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Combining Ability Estimation for Fibre Quality Parameters in Desi Cotton (*Gossypium arboreum*)

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ABSTRACT

Present study was conducted to estimate combining ability and type of gene action for fibre quality parameters in desi cotton genotypes. Ten genotypes (six lines and four testers) and twenty-four crosses were evaluated in randomized block design with three replications during kharif 2012-13. The characters viz., ginning outturn, 2.5% span length, fibre fineness, fibre strength, uniformity ratio and short fibre index were included under the study. Predominance of non-additive gene action was obtained for almost all the characters under study. The mean squares due to males were non-significant for all characters studied. The female lines exhibited significant differences for fibre strength only. Mean square due to crosses was significant for all the six characters indicating the importance of the studied traits. The estimates of GCA effects revealed that among lines, PA-08 was highest performing line for more number of characters followed by PA-720 and PA-255 while, among testers GAM-162 was the highest performing for more number of characters. These lines and testers being good general combiners can be used as donor parent for desirable genes regarding the mentioned traits.

Key words: *Kharif, GCA, Cotton, Fibre.*

INTRODUCTION

Cotton is an important cash crop which is mainly grown for its fibre in more than 65 countries of the world[3]. Cotton is also called as 'White Gold' or 'King of Apparel Fibre'. Cotton has four cultivated species, classified into new world cotton (*Gossypium hirsutum* L. and *Gossypium barbadense* L.,) which are tetraploids (2n = 4x = 52) and old world cotton (*Gossypium herbaceum* L. and *Gossypium arboreum* L.) which are diploids (2n = 2x = 26). Most of the breeding programmes in cotton are designed for increasing yield and improve fibre quality because it is important for textile industry. Sprague and Tatum[20] 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[1].

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Combining ability analysis is used to compare the performance of breeding material[10], allows estimation of different genetic components[22] and reflects the performance of lines, testers and crosses. Thus, the present investigation was conducted to identify superior parents and crosses in relation to fibre quality through L x T analysis.

MATERIAL AND METHODS

The present investigation was undertaken to study combining ability in *desi* cotton (*Gossypium arboreum* L.) for fibre quality traits in line x tester programme involving twenty-four hybrid combinations which were derived by crossing six *arboreum* lines (PA-720, PA-08, PA-528, PA-532, PA-255 and PA-402) with four *arboreum* testers (AKA-7, GAM-162, Dwd-arb-10-1 and JLA-802). The crosses and parents were evaluated at Cotton Research Station, Mahboob Baugh farm, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *kharif* season of 2012-13.

The experiment was conducted in randomized block design in three replications. Data were recorded on five randomly selected plants per entry for all the six characters *viz*., ginning out-turn (%), 2.5% span length (mm), micronaire/ fibre fineness (10^{-6}g/inch), fibre strength (g/tex) uniformity ratio (%) and short fibre index. All recorded datas were subjected to analysis of variance for testing the significance of treatments as suggested by Panse and Sukhatme[19]. Combining ability analysis and the testing of significance of different genotypes was based on the procedure given by Kempthorne[14].

RESULTS AND DISCUSSION

Combining ability is defined as the ability of parents or cultivars to combine amongst each other or capability of transmission of favourable genes during the process of hybridization. Combining ability is of two types. Specific combining ability is the deviation in the performance of hybrids from the expected productivity. It occurs due to the genes with dominance or epistatic effect and non-fixable. On the other hand, general combining ability is the average performance of a line in a series of crosses. It occurs due to additive genes and is fixable[20].

Analysis of variance of combining ability with respect to all six characters under study is summarized in Table-1. The mean squares due to males were non-significant for all characters studied. The female lines exhibited significant differences for fibre strength only. Mean square due to crosses was significant for all the six characters indicating the importance of the studied traits. Significant variance was observed for all the studied characters (excluding uniformity ratio) for line × tester interactions.

By evaluation of GCA variances and SCA variances, it was observed that SCA variance was higher than GCA variances in all traits which indicate predominance of non-additive gene action. These results are in line with Tang and Xiao[21] and Ali *et al*[2]. All the studied characters might be under non-additive gene action (performed significance only for sca variances) except 2.5% span length and fibre strength (performed significance for both sca and gca variances) which might be due to both additive and non-additive gene action (Table-2). Basal *et al*[6]., and Ali *et al*[3]., observed the predominance of additive gene action for fibre strength. The ratio of $\boldsymbol{\delta}^2$ GCA /$\boldsymbol{\delta}^2$ SCA was less than unity for all the studied characters indicating preponderance of non-additive gene action (dominance and epistasis). The contribution of line x tester was higher than both lines and testers for most of the characters except for fibre strength in which, contribution of line was more (56.10%). In comparison of both lines and testers it was found that contribution of lines to the total variability was more than testers for all the studied characters. Non-additive gene action for fibre quality traits *viz.*, fibre length, fibre strength and micronaire value have been reported by Khan *et al*[15]., Baloch *et al*[5]., Hassan *et al*[11]., and Hassan *et al*[12]. These results suggested that heterosis breeding was suitable for all the characters including fibre properties.

The estimates of general combining ability effects of females and males are presented in Table-3. Among lines, PA-720 (1.02) and PA-528 (0.60) while, among testers GMA-162 (0.73) showed positive and significant gca effect for ginning outturn. The lines PA-08 (1.20) and PA-720 (0.80) while, among male parents, Dwd-arb-10-1 (0.64) displayed significant gca effect in positive direction respect of 2.5 % span length. The line PA-255 (0.18) exhibited highly positive significant gca effects and none of the testers exhibited significant gca effects for fibre fineness. As far as fibre strength is concerned, the line PA-08 (1.21) displayed significant GCA effects in positive direction while, none of the male parents exhibited significant gca effects. The line PA-08 (0.87) exhibited highly positive significant gca effects while, none of the testers exhibited significant gca effects for uniformity. Among female parents, PA-532 (-0.82) and PA-08 (-0.47) showed significant negative gca effects and among male parents, Dwd-arb-10-1 (-0.84) showed negative significant gca effect for short fibre index.

The estimates of GCA effects revealed that among lines, PA-08 was highest performing line for more number of characters followed by PA-720 and PA-255 while, among testers GAM-162 was the highest performing for more number of characters. These lines and testers being good general combiners can be used as donor parent for desirable genes regarding the mentioned traits[1,16].

The estimates of specific combining ability effects of combinations for various traits are given in Table 4. The hybrid PA-532 x JLA-802 (2.32) showed maximum significant positive SCA effects followed by cross PA-528 x AKA-7 (1.90), PA-402 x JLA-802 (1.53) and PA-402 x GAM-162 (1.23) were highest performing crosses for ginning outturn. The cross PA-720 x JLA-802 (2.32) showed maximum significant positive SCA effects followed by PA-255 x AKA-7 (1.55), PA-255 x Dwd-arb-10-1 (1.28) and PA-528 x GAM-162 (1.15) for 2.5% span length. For Fibre fineness, the crosses *viz.*, PA-532 x AKA-7 (-0.47) and PA-720 x JLA-802 (-0.33) showed significant negative SCA effect while, the crosses PA-720 x JLA-802 (1.52), PA-402 x AKA-7 (1.42) and PA-402 x JLA-802 (1.19) showed significant positive SCA effect for fibre strength. None of the crosses exhibited significant SCA effects for uniformity ratio. However, PA-402 x AKA-7 (1.29) and PA-08 x GAM-162 (1.20) were found to be highest performing crosses in positive direction. For short fibre index, the cross PA-720 x JLA-802 (-3.56) and PA-255 x AKA-7 (-3.44) recorded maximum significant negative SCA effects.

Similar results related to GCA and SCA were also reported by Anandan[4], Bolek *et al*[7], Karademr and Gencer[13], Dewdar[9], Nadagundi *et al*[18]., Mendez-Natera *et al*[17]., and DaiGang *et al*[8]., for these characters.

Table 1: Analysis of variance for combining Ability for different characters including parents

Source	d.f.	Ginning outturn (%)	2.5% SL length (%)	Fibre fineness/ Micronaire (µg/inch)	Fibre strength (g/tex)	Uniformity ratio (%)	Short fibre index (%)
Replications	2	3.453	0.017	0.008	0.557	0.007	0.050
Crosses	23	6.506**	6.725**	0.167**	3.642**	3.603*	12.467**
Females	5	6.567	11.078	0.170	9.398*	7.125	5.325
Males	3	6.474	4.485	0.144	0.615	2.458	8.321
M x F	15	6.493**	5.722**	0.170**	2.328**	2.658	15.678**
Error	66	0.561	0.699	0.051	0.984	1.961	0.326

Table 2: Variances for General and Specific Combining Ability and Percent contribution of lines, testers and LxT for quality parameters in cotton

Sr. No.	Character	δ^2 GCA	δ^2SCA	δ^2GCA / δ^2SCA	Percent contributions of		
					Lines	Testers	LxT
1.	Ginning outturn (%)	0.3973	1.9770**	0.2009	21.94	12.97	65.07
2.	2.5% SL length (%)	0.4722*	1.6743**	0.2820	35.81	8.69	55.49
3.	Fibre fineness (Micronaire) (µg/inch)	0.0071	0.0396**	0.1786	22.19	11.29	66.50
4.	Fibre strength (g/tex)	0.2681*	0.4478*	0.5988	56.10	2.20	41.69
5.	Uniformity ratio (%)	0.0107	0.0589**	0.1817	42.98	8.89	48.11
6.	Short fibre index (%)	0.4331	5.1170**	0.0846	9.28	8.70	82.00

Table 3: Estimates of General Combining Ability (GCA) for Lines and Testers

Parents	Ginning outturn (%)	2.5% SL length (%)	Fibre fineness (Micronaire) (µg/inch)	Fibre strength (g/tex)	Uniformity ratio (%)	Short fibre index (%)
Lines						
PA-720	1.02**	0.80**	0.01	-0.85**	0.62	-0.32
PA-08	-0.90**	1.20**	-0.09	1.21**	0.87*	-0.47**
PA-528	0.60**	-0.21	-0.14*	0.54	0.37	0.17
PA-532	-0.05	0.30	0.08	0.49	-0.62	-0.82**
PA-255	-0.71**	-0.79	0.18**	-0.38	-0.12	0.97**
PA-402	0.04	-1.31	-0.04	-1.00**	-1.12**	0.47**
S.E.(Gi)	0.216	0.241	0.6054	0.2864	0.404	0.1650
S.E.(Gi-Gj)	0.306	0.341	0.0925	0.4051	0.571	0.2333
CD @5%	0.435	0.485	0.1317	0.5766	0.813	0.3321
CD @1%	0.581	0.648	0.1758	0.7697	1.086	0.4433
Testers						
AKA-7	-0.09	0.14	0.09	-0.12	0.37	0.60**
GMA-162	0.73**	-0.45*	-0.00	-0.19	0.20	0.49**
Dwd-arb-10-1	-0.72**	0.64**	0.02	0.15	-0.45	-0.84**
JLA-802	0.08	-0.32	-0.11	0.15	-0.12	-0.25
S.E.(Gi)	0.176	0.197	0.0534	0.2339	0.330	0.1347
S.E.(Gi-Gj)	0.249	0.278	0.0755	0.3308	0.466	0.1905
CD @5%	0.355	0.396	0.1075	0.4708	0.664	0.2712
CD @1%	0.474	0.529	0.1435	0.6284	0.887	0.3620

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

Hybrids	Ginning outturn (%)	2.5% SL length (%)	Fibre fineness (Micronaire) (µg/inch)	Fibre strength (g/tex)	Uniformity ratio (%)	Short fibre index (%)
PA-720 x JLA-802	-1.458**	2.358**	-0.332*	1.525*	-0.625	-3.558**
PA-528 x AKA-7	1.899**	-2.442**	0.168	-1.208*	-0.458	4.258**
PA-08 x GAM-162	-0.816	-0.342	0.079	0.242	1.208	0.292
PA-532 x Dwd-arb-10-1	0.375	0.425	0.085	-0.558	-0.125	-0.992**
PA-255 x JLA 802	-0.649	-0.342	-0.224	0.250	-0.875	0.292
PA-402 x AKA-7	0.501	-0.742	0.076	1.417*	1.292	-0.292
PA-720 x GAM 162	-0.470	0.258	0.154	-1.233*	-0.042	-0.158
PA-528 x Dwd-arb-10-1	0.618	0.825	-0.007	-0.43	-0.375	0.158
PA-08 x JLA-802	-1.344**	0.783	0.226	-0.075	0.625	-1.458**
PA-532 x AKA -7	-0.604	0.683	-0.474**	-0.108	-1.208	-0.642
PA-255 x GAM -162	0.091*	-0.817	0.004	0.342	-0.542	0.19
PA-402 x Dwd-arb-10-1	1.046*	-0.650	0.243	-0.158	1.125	1.908**
PA-528 x JLA 802	1.014*	-1.342**	0.101	-0.525	-0.375	1.442**
PA-720 x AKA-7	0.067	0.458	0.201	0.042	-0.208	0.058
PA-528 x GAM-162	-0.211	1.158*	-0.221	0.392	0.458	-1.608**
PA-08 x Dwd-arb-10-1	-0.870	-0.275	-0.082	0.092	0.125	0.108
PA-532 x JLA 802	2.322**	-0.842	0.301*	0.050	1.125	0.042
PA-255 x AKA-7	-0.848	1.558**	-0.099	0.117	0.292	-3.442**
PA-402 x GAM -162	1.230**	-1.542**	-0.121	-0.033	-0.042	2.592**
PA-720 x Dwd-arb-10-1	-2.705**	0.825	-0.082	-0.133	-1.375	0.808*
PA-08 x AKA-7	0.115	-0.617	-0.074	-1.225*	0.125	3.242**
PA-532 x GAM-162	-1.015*	0.483	0.126	-0.258	0.292	0.058
PA-255 x Dwd-arb-10-1	-0.634	1.283*	0.104	0.292	-1.042	-1.308**
PA-402 x JLA-802	1.535**	-1.150*	-0.157	1.192*	0.625	-1.992**
S.E. ±	0.4327	0.4828	0.1308	0.5729	0.8087	0.3300

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