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Combining Ability for Yield and its Components in Up-land Cotton

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Abstract: Diallel cross analysis experiment of eight varieties/strains of Upland cotton *Gossypium hirsutum* L. viz: CYTO 9/91, B-496, SLS-1, Niab-78, NIAB-313/12, B-622, NIAB-92 and CYTO-11/9 was conducted at experimental area of the Department of Plant Breeding and Genetics, Faculty of Agriculture, Gomal University, Dera Ismail Khan, Pakistan, during the years 1996-1998 to conclude the combining ability analysis in the inheritance of some quantitative characters like, seeds boll^{-1}, seed index, lint index and staple length using Griffing's (1956) Method-1, Model-II in F_1 generation. The mean squares for General combining ability (GCA), Specific combining ability (SCA) and reciprocals effects were observed to be highly significant for characters of seeds boll^{-1}, seed index, lint index and staple length. The estimates of components of variance exposed that the variance due to SCA was much higher in magnitude and more vital than GCA in case of seed index, lint index and staple length showing thus the prevalence of non additive type of gene action with (dominance or epistatic effects) in the inheritance of the characters mentioned. Concurrently GCA was much higher in magnitude and more significant than SCA in case of seeds boll^{-1} reflecting the role of additive type of gene action.

Key words: *Gossypium hirsutum* L., cultivars, agronomic characters, combining ability, Pakistan

Introduction

Hybridization program requires selection of bendable parental lines to be used to produce genetically modified and potentially rewarding germplasm with collection of fixable gene effects relatively in a homozygous line. Relative magnitude of genetic variance and combining ability estimates are important and fundamental parameters to shape the genetic framework of cotton like crop. Such type of exploration could prove an indispensable approach to the cotton breeders in the screening of better parental combinations for further enhancement. Heterosis predominantly dependent on the screening and selection of available germplasm that could produce better combinations of genetically modified important characters. 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). In addition reciprocal effects were defined by Griffing (1956). Khajidoni *et al.* (1984), Gafoor and Khan (1987) and Hassan *et al.* (1999) reported the importance of SCA effects than GCA revealing the importance of non-additive (dominant or epistatic) type of gene action. At the other hand, Shekry *et al.* (1981), Bhatade and Bhale (1983), Khan *et al.* (1991a), Yaqoob *et al.* (1997), Baloch *et al.* (2000) and Bhutto *et al.* (2001) who concluded predominance of additive type of gene action for yield and its components in *Gossypium hirsutum* L.

Numerous commercial cultivars in addition to their soaring agronomic performances execute feebly because of genetic hindrances in different cross combinations. Consequently crossing in a diallel approach is the only precise and prosperous technique of measurement for recognition and assortment of better genetically modified material. The present research work was conducted to scrutinize some important cotton cultivars/genotypes to establish the relative performance regarding combining ability effects for yield and its components.

Materials and Methods

Eight local cultivars belonging to Upland cotton, *Gossypium hirsutum* L. viz. CYTO 9/91, B-496, SLS-1, NIAB-78, NIAB-313/12, B-622, NIAB-92 and CYTO-11/91 maintained by selfing were crossed in complete diallel fashion at Faculty of Agriculture, Gomal University, D.I.Khan during 1996-98. The 56 F_1's along with their eight parents were dibbled in Randomized Complete Block Design (RCBD) with three replications. Row to row and plant-to-plant distance were kept as 75 and 30 cm, respectively. Each entry was planted in a 3.3 meter long row keeping ten plants experimental while two plants were left as non experimental on either side of the row. The data with regard to seeds boll^{-1}, seed index, lint index and staple length were recorded in F_1 generations.

The averaged data were subjected to the standard techniques of analysis of variance (Steel and Torrie, 1980) to set up the level of significance. The estimates of general and specific combining ability as defined by Sprague and Tatum (1942) and reciprocal effects as defined by Griffing method I, model II (1956) were calculated.

Results and Discussion

Combining ability effects: The mean squares for GCA, SCA and reciprocals were observed to be highly significant for all the characters like, seeds boll^{-1}, seed index, lint index and staple length (Table 1). The out put of data of component of variance elucidated that the variance due to SCA was much higher in scale and very important than GCA for seed index, lint index and staple length, reflecting the predominance of non additive type of gene action in the inheritance of these characters.

This exposed that the major portion of genetic variance (in percentage) for these characters is owing to non additive type of gene action with (dominance or epistatic effects). Kaushik *et al.* (1984), (Khajidoni *et al.,* 1984); Gafoor and Khan *et al.* (1987), Sayal *et al.* (1997) and Hassan *et al.* (1999) who already concluded the magnitude of SCA effects.

Table 1: Mean square due to GCA, SCA and reciprocal effects for various characters of cotton(*Gossypium hirsutum* L.) in an 8 x 8 diallel cross experiment (1996-98)

Source of variation	d.f.	Seeds per boll	Seed Index	Lint index	Staple Length
General combining Ability	7	5.32**	0.28**	0.083**	0.91**
Specific combining Ability	28	0.37**	0.04**	0.032**	0.39**
Reciprocals	28	0.018**	0.002**	0.003**	0.089**
Error	126	0.446	0.009	0.003	0.183

Table 2: Estimates of components of variance due to GCA, SCA and reciprocal effects for various characters of cotton (*Gossypium hirsutum* L.) in an 8 x 8 diallel cross experiment (1996-98)

Variance components	Seeds per boll	Seed Index	Lint Index	Staple Length
General	00.309	00.015	00.003	00.032
Combining	62.210	42.30	13.97	11.32
Ability				
Specific	-0.043	00.02	00.017	00.1182
Combining	-8.740	42.66	72.95	41.26
Ability				
Reciprocals	-00.214	-0.003	0.0003	-00.047
	-43.030	-9.29	1.31	-16.36
Error	00.450	00.009	00.003	00.18
	89.560	24.33	11.77	63.78
Total	0.759	0.04	0.02	0.32
	100.000	100.00	100.00	100.00

* Upper values denote variance estimates

** Lower values denote variance components in percentage

Table 3: Estimates of general combining ability effects for various characters of cotton (*Gossypium hirsutum* L.) in a 8 x 8 diallel cross experiment (1996-98)

Varieties	Seeds per boll	Seed Index	Lint index	Staple Length
CYTO-9/91	1.137	0.230	0.012	-0.374
B-496	0.366	-0.026	-0.079	-0.238
SLS-1	-0.819	-0.021	0.032	-0.058
NIAB-78	-0.157	-0.111	0.132	0.235
NIAB-313/12	0.023	-0.033	0.039	0.135
B-622	-0.442	0.100	0.003	-0.060
NIAB-92	-0.011	-0.206	-0.083	0.347
CYTO-11/91	-0.095	0.067	-0.056	0.013
CD (gi – gj)	0.462	0.065	3.618	0.296

Table 4: Estimates of specific combining ability effects for various characters of cotton (*Gossypium hirsutum* L.) in a 8 x 8 diallel cross experiment (1996-98)

Cross combinations	Seeds per boll	Seed Index	Lint index	Staple length
CYTO-9/91 X B-496	0.03	-0.05	-0.01	0.34
CYTO-9/91 X SLS-1	0.61	0.13	0.17	0.21
CYTO-9/91 X NIAB-78	0.24	-0.02	0.10	-0.18
CYTO-9/91 X NIAB-313/12	0.22	0.16	0.16	-0.14
CYTO-9/91 X B-622	-0.74	-0.01	-0.01	0.14
CYTO-9/91 X NIAB-92	0.51	0.12	0.16	0.41
CYTO-9/91 X CYTO-11/91	0.06	-0.11	0.01	0.55
B-496 X SLS-1	0.33	0.04	0.03	0.37
B-496 X NIAB-78	0.42	-0.07	-0.03	0.31
B-496 X NIAB-313/12	-0.06	0.10	0.08	-0.02
B-496 X B-622	0.26	-0.03	-0.03	0.44
B-496 X NIAB-92	-0.25	0.02	0.08	-0.13
B-496 X CYTO-11/91	-0.27	0.09	0.01	-0.27
SLS-1 X NIAB-78	-0.09	-0.08	-0.06	0.10
SLS-1 X NIAB-313/12	-0.02	0.03	0.02	-0.16
SLS-1 X B-622	0.44	0.06	0.05	-0.06
SLS-1 X NIAB-92	0.16	-0.09	-0.05	0.00
SLS-1X CYTO-11/91	0.55	0.04	0.04	0.20
NIAB-78 X NIAB-313/12	-0.04	0.16	-0.08	0.03
NIAB-78 X B-622	-0.07	0.22	0.10	0.01
NIAB-78 X NIAB-92	-0.14	0.03	-0.03	-0.30
NIAB-78 X CYTO-11/91	-0.07	0.03	-0.02	0.15
NIAB-313/12 X B-622	0.28	-0.19	-0.02	0.35
NIAB-313/12 X NIAB-92	0.00	-0.11	-0.02	0.73
NIAB-313/12 X CYTO-11/91	-0.10	-0.02	0.06	0.10
B-622 X NIAB-78	-0.02	0.24	0.11	0.17
B-622 X CYTO-11/91	0.18	-0.09	-0.01	0.05
NIAB-92 X CYTO-11/91	-0.04	0.17	0.10	0.02
CD(Sij – Sik)	1.22	0.17	0.10	0.73
CD(Sij - Ski)	1.13	0.16	0.09	0.84

Similarly the estimates of components of variance clarified that the variance due to GCA was much higher in magnitude and more important than SCA for the traits like seeds boll^{-1} showing in that way the predominance of additive type of gene action for the inheritance of this imperative trait. These research findings are quite in agreement with Bhatade and Bhale (1983), Khan *et al.* (1991), Yaqoob *et al.* (1997), Baloch *et al.* (2000) and Bhutto *et al.* (2001) who reported the noticeable extent of variance due to GCA for the parameter like seeds boll^{-1} (Table 2).

General combining ability effects: The variety Cyto-9/91 expressed its superiority and proved to be the best

Table 5: Estimates of reciprocal effects for various characters of cotton (*Gossypium hirsutum* L.) in an 8 x 8 diallel cross experiment (1996-98)

Cross combinations	Seeds per boll	Seed Index	Lint index	Staple length
B-496 X CYTO-9/91	0.05	0.01	0.02	-0.18
SLS-1 X CYTO-9/91	0.35	0.03	0.04	-0.32
NIAB-78 X CYTO-9/91	-0.06	0.04	0.00	-0.12
NIAB-313/12 X CYTO-9/91	0.00	-0.01	0.01	0.13
B-622 X CYTO-9/91	0.17	0.04	0.03	-0.10
NIAB-92 X CYTO-9/91	0.05	0.04	0.04	-0.01
CYTO-11/91 X CYTO-9/91	0.08	0.03	0.08	-0.31
SLS-1 X B-496	0.10	0.03	0.03	-0.13
NIAB-78 X B-496	0.05	0.03	0.03	0.01
NIAB-313/12 X B-496	0.05	0.03	0.00	0.09
B-622 X B-496	0.10	-0.02	-0.12	-0.36
NIAB-92 X B-496	0.08	0.03	0.03	-0.02
CYTO-11/91 X B-496	-0.08	-0.01	-0.02	-0.04
NIAB-78 X SLS-1	-0.05	0.01	0.02	-0.04
NIAB-313/12 X SLS-1	0.10	0.01	-0.08	-0.38
B-622 X SLS-1	0.10	0.03	0.02	0.03
NIAB-92 X SLS-1	0.05	0.08	-0.05	-0.01
CYTO-11/91 X SLS-1	0.05	0.03	-0.06	-0.15
NIAB-313/12 X NIAB-78	0.05	-0.05	-0.01	-0.40
B-622 X NIAB-78	0.05	0.05	0.02	-0.01
NIAB-92 X NIAB-78	0.01	0.05	0.04	-0.01
CYTO-11/91 X NIAB-78	0.00	0.02	0.03	-0.39
B-622 X NIAB-313/12	-0.02	0.02	-0.04	0.08
NIAB-92 X NIAB-313/12	0.03	0.01	-0.04	0.02
CYTO-11/91X NIAB-313/12	0.05	0.05	0.04	-0.25
NIAB-92 X B-622	0.05	0.03	0.03	0.17
NIAB-92 X CYTO-11/91	0.04	0.02	0.02	-0.29
CYTO-11/91 X NIAB-92	0.02	0.02	0.02	-0.42
CD(rij - rki)	1.31	0.18	0.10	0.84

general combiner for seeds boll^{-1} and seed index. Like wise variety Niab-78 was superior in general combining ability for lint index. Furthermore Niab-92 reflected its best general combining ability for staple length. Therefore, the best yielding parents for quantitative and those parents reflecting attractive qualitative performance might be exploited separately for varietals improvement for different cross combinations. Sufficient literature is available in support of such inferences such as Hassan *et al.* (1999), Kalwar and Babar (1999) and Hassan *et al.* (2000) who also concluded that best yielding parents having high GCA produced the best hybrid combinations (Table 3).

Specific combining ability: (Table 4) highlighting the estimates of specific combining ability effects of the characters mentioned that the highest SCA value was observed in the hybrid combination Cyto-9/91 x SLS-1(0.61) regarding seeds boll $^{-1}$ while the highest specific combining ability value (0.24) was observed in hybrid combination B-622 x Niab-78 in case of seed index. Further more the highest magnitude of SCA effects was expressed by hybrid Cyto-9/91 x SLS-1 with a value of (0.17) in case of lint index. Other than the hybrid Niab-313/12 x Niab-92 achieved the highest SCA value of (0.73), consequently exceeded in its performance from the rest of the twenty seven crosses for staple length.

Conclusion of the present study of combining ability is that in case of seed index and lint index, the parents with best general combining ability on their exploitation in cross combinations as one of the parents did not produce superior hybrid combinations. Nevertheless the parents with highest general combining ability produced good hybrid combinations for seeds boll^{-1} and staple length.
The results are in partial conformity with the findings of Khan and Khan (1985), Ghafoor and Khan (1987) and Baloch *et al.* (1995) who reported that GCA is not the crucial factor for forecast the SCA. Simultaneously as the results are to some extent corresponding with the findings of earlier workers like, Khan *et al.* (1991), Baloch *et al.* (1997), Hassan *et al.* (1999), Kalwar and Babar (1999) and Hassan *et al.* (2000) who reported that the parents with best general combining ability on their utilization in cross combination as one of the parents produced good hybrid combinations. This type of disagreement may be due to different germplasm materials exploited and the divergent climatic conditions under which these workers initiated their experiments.

Reciprocal effects: The best score was maintained by the cross combination of SLS-1 x Cyto-9/91 with a maximum reciprocal effects value of (0.35) for parameter seeds boll^{-1}. Though Niab-92 x SLS-1 reached at the climax in case of seed index and similarly Cyto-11/91 x Cyto-9/91 achieved the highest target of reciprocal effects for lint index. Nevertheless Niab-92 x B-622 achieved the highest target of reciprocal effects for staple length (Table 5).
From the findings, it is suggested, that single cross performance might be composited with their reciprocal effects, if yield and its components are to be kept in breeding strategy. Bhatade *et al.* (1980) also suggested this type of scheme earlier.

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