Bull. Fac. Agric., Cairo Univ., 61: 1-7 (2010)

HETEROSIS AND COMBINING ABILITY IN DIALLEL CROSSES AMONG CULTIVARS OF UPLAND COTTON

(Received: 7.6.2009)

By

Kh. M. Dawod and Kh. Kh. Al-Guboory*

*College of Agriculture & Forestry, Mosul University and*College of Agriculture, Karkuk University, Iraq*

ABSTRACT

A seven parent (Halab 90 = P_1, SP 8886 = P_2, Dunn 1517 = P_3, Coker 5114 = P_4, Lachata = P_5, Dunn 1047 = P_6 and Coker 310 = P_7) diallel of upland cotton was planted in a randomized complete block design with three replications at Al-Haweja, Karkuk Governorate during the season of 2007. Data collected from the diallel were used to estimate combining ability and heterosis for plant height, number of bolls per plant, boll weight, lint index, ginning outturn and seed cotton yield. The results showed that the hybrids P_1 x P_4, P_3 x P_5, P_4 x P_5, P_5 x P_6 and P_5 x P_7 had significantly positive mid parents and higher parent heterosis for a larger number of characters. Significant variances of genotype, parents vs crosses, general combining ability (gca) and specific combining ability (sca) were observed for all studied characters. Almost additive genetic variance was preponderant for plant height, boll weight, ginning outturn and seed cotton yield and non-additive gene action was involved in the number of bolls per plant and lint index. The two cultivars Coker 310 and Lachata, and the crosses P_1 x P_4 and P_5 x P_7 exhibited significant positive gca and sca effects respectively for a larger number of characters, and were found to be the best general and specific combiners, and could be used for future breeding programmes.

Key words: genotypes, heterosis, combining ability, upland cotton.

1. INTRODUCTION

Cotton as a commercial crop has played an important role in boosting national economy of several countries, and provides fiber, food, feed and fuel to high percentage of people as well as livestock (Ahmad *et al.*, 2005). The increase in yield per unit area of the crop is a prime concern of breeding programmes, and cotton breeders all over the world. They have been utilizing genetic resources to modify the cultivars to meet the ever changing requirements of their society. The first step in a successful breeding programme is to select appropriate parents. Diallel analysis provides a systematic approach for the detection of appropriate parents and crosses superior in terms of the investigated traits (Basal and Turgut, 2003). It also helps plant breeders to choose the most efficient selection method by allowing them to estimate several genetic parameters (Verhalen and Murray, 1967).

Heterosis is the superiority in performance of hybrid individuals compared with their parents. Regarding previous studies on heterosis in cotton, Salam (1991), Altaf *et al.* (1996) and Abro *et al.* (2009) conducted such studies for yield contributing characters and reported promising heterosis for yield parameters, and through heterosis, seed cotton contributing characters can be improved significantly (Naquibullah *et al.*, 2000).

Combining ability describes the breeding value of parental lines to produce hybrids. Sprague and Tatum (1942) used the term general combining ability (gca) to designate the average performance of a line in hybrid combinations, and used the term specific combining ability (sca) to define those cases in which certain combinations do relatively better or worse than the expected on the basis of the average performance of the lines involved.

In order to choose appropriate parents and crosses, and to determine the combining abilities of parents in the early generations, the diallel analysis method has been widely used by plant breeders. This method was applied to improve self and cross-pollinated plants (Jinks and Hayman, 1953; Hayman, 1954; Jinks, 1956; Griffing, 1956; and Hayman, 1960). The importance of combining ability studies lies in the assessment of of parental lines and their hybrids showing significant additive and non additive effect with respect to certain characters. In a systematic breeding programme, it is essential to identify superior parents for hybridization and crosses to expand the genetic variability for selection of superior genotypes (Inamullah *et al.* 2006).

The present study with 7 x 7 diallel cross was undertaken for isolating superior cultivars and better combining parents for suitable hybrids.

2. MATERIALS AND METHODS

Seven cultivars of upland cotton (Halab 90 = P_1, SP 8886 = P_2, Dunn 1517 = P_3, Coker 5114 = P_4, Lachata = P_5, Dunn 1047 = P_6 and Coker 310 = P_7) were mated in a diallel fashion excluding the reciprocals during the season of 2006. The resulting 21 F_1s and their parents were planted at Al-Haweja, Karkuk Governorate, Iraq, in mid April, 2007 using a randomized complete block design with three replications. Each plot consisted of three rows of 5 m length. The spacing between rows was 75 cm and plant to plant was 25 cm. One plant per hill was maintained. Fertilizers were applied at the rate of 200 kg/hectare P_2O_5 before planting, and 200 kg/hectare N as urea at twice, the first time after germination and the second at the beginning of flowering.

Observations were recorded on ten randomly selected guarded plants from each plot for plant height (cm), number of bolls per plant, boll weight (gm), lint index (gm fiber per 100 seeds), ginning outturn (ratio of fiber cotton weight in the sample to the seed cotton yield as percentage) and seed cotton yield per plant (gm).

Data of the genotypes (parents and their F_1s) were subjected to analysis of variance for all the characters studied according to the method of experimental design used, and comparisons between means were done according to Duncan's Multiple Range Test method (Steel and Torrie, 1980). General combining ability (gca) and specific combining ability (sca) effects were estimated by following Model – 1, method 2 of Griffing (1956). The mean squares for gca and sca were tested against error variance desired. Mid parent (MP) and higher parent (HP) heterosis (Halluer and Miranda, 1981) values were calculated by using the means of the parents and F_1s and through the formulas: $(F_1 - MP) / MP$ and $(F_1 - HP) / HP$, respectively. All statistical analyses were performed by using SAS (Statistical Analyses System V. 9) and Microsoft Office Excel 2003.

3. RESULTS AND DISCUSSION

Mid parent heterosis and higher parent heterosis for different characters in cotton are presented in Table (1). For plant height, the cross P_1 x P_6 has the highest positive (desirable) heterosis over the both higher parent and mid parents. Heterosis over mid parent was found in the range of -15.4% to 79%. The crosses P_2 x P_4, P_3 x P_4 and P_4 x P_7 showed significant and negative (undesirable) heterosis over the higher parent as well as mid parents, while the estimates of heterosis were significantly positive in fourteen of the crosses. Heterosis over higher parent for the numbers of bolls per plant ranged from -33.4% to 48.3%. Significant positive heterosis over both higher parent and mid parents was observed in crosses P_1 x P_6, P_1 x P_7, P_4 x P_5, P_4 x P_6, P_4 x P_7, P_5 x P_6, P_5 x P_7 and P_6 x P_7, with highest percents in the cross P_4x P_5. Nine crosses showed significantly negative heterosis over both higher parent and mid parents. For boll weight, significant positive heterosis was observed in the crosses P_1 x P_3, P_1 x P_5, P_2 x P_4 and P_3 x P_5 over higher parent as well as mid parents, while the crosses P_3 x P_6, P_4 x P_6 and P_6 x P_7 showed significant negative heterosis. Heterosis of lint index over higher parent and mid parents varied from -25.2% to 13.6% and -24.9 to 8.16% respectively. The cross P_1 x P_6 showed significant positive heterosis over higher parent and mid parents, while significantly negative heterosis was observed in fourteen other crosses over higher parent and mid parents for this character. The highest heterosis percents over higher parent and mid parents were exhibited by the crosses P_2 x P_7 and P_3 x P_4 respectively. For ginning outturn, the crosses P_1 x P_4, P_1 x P_7, P_2 x P_4, P_2 x P_5, P_3 x P_6, P_3 x P_7, P_4 x P_5, P_4 x P_6, P_5 x P_6 and P_5 x P_7 showed significant positive heterosis, and the crosses P_1 x P_2, P_1 x P_5, P_1 x P_6 and P_2 x P_7 showed significant negative heterosis over higher and mid parents. The highest percentages of heterosis over mid parents and higher parent were exhibited by the crosses P_5 x P_6 and P_4 x P_5 respectively. The crosses P_1 x P_4, P_1 x P_5, P_2 x P_7, P_3 x P_5, P_4 x P_5, P_5 x P_6 and P_5 x P_7 showed significant and positive heterosis for seed cotton yield per plant, over better parent and mid parents, while significantly negative heterosis was exhibited by the crosses P_1 x P_3, P_2 x P_3 and P_3 x P_7. The cross P_4x P_5 has the highest percent of mid parent heterosis and better parent heterosis. These findings are supported by other researchers like Khan *et al.* (1999), Mukhtar and Khan (2000), Solangi *et al.* (2002), Abro *et al.*

Table (1): Heterosis over mid parents and higher parent (%) for different characters for 21 crosses in upland cotton.

cross	Plant height		No. bolls per plant		Boll weight		Lint index		Ginning outturn		Seed cotton yield	
	MP	HP	MP	HP	MP	HP	MP	HP	MP	HP	MP	HP
P_1x P_2	61.9**	40.9**	0.689	-4.84**	11.1**	-0.79	3.70**	-0.59	-3.63**	-3.77**	11.1**	-5.59*
P_1x P_3	20.2**	-7.2**	-25.4**	-33.4**	27.3**	20.9**	-12.2**	-12.7**	1.03**	0.09	-5.65*	-19.5**
P_1x P_4	27.7**	-4.2**	5.53**	1.78	15.9**	3.15	5.47**	-0.65	6.81**	2.19**	22.9**	13.0**
P_1x P_5	22.7**	4.00**	3.50**	-2.62*	18.8**	4.62*	-4.94**	-8.88**	-0.99**	-5.67**	24.0**	15.5**
P_1x P_6	79.0**	63.9**	11.58**	3.77**	1.19	-16.9**	4.43**	2.48*	-3.26**	-5.57**	14.8**	0.29
P_1x P_7	17.5**	-9.4**	12.14**	11.09**	8.24**	-11.5**	-24.9**	-25.2**	9.74**	8.57**	21.7**	0.17
P_2x P_3	30.6**	13.3**	-28.1**	-32.3**	5.93**	-0.79	-15.3**	-18.3**	0.98**	0.19	-23.5**	-23.9**
P_2x P_4	-5.4**	-20.8**	-8.46**	-16.4**	13.8**	13.4**	-15.0**	-23.1**	7.37**	2.58**	4.22*	-4.47*
P_2x P_5	33.3**	29.2**	-3.39**	-13.8**	3.13	1.54	-7.69**	-7.69**	13.2**	7.74**	-0.11	-9.60**
P_2x P_6	48.3**	40.3**	-5.49**	-16.6**	3.57*	-5.84**	-7.88**	-10.1**	2.19**	-0.39	-0.81	-4.01
P_2x P_7	6.28**	41.1**	-4.37**	-10.4**	12.8**	1.92	-9.59**	13.6**	-0.74**	-1.66**	8.64**	4.56*
P_3x P_4	-15.4**	-18.9**	-21.6**	-32.2**	9.71**	2.39	8.16**	1.27	2.78**	-2.54**	-13.0**	-4.92
P_3x P_5	15.9**	3.44**	11.1**	-5.92**	20.0**	10.8**	-17.2**	-20.1**	4.65**	-1.17**	35.4**	23.1**
P_3x P_6	23.7**	2.47**	-4.51**	-19.9**	-3.79*	-17.5**	-11.9**	-13.1**	9.74**	6.15**	-5.09*	-2.38
P_3x P_7	13.2**	12.8**	-12.7**	-22.7**	3.01	-12.2**	1.61	0.64	6.19**	6.04**	-8.05**	-11.9**
P_4x P_5	20.1**	3.18**	52.2**	48.3**	1.95	0.77	-11.1**	-19.5**	12.4**	11.9**	55.1**	52.9**
P_4x P_6	47.9**	18.5**	13.8**	9.57**	-4.63*	-12.9**	-13.4**	-19.9**	6.67**	4.49**	8.92**	2.98
P_4x P_7	-7.1**	-10.7**	9.31**	6.39**	7.42**	-2.56	-0.34	-5.84**	2.83**	-2.63**	17.1**	3.69
P_5x P_6	48.2**	36.1**	13.8**	12.3**	11.9**	3.25	-13.3**	-15.4**	13.6**	10.8**	27.51**	18.9**
P_5x P_7	22.3**	8.79**	28.9**	22.4**	7.69**	-1.28	-3.41**	-7.69**	6.87**	0.78**	38.2**	20.8**
P_6x P_7	12.6**	-6.97**	23.8**	16.1**	-13.5**	-14.1**	-7.30**	-9.32**	4.03**	0.49	6.95**	-0.26

(**) and (*) significant at 5% and 1% levels respectively.

P_1=Halab 90, P_2=SP 8886, P_3=Dunn 1517, P_4=Coker 5114, P_5=Lachata, P_6=Dunn 1047 and P_7=Coker 310

MP = mid parents HP = higher parent

(2009) who also reported a fair degrees of heterosis over mid parents and higher parent for different characters. From the previous information it is concluded that the hybrids P_1 x P_4, P_3 x P_5, P_4 x P_5, P_5 x P_6 and P_5 x P_7 have significantly positive heterosis over mid parents and higher parent for larger number of traits as compared with the other hybrids, and that the cultivar P_5 (Lachata) was shared a common factor in four of these hybrids.

Analysis of variance for the genotypes and combining ability (gca and sca) is presented in Table (2). Genotypes and parents vs. crosses mean squares were highly significant for all studied characters which indicate considerable distance among the genotypes and over all parents and crosses means respectively. Mean squares of gca and sca were also highly significant for all characters, which indicates additive and non additive types of the gene action involved in the manifestation of characters under study. These findings are in accordance with those of Zia-ul-Islam *et al.* (2001), Deshpande and Baig (2003) and Abro *et al.* (2009). The mean squares due to sca was much higher than gca for the number of bolls per plant and lint index which revealed the predominance of non additive gene action for controlling these characters. The higher magnitude of gca variance was found for boll weight and seed cotton yield which indicated predominance of additive gene action, while both additive and non additive gene action showed similar importance for plant height and ginning outturn. Ahmad *et al.* (2005) reported similar results for number of bolls per plant. Abro *et al.* (2009) also reported predominance of additive gene action for seed cotton yield per plant.

Table (2): Mean square due to genotypes, gca and sca for different characters in cotton.

Source of variation	d.f.	Plant height (cm)	No. bolls per plant	Boll weight (gm)	Lint index (gm)	Ginning outturn (%)	Yield (gm)
Reps.	2	0.202	0.922	0.004	0.002	0.037	26.06
Genotypes	27	750.9**	50.41**	0.659**	0.592**	8.046**	1527.7**
(Parents)	(6)	1248.02**	64.95**	1.461**	0.398**	8.228**	1182.2**
(Crosses)	(20)	369.05**	48.19**	0.379**	0.563**	6.461**	1540.2**
(P. vs crosses)	(1)	5405.9**	7.61**	1.463**	2.343**	38.66**	3351.1**
Error	54	0.105	0.286	0.017	0.007	0.016	21.284
gca	(6)	765.5**	17.97**	1.711**	0.417**	8.718**	2698.4**
sca	(21)	746.8**	59.68**	0.359**	0.642**	7.854**	1193.3**
Error	54	0.035	0.095	0.006	0.002	0.006	7.095
gca / sca		1.024	0.301	4.766	0.649	1.110	2.261

(**) and (*) significant at 5% and 1% levels respectively.

Table (3): Mean performance and gca effects (g_i) for different characters in cotton.

Parents		Plant height (cm)	No. bolls per plant	Boll weight (gm)	Lint index (gm)	Ginning outturn (%)	Yield (gm)
P_1	mean	54.50 f	31.867 c	3.300 d	5.167 c	33.50 b	105.09 e
	g_i	(- 9.527)*	(- 0.454)*	(- 0.358)*	(0.052)*	(- 0.242)*	(- 13.355)*
P_2	mean	73.50 d	35.800 b	4.200 b	5.633 a	33.60 b	150.35 b
	g_i	(- 3.171)*	(- 0.554)*	(- 0.014)	(0.141)*	(0.135)*	(- 3.051)*
P_3	mean	99.90 b	40.533 a	3.667 c	5.233 bc	34.13 a	148.67 bc
	g_i	(4.188)*	(0.453)*	(- 0.258)*	(-0.033)*	(0.650)*	(- 7.144)*
P_4	mean	109.0 a	29.600 d	4.233 b	4.567 d	30.60 d	125.30 d
	g_i	(6.722)*	(- 0.239)*	(- 0.036)*	(- 0.233)*	(- 0.694)*	(- 2.025)*
P_5	mean	78.33 c	28.100 e	4.333 b	5.633 a	30.33 d	121.77 d
	g_i	(- 0.485)*	(1.016)*	(0.112)*	(0.104)*	(- 0.449)*	(8.922)*
P_6	mean	65.57 e	27.400 e	5.133 a	5.367 b	31.90 c	140.65 c
	g_i	(- 0.234)*	(- 1.150)*	(0.183)*	(0.026)*	(- 0.235)*	(0.003)
P_7	mean	100.5 b	31.267 c	5.200 a	5.133 c	34.23 a	162.55 a
	g_i	(2.507)*	(0.928)*	(0.371)*	(- 0.056)*	(0.835)*	(16.650)*
P. means		83.043	32.081	4.295	5.248	32.614	136.342
SE (gi)		0.088	0.146	0.035	0.023	0.035	1.256

P_1=Halab 90, P_2=SP 8886, P_3=Dunn 1517, P_4=Coker 5114, P_5=Lachata, P_6=Dunn 1047 and P_7=Coker 310

Means of the studied characters (x) and gca effects (g_i) of the parents are given in Table (3). Duncan multiple range test showed significant differences between parent means for all the studied characters. While P_7 (Coker 310) significantly surpassed other parents for boll weight, ginning outturn and seed cotton yield, the parents Coker 5114, Dunn 1517 and Lachata had higher means for plant height, number of bolls per plant and lint index, respectively. These four parents showed also significant positive gca effects for the same characters.

Significant desirable gca effects were found in 3 cultivars for plant height, number of bolls per plant, boll weight and ginning outturn, 4 cultivars for lint index, and 2 cultivars for seed cotton yield. The two cultivars Coker 310 and Lachata exhibited significant positive (desirable) gca effects for 5 traits (plant height, number of bolls per plant, boll weight, ginning outturn and

Table (4): Mean performance and sca effects (S_{ih}) for different characters for 21 crosses in upland cotton.

Crosses		Plant height (cm)	No. bolls per plant	Boll weight (gm)	Lint index (gm)	Ginning outturn (%)	Yield (gm)
P_1x P_2	mean	103.60 h	34.07 e	4.167 g	5.600 a	32.33 i	141.95 de
	S_{ih}	(19.360)*	(2.472)*	(0.015)	(0.449)*	(- 1.349)*	(11.071)*
P_1x P_3	mean	92.757 n	27.00 k	4.433def	4.567 gh	34.17 f	119.72 f
	S_{ih}	(1.159)*	(- 5.609)*	(0.526)*	(- 0.410)*	(0.031)	(- 7.066)*
P_1x P_4	mean	104.40 g	32.43 fg	4.367d-g	5.133 cd	34.23 ef	141.63 de
	S_{ih}	(10.268)*	(0.524)*	(0.237)*	(0.356)*	(1.381)*	(9.728)*
P_1x P_5	mean	81.47 r	31.03 i	4.53 de	5.133 cd	31.60 j	140.68 de
	S_{ih}	(- 5.458)*	(- 2.131)*	(0.256)*	(0.019)	(- 1.497)*	(- 2.169)
P_1x P_6	mean	107.47 e	33.07 f	4.267fg	5.500 a	31.63 j	141.07 de
	S_{ih}	(20.289)*	(2.069)*	(- 0.081)	(0.464)*	(- 1.679)*	(7.137)*
P_1x P_7	mean	91.07 o	35.40 d	4.600bcd	3.867 j	37.17 a	162.83 c
	S_{ih}	(1.149)*	(2.324)*	(0.063)	(- 1.088)*	(2.784)*	(12.256)*
P_2x P_3	mean	113.20 b	27.43 k	4.167 g	4.600 gh	34.20 ef	114.31 f
	S_{ih}	(15.245)*	(- 5.069)*	(- 0.085)	(- 0.466)*	(- 0.375)*	(- 22.777)*
P_2x P_4	mean	86.33 q	29.93 j	4.800 bc	4.333 i	34.47 d	143.65 de
	S_{ih}	(- 14.156)*	(- 1.876)*	(0.326)*	(- 0.532)*	(1.236)*	(1.440)
P_2x P_5	mean	101.23 k	30.87 i	4.400d-g	5.200bcd	36.20 b	135.91 e
	S_{ih}	(7.952)*	(- 2.198)*	(- 0.222)*	(- 0.003)	(2.725)*	(- 17.239*)
P_2x P_6	mean	103.13 i	29.87 j	4.833 b	5.067 d	33.47 h	144.33 de
	S_{ih}	(9.599)*	(- 1.031)*	(0.141)*	(- 0.058)	(- 0.223)*	(0.093)
P_2x P_7	mean	92.47 n	32.07 gh	5.300 a	4.867 e	33.67 g	169.96 c
	S_{ih}	(- 3.808)*	(- 0.909)*	(0.419)*	(- 0.177)*	(- 1.094)*	(9.079)*
P_3x P_4	mean	88.33 p	27.50 k	4.333efg	5.300 b	33.27 h	119.14 f
	S_{ih}	(- 19.514)*	(- 5.317)*	(0.104)*	(0.608)*	(- 0.479)*	(- 18.973)*
P_3x P_5	mean	103.33 hi	38.13 b	4.800 bc	4.500 h	33.73 g	183.05 b
	S_{ih}	(2.693)*	(4.061)*	(0.422)*	(- 0.529)*	(- 0.256)*	(33.993)*
P_3x P_6	mean	102.37 j	32.43 fg	4.233 fg	4.667 fg	36.23 b	137.30 de
	S_{ih}	(1.475)*	(0.528)*	(- 0.215)*	(- 0.284)*	(2.029)*	(- 2.841)
P_3x P_7	mean	113.40 b	31.33 hi	4.567cde	5.267 bc	36.30 b	143.09 de
	S_{ih}	(9.768)*	(- 2.650)*	(- 0.070)	(0.397)*	(1.025)*	(- 13.695)*
P_4x P_5	mean	112.47 c	43.90 a	4.367d-g	4.533 gh	34.23 ef	191.62 a
	S_{ih}	(9.292)*	(10.520)*	(- 0.233)*	(- 0.295)*	(1.588)*	(37.444)*
P_4x P_6	mean	129.17 a	32.43 fg	4.467def	4.300 i	33.33 h	144.84 d
	S_{ih}	(25.740)*	(1.220)*	(- 0.204)*	(- 0.451)*	(0.473)*	(- 0.418)
P_4x P_7	mean	97.30 l	33.27 f	5.067 a	4.833 e	33.33 h	168.55 c
	S_{ih}	(- 8.867)*	(- 0.024)	(0.207)*	(0.164)*	(- 0.597)*	(6.639)*
P_5x P_6	mean	106.63 f	31.57 hi	5.300 a	4.767 ef	35.33 c	167.31 c
	S_{ih}	(10.415)*	(- 0.902)*	(0.481)*	(- 0.321)*	(2.229)*	(11.099)*
P_5x P_7	mean	109.33 d	38.27 b	5.133 a	5.200bcd	34.50 d	196.43 a
	S_{ih}	(10.374)*	(3.720)*	(0.126)*	(0.194)*	(0.325)*	(23.579)*
P_6x P_7	mean	93.50 m	36.30 c	4.467def	4.867 e	34.40 de	162.14 c
	S_{ih}	(- 5.711)*	(3.920)*	(- 0.611)*	(- 0.062)	(0.010)	(- 1.799)
Crosses means		101.569	32.776	4.600	4.862	34.181	150.929
SE (Sij)		0.249	0.412	0.099	0.064	0.099	3.551

P_1=Halab 90, P_2=SP 8886, P_3=Dunn 1517, P_4=Coker 5114, P_5=Lachata, P_6=Dunn 1047 and P_7=Coker 310

seed cotton yield) and 4 traits (number of bolls per plant, boll weight, lint index and seed cotton yield) characters respectively. These could be used as donor parents for the above mentioned characters in hybridization programmes. Other cultivars exhibited good gca for 1 to 3 characters and could be used for improvement of these characters. Hassan *et al.* (2000), Ahmad *et al.* (2005) and Abro *et al.* (2009) reported that the best performance parents with high gca produce the best hybrid combinations.

The sca effects and means of the crosses for different characters are presented in Table 4. The crosses P_4 x P_6, P_4 x P_5, P_5 x P_6, P_1 x P_2, P_1 x P_7 and P_5 x P_7 showed significantly higher mean performance for plant height, number of bolls per plant, boll weight, lint index, ginning outturn and seed cotton yield, respectively, and at the same time they have positive desirable mid parents heterosis, and also five of them (excluding P_1 x P_2) showed positive desirable heterosis over higher parent. The crosses P_1 x P_4 and P_5 x P_7 showed significantly positive sca effects for all the studied characters. Six crosses viz, P_1 x P_2 and P_1 x P_6 (for lint index), P_3 x P_5 (for number of bolls per plant), P_3 x P_7 (for number of bolls per plant and ginning outturn), P_5 x P_6 (for number of bolls per plant) and P_5 x P_7 (for number of bolls per plant and seed cotton yield) involved high x high interaction of gca of the parents, while some other crosses involved low x high or low x low interactions.

The crosses P_1 x P_7, P_2 x P_5 and P_6 x P_7, although showing high mean performance for boll weight, lint index seed cotton yield, respectively, did not show significant or desirable sca effect. This indicats that high mean performance value per se of the cross may not necessarily indicate their potentiality in crosses. Moll and Stuber (1974) reported that any combination among the parents may produce higher hybrid vigor over parents, which might be due to dominant, over dominant or epistatic gene action. So, the crosses showing desirable sca effects can be used in future breeding programme.

It was concluded that cultivars P_5 (Lachata) and P_7 (Coker 310) being good general combiners for most of the characters (number of bolls per plant, boll weight, lint index and seed cotton yield) and (plant height, boll weight, ginning outturn and seed cotton yield), respectively, can be considered good breeding materials to be exploited in breeding programs for the improvement of these characters, while the crosses P_1 x P_4 (Halab 90 x Cocker 5114) and P_5 x P_7 (Lachata x Coker 310) exhibited significant desirable specific combining ability for all studied characters. However, the crosses P_1 x P_4 (Halab 90 x Cocker 5114), followed by P_5 x P_7 (Lachata x Coker 310) exhibited high positive heterosis over mid parents and higher parent for most of the studied characters, and could be exploited in producing hybrid cotton.

4. REFERENCES

Abro S., Kandhro M. M., Laghari S., Arain M. A. and Deho Z. A. (2009). Combining ability and heterosis for yield contributing traits in upland cotton (*G. hirsutum* L.). Pak. J. Bot., 41(4): 1769-1774.

Ahmad R. D., Malik A. J., Hassan G. and Subhan M. (2005). Estimation of combining ability for seed cotton yield and its components in inter–varietal crosses of cotton. Camal Univ. J. of Res., 21: 1-6.

Altaf M., Sadaqat H. A., Khan M.A. and Ubair M. Z. (1996). Genetic variability and correlation studies in some promising cotton strains under cotton leaf curl virus epidemic. The Pak. Cottons, 40(3- 4): 80-90.

Basal T. and Turgut I. (2003). Heterosis and combining ability for yield components and fiber quality parameters in half diallel cotton (*G. hirsutum* L.). Turk. J. Agric., 27: 207-212.

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

Griffing J.B. (1956). Concept of general and specific combining ability in relation to diallel crossing system. Austral. J. Biol. Sci., 9: 463-493.

Halluer A. R. and Miranda J. B. (1981). Quantitative genetics in maize breeding. Iowa State Univ. Press, Ames, USA.

Hassan G., Mahmood G., Razzaq A. and Hayatullah (2000). Combining ability in inter-varietal crosses of upland cotton. Sarhad J. Agri., 16(4): 407-410.

Hayman B.I. (1954). The theory and analysis of diallel crosses. Biometrics, 10: 235-244.

Hayman B.I. (1960). The theory and analysis of diallel crosses III. Genetics, 45: 155-172.

Inamullah H. A., Muhammad F., Sirajuddin G. Hassan G. and Gul R. (2006). Evaluation of heterotic and heterobeltiotic potential of wheat genotype for improved yield. Pak. J. Bot., 38(4): 1159-1168.

Jinks J. L. (1956). The F_2 and backcross generation from a set of diallel crosses. Heredity 10: 1-30.

Jinks J. L. and Hayman B. I. (1953). The analysis of diallel crosses. Maize Genet. Coop. News Letter, 27: 48-54.

Khan N. U., Abro H. K., Kumbhar M. B., Hassan G. and Khan M. (1999). Study of heterosis in upland cotton - 1. Quality traits. The Pak. Cotton, 43(3-4): 53-64.

Moll R. H. and Stuber C.W. (1974). Quantitative genetics empirical results relevant to plant breeding. Ad. Agron. J., 26: 277-313.

Mukhtar M. S. and Khan T. M. (2000). Estimation of heterosis for yield and its components in cotton. Pak. J. Bio. Sci., 3: 1412-1413.

Naquibullah H., Abro K., Lumbhar M. B., Hassan G. and Mahmood G. (2000). Study of heterosis in upland cotton–II. Morphology and yield traits. The Pak. Cottons, 44 (1-2): 13-23.

Salam C. A. (1991). Status of itnra-specific commercial hybrids in Punjab. The Pak. Cottons, 35 (1): 5-17.

Solangi M., Baloch H., Bhutto H., Lakho A. R. and Solangi M. H. (2002). Hybrid vigour in intraspecific crosses of F1 hybrids of *G. hirsutum* x *G. barbadense*. Pak. J. Bio. Sci., 4: 945- 948.

Sprague G. F. and Tatum L. A. (1942). General vs specific combining ability in single crosses of corn. J. American Soc. Agron., 34: 923–52.

Steel R. G. D. and Torrie J. H. (1980). Principles and Procedures of Statistics. (2^{nd} ed.). McGraw Hill Inc., New York.

Verhalen L. M. and Murray J. C. (1967). A diallel analysis of several fiber properties traits in upland cotton (*G. hirsutum* L.). Crop. Sci. 7: 501-505.

Zia-ul-Islam H., Sadaquat A. and Khan F.A. (2001). Combining ability of some *hirsutum* cotton types for economic traits. International J. of Agric. and Biol., 3 (4): 411-412.

قوة الهجين والقدرة على الائتلاف في الهجن التبادلية بين أصناف من القطن الابلند

خالد محمد داؤد ــ خالد خليل الجبوري*
كلية الزراعة والغابات ــ جامعة الموصل ــ *كلية الزراعة ــ جامعة كركوك - العراق

ملخص

زرعت سبعة أصناف من القطن الابلند (حلب ٩٠ وسبيرو ٨٨٨٦ ودن ١٥١٧ وكوكر ٥١١٤ ولاشاتا ودن ١٠٤٧ وكوكر ٣١٠) وهجنها التبادلية ما عدا الهجن العكسية في الحويجة بمحافظة كركوك خلال موسم ٢٠٠٧ باستخدام تصميم القطاعات العشوائية الكاملة بثلاثة مكررات. اعتمدت البيانات التي سجلت من التهجين التبادلي في تقدير القدرة على الائتلاف وقوة الهجين لصفات ارتفاع النبات وعدد اللوز بالنبات ووزن اللوزة ودليل التيلة وتصافي الحليج وحاصل القطن الزهر بالنبات. أظهرت النتائج أن الهجن (حلب ٩٠ x كوكر ٥١١٤) و (دن ١٥١٧ x لاشاتا) و (دن ١٥١٧ x لاشاتا) و (لاشاتا x دن ١٠٤٧) و (لاشاتا x كوكر ٣١٠) كان لها قوة هجين موجبة ومعنوية قياساً إلى متوسط الأبوين والأب الأعلى لأكبر عدد من الصفات التي درست. كان التباين الراجع للتراكيب الوراثية وللآباء مقابل الهجن وللقدرة العامة والخاصة على الائتلاف عالي المعنوية للصفات جميعها. كان التباين الوراثي المضيف هو الأرجح لصفات ارتفاع النبات ووزن اللوزة وتصافي الحليج وحاصل القطن الزهر بالنبات، وان الفعل الجيني غير المضيف كان مسيطراً على وراثة صفتي عدد اللوز بالنبات ودليل التيلة. ظهر للصنفين كوكر٣١٠ ولاشاتا وللهجينين (حلب ٩٠ x كوكر ٥١١٤) و (لاشاتا x كوكر ٣١٠) تأثيرات معنوية وموجبة للقدرة العامة والخاصة على الائتلاف على التوالي لأكبر عدد من الصفات التي درست، وانه يمكن استخدامها في برامج التربية المستقبلية.

المجلة العلمية لكلية الزراعة – جامعة القاهرة – المجلد (٦١) العدد الأول (يناير ٢٠١٠):١-٧.