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Genetic Studies on Some Quantitative Traits in Upland Cotton (*Gossypium hirsutum* L.)

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Abstract: The present investigation was carried out at Nuclear Institute of Agriculture (NIA), Tandojam during Kharif 2013 to estimate general and specific combining ability effects and the magnitude of heterosis in 15 genotypes of cotton (*Gossypium hirsutum* L.). Out of fifteen genotypes, 06 parents along with their 9 F_1 hybrids obtained from line x tester method were grown in a Randomized Complete Block Design (RCBD) with three replications; observations were recorded for plant height, sympodial branches plant^{-1}, number of bolls plant^{-1} and seed cotton yield plant^{-1} (g). The line Sadori and tester IR-2620, displayed high positive GCA effects which indicates that these parents were good general combiners and cross of both parent indicated higher SCA effects which shows best specific combiner for yield and yield contributing traits. Cross Sadori x IR-2620 showed highest heterosis and heterobeltiosis for plant height, bolls plant^{-1} and seed cotton yield plant^{-1}. Hence, these particular parents and hybrids may be utilized for producing hybrid seed and developing new cotton varieties for high yield.

Keywords: *Gossypium hirsutum*, F_1 hybrids, line x tester, combining ability, heterosis

1. INTRODUCTION

Pakistan economy depends heavily on cotton crop which significantly contributes by providing raw material to the textile industry, such as cotton lint as an export item. It accounts for 7.0 percent of value added in agriculture and 1.5 percent of GDP. During 2012-13, the crop was sown on an area of 2879 thousand hectares, 1.6 percent more than last year (2835 thousand hectares). The production of 13.0 million bales during the period 2012-13 against the target of 14.5 million bales resulted in decline of 10.3 percent against the target and decrease of 4.2 percent over the preceding year production which was 13.6 million bales (GOP, 2012-13).

Combining ability plays an important role in the identification of parents and production of superior lines or hybrids. The genotypes found good in performance might not necessarily produce desirable progenies when used in hybrids development. It is therefore, necessary to identify promising lines based on crosses using appropriate mating design. The combining ability study is very important for the selection of parents and crosses which give highest improvement for the character under consideration and also provide information on the nature of genetic variation present in material under study. Combining ability is most widely used biometrical genetical approach in plant breeding. Success of development of high yielding and widely adapted hybrid depends on the specific combining ability of parental crosses. Thus, present study was conducted to identify desirable parents and promising hybrids on the basis of combining ability (Kumar *et al.*, 2013).

Using heterosis (hybrid vigour) to raise yield and fibre quality of cotton has long been an objective for researchers and producers (Meredith and Brown, 1998). Heterosis in cotton was reported as early as in 1894 by Mell (cited indirectly from Randhawa and Singh, 1994), and the foundation of the modern concept of heterosis was laid in 1908 by Shull (Randhawa and Singh, 1994). In hybrid research study on cotton, large numbers of crosses involving varietal lines are used for assessing combining ability status. On constantly observing the most potential crosses attempts are made to infer about the causes of high heterosis. What are the combinations that give potential crosses? What would be the probable cause for high potentiality revealed by the F_1? What is the genetic base or is there any physiological mechanism linked to high productivity of F_1 etc., are the questions which are examined and on the basis of the information available, heterotic groups are developed (Patil *et al*., 2011).

2. MATERIALS AND METHODS

The study was conducted at Nuclear Institute of Agriculture (NIA), Tandojam, during Kharif 2013. The experimental material used in the present study comprised of three lines and three testers along with their 9 F_1 hybrids, to estimate general and specific combiners and manifestation of heterosis in F_1 generation of (*Gossypium hirsutum* L.). The genotypes used in the study were three lines, namely, Sadori, NIA-

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Ufaq and NIA-80 and three testers such as IR-2620, Bt-555 and Bt-008 along with their 9 F_1 hybrids viz. Sadori x IR-2620, Sadori x Bt-555, Sadori x Bt-008, NIA-Ufaq x IR-2620, NIA-Ufaq x Bt-555, NIA-Ufaq x Bt-008, NIA-80 x IR-2620, NIA-80 x Bt-555 and NIA-80 x Bt-008.The seeds of three lines and three testers along with their 9 F_1 hybrids were provided by the Nuclear Institute of Agriculture (NIA), Tandojam. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The parents and hybrid were sown in rows, four rows per genotypes; 20 ft row length of each genotype was sown through hand dibbling keeping 1ft plant to plant and 2.5 ft row to row distance. Later thinned to one plant per hill, all the normal agronomic and cultural practices were carried out at appropriate time. Data were recorded on 5 randomly selected plants from each entry from all replications and mean of 5 plants was taken for further analysis. The collected data will be subjected to the statistical analysis (ANOVA) as suggested by Gomez and Gomez (1984), the heterosis and heterobeltiosis according to Falconer, (1989) and line x tester analysis by Kempthorne (1957).

3. RESULTS AND DISCUSSION

The research work was carried out to find out the combining ability variance affect, heterosis and heterobeltosis of parents and their F_1 hybrids for planning efficient breeding programme. The analysis of variance (ANOVA) of parents and their hybrids (line x tester) for the traits under study is present in **(Table-1)**. It reveals that traits were highly significant at 0.01 level of probability which indicate considerable distance among genotypes, which indicates additive and non additive type of gene action involved in the manifestation of character under study. The findings of the parental study are in accordance with those Deshpade and Baig (2003). The mean performance of genotypes for various quantitative and qualitative characters was tested through Duncan's Multiple Range Test (DMRT) and the results are presented in **(Table 2)**. While, the general combining ability (GCA) and specific combining ability (SCA) showed in **(Table 3 and 4)** where as heterosis and heterobeltosis are presented in **(Table 5)**. The results of each trait are discussed below.

Table 1. Mean squares from analysis of variance for various characters of cotton.

Source of variance	D.F	Plant height	Sympodial branches plant^{-1}	Bolls plant^{-1}	Seed cotton yield plant^{-1}
Replication	2	109.89	9.60	4.67	42.35
Genotype	14	126.49*	11.82**	39.19**	613.23**
Parents	5	205.34*	12.38*	36.55**	715.12*
Parents vs. Crosses	1	276.44**	52.97**	0.83^{ns}	1217.49*
Crosses	8	58.47^{ns}	6.32^{ns}	45.63**	474.02*
Lines (female)	2	26.16^{ns}	2.50^{ns}	15.04^{ns}	2.61^{ns}
Testers male)	2	43.91^{ns}	16.19^{ns}	130.12^{ns}	1594.28^{ns}
Lines x Testers	4	81.90^{ns}	3.30^{ns}	18.68^{ns}	149.61^{ns}
Pooled error	28	62.48	4.71	8.92	163.68

* = Significant at 5% level of Probability,** = Significant at 1% level of Probability,NS = Non Significant

Table 2. Means for in parents and their F_1 hybrids for various traits in upland cotton.

Genotypes	Plant height (cm)	Sympodial branches plant^{-1}	Bolls plant^{-1}	Seed cotton yield plant^{-1} (g)
Sadori	109.30 c	19.47 ab	38.00 abc	126.82 abc
NIA Ufaq	125.00 ab	21.07 ab	35.00 bcd	119.26 bcd
NIA-80	115.00 bc	20.00 ab	39.00 ab	113.09 cd
IR-2620	128.10 ab	18.00 bc	36.06 bcd	119.60 bcd
Bt-555	130.00 ab	15.20 c	29.06 e	84.49 e
Bt-008	126.80 ab	18.93 abc	36.20 bcd	101.39 de
Sadori x IR-2620	130.00 ab	22.27 ab	42.20 a	143.45 a
Sadori x Bt-555	131.00 a	20.20 ab	35.06 bcd	108.65 cd
Sadori x Bt-008	116.90 abc	22.33 a	33.00 cde	112.39 cd
NIA-Ufaq x IR-2620	128.80 ab	22.93 a	35.73 bcd	128.25 abc
NIA-Ufaq x Bt-555	128.00 ab	19.07 abc	32.73 de	114.78 bcd
NIA-Ufaq x Bt-008	131.10 a	19.93 ab	34.60 bcd	122.58 abcd
NIA-80 x IR-2620	129.30 ab	21.00 ab	42.73 a	136.63 ab
NIA-80 x Bt-555	124.80 ab	19.20 abc	33.43 cde	107.17 cd
NIA-80 x Bt-008	127.00 ab	22.00 ab	33.00 cde	118.63 bcd

Means followed by similar alphabetic letters are not significantly different from each other according to DMR test.

Table 3. Estimates of GCA effects for yield and its components in F_1 hybrid generation of *Gossypium hirsutum* L.

Parents	Plant height	Sympodial branches plant^{-1}	Bolls plant^{-1}	Seed cotton yield plant^{-1}
Sadori	-1.46	0.61	0.92	0.10
NIA- Ufaq	1.87	-0.35	-1.48	0.48
NIA-80	-0.41	-0.26	0.56	-0.58
IR-2620	1.92	1.07	4.39	14.72
Bt-555	0.50	-1.50	-2.09	-11.19
Bt-008	-2.41	0.43	-2.30	-3.52

Table 4. Estimates of SCA effects for yield and its components in F_1 hybrid generation of *Gossypium hirsutum* L.

Crosses	Plant height (cm)	Sympodial /plant (No)	Bolls/ plant (No)	Seedcotton yield / plant (g)
Sadori x IR-2620	2.00	-0.41	1.06	7.00
Sadori x Bt-555	5.00	0.10	0.40	-2.00
Sadori x Bt-008	-7.00	0.30	-1.46	-6.00
NIA-Ufaq x IR-2620	-2.00	1.21	-3.01	-8.00
NIA-Ufaq x Bt-555	-2.00	-0.07	0.47	4.00
NIA-Ufaq x Bt-008	4.00	-1.14	2.54	4.00
NIA-80 x IR-2620	0.00	-0.81	1.96	1.00
NIA-80 x Bt-555	-3.00	-0.03	-0.87	-2.00
NIA-80 x Bt-008	2.00	0.84	-1.09	1.00

Table 5. Estimate of Heterosis and Heterobeltiosis for yield and its components in F_1 Hybrid.

Cross combinations	Plant height		Sympodial branches plant^{-1}		Bolls plant^{-1}		Seed cotton yield plant^{-1}	
	Percent increase (+) or decrease (-) over							
	MPH	HB	MPH	HB	MPH	HB	MPH	HB
Sadori x IR-2620	+9.49	+1.45	+16.52	+3.74	+27.13	+16.44	+14.10	+13.11
Sadori x Bt-555	+9.47	+0.76	+16.30	+14.68	+18.74	+16.90	+2.83	-14.32
Sadori x Bt-008	-0.96	-7.78	+17.37	+8.82	-0.30	-8.83	-1.49	-11.37
NIA-Ufaq x IR-2620	+1.76	+0.52	+5.15	-9.49	+0.54	-0.94	+7.83	+7.23
NIA Ufaq x Bt-555	+0.39	-1.53	-0.35	-5.41	+2.16	-6.48	+13.22	-2.94
NIA-Ufaq x Bt-008	+4.15	+3.41	+10.52	+5.00	-2.80	-4.41	+2.51	-4.80
NIA-80 x IR-2620	+6.33	+0.88	+9.09	-4.00	+13.84	+9.56	+17.02	+14.23
NIA-80 x Bt-555	+1.87	-4.00	+13.02	+10.00	-1.77	-14.28	+8.03	-5.90
NIA-80 x Bt-008	+5.04	+0.15	+18.86	+14.38	-12.23	-15.38	+10.20	+4.15

Note. MPH= Mid Parent Heterosis; HB= Heterobeltiosis

Plant height: The maximum plant height (131.1cm) was shown by cross NIA-Ufaq x Bt-008 and Sadori x Bt-555 (131.0cm), whereas parent Sadori produced dwarf plants (109.3cm). A seed parent *viz.* NIA-Ufaq and pollen parent, IR-2620 and Bt-555 exhibited positive GCA effects for plant height, hence suggesting that in breeding program for development of taller plants if necessary, these varieties mentioned above could be used. As compare to certain crops where logging take place but in cotton it does not occur due to stem stiffness therefore taller plants in cotton which bear more number of sympodial branches and number of bolls can be selected for increasing ultimate yield. The data presented in Table 4 showed that the hybrids, which manifested SCA effects for tall plant height was a result of gene interaction. For developing a variety with tall plant height selection should be made in progenies of crosses, Sadori x IR-2620, Sadori x Bt-555, Ufaq x Bt-008, NIA-80 x IR-2620, NIA-80 x Bt-008. For dwarfism the progenies of hybrids displaying negative SCA effects would be fruitful; to be passed through sieves of selection. Similar result have been reported by Kumar *et al.* (2013) for the characterplant height. Cross Sadori x IR-2620 had exhibited highest positive value for relative heterosis, heterobeltiosis followed by NIA-Ufaq x Bt-008. This shows that these crosses are best combiners for the taller plant while Sadori x Bt-008 had negative value suggesting for the dwarf plants. The lines Sadori and NIA-80 have proved dwarfness, in the progenies and would be successfully exploited for higher seed cotton yield. Similar results have been reported by Khan and Qasim (2012).

Sympodial branches plant^{-1}: As regards to sympodial branches plant^{-1}, hybrids, Sadori x Bt-008 (22.33) and NIA-Ufaq x IR-2620 (22.93) showed highest number, whereas parents Bt-555 (15.20) showed lowest number of sympodial branches plant^{-1}. A line Sadori and two tester IR-2620 and Bt-008 expressed meaningful GCA effect for the trait number of sympodial branches plant^{-1}**.** There were only four hybrids Sadori x Bt-555, Sadori x Bt-008, NIA-Ufaq x IR-2620 and NIA-80 x Bt-008, which displayed positive SCA effects for the trait number of sympodial branches plant^{-1}. It is suggested that there is a chance of isolating potential segregates from the progenies of these five hybrids. These results are in agreement with those obtained by Soomro *et al.* (2012). In case of heterosis Sadori x IR-2620 had highest positive value for mid parent, better parent and

standard followed by Sadori x Bt-008. These results are in agreement with those obtained by Khan and Qasim (2012).

Number of bolls plant^{-1}: Considering number of total bolls plant^{-1}, hybrids NIA-80 x IR-2620 (42.73) and Sadori x IR-2620 (42.20) formed higher number of bolls plant^{-1}, while Parent Bt-555 (29.06) recorded lowest number of total bolls plant^{-1}. Two lines, Sadori and NIA-80, tester IR-2620 displayed positive GCA effects for the trait number of bolls plant^{-1} which indicates that, additive genes controlled the trait in these parents. Similar trend was followed by hybrids Sadori x IR-2620, Sadori x Bt-555, NIA-Ufaq x Bt-555, NIA-Ufaq x Bt-008 and NIA-80 x IR-2620, the crosses expressed either positive SCA effects for number of bolls plant^{-1}. These results are confirmation of the results obtained by Kumar *et al.* (2013). For the character, number of bolls plant^{-1} a cross Sadori x IR-2620 showed highly positive relative heterosis, heterobeltiosis. Highest values of mid parent and better parent shown by-cross Sadori x IR-2620 followed by Sadori x Bt-555. These crosses are good combiner and producing highest number of total bolls plant^{-1}. These results are in confirmation with the results obtained by Nassar (2013).

Seed cotton yield plant^{-1}: For the trait seed cotton yield, hybrid Sadori x IR-2620 (143.45) and NIA-80 X IR-2620 (136.63) produced highest seed cotton yield plant^{-1}, while, among the parents Sadori (126.82) produced maximum seed cotton yield while Bt-555 (84.49) gave lowest seed cotton yield plant^{-1} . In case of GCA, Sadori and NIA-Ufaq female parent and IR-2620 expressed positive additive type of gene action for seed cotton yield plant^{-1}. Data presented in Table 03 suggest that none of the parents exhibited remarkable general performance regarding the trait seed cotton yield plant^{-1}. However, the hybrids Sadori x IR-2620, NIA-Ufaq x Bt-555, NIA-Ufaq x Bt-008, NIA-80 x IR-2620 and NIA-80 x Bt-008 displayed positive SCA effects for seed cotton yield plant^{-1}. In late generations of these hybrids selection is suggested to isolate promising genotypes for developing cultivars/hybrids for boosting up the seed cotton yield/unit area. Such types of results are also reported by Kumar *et al.* (2013). Yield is polygenic character had the highest value of mid parent and better parent shown by Sadori x Bt-008. Eight crosses showed positive mid parent and better parent for the character seed cotton yield plant^{-1}. Such types of results are also reported by El-Hashash (2013).

4. CONCLUSIONS

The line Sadori and tester IR-2620 displayed positive GCA which indicated that these parents were good general combiners and cross of both the parents indicated higher SCA effects which shows best specific combiner for yield and yield contributing traits. While same cross (Sadori x IR-2620) gave more heterosis and heterobeltiosis for all traits under study.

REFERENCES:

Deshpande, L. A. and K. S. Baig, (2003) Combining ability analysis for yield, economic and morphological traits in American cotton (*Gossypium hirsutum* L) . Journal of research ANGRAU, Vol. (31) Issue 3: 28-34.

El-Hashash, E. F. (2013) Heterosis and gene action among single and double-cross hybrids performances in cotton. American-Eurasian J. Agric. and Environ. Sci., Vol. (13): Issue 4: 505-516.

Endrizzi, J. E., E. L. Turcotle and R. J. Kohel, (1985) Genetics, cytology and evolution of *Gossypium*. Adv. in Genet., Vol. (23): 271-375.

Falconer, D. S. (1989) Introduction to quantitative genetics. (3rded). Longman Scientific and Technical Co. U. K. 117Pp.

Gomez, K. A. and A. A. Gomez, (1984) Statistical procedures for agricultural research. John Wiley, New York, New York. 680Pp.

GOP, (2011-12) Government of Pakistan, economic survey report, Finance Division, economic advisory wing Islamabad. 19Pp.

Kempthorne, O. (1957). An Introduction to Genetical Statistics. The Iowa State Univ. Press, Ames, Iowa. 545Pp.

Khan, T. M. and M. U. Qasim, (2012) Genetic studied of yield traits in cotton *Gossypium hirsutum* L. J. Agric. Res., Vol. (50): Issue 1: 21-28.

Kumar M., K. S. Nirania., R. S. Sangwan and N. K. Yadav, (2013) Combining ability studies for yield and quality traits in upland cotton *Gossypium hirsutum L.* J. Cotton Res. Dev., Vol. (27): Issue 2: 171-174.

Mell, P. H. (1894) Experiments in crossing for the purpose of improving the cotton fibre, Albana (US) Agric. Experimental Station Bulletin, 56Pp.

Nassar, M.A.A. (2013) Some genetic parameters and heterosis in two crosses of Egyptian cotton. Journal of Applied Sciences Research, Vol. (9) Issue 1: 548-553.

Patil S. S., V. Ramakrishna, S.M. Manjula, P. Swati, H.M. Ranganatha, H.C. Kencharaddi and H. Deepakbabu, (2011) Deploying reciprocal selection for combining ability for improving performance of hybrids in cotton *Gossypium hirsutum* L. Indian J. Genet., Vol. (71) Issue 2: 180-184.

Randhawa L. S. and T. H. Singh, (1994) Heterosis breeding for crossing parent yield barriers in cotton, In: G. A. Constable, and N. W. Forester (eds), Proc. World Cotton Res. Conf. 1, Challenging the Future, CSIRO, Brisbane, Australia.