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COMBINING ABILITY AND HETEROSIS STUDIES FOR YIELD AND ITS COMPONENTS IN OKRA (*Abelmoschus esculentus* (L.) MOENCH).

Rashwan, A.M.A.
Dept. of Hort. (Vegetable Crops), Fac. of Agric., South Valley Univ., Qena, Egypt.

ABSTRACT

The present investigation was carried out at South Valley University Experimental Farm during the two summer seasons of 2007 and 2008 using 8×8 half diallel cross. The objectives of this investigation were two study combining ability and heterosis of okra. Highly significant differences were found among parents and their F_1 hybrids for all the studied traits. Both general combining ability (GCA) and specific combining (SCA) variance were highly significant for all the studied traits. The mean squares for GCA were greater in magnitude than SCA value. Among parents, Balady and Pusa Sewani cvs. were the best combiner for total green fruit yield, number of branches, diameter at mid-green fruit fruit length and plant height traits; Iraqi and White Velvet cvs. for days to 50% flowering, White Velvet cv. for weight of green fruit; Pusa Sewani for number of green fruit. However, in specific combining ability study, the cross (Escandrany x Iraqi) and (White Velvet x Pusa Sewani) were the best for total green fruit yield, number of fruits/plant, number of branches/plant and plant height; (Escandrany x Pusa Sewani) and (Escandrany x Dot) for weight fruit and total green fruit yield, number of green fruit and number of branches; (Clemson Spineless x Iraqi), (Balady x Escandrany) and (Pusa Sewani x Iraqi) for days to 50% flowering, diameter at mid-green fruit and weight of green fruit. Heterosis over mid-parent was found for total green fruit yield and its components.

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) is considered one of the most favorable vegetables in Egypt. It is grown as summer crop, primarily for the immature fruits which are used fresh, cannaed, frozen or in dry state. Okra fruit has high nutrition value. It contains protein, fats, carbohydrates, oil, mineral, fibers and vitamins (Watt and Merril, 1963).

Combining ability of the parents is becoming increasingly important in plant breeding, especially in hybrid production. It is useful in connection with the testing procedures in which it is desired to study and compare the performance of the line in hybrid combination. Information on the general and specific combining abilities will be helpful in the analysis and interpretation of the genetic basis of important traits. In okra studies on this aspect have been made by many workers [Nassar *et al*. (1983); Partap and Dhankhar (1983); Vijay and Manohar (1986); Poshiya (1986a); Jawili and Rasco (1990); Ali (1995); Ahmed (2001); Abbas (2006); Srivastava *et al*. (2008)].

Heterosis is a special genetic mechanism wherein the distant genotypes are brought together in a specific pattern to express their ability to make a dramatic shift in the magnitude of a particular trait. In okra, heterosis

has been reported for yield and other yield related traits by Partap *et al*. (1981); Poshiya (1986b); Shukla *et al.* (1989); El-Gazar *et al*. (1988); Mohamed *et al*. (1994); Ahmed (2001); Dhankhar and Dhankhar (2001); Nandan Mehta (2007).

Hence, the present study was undertaken with a view to assess the combining ability of eight genetically divergent lines of okra in a diallel analysis.

MATERIALS AND METHODS

The present genetic study was carried out at the Experimental Farm of the Faculty of Agriculture, South Valley University, Qena Governorate, Egypt, during the summer season of 2007 and 2008. The soil type was clay loam.

Eight genotypes (*Abelmoschus esculentus* (L.) Moench), provided by Prof. Dr. A. M. Damarany were used as parents [inbreed line seeds (s_1)] in this investigation.

Table (1): The general characteristics of The Eight Parents of okra used in The Present study .

No.	Genotypes	Coloure of fruit	Leaf Shape	Flowering	Plant height
1	(P1) Balady	Dark green	Lobed	Eaely	Long
2	(P2) Esscandrany (Escand)	Green	Lobed	Medium	Medium
3	(P3)Clemson Spineless (Clm.s.)	Green	Very Lobed	medium	short
4	(P4) Emerald	Dark green	Palmately	medium	short
5	(P5) White Velvet (White V.)	Light green	Loped	medium	medium
6.	(p6) Pusa Sewani (Pusa S.)	Green	Loped	Eaely	Long
7	(p7) Dot	Green	Semei– Loped	late	medium
8	(P8) Iraqi	Whit green	Loped	late	long

Source: Prof. Dr . A.M .Damarany ,Hort . Dept ., Faculty of Agric., South Valley Univ .

In 2007, March 10, the eight cultivates each presented by ten plants, were planted crossed with a diallel fashion without reciprocals.

In 2008, March 10, seeds of the 8 parents genotypes and The 28 F_1 hybrids were planted in the field and arranged in a randomized complete block design with three replications. Each replicate was represented by 28 plots of F_1 hybrids and 8 plots of parents. Each plot consisted of one row, 3 m. long and 0.7 m. wide. The seeds were planted in hill spaced 30 cm apart. Thinning to one plant/hill was done after 25 days from sowining.

The normal agriculture practice of irrigation, fertilization, weed and pest control were practiced as recommended for okra production. Harvesting of green fruits took place during the period May 10–July 20 every 2 days-intervals.

Data were taken on 5 to 10 plants and on 10 fruits every two days.

Measurements:

The following characters were studied:

1- Days to flowering: recorded as number of days from planting to 50% of the plants that were in bloom.

2- Plant height in cm: was measured from the cotyledonary to the terminal bud of the main stem at the end of the picking season.
3- Number of branches per plant: counted also at the end of the picking season.
4- Number of green fruits per plant: total number of edible fruits that were picked per plant during the growing season.
5- Total green fruit yield (ton/feddan): weight of all edible fruits that picked (harvested) all over the growing season.
6- fruit length (cm).
7- Fruit diameter (cm): measured at mid-green fruit.
8- Weight of green fruits per plant (g).

Statistical procedure:

General and specific combining ability:

Statistical analysis was made on an entry mean basis. The variation among parents and F_1 crosses was partitioned into general and specific combining ability as illustrated by Griffing (1956), Method (2), Model 1.

Heterosis %:

The heterosis % expressed by the F_1 hybrid and mid parent ($\overline{MP}$) was calculated according to Singh and Khanna (1975) as follows:

$$\text{The Heterosis \%} = \frac{\overline{F}_1 - \overline{MP}}{\overline{MP}} \times 100$$

$$\text{Where } \overline{MP} \text{ (mid parent)} = \frac{\overline{P}_1 + \overline{P}_2}{2}$$

RESULTS AND DISCUSSION

I – F_1 performance:

The analysis of variance among the different entries of the F_1 diallel crosses of studied traits revealed highly significant differences among genotypes as shown in table (2).

Table (2). The analysis of variance of all studied characters among the different entries of diallel in the growing summer season of 2008.

Source of variance	d.f	Days to flowering	Plant height (cm)	Number of branches/ plant	Number of green fruit/ plant	Total green fruit yield	Fruit length (cm)	Fruit diameter (cm)	Weight of fruit/ plant (g)
Replication	2	0.444	0.391	0.009	0.023	0.011	0.006	0.001	0.014
Genotypes	35	96.87**	474.86**	2.22**	45.96**	1.82**	20.95**	0.36**	3.15**
Error	70	0.616	0.3045	0.0180	0.0234	0.0273	0.005	0.0032	0.0052
GCA	7	431.352**	2014.238**	7.929**	167.458**	5.638**	76.522**	1.340**	9.563**
SCA	28	13.256**	90.009**	0.794**	15.587**	0.869**	7.066**	0.116*	1.550**
GCA/SCA	-	32.5:1	22.37:1	9.98:1	10.74:1	6.48:1	10.82:1	11.55:1	6.16:1
Error	70	0.6160	0.3045	0.018	0.0234	0.0273	0.005	0.0032	0.0052

*** and ** are significant at 0.05 and 0.01 level of probability, respectively.**

Days to flowering: The results in Table (3) showed that the average number of days to 50% flowering appearance for parents ranged from 42.33 days for P_1 (Balady) to 70.33 days for P8 (Iraqi). This is in agreement with Ahmed (2001) who found that parental mean values for this trait ranged from 41.33 to 71.33 day, with a grand mean. The average of F_1 crosses ranged from 47.33 days for the cross P_1xP_6 (Balady x Pusa S.) to 65 days for the cross P_3xP_8 (Clms.S. x Iraqi). These are in accordance with the findings of Jordan-Molero (1986), Damarany and Farag (1994), Ali (1995) and Abbas (2006).

Table (3)|: Mean performance of parents and hybrids in the growing summer season of 2008.

Genotypes	Days to 50% flowering	Plant height (cm)	Number of branches / plant	Number of green fruit/ plant	Total green fruit yield (ton/fed)	Fruit length (cm)	Fruit diameter (cm)	Weight of fruit(g)
Parents								
P_1	42.33	81.53	3.61	11.23	7.250	5.80	2.30	4.70
P_2	57.67	62.70	1.50	7.40	5.717	6.40	1.90	6.01
P_3	57.00	52.80	2.40	10.50	6.317	10.50	1.80	5.45
P_4	51.33	50.03	2.31	15.77	6.880	11.50	1.35	6.53
P_5	57.33	78.37	1.90	10.53	5.900	10.21	1.20	8.33
P_6	48.00	88.63	3.05	18.77	7.233	8.23	1.75	5.75
P_7	60.00	57.73	4.11	11.23	7.017	4.53	1.46	6.45
P_8	70.33	84.93	3.06	9.50	6.050	5.45	2.06	5.51
Means	**55.49**	**69.59**	**2.74**	**11.86**	**6.54**	**7.82**	**1.73**	**6.09**
L.S.D 0.05	**1.41**	**0.93**	**0.36**	**0.50**	**0.43**	**0.16**	**0.11**	**0.14**
P_1xP_2	80.00	74.77	2.17	9.30	6.450	7.02	1.92	6.65
$P_{1x}P_3$	54.00	68.53	2.78	11.47	7.500	11.35	1.83	5.85
$P_{1x}P_4$	51.00	65.32	2.78	17.30	7.900	11.78	1.60	6.81
$P_{1x}P_5$	55.00	79.53	2.09	11.43	6.300	10.35	1.45	8.83
$P_{1x}P_6$	47.33	84.73	3.41	21.30	8.383	8.35	1.81	5.93
$P_{1x}P_7$	55.67	61.80	4.83	12.40	7.700	4.65	1.50	5.76
$P_{1x}P_8$	61.67	82.80	3.73	10.40	6.750	5.63	2.15	5.80
$P_{2x}P_3$	56.67	56.77	2.60	10.77	7.117	11.66	1.85	5.55
$P_{2x}P_4$	55.33	54.60	2.46	16.80	7.400	11.71	1.46	6.73
$P_{2x}P_5$	57.33	80.97	2.13	11.23	6.233	10.35	1.25	8.51
$P_{2x}P_6$	53.33	72.30	3.36	20.10	8.200	8.30	1.83	5.80
$P_{2x}P_7$	58.67	60.17	4.58	11.67	7.433	4.70	1.56	6.85
$P_{2x}P_8$	63.67	81.21	3.41	10.00	6.650	5.65	2.25	5.60
$P_{3x}P_4$	54.33	52.90	2.65	18.30	7.200	11.80	1.56	6.75
$P_{3x}P_5$	58.00	75.13	2.27	10.57	6.157	10.40	1.43	8.81
$P_{3x}P_6$	50.00	85.83	3.61	20.43	8.617	8.50	1.86	5.85
$P_{3x}P_7$	56.33	57.87	4.40	11.33	7.633	4.63	1.58	6.45
$P_{3x}P_8$	65.00	77.60	3.51	10.63	8.467	5.65	2.31	5.73
$P_{4x}P_5$	54.00	67.63	2.11	12.33	6.150	10.65	1.50	8.65
$P_{4x}P_6$	48.67	70.60	3.35	21.23	8.150	8.55	1.78	5.75
$P_{4x}P_7$	55.00	55.53	4.31	13.23	7.300	4.66	1.60	6.80
$P_{4x}P_8$	60.00	76.53	3.51	11.37	6.200	5.69	2.43	5.88
$P_{5x}P_6$	50.67	91.70	3.25	20.27	7.900	8.61	1.85	6.11
$P_{5x}P_7$	58.00	59.67	4.30	11.47	7.600	4.80	1.35	6.75
$P_{5x}P_8$	63.00	83.60	3.40	10.17	6.400	5.75	1.95	5.60
$P_{6x}P_7$	51.33	65.63	4.65	13.47	8.350	4.60	1.73	6.80
$P_{6x}P_8$	61.67	92.87	3.61	12.33	7.283	5.65	2.53	5.78
$P_{7x}P_8$	64.33	87.20	3.71	10.53	6.850	5.78	2.37	5.88
Mean	**56.24**	**72.27**	**3.32**	**13.63**	**7.22**	**7.75**	**1.79**	**6.54**
L.S.D 0.05	**1.28**	**0.89**	**0.22**	**0.25**	**0.27**	**0.12**	**0.09**	**0.12**

Plant height (cm): Mean plant height of the parents ranged from 50.03 cm P_4 (Emerald) to 88.63 cm for P_6 (Pusa S.) and from 52.90 cm for P_3xP_4 cross (Clms.S. x Emerald) to 92.67 cm P_6xP_8 (Pusa S. x Iraqi). Similar results in

okra were reported by Rao *et al*. (1989), Ahmed (2001), Khan *et al*. (2002), Abbas (2006).

Number of branches: The mean of the parents ranged from 1.5 for P_2 (Escandrany) to 4.12 for P_7 (Dot) and her too from 2.09 for P_1xP_5 (Balady x White Velvet) to 4.83 for P_1xP_7 (Balady x Dot). These results are in same line with Alok Nandi (1990), Ali (1995), Abbas (2001) and Indu Rani *et al*. (2003).

Number of green fruits/plant: the results in Table (3) showed that the mean number of green fruits/plant of the parents ranged from 7.4 for P_2 (Escandrany) to 18.77 P_6 (Pusa S.) and ranged from 9.3 for P_1xP_2 (Balady x Escandrany) to 21.30 for P_1xP_6 (Balady x Pusa S.). These results are in agreement with the findings of Damarany and Farag (1994), Ali (1995), Ahmed (2001) and Indu Rani *et al*. (2003).

Total green fruit yield (ton/feddan): Mean total green fruit yield of the parents ranged from 5.71 for P_2 (Escandrany) to 7.25 for P_1 (Balady) and from 6.15 for P_4xP_5 (Emerald x White Velvet) to 8.62 for P_3xP_6 (Clm.S. x Pusa S.). Similar results were obtained by Ali (1996), Ahmed (2001), Abbas (2001), Indu Rani *et al*. (2003) and Abbas (2006).

Fruit length (cm): Regarding green fruit length, its ranged from 4.53 (cm) to 11.5 (cm) for parents and ranged from 4.6 (cm) to 11.8 (cm) for F_1 hybrids. These are in accordance with the findings of Ahmed (2001), Khan *et al*. (2002), Indu Rani *et al*. (2003) and Adeniji and Kehinde (2007).

Fruit diameter (cm): The range of diameter green fruit varied from 1.2 cm for P_3 (White Velvet) to 2.3 cm for P_1 (Balady) and ranged from 1.25 cm for P_2xP_5 to 2.53 cm for P_6xP_8 among parents and hybrids, respectively. These results have been promoted by Ahmed (2001), Indu Rain *et al*. (2003) and Adeniji and Kehinde (2007).

Weight of green fruit(g): The mean weight of green fruits (gm) in Table 3 ranged from 4.7 (gm) for P_1 (Balady) to 8.33 for P_5 (White Velvet) and ranged 5.55 (gm) for P_2xP_3 (Escand. X Clm.S.) to 8.83 for P_1xP_5 (Balady x White Velvet). Similar results were reported by Jordan-Molero (1986), Ali (1996), Ahmed (2001), Khan *et al*. (2002) and Abbas (2006).

II- General and specific combining ability:

The variance due to GCA and SCA (Table 2) were significant indicating both additive and non-additive types of gene action in the inheritance of all studied traits. The obtained results are in line with those obtained by Ali (1995), Ahmed (2001) and Abbas (2006). The estimates of the GCA effects of the eight parents and the SCA effects of F_1 hybrids are presented in Table (4) and (5), prospectively.

Days to flowering: The parents P_2, P_7, P_8 and P_5 (Table 4) exhibited high significant positive GCA effect of 7.04, 1.43, 1.33 and 0.46 Abbas (2006) reported similar results while the hybrids P_1xP_2, P_6xP_8, P_1xP_5, P_1xP_7, P_1xP_8 and P_3xP_8 showed significant positive SCA effect of 6.01, 2.74, 1.97, 1.77 and 1.14 (Table 5) respectively. Thus, the cross P_1xP_2 was the best specific combination closely followed by P_6xP_8 and P_1xP_5. These results are in harmony with those obtained by Nassar *et al*. (1983), Poshiya (1986a), Ali (1996), Ahmed (2001) and Abbas (2006).

Plant height (cm): However, since the P8 had the highest GCA effect of 10.63 among the parents thus it was general combiner. The highest specific combination was P_7xP_8 (10.06) followed by P_3xP_6 (11.07) and P_5xP_6 (5.47). These results are in same with those reported by Partap and Dhankhar (1983), Rajani *et al*. (2001) and Srivastava *et al*. (2008).

Table (4). Estimates of general combining GCA effects of parents for all studied traits in the growing summer season 2008.

Characters \ Genotypes	(P1) Balady	(P2) Escand.	(P3) Clm.S.	(P4) Emerald	(P5) Emerald	(P6) Pusa S.	(P7) Dot	(P8) Iraqi	S.E. (g_i)	S.E. (g_i-g_j)
Days to flowering	-3.667**	1.433**	0.233	-2.500**	0.467**	-4.700**	1.333**	7.400**	0.134	0.202
Plant height (cm)	3.547**	-3.891**	-6.458**	-10.190**	4.989**	9.565**	-8.175**	10.639**	0.094	0.142
Number of branches	0.029**	-0.502**	-0.212**	-0.293**	-0.539**	0.261**	1.027**	0.229**	0.002	0.034
Number of green fruit/plant	-0.313**	-1.453**	-0.469**	2.291**	-1.066**	4.747**	-1.263**	-2.476**	0.026	0.040
Total green fruit yield (ton/fed.)	0.182**	-0.274**	-0.034	0.040	-0.512**	0.769**	0.324**	-0.496**	0.028	0.042
Fruit length (cm)	0.077**	0.223**	1.503**	1.788**	1.137**	-0.094**	-2.708**	-1.926**	0.014	0.020
Fruit diameter (cm)	0.089**	-0.006	0.006	-0.135	-0.302**	0.071**	-0.137**	0.414**	0.010	0.014
Weight of green fruits (g)	-0.197**	-0.028	-0.212**	0.243**	1.193**	-0.448**	0.118**	-0.670**	0.014	0.017

*** and ** are significant at 0.05 and 0.01 level of probability, respectively.**

Table (5). Specific combining ability for all studied traits in Okra in the growing summer season 2008.

Characters / Crosses	Days to 50% flowering	Plant height (cm)	Number of branches/ plant	Number of green fruit/plant	Total green fruit yield (ton/fed.)	Fruit length (cm)	Fruit diameter (cm)	Weight of fruit (g)
P_1xP_2	6.011**	3.435**	-0.549**	-2.179**	-0.531**	-1.048**	0.066*	0.429**
$P_{1x}P_3$	1.211	-0.204	-0.229**	-0.995**	0.278**	1.995**	-0.036	-0.188**
$P_{1x}P_4$	0.944	0.284	-0.149*	2.078**	0.604**	2.143**	-0.131**	0.324**
$P_{1x}P_5$	1.978**	-0.678*	-0.592**	-0.432**	-0.444**	1.361**	-0.115**	1.390**
$P_{1x}P_6$	-0.522	-0.054	-0.069	3.621**	0.359**	0.592**	-0.121**	0.132**
$P_{1x}P_7$	1.778**	-5.248**	0.581**	0.731**	0.120	-0.494**	-0.230**	0.339**
$P_{1x}P_8$	1.711**	-3.062**	0.280**	-0.055	-0.010	0.292**	-0.124**	0.220**
$P_{2x}P_3$	-1.222	-4.533**	0.118	-0.055	0.351**	2.166**	0.072*	-0.656**
$P_{2x}P_4$	0.178	-2.995**	0.066	2.718**	0.561**	1.927**	-0.170**	0.072
$P_{2x}P_5$	-0.789	8.193**	-0.021	0.508**	-0.054	1.214**	-0.220**	0.905**
$P_{2x}P_6$	0.378	-5.050**	0.412**	3.561**	0.632**	0.395**	-0.009	-0.170**
$P_{2x}P_7$	-0.322	0.557	0.862**	1.138**	0.310**	-0.591**	-0.075*	0.314**
$P_{2x}P_8$	-1.389*	2.783**	0.494**	0.685**	0.347**	0.422**	0.064*	-0.148**
$P_{3x}P_4$	0.378	-2.101**	-0.041	3.235**	0.120	0.734**	-0.082*	0.272**
$P_{3x}P_5$	1.078	4.954**	-0.171*	-1.142**	-0.371**	-0.015	-0.049	1.383**
$P_{3x}P_6$	-1.756**	11.077**	0.372**	2.911**	0.808**	-0.681**	0.005	0.064
$P_{3x}P_7$	-1.456**	0.851**	0.389**	-0.179*	0.270**	-1.937**	-0.094*	0.097*
$P_{3x}P_8$	1.144**	1.770**	0.304**	0.335**	-0.077	-1.702**	0.376**	0.169**
$P_{4x}P_5$	-0.189	1.159**	-0.247**	-2.135**	-0.451**	-0.051	0.159**	0.767**
$P_{4x}P_6$	-0.356	-0.451	0.186*	0.951**	0.268**	-0.920**	0.067*	-0.491**
$P_{4x}P_7$	-0.056	2.222**	0.386**	1.039**	-0.137	-2.189**	0.094**	-0.008
$P_{4x}P_8$	-1.122*	4.408**	0.385**	-1.692**	-0.417**	-1.944**	0.376**	-0.136**
$P_{5x}P_6$	-1.322*	5.471**	0.333**	3.341**	0.570**	-0.202**	0.103**	-1.075**
$P_{5x}P_7$	-0.022	-8.823**	0.616**	0.551**	0.715**	-1.405**	0.011	-1.008**
$P_{5x}P_8$	-1.089*	-3.703**	0.515**	0.465**	0.335**	-1.236**	0.059	-1.370**
$P_{6x}P_7$	-1.522**	-7.433**	0.166*	-3.262**	0.184*	-0.374**	0.022	0.684**
$P_{6x}P_8$	2.744**	0.787*	0.069	-3.182**	-0.063	-0.102*	0.270**	0.455**
$P_{7x}P_8$	-0.622	13.060**	0.835**	1.028**	-0.051	2.642**	0.315**	-0.011
SE (S_{ii})	0.496	0.288	0.07	0.080	0.086	0.038	0.030	0.037
SE (S_{ii}-S_{ik})	0.607	0.427	0.103	0.180	0.128	0.057	0.043	0.055
SE (S_{ii}-S_{ki})	0.573	0.403	0.097	0.112	0.120	0.053	0.041	0.052

*** and ** significantly at 0.05 and 0.01 level of probability, respectively.**

Number of branches: Parents, P_7 (1.02), P_6 (0.26) and P_8 (0.22) showed highly significant positive GCA effects. The best specific combination was displayed by P_2xP_7 (0.86) followed by P_7xP_8 (0.73) and P_5xP_7 (0.61) Table 5. Vijay and Manohar (1986), Ali (1995), Rajani *et al*. (2001) and Abbas (2001) reported that GCA and SCA effects were highly significant.

Number of green fruit/plant: Among the parents, P_6 (4.74) and P_4 (2.29) exhibited significant positive GCA effect while hybrids P_1xP_6 (3.62), P_2xP_6 (3.56), P_5xP_6 (3.34) and P_3xP_6 showed high significant positive SCA effect. Similar results were obtained by Partap and Dhankhar (1983), Shukla *et al*. (1989), Ahmed (2001) and Srivastava *et al*. (2008).

Total green fruit yield (ton/feddan): Highly significant positive GCA effect observed among parents, P_6 (0.76), P_7 (0.32) and P_1 (0.18). Manifested the best specific combination were the P_5xP_7 (0.72) followed by P_2xP_6 (0.63) and P_1xP_4 (0.60). These results are in agreement with those reported by Ali (1996), Poshiya (1986a), Ahmed (2001), Abbas (2006) and Srivastava *et al*. (2008).

Fruit length (cm): Three parents P_4, P_3 and P_5 showed highly significant positive GCA effect of 1.78, 1.50 and 1.13. The hybrids P_7xP_8, P_2xP_3 and P_1xP_4 showed highly significant positive SCA effect of 2.64, 2.16 and 2.14, respectively. Similar results were obtained by Nassar *et al*. (1983), Abbas (2001) and Adeniji and Kehinde (2007).

Fruit diameter (cm): Among the parents, P_8 had the best combiner with the highest GCA effect of (0.41) while the hybrids P_7xP_8, P_4xP_8, P_3xP_8 and P_6xP_8 showed highly significant positive SCA effect of 0.31, 0.37, 0.37 and 0.27, respectively. These results are in agreement with those reported by Vijay and Manohar (1986), Ahmed (2001), Abbas (2001) and Adeniji and Kehinde (2007).

Weight of green fruits (g): Three parents, P_5, P_6 and P_4 showed highly significant positive GCA effect of 1.19, 0.44 and 0.24. The bet specific combination were P_1xP_5 (1.39) followed by P_1xP_5 (1.39), P_3xP_5 (1.38) and P_2xP_5 (0.90). These results are in harmony with those reported by Partap and Dhankhar (1983), Ahmed (2001) and Abbas (2006).

III- Heterosis %:

Heterosis % value expressed as the percentage deviation from F_1 mean performance from mid-parent in the analysis are presented in Table 6.

Days to flowering: The heterosis % value ranged from (-4.94%) to (20.0%). The maximum heterosis was observed in cross "(Pusa S. x Dot)" (-4.94%), followed by the cross "Clm.S. x Pusa S." (-4.76%) and "Clm.S. x Dot" (-3.71%), while the heterosis % of cross "Balady x Escand." gave the lowest number of days to 50% flowering (20%). These results are in same line with those reported by El-Gazar *et al*. (1988), Shukla *et al*. (1989) and Ahmed (2001).

Plant height (cm): Heterosis above mid-parent ranged from (22.24%) to (0.08%). The maximum heterosis being in the cross "Dot x Iraqi" (22.24%) followed by "Clm.S. x Pusa S." (-12.31), while the heterosis of cross P_5xP_7 gave the lowest value (-12.31%). Poshya (1986b), Mohamed *et al*. (1994) and Abbas (2006) also reported similar results.

Table (6). Estimate of heterosis based on deviation from the respective mid-parent ($\overline{MP}$) of 28 F_1 crosses for all studied traits in summer 2008 season.

Entries and comparisons	Heterosis % ($\overline{MP}$)							
	Days to 50% flowering	Plant height (cm)	Number of branches/ plant	Number of green fruit/plant	Total green fruit yield ton/fed	Fruit length (cm)	Fruit diameter (cm)	Weight of fruit/ plant (g)
P_1xP_2	20.00	3.67	-15.12	-0.21	-0.64	15.19	-8.23	24.06
$P_{1x}P_3$	8.73	2.02	-7.54	5.61	10.62	39.26	-10.39	15.38
$P_{1x}P_4$	8.90	-0.69	-5.97	28.14	11.89	31.56	-12.56	21.29
$P_{1x}P_5$	10.37	-0.63	-0.24	5.05	-4.11	29.21	-17.14	35.76
$P_{1x}P_6$	4.81	-0.41	2.61	42.0	15.74	18.99	1.04	13.65
$P_{1x}P_7$	8.79	-11.25	25.20	10.41	7.99	-10.05	-20.21	21.49
$P_{1x}P_8$	9.81	-0.51	11.76	0.38	1.50	0.05	-1.05	13.50
$P_{2x}P_3$	-1.16	-1.69	33.33	20.33	18.28	38.07	-0.18	-3.14
$P_{2x}P_4$	1.52	-3.12	29.16	45.07	17.64	30.87	-10.00	7.33
$P_{2x}P_5$	-0.29	14.78	25.47	25.33	7.28	24.54	-19.35	18.78
$P_{2x}P_6$	0.94	-4.44	47.67	53.66	26.73	16.12	0.16	-1.36
$P_{2x}P_7$	-0.28	-0.08	63.09	25.34	16.82	14.07	-7.14	9.95
$P_{2x}P_8$	-0.51	10.01	49.86	18.93	13.09	-4.72	13.63	-2.77
$P_{3x}P_4$	0.30	2.88	12.28	13.14	9.25	7.27	-0.82	12.68
$P_{3x}P_5$	1.46	14.54	5.72	0.57	0.76	0.38	-4.46	27.96
$P_{3x}P_6$	-4.76	21.36	32.97	39.64	27.28	-9.28	4.49	4.46
$P_{3x}P_7$	-3.71	4.70	35.38	4.32	14.48	-38.39	-3.47	8.40
$P_{3x}P_8$	2.10	12.67	28.35	6.30	4.64	-29.02	19.43	4.61
$P_{4x}P_5$	-0.60	5.34	0.33	-6.23	-3.75	-1.84	17.18	16.41
$P_{4x}P_6$	-1.33	1.83	25.00	22.92	15.43	-13.28	14.83	-6.35
$P_{4x}P_7$	-1.20	3.06	34.06	0.60	5.18	-41.80	13.47	4.77
$P_{4x}P_8$	-1.09	12.74	30.74	-9.97	4.02	-32.78	42.28	-9.76
$P_{5x}P_6$	-3.79	9.64	31.57	38.36	20.24	-6.54	12.24	-13.11
$P_{5x}P_7$	-1.13	-12.31	42.85	5.42	17.82	-34.87	1.50	-8.66
$P_{5x}P_8$	-1.30	2.38	37.09	1.49	7.20	-26.56	19.63	-19.07
$P_{6x}P_7$	-4.94	-10.31	29.88	-10.20	17.11	-27.89	7.45	11.47
$P_{6x}P_8$	4.24	6.78	18.20	-12.73	9.68	-17.35	32.46	2..66
$P_{7x}P_8$	-1.29	22.24	3.53	1.54	4.90	15.38	34.65	-1.62
Maxi. value	20.00	22.24	63.09	53.66	27.28	39.26	42.28	35.38
Mini. value	-4.94	-12.31	-15.12	-12.73	-4.11	-41.80	-19.35	-19.07

Number of branches: The variation in heterosis % ranged from (-15.12%) to (63.09%). The maximum was observed in cross "Escand. x Dot" (63.09%) followed by "Escand. x Iraqi" (49.86) and "Escand. x Pusa S." (47.67), while the heterosis % of "Cross Balady x Escand." gave the lowest value (-15.12). These are in accordance with the finding of Partap *et al*. (1981), Shukla *et al*. (1989) and Ahmed (2001).

Number of green fruit/plant: The results in Table 6 showed that the heterosis % varied from (-12.73%) to (53.66%). The maximum heterosis % value being in the cross "Escand. Pusa S." (53.66) followed by "Escand. x Emerald" (45.07%) and "Balady x Pusa S." (42.00%), while the heterosis of % cross "P6xP8" gave the lowest value (-12.73%). Ahmed (2001) reported similar results.

Total green fruit yield: Heterosis % above mid-parent ranged from (-4.11%) to (27.28%). The maximum heterosis was observed in cross "Clm.S. x Pusa S." (27.28%) followed by "Escand. x Pusa S." (26.73%) and "White Velvet x Pusa S." (20.24%), while the heterosis of cross "Balady x White Velvet" gave the lowest value (-4.11%). Similar results have been obtained by Mohamed *et al*. (1994), Dhankhar and Dhankhar (2001) and Nandan-Mehta *et al*. (2007).

Fruit length (cm): The range of green fruit length varied from (-41.8%) to (39.26%). The maximum heterosis % being in the cross "Balady x Clm.S." (39.26% followed by "Escand. x Clm.S." (38.07%) and "Balady x Emerald" (31.56%), while the heterosis of cross "P_4xP_7" gave the lowest value (-41.8%). These are in accordance with the findings of Poshiya (1986b), Shukla *et al*. (1989) and Nandan-Mehta *et al*. (2007).

Fruit diameter (cm): The heterosis % value ranged from (-19.35%) to (42.28%). The maximum heterosis was observed in cross "Emerald x Iraqi" (42.28%) followed by "Dot x Iraqi" (34.65) and "Pusa S. x Iraqi" (32.46), while the heterosis of cross "Escand. x White Velvet" gave the lowest value (-19.35). These results are in harmony with those obtained by Ahmed (2001) and Abbas (2006).

Weight of green fruits/plant (g): Results in (Table 6) showed that heterosis % over mid-parent ranged from (-19.07%) to (35.38%). The maximum heterosis % was observed in cross "Balady x Clm.S." (35.38%) followed by "Clm.S. x White Velvet" (27.96%) and "Balady x Escand." (24.06%), while the heterosis % of cross "White Velvet x Iraqi" gave the lowest value (-19.07%). These are in agreement with the findings of El-Gazar *et al*. (1988), Mohamed *et al*. (1994), Abbas (2006) and Nandan-Mohta *et al*. (2007).

Conclusions

1- Balady and Pusa Sewani cvs. Were good general combiners for total fruit yield (ton/fed), number of branches/plant, pant height (cm) and green fruit diameter (cm). These parents Could be used in breeding program in different ways.
2- The Cross (White Valvet × Pusa Sawani) Showed high Performance for total fruit yield ton/fed , number of Fruit/Plant, number of branches/plant, plant height and Could be used in Practical Plant breeding.
3- The F_1 (Clemson Spineless × Pusa Sewani) exhibited The maximum heterosis % over mid parent for Fruit yield (8.62 ton/Fed. This F_1 can be consider promising cross for exploition in hybrid Production.

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دراسة القدرة على التآلف وقوة الهجين للمحصول ومكوناته فى الباميا

أيمن محمد عبد النبى رشوان
قسم البساتين (خضر) – كلية الزراعة – جامعة جنوب الوادى

أجريت هذه الدراسة بمزرعة ومعامل كلية الزراعة بقنا – جامعة جنوب الوادى خلال موسمى صيف ٢٠٠٧ ، ٢٠٠٨ . فى الموسم الأول أجرى التهجين بين ثمانية آباء (أصناف) من الباميا على نظام الـ Half Diallel Cross وكانت هذه الأصناف هى :

١- البلدى ٢- الاسكندرانى ٣- كليمسون سباينلس ٤- اميرالد
٥- هوايت فلفت ٦- بوذا سوانى ٧- دوت ٨- العراقى

فى الموسم الثانى ٢٠٠٨ تم زراعة الآباء الثمانية والجيل الأول الهجين (F_1) الناتج منها (٢٨ هجين) فى تجربة مصممة على نظام القطاعات كاملة العشوائية فى ثلاث مكررات وكانت الصفات المدروسة على النحو التالى:

١- تفتح الازهار ٢- طول النبات ٣- عدد الأفرع/ النبات
٤- عدد الثمار/النبات ٥- وزن محصول الثمار الأخضر (طن/ فدان)
٦- متوسط طول الثمرة ٧- قطر الثمرة ٨- متوسط وزن الثمرة/ النبات

نتائج التحليل الوراثى:

١- أظهرت الآباء والهجن الناتجة منها اختلافاً جوهرياً فى جميع الصفات قيد الدراسة .
٢- كانت الاختلافات الراجعة للقدرة العامة والخاصة على الائتلاف عالية المعنوية لجميع الصفات قيد الدراسة، وهذا يوضح أهمية كل من الفعل المضيف وغير المضيف فى وراثة هذه الصفات .
٣- كانت الاختلافات الراجعة للقدرة العامة على الائتلاف (GCA) أكبر من القدرة الخاصة على الائتلاف (SCA) فى جميع الصفات قيد الدراسة ، وهذا يوضح أن فعل الجينات الاضافى (التراكمى) كان أكثر تأثيراً فى وراثة هذه الصفات .
٤- أظهرت الأصناف (البلدى ، بوذا سوانى) قدرة ائتلافية عامة عالية فى صفات عدد الأفرع/النبات، كمية المحصول (طن/فدان)، طول النبات، قطر الثمرة. أما الأصناف (هوايت فلفت ، والعراقى) فى صفة الازهار، وكان الصنف (بوذا سوانى) فى صفة عدد القرون/النبات. أما الصنف (هوايت فلفت) فى صفة وزن قرون/النبات. وبالتالى يمكن استخدام هذه الأصناف فى برامج التربية فى الباميا لهذه الصفات .
٥- أظهرت الهجن (الاسكندرانى × العراقى) ، (هوايت فلفت × بوذا سونى) قدرة إئتلافية خاصة عالية فى صفات محصول الثمار الأخضر (طن/فدان)، عدد القرون/النبات، عدد الأفرع/النبات، طول النبات بينما أظهر الهجينان (الاسكندرانى × بوذا سوانى) ، (الاسكندرانى × دوت) قدرة ائتلافية خاصة عالية فى صفات وزن الثمرة/النبات، محصول الثمار الأخضر (طن/فدان)، عدد الثمار/النبات، عدد الأفرع/النبات وكذلك الهجن (كليمسون سبانيلس × العراقى) ، (البلدى × الاسكندرانى) فى صفات التزهير، قطر الثمرة، وزن قرون/النبات .

قوة الهجين لمتوسط الآباء:

أظهرت قوة الهجين النتائج التالية :

١. صفة الازهار : (بوذا سونى × دوت) – ٤,٩٤% ، (كليمسون سبانيلس × بوذا سوانى) – ٤,٧٦% ، (كليمسون سبانيلس × دوت) - ٣,٧١% .
٢. طول النبات : (دوت × العراقى) ٢٢,٢٤% ، (كليمسون سبانيلس × بوذا سوانى) ٢١,٣٦% ، (الاسكندرانى × هوايت فلفت) ١٤,٧٨% .
٣. عدد الأفرع/النبات : (الاسكندرانى × دوت) ٦٣,٠٩% ، (الاسكندرانى × العراقى) ٤٩,٨٦%، (الاسكندرانى × بوذا سوانى) ٤٧,٦٧%.

٤. عدد الثمار/النبات: (الاسكندرانى × بوذا سوانى) ٥٣,٦٦% ، (الاسكندرانى × أميرالد) ٤٥,٠٧ ، (البلدى × بوذا سوانى) ٤٢,٠٠% .
٥. محصول الثمار الأخضر (طن/فدان): (كليمسون سبانيلس × بوذا سوانى) ٢٧,٢٨% ، (الاسكندرانى × بوذا سوانى) ٢٦,٧٣% ، (هوايت فلفت × بوذا سوانى) ٢٠,٢٤% .
٦. طول الثمرة : (البلدى × كليمسون سبانيلس) ٣٩,٢٦ ، (الاسكندرانى × كليمسون سبانيلس) ٣٨,٠٧% ، (البلدى × أميرالد) ٣١,٥٦% .
٧. قطر الثمرة: (أميرالد × العراقى) ٤٢,٢٨% ، (دوت × العراقى) ٣٤,٥٦% ، (بوذا سوانى × العراقى) ٣٢,٤٦% .
٨. وزن الثمرة : (البلدى × كليمسون سيانيلس) ٣٥,٣٨% ، (كليمسون سيانيلس × هوايت فلفت) ٢٧,٩٦% ، (البلدى × الاسكندرانى) ٢٤,٠٦% .

الخلاصة والفائدة التطبيقية:

١- أظهرت الأصناف (البلدي – بوذا سواني) قدرة ائتلافية عامة عالية في صفات وزن محصول الثمار الأخضر (طن/فدان)، عدد أفرع/النبات، طول النبات، قطر الثمرة، لذلك يوصي باستخدام هذه الأصناف في برامج التربية لهذه الصفات في الباميا تحت ظروف جنوب الوادي بمحافظة قنا .
٢- كما أظهر الهجين (هوايت فلفت × بوذا سواني) قدرة ائتلافية خاصة عامة عالية في صفات وزن محصول الثمار الأخضر (طن/ فدان) عدد قرون/ النبات، عدد أفرع/ النبات، طول النبات ، وبذلك يوصي باستخدام هذا الهجين في برامج التربية لهذه الصفات في الباميا تحت ظروف جنوب الوادي بمحافظة قنا.
٣- الاستفادة من ظاهرة قوة الهجين في الباميا خاصة الهجين (كليمسون سباينلس × بوذا سواني) والذى إنتاجيته بلغت (٨,٦٢ طن / فدان) .