013	0.41**	-0.74**	-0.48**	-0.03	-0.12	0.00	-1.00**	-0.12*	-0.22**
S.E.(Gi-)	0.109	0.083	0.083	0.020	0.844	0.059	0.116	0.052	0.038
S.E.(Gi-Gj)	0.155	0.118	0.117	0.029	1.194	0.084	0.164	0.073	0.053
CD @5%	0.226	0.173	0.172	0.042	1.746	0.123	0.240	0.107	0.078
CD @1%	0.307	0.235	0.233	0.057	2.370	0.168	0.326	0.146	0.107

Table 3 Continued

Parents	2.5% Span length (mm)	Fibre fineness (Micronaire) (µg/inch)	Fibre strength (g/tex)	Uniformity ratio (%)	Ginning outturn (%)
NDLA 3047	-0.67**	0.07	-0.21	-0.83**	-0.04
JLA 0716	-0.10	0.12*	0.35**	-0.16	-0.18
ARBAS 1401	0.46**	-0.04	0.23*	0.50*	-0.48**
CNA 1013	0.30	-0.15**	-0.36**	0.50*	0.71**
S.E.(Gi)	0.159	0.056	0.106	0.214	0.101
S.E.(Gi-Gj)	0.225	0.079	0.150	0.302	0.142
CD @5%	0.329	0.116	0.220	0.442	0.208
CD @1%	0.446	0.158	0.298	0.600	0.283

* and ** indicate significance of values at P=0.05 and 0.01, respectively.

positive general combining ability effects (GCA) were recorded by lines PA 832, PA 778 and PAIG 62, while in testers NDLA 3047 and JLA 0716. Among parents, male parents JLA 0716 showed positive significant general combining ability effects (GCA) for boll weight. In case of plant height female parents PA 832 and PA 800, while in male parents NDLA 3047 exhibited positive significant general combining ability effects (GCA). With regards to days to maturity two line PAIG 62 and PA 785, in testers ARBAS 1401 and NDLA 3047 recorded negative significant general combining ability effects.

The seed cotton yield in intraspecific crosses of diploid cotton is generally contributed by number of bolls per plant and boll weight. Hence, in the present study, the results of these traits discussed as component characters of seed cotton yield. Among parents, PA 778, PA 832 and PAIG 62 while in males NDLA 3047 exhibited significant positive general combining ability effects (GCA) effects. Similar findings were observed Dhamaynthi (2011), Mendez-Natera *et al.* (2012), Dai Gang *et al.* (2012) and Kumar *et al.* (2014). For seed cotton yield per plant the cross PA 807 x NDLA 3047 exhibited significant positive specific combining ability (SCA) effect, similar results were reported by Dhamayanthi (2011); Nidagundi *et al.* (2011) and Kumar *et al.* (2014). The lines PA 778, PAIG 62 and among males ARBAS 1401 exhibited significant positive general combining ability effects (GCA). With regards to seed index PA 778, PAIG 62 and JLA 0716 recorded significant positive general combining ability effects (GCA). Among parents, male parent PA 832 and in lines ARBAS 1401 had significant positive general combining ability effects

Table 4 : Estimates of specific combining ability (SCA) for different characters

Hybrids	Days to 50% flowering	No. of sympodia/ plant	No. of bolls/ plant	Boll weight (g)	Plant height (cm)	Days to maturity	Seed cotton yield/ plant (g)
PA 807 X NDLA 3047	4.32**	1.46**	3.25**	0.18**	9.13**	4.15**	7.93**
PA 778 X JLA 0716	-0.45	1.20**	3.00**	0.14**	3.20	1.11**	7.40**
PA 832 X NDLA 3047	-4.12**	3.35**	2.77	-0.03	3.09	-3.79**	6.00**
PA 785 X CNA 1013	-2.04**	0.96**	1.98**	-0.02	-3.39	0.32*	4.77**
PA 785 X ARBAS 1401	0.70*	1.62**	1.05**	0.15*	23.24**	1.48**	4.14**
PA 778 X CNA 1013	0.58*	0.89**	2.38**	-0.01	-9.29**	-1.30**	3.20**
PA 832 X ARBAS 1401	0.70*	-1.04**	0.17	0.17**	-12.10**	1.13**	2.94**
PA 800 X CNA 1013	1.70**	-0.13	0.71**	-0.15**	15.32**	3.02**	2.75**
PAIG 62 X CNA 1013	1.83**	0.50*	0.81**	0.08	-31.88**	-1.82**	1.80**
PA 800 X JLA 0716	1.20**	0.19	-0.37	0.08	-20.37**	0.93**	1.55**
PAIG 62 X JLA 0716	-2.16**	-0.28	-0.27	0.10	-9.53**	0.28	0.30
PAIG 62 X ARBAS 1401	0.58*	-0.83**	0.07	-0.10*	16.30**	-0.16	0.16
S.E.±	0.268	0.205	0.203	0.050	2.068	0.146	0.284

Table 4 Continued

Hybrids	Lint index	Seed index (g)	2.5% Span length (mm)	Fibre fineness (Micronaire) (µg/inch)	Fibre strength (g/tex)	Uniformity ratio (%)	Ginning outturn (%)
PA 807 X NDLA 3047	-0.26	0.05	0.82*	-0.20	0.36	1.08	1.56*
PA 778 X JLA 0716	-0.70**	-0.41**	-0.17	-0.35*	0.72*	0.16	-0.29
PA 832 X NDLA 3047	0.36**	-0.19*	-0.96*	0.075	-0.30	-0.16	0.47
PA 785 X CNA 1013	0.17	0.06	0.78*	-0.04	0.26	-1.00	0.20
PA 785 X ARBAS 1401	-0.02	0.18	-1.57**	-0.05	-0.33	2.00**	2.52**
PA 778 X CNA 1013	0.21	-0.84**	-0.58	0.13	0.34	0.50	1.44**
PA 832 X ARBAS 1401	-0.20	-0.23*	2.19**	-0.20	0.51	1.51**	-0.09
PA 800 X CNA 1013	0.33*	0.74**	-0.80*	-0.24	0.31	0.75	2.29**
PAIG 62 X CNA 1013	-0.54**	-0.03	2.26**	-0.19	-0.25	1.50**	-1.76**
PA 800 X JLA 0716	0.04	-0.60**	1.70**	-0.20	0.30	0.41	1.22**
PAIG 62 X JLA 0716	0.36**	0.24*	-1.12**	0.32*	0.02	1.16*	3.31**
PAIG 62 X ARBAS 1401	0.021	0.36**	-0.49	-0.008	0.44	-1.50**	0.78**
S.E.±	0.127	0.093	0.389	0.137	0.260	0.524	0.247

* and ** indicate significance of values at P=0.05 and 0.01, respectively.

(GCA) for 2.5% span length. The female parents PAIG 62 and CNA 1013 exhibited significant positive general combining ability effects (GCA). Among testers JLA 0716, ARBAS 1401 was recorded significant positive general combining ability effects (GCA) for fibre strength. For uniformity ratio PAIG 62, ARBAS 1401 and CNA 1013 recorded significant positive general combining ability effects (GCA). The lines PA 807, PAIG 62 and PA 832 showed significant positive general combining ability effects (GCA) for for ginning outturn. Parent. Similar results were reported by Similar findings were reported by Giri *et al*. (2006); Ashokkumar *et al.* (2010); Saravanan *et al.* (2010); Nidagundi *et al.* (2011); Kumar *et al*. (2013) and Patil *et al*. (2015).

Among parents, PA 832 and NDLA 3047 exhibited significant positive general combining ability effects for number of boll per plant in desirable direction revealing that these are best general combiners for this trait. Parent JLA 0716 exhibited highest significant positive general combining ability effects (GCA) for boll weight, while parents PA 778 and NDLA 3047 had significant positive general combining ability effect (GCA)for seed cotton yield per plant. Similar findings were observed by Dhamayanthi (2011); Mendez-Natera *et al*. (2012); Dai Gang *et al*. (2012); Kumar *et al*. (2014); Ambhore *et al*. (2012) and Singh *et al*. (2013).

The hybrid PA 807 x NDLA 3047 (7.93) exhibited highest positive significant specific combining ability effect (SCA) for seed cotton yield per plant. Whereas, the hybrids PA 807 x NDLA 3047, PA 832 x ARBAS 1401and PA 785 x JLA 0716 recorded significant positive specific combining ability effects (SCA) for boll weight. Similar results were reported by Dhamayanthi (2011); Nidagundi *et al*. (2011); Kumar *et al*. (2014) and Patel and Chaudhari (2015).

The specific combining ability effects of crosses are presented in Table 4. The study of specific combining ability effect (SCA) of economic traits revealed that the cross PA 778 x ARBAS 1401 exhibited significant specific combining ability effect (SCA) for lint index, while the hybrid PA 800 x CNA 1013 had highest positive significant specific combining ability effect (SCA) for seed index. For ginning outturn the hybrid PA 807 x ARBAS 1401 exhibited significant positive specific combining ability effect (SCA) in desirable direction. Similar results were reported by Preetha and Raveendran (2008); Khan *et al*. (2009); Giri *et al*. (2010); Saravanan *et al*. (2010); Kumar *et al* (2013); Rangnatha *et al*. (2013) and Kumar *et al*. (2014)

The study of specific combining ability effect (SCA) of fibre quality traits revealed that the cross PAIG 62 x CNA 1013 showed high significant positive specific combining ability effect (SCA) for 2.5 % span length followed by PA 832 x ARBAS 1401 and PA 800 x JLA 0716. Whereas, the crosses PA 785 x ARBAS 1401, PA 832 x ARBAS 1401 and PAIG 62 x CNA 1013 exhibited positive significant specific combining ability effect (SCA) for uniformity ratio. One cross PA 778 x JLA 0716 (0.72) showed highest significant positive specific combining ability effect (SCA) for fibre strength. Similarly, the cross PA 778 x JLA 0716 exhibited negative significant specific combining ability effect (SCA) for micronaire value in desirable direction. The results are in agreement with findings of Anandan (2010); Bolek *et al*. (2010); Madhuri *et al*. (2014); Khan *et al*. (2015) and Kannan and Saravanan (2016).

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