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COMBINING ABILITY AND NATURE OF GENE ACTION IN OKRA (*Abelmoschus esculentus* [L.] MOENCH)

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ABSTRACT

Nine parental genotypes of okra were crossed in complete diallel design to study combining ability and nature of gene action for earliness and yield components. Mean squares of genotypes were found to be highly significant for all studied traits, providing evidence for presence of considerable amount of genetic variation among studied genotypes. The results showed that (P_5) and (P_9) were the best general combiners for earliness, while (P_1), (P_4), (P_5) and (P_7) were found to be good general combiners for total yield per plant. The crosses (P_5xP_6), (P_5xP_9), (P_5xP_8) ang (P_9xP_2) were the earliest crosses in comparison with the other crosses. Meanwhile, the cross (P_1xP_9) had the highest mean value for fruit diameter, plant height and fruit weight. In addition, the crosses, (P_1xP_6), (P_1xP_7), (P_5xP_9) and (P_6xP_4) had the highest mean values for No. of fruit/plant and total yield /plant. Therefore, these promising crosses among F_1 hybrids and F_1 reciprocal (F_{1r}) combinations could be used for further breeding studies to improve the economic traits in okra. The results revealed that the general combining ability (GCA) and specific combining ability (SCA) mean squares were highly significant for all studied traits. Significant reciprocal effect mean squares were observed for all studied traits, indicating that these traits were controlled by extra-nuclear factors as well as nuclear factors. The results indicated that the magnitude of additive genetic variance (σ^2A) were positive and lower than those of non additive (σ^2D) one for most of studied traits, indicating that non additive gene action played a major role in the inheritance of these traits. The broad sense heritability estimates (H^2_b %) were more than 75% and larger than their corresponding narrow sense heritability (H^2_n %) for all studied traits. However, estimates of narrow sense heritability were 13.9%, 32.4, 40.5, 47.1, 76.8 for earliness, fruit length, fruit weight, plant height and fruit diameter, respectively. The estimates of narrow sense heritability ranged from 11.3 % to 17.34% for total fruit yield per plant and No. of fruit per plant, respectively. It could be concluded that the most studied traits were mainly controlled by non additive effects and cytoplasmic factors. Therefore, the genetic material used in this study could be used for hybridization for producing promising crosses to improve economic traits in okra.

Keywords: General Combining Ability, Specific combining Ability, gene action, earliness, yield, Okra

INTRODUCTION

Okra (*Abelmoschus esculentus* L.) is one of the most important vegetable crops in Egypt. Combining ability of the parents is becoming important in plant breeding, especially in hybrid production. It is useful in connection with the testing and compare the performance of the lines in hybrid combinations. Information on the general and specific combining abilities will be helpful in the analysis and interpretation of the genetic basis of important traits. GCA and SCA provide a guideline for the nature of gene action involved in the expression of economic traits. The genetic information obtained from this method is considerable use for selecting parental lines and their crosses to develop and release new high yielding genotypes. Ramesh and Singh (1999), El-Gendy and El-Sherbeny (2005) and El-Sherbeny *et al* (2005) found that the magnitudes of additive genetic variance (σ^2A) were larger than those of non-additive ones (σ^2D) for most okra economic traits. On the other hand, Dhankhar and Dhankhar (2001), Prakash *et al* (2002) and Solankey and Singh (2010) stated that non additive genetic variance was higher than the additive one for days to flowering, plant height, number of branches, number of pods per plant and pod yield per plant. However, Vagish *et al* (2002), liou *et al* (2002), El-Gendy and El-Diasty (2004) and Singh *et al* (2011) indicated that both additive and non additive gene action involved in the inheritance of days to flowering, number of pods per plants and pod yield per plant.

Hence, the objective of this study was to assess the combing ability of nine genetically divergent lines in a complete diallel analysis to choose suitable breeding program for improving economic traits in okra.

MATERIALS AND METHODS

Nine genetically divergent parent lines of okra were previously created and developed by Soher El-Gendy in 2009 (Elgendy,Soher 2012). These genotypes are: line 1 (P_1), line 2 (P_2), line 3 (P_3), line 4 (P_4), line 5 (P_5), line 6 (P_6), line 7 (P_7), line 8 (P_8) and line 9 (P_9). The present study was conducted at El-Baramoon research Station, Horticulture Research Institute, ARC, Egypt during the summer seasons of 2010 and 2011. In the summer season of 2010, the seeds of nine inbred lines were sown on April and all possible combinations among them were made according to a complete diallel mating design to produce 36 F_1 and 36 F_1 reciprocal (F_{1r}) hybrids. In the summer season of 2011, 72 F_1 hybrids were evaluated in a randomized block design with three replications. Each block contains 72 plots. Each plot was 3 rows, 3.5 m. long and 60 cm. wide. Hills were spaced 30 cm. Apart. All other agricultural practices were applied as recommended for okra production.

Data were recorded on 10 plants chosen at random from each plot for the following traits: Number of days to 50% flowering (No. of DF) ; Plant height (PH cm); Number of fruit/plant (No. of F/P); Fruit Diameter (FD cm); Fruit Length (FL cm); Fruit weight (FW gm) and Total yield per plant (TY/P gm).

Data were subjected to the analysis of variance in order to test the significance of the differences among the 72 F1 and F_1 reciprocal hybrids according to Cochran and Cox (1957).

Sum squares of studied genotypes was partitioned according to Griffing`s (1956) as method 3 into sources of variations due to GCA and SCA.

The variances of GCA (σ^2g) and SCA (σ^2s) were obtained on the basis of the expected mean squares for all studied traits. Additive (σ^2A) and non-additive (σ^2D) genetic variances were estimated according to Matzinger and Kempthorne (1956) as follows:

$\sigma^2A = 2\sigma^2g$

$\sigma^2D = \sigma^2s$

Estimates of heritability in both broad and narrow sense were calculated according to the following equations:

$h^2b\% = [(\sigma^2A + \sigma^2D) / (\sigma^2A + \sigma^2D + \sigma^2e)] \times 100$

$h^2n\% = [(\sigma^2A) / (\sigma^2A + \sigma^2D + \sigma^2e)] \times 100$

RESULTS AND DISSCUSION

Genotypic variations

Analyses of variance for all genotypes are presented in Table 1 for all studied traits. Mean squares of genotypes were found to be highly significant for all studied traits. This provides evidence for presence of considerable amount of genetic variation among studied genotypes. These results are in harmony with those previously obtained by El-Sherbeny *et al* (2005) and Abdelmageed (2010).

Table 1: Analysis of variance and mean squares of all genotypes for studied traits

SV	DF	No. of DF	PH (cm)	No. of F/P	FD (cm)	FL (cm)	FW (gm)	TY/P (gm)
Reps	2	32.31	12.0	102.0	0.40	1.78	4.84	110030.8**
Geno.	71	20.96**	2937.1**	3532.9**	0.52**	1.13**	1.53**	103112.9**
Error	142	1.45	72.1	34.3	0.05	0.20	0.27	6649.9

Mean performance

Mean performance of the 36 F_1 hybrids for all studied traits are shown in Table 2. The results showed considerable variation were obtained among all F_1 hybrids for all studied traits. The crosses (P_5xP_6), (P_5xP_9) and (P_5xP_8) were the earliest crosses in comparison with the other crosses. Meanwhile, the cross (P_1xP_9) had the highest mean value for fruit diameter, plant height and fruit weight. In addition, the crosses, (P_1xP_6), (P_1xP_7) and (P_5xP_9) had the highest mean values for No. of fruit/plant and total yield /plant.

Mean performance of the 36 F_1 reciprocal crosses (F_{1r}) for all studied traits are presented in Table 3. No specific reciprocal hybrid showed superiority over other crosses for all studied traits. The best combination for earliness was (P_9xP_2) with mean of 53.7. The crosses (P_8xP_6), (P_9xP_3) and (P_4xP_1) were the highest combinations for plant height, fruit diameter and fruit weight with mean of 280, 6.17 and 5.97, respectively. Moreover, the cross (P_6xP_4) was the best for no. of fruit per plant, fruit length and total yield per plant with the mean of 239, 4.57 and 1035.7, respectively. Therefore, these promising crosses among F_1 hybrids and F_1 reciprocal combinations could be used for further breeding studies to improve the economic traits in okra.

Table 2: Mean performance of F_1 hybrids for all studied traits

Hybrids		No. of DF	PH (cm)	No. of F/P	FD (cm)	FL (cm)	FW (gm)	TY/P (gm)
1	P_1xP_2	60.7	175	136	5.33	3.43	4.60	625.9
2	P_1xP_3	60.7	190	181	5.53	3.03	4.00	724.4
3	P_1xP_4	59.7	230	104	4.93	3.83	3.57	370.7
4	P_1xP_5	55.7	190	190	5.67	2.67	3.83	728.1
5	P_1xP_6	59.7	220	211	5.40	4.57	5.00	1052.3
6	P_1xP_7	61.0	230	180	5.73	4.40	6.00	1080.2
7	P_1xP_8	61.0	195	114	5.97	4.43	5.40	615.9
8	P_1xP_9	59.3	205	84	6.13	3.63	6.20	522.3
9	P_2xP_3	62.0	191	92	5.50	3.53	4.47	410.9
10	P_2xP_4	56.7	218	133	4.97	3.27	3.87	515.6
11	P_2xP_5	58.7	188	190	5.57	3.40	3.83	726.9
12	P_2xP_6	58.3	238	179	4.70	4.03	4.00	716.5
13	P_2xP_7	58.0	195	149	5.07	4.47	4.53	675.3
14	P_2xP_8	56.7	206	168	4.67	3.63	3.60	604.8
15	P_2xP_9	57.3	217	170	4.83	3.60	3.60	612.8
16	P_3xP_4	58.7	205	167	5.63	3.40	4.63	771.9
17	P_3xP_5	57.0	187	153	5.47	4.10	3.97	606.6
18	P_3xP_6	57.3	190	168	4.97	6.00	5.40	907.2
19	P_3xP_7	58.7	230	150	5.13	3.03	3.47	520.0
20	P_3xP_8	59.7	215	110	5.13	3.37	3.80	416.7
21	P_3xP_9	57.0	170	104	5.17	3.57	3.80	394.5
22	P_4xP_5	58.7	190	169	5.17	3.57	4.20	710.2
23	P_4xP_6	58.0	211	148	4.87	5.70	5.07	749.9
24	P_4xP_7	63.3	225	151	5.50	3.90	5.20	784.5
25	P_4xP_8	57.7	113	156	5.07	3.47	4.20	655.5
26	P_4xP_9	55.0	253	159	5.20	3.10	4.23	671.8
27	P_5xP_6	53.0	212	112	4.80	3.70	3.87	432.5
28	P_5xP_7	55.3	185	93	5.83	3.53	5.53	514.0
29	P_5xP_8	54.7	121	180	5.27	3.73	4.73	853.0
30	P_5xP_9	54.3	210	179	5.70	3.20	5.77	1031.9
31	P_6xP_7	63.3	252	152	5.10	3.33	4.17	633.3
32	P_6xP_8	63.7	223	161	5.03	3.37	4.07	654.9
33	P_6xP_9	63.0	270	180	4.43	3.23	3.33	599.7
34	P_7xP_8	62.7	232	142	5.73	3.83	4.93	702.9
35	P_7xP_9	56.0	240	171	6.00	3.10	5.27	900.6
36	P_8xP_9	58.3	232	140	5.23	3.07	4.87	681.3
LSD	0.05	1.94	13.7	9.5	0.37	0.72	0.83	131.62
	0.01	2.56	18.1	12.5	0.49	0.95	1.10	173.84

Table 3: Mean performance of F_1 reciprocal hybrids (F_{1r}) for all studied traits

Hybrids		No. of DF	PH (cm)	No. of F/P	FD (cm)	FL (cm)	FW (gm)	TY/P (gm)
1	P_2xP_1	58.7	223	151	4.90	3.80	3.30	498.5
2	P_3xP_1	59.7	190	124	5.97	3.53	4.73	586.5
3	P_4xP_1	61.3	235	170	5.83	3.37	5.97	1013.7
4	P_5xP_1	54.3	210	148	5.73	3.83	4.87	723.3
5	P_6xP_1	54.3	194	49	5.43	3.87	4.87	237.5
6	P_7xP_1	58.3	255	148	5.83	3.17	5.27	780.3
7	P_8xP_1	59.0	285	190	5.47	3.17	4.37	827.3
8	P_9xP_1	56.7	240	159	5.97	2.97	4.67	742.3
9	P_3xP_2	57.7	195	139	4.90	3.97	3.70	514.8
10	P_4xP_2	59.3	220	161	5.13	4.13	4.13	665.5
11	P_5xP_2	57.0	230	140	4.93	4.37	4.10	574.0
12	P_6xP_2	59.0	230	159	4.40	5.43	3.83	609.4
13	P_7xP_2	60.0	212	150	5.37	3.77	4.83	725.0
14	P_8xP_2	58.3	212	159	4.87	3.63	3.33	529.0
15	P_9xP_2	53.7	210	102	5.10	3.80	3.90	398.0
16	P_4xP_3	59.3	215	191	5.53	2.97	3.90	745.0
17	P_5xP_3	55.7	180	141	5.80	3.77	4.60	648.9
18	P_6xP_3	59.0	235	157	5.23	4.27	4.77	748.3
19	P_7xP_3	56.7	175	79	6.07	3.13	5.50	436.5
20	P_8xP_3	60.3	228	171	5.97	4.07	5.17	883.4
21	P_9xP_3	55.0	245	120	6.17	3.30	5.67	680.0
22	P_5xP_4	54.7	225	130	5.40	3.70	4.80	624.9
23	P_6xP_4	54.0	251	239	4.73	4.57	4.33	1035.7
24	P_7xP_4	61.3	270	172	5.97	3.87	5.90	1015.0
25	P_8xP_4	57.0	275	162	5.03	3.93	3.73	605.3
26	P_9xP_4	57.7	241	150	5.17	3.10	3.97	595.7
27	P_6xP_5	59.7	216	150	4.90	3.50	3.83	575.0
28	P_7xP_5	59.3	197	150	5.57	3.30	5.13	769.4
29	P_8xP_5	63.7	230	193	5.37	4.03	4.90	941.0
30	P_9xP_5	57.3	230	163	5.43	2.90	4.43	722.6
31	P_7xP_6	56.3	239	131	5.20	3.17	4.80	628.6
32	P_8xP_6	56.3	280	169	5.47	3.87	4.93	832.9
33	P_9xP_6	62.0	228	103	5.00	3.37	4.20	432.6
34	P_8xP_7	55.7	212	168	5.30	3.43	4.57	766.7
35	P_9xP_7	62.0	180	74	5.70	2.67	4.33	319.8
36	P_9xP_8	61.7	262	79	5.30	3.53	3.90	307.9
LSD	0.05	1.94	13.7	9.5	0.37	0.72	0.83	131.62
	0.01	2.56	18.1	12.5	0.49	0.95	1.10	173.84

Combining ability analysis

Mean squares of general, specific combining ability and reciprocal effects for all studied traits are given in Table 4. The results exhibited that mean squares of general combining ability (GCA), specific combining ability (SCA) and reciprocal effects were highly significant for all studied traits. These results indicate that both GCA and SCA were important in the inheritance of these traits. However, the magnitudes of GCA were larger than those of SCA for all studied traits pointed out the predominance of the additive gene action. In addition, significant reciprocal effect mean squares were observed for all studied traits, indicating that these traits were controlled by extra-nuclear factors as well as nuclear factors. These results are in agreement with those reported by Prakash *et al* (2002), Rewale *et al* (2003), El-Sherbeny *et al*., (2005), El-Gendy and El-Sherbeny (2005), Sinthil *et al* (2006) and Singh *et al* (2006).

Table 4: The analysis of variance and mean squares for combining ability analysis

SV	DF	No. of DF	PH (cm)	No. of F/P	FD (cm)	FL (cm)	FW (gm)	TY/P (gm)
GCA	8	9.68**	2048.2**	1337.4**	0.939**	1.070**	1.355**	42848.2**
SCA	27	6.01**	479.7**	766.4**	0.059**	0.359**	0.338**	28945.0**
Reciprocal	36	7.12**	1116.0**	1450.5**	0.091**	0.235**	0.449**	36556.6**
Error	142	0.48	24.0	11.4	0.017**	0.066	0.089	2216.6

GCA effects (gi)

Estimates of general combining ability effects (g_i) of each parent for all studied traits are presented in Table 5. (P_5) was the best general combiner for all studied traits except fruit length, fruit weight and plant length. While (P_1) was good general combiner for fruit diameter, fruit weight and total yield per plant. (P_2) was good general combiner for fruit length. (P_3) was good general combiner for fruit diameter. (P_4) was good general combiner for plant length, number of fruit per plant and total yield. (P_6) was good general combiner for fruit length, plant length and number of fruit per plant. (P_7) was the best general combiner for all studied traits except fruit length, number of fruit per plant and earliness. (P_8) was the best general combiner for plant length and number of fruit per plant. (P_9) was the best general combiner for fruit diameter, plant length and earliness. Generally, the results showed that (P_5) and (P_9) were the best general combiners for earliness, while (P_1), (P_4), (P_5) and (P_7) were found to be good general combiners for total yield per plant.

It could be suggested that these parental genotypes posses favorable genes to improve hybrids for earliness and yield components.

Table 5: Estimates of general combining ability effects (gi) of each parental lines for all studied traits

Genotypes	No. of DF	PH (cm)	No. of F/P	FD (cm)	FL (cm)	FW (gm)	TY/P (gm)
P_1	0.434*	-0.12	-2.25**	0.312 **	-0.076	0.327**	34.4 **
P_2	-0.138	-7.79**	0.54	-0.373 **	0.250 **	-0.601**	-88.9 **
P_3	0.029	-16.26**	-8.82**	0.193 **	0.019	-0.035	-46.6 **
P_4	-0.114	7.74**	13.68**	-0.095 **	0.078	-0.025	63.1 **
P_5	-1.780**	-19.14**	7.90**	0.081 *	-0.105	0.025	38.2 **
P_6	0.220	15.76 **	6.97**	-0.414 **	0.514 **	-0.113	14.2
P_7	1.005**	4.33 **	-7.89**	0.260 **	-0.191 **	0.527**	43.2 **
P_8	0.886**	3.74 **	6.54**	-0.042	-0.015	-0.111	16.5
P_9	-0.542**	11.74 **	-16.67**	0.077 *	-0.474 **	0.006	-73.9 **
SE(gi)	0.175	1.24	0.85	0.033	0.065	0.075	11.9

SCA effects (Sij)

Estimated specific combining ability effects (S_{ij}) of each cross combination for all studied traits are found in Table 6. The results revealed that the cross combination (P_1xP_6), (P_2xP_8), (P_3xP_7), (P_4xP_6), (P_4xP_8), (P_7xP_8), showed desirable negative significant SCA effects for earliness. Moreover, seven, seven, five and twelve out of thirty six crosses exhibited positive SCA effects for fruit diameter (cm), fruit length (cm), fruit weight (gm) and plant height (cm), respectively. Concerning to total yield per plant, fifteen and nine out of the thirty six hybrids were the best yielding crosses for number of fruit per plant, and total yield/plant, respectively.

Table 6: Estimates of specific combining ability effects (S_{ij}) of each cross for all studied traits

Crosses	No. of DF	PH (cm)	No. of F/P	FD (cm)	FL (cm)	FW (gm)	TY/P (gm)
P_1xP_2	1.00*	-9.89**	-2.95	-0.164 *	-0.230	-0.279	-48.8
P_1xP_3	1.33**	-10.41**	15.41**	-0.097	-0.332*	-0.429**	2.2
P_1xP_4	1.81**	8.09**	-22.59**	-0.176 *	-0.075	-0.039	-70.8*
P_1xP_5	-2.02**	2.47	15.20**	-0.035	-0.242	-0.505**	-12.4
P_1xP_6	-2.02**	-25.43**	-22.88**	0.177 *	0.106	0.216	-69.1 *
P_1xP_7	-0.14	21.49**	25.98**	-0.130	0.377*	0.276	187.2 **
P_1xP_8	0.31	19.59**	-0.45	0.105	0.218	0.164	5.3
P_1xP_9	-0.26	-5.91*	-7.73**	0.320 **	0.177	0.597**	6.3
P_2xP_3	1.57**	0.26	-24.38**	0.039	-0.192	0.216	-67.1*
P_2xP_4	-0.12	2.26	-15.38**	0.177 *	-0.301	0.123	-49.1
P_2xP_5	1.38**	18.97**	8.41**	0.201 *	0.065	0.040	35.7
P_2xP_6	0.21	9.23**	13.34**	-0.004	0.296	0.128	72.2 *
P_2xP_7	-0.24	-9.84**	8.70**	-0.011	0.385*	0.254	80.4 **
P_2xP_8	-1.62**	-3.74	8.27**	-0.159*	-0.275	-0.324	-26.1
P_2xP_9	-2.19**	-7.24*	3.98	-0.078	0.251	-0.158	2.7
P_3xP_4	0.71	1.73	25.98**	0.143	-0.587**	-0.177	76.5 **
P_3xP_5	-0.29	2.11	-0.23	0.017	0.346*	-0.210	-29.3
P_3xP_6	-0.45	-3.79	16.20**	-0.021	0.927**	0.728**	194.7 **
P_3xP_7	-1.74**	-2.36	-16.95**	-0.195 *	-0.418**	-0.512**	-183.8 **
P_3xP_8	0.71	17.23**	-5.37**	0.058	0.039	0.126	14.7
P_3xP_9	-1.86**	-4.77	-10.66**	0.055	0.215	0.259	-7.8
P_4xP_5	0.19	2.11	-20.23**	-0.045	-0.013	-0.003	-99.1 **
P_4xP_6	-2.48**	-9.29**	24.70**	-0.033	0.868**	0.335	150.1 **
P_4xP_7	3.07**	18.64**	7.55**	0.227 **	0.323*	0.545**	128.1 **
P_4xP_8	-1.81**	-34.27**	-9.37**	-0.154	-0.037	-0.401*	-114.7 **
P_4xP_9	-1.38**	10.73**	9.34**	-0.140	-0.177	-0.384*	-21.0
P_5xP_6	-0.48	0.59	-32.02**	-0.159 *	-0.482**	-0.565**	-214.1 **
P_5xP_7	-0.26	-10.98**	-26.66**	0.017	0.039	0.278	-105.1 **
P_5xP_8	1.69**	-25.89**	23.91**	-0.064	0.330*	0.399*	176.9 **
P_5xP_9	-0.21	10.61**	31.63**	0.067	-0.044	0.566**	247.5 **
P_6xP_7	0.24	8.78**	-5.73**	-0.037	-0.746**	-0.434*	-91.9 **
P_6xP_8	0.52	15.21**	3.34	0.365 **	-0.556**	0.221	47.8
P_6xP_9	4.45**	4.71	3.05	-0.288 **	-0.413**	-0.629**	-89.7 **
P_7xP_8	-1.10**	-2.86	8.20**	-0.042	0.165	-0.170	9.6
P_7xP_9	0.17	-22.86**	-1.09	0.172 *	-0.125	-0.236	-24.6
P_8xP_9	1.29**	14.73**	-28.52**	-0.109	0.115	-0.015	-113.5**
SE (Sij)	0.43	3.00	2.07	0.081	0.157	0.182	28.8

Specific combining ability effects (S_{ij}) of each reciprocal cross combination (F_{1r}) for all studied traits are found in Table 7. The results showed that no reciprocal cross was the best for all studied traits. However, nine and five out of thirty six reciprocal hybrids exhibited significant SCA effects for earliness and plant height, respectively. For yield and its component, sixteen, four, three, six and nine out of thirty six reciprocal crosses revealed desirable SCA for number of fruit per plant, fruit diameter, fruit length, fruit weight and total yield per plant, respectively.

Table 7: Estimates of specific combining ability effects (Sij) of each reciprocal cross (F_{1r}) for all studied traits

Crosses	No. of DF	PH (cm)	No. of F/P	FD (cm)	FL (cm)	FW (gm)	TY/P (gm)
P_2xP_1	1.00*	-24.00**	-7.50**	0.217*	-0.183	0.650**	63.7
P_3xP_1	0.50	0.00	28.50**	-0.217*	-0.250	-0.367	68.9 *
P_4xP_1	-0.83	-2.50	-33.00**	-0.450**	0.233	-1.200**	-321.5**
P_5xP_1	0.67	-10.00**	21.00**	-0.033	-0.583**	-0.517*	2.4
P_6xP_1	2.67**	13.00**	81.00**	-0.017	0.350	0.067	407.4 **
P_7xP_1	1.33**	-12.50**	16.00**	-0.050	0.617**	0.367	150.0 **
P_8xP_1	1.00*	-45.00**	-38.00**	0.250**	0.633**	0.517*	-105.7 **
P_9xP_1	1.33**	-17.50**	-37.50**	0.083	0.333	0.767**	-110.0 **
P_3xP_2	2.17**	-2.00	-23.50**	0.300**	-0.217	0.383	-51.9
P_4xP_2	-1.33 **	-1.00	-14.00**	-0.083	-0.433*	-0.133	-74.9 *
P_5xP_2	0.83	-21.17**	25.00**	0.317**	-0.483**	-0.133	76.4 *
P_6xP_2	-0.33	4.00	10.00**	0.150	-0.700**	0.083	53.5
P_7xP_2	-1.00*	-8.50*	-0.50	-0.150	0.350	-0.150	-24.9
P_8xP_2	-0.83	-3.00	4.50	-0.100	0.000	0.133	37.9
P_9xP_2	1.83**	3.50	34.00**	-0.133	-0.100	-0.150	107.4**
P_4xP_3	-0.33	-5.00	-12.00**	0.050	0.217	0.367	13.5
P_5xP_3	0.67	3.50	6.00*	-0.167	0.167	-0.317	-21.1
P_6xP_3	-0.83	-22.50**	5.50*	-0.133	0.867**	0.317	79.5 *
P_7xP_3	1.00*	27.50**	35.50**	-0.467**	-0.050	-1.017**	41.8
P_8xP_3	-0.33	-6.50	-30.50**	-0.417**	-0.350	-0.683**	-233.4**
P_9xP_3	1.00*	-37.50**	-8.00**	-0.500**	0.133	-0.933**	-142.7 **
P_5xP_4	2.00**	-17.50**	19.50**	-0.117	-0.067	-0.300	42.6
P_6xP_4	2.00**	-20.00**	-45.50**	0.067	0.567**	0.367	-142.9 **
P_7xP_4	1.00*	-22.50**	-10.50**	-0.233*	0.017	-0.350	-115.2 **
P_8xP_4	0.33	-81.00**	-3.00	0.017	-0.233	0.233	25.1
P_9xP_4	-1.33**	6.00	4.50	0.017	0.000	0.133	38.1
P_6xP_5	-3.33**	-2.00	-19.00**	-0.050	0.100	0.017	-71.3 *
P_7xP_5	-2.00**	-6.00	-28.50**	0.133	0.117	0.200	-127.7**
P_8xP_5	-4.50**	-54.50**	-6.50**	-0.050	-0.150	-0.083	-44.0
P_9xP_5	-1.50**	-10.00**	8.00**	0.133	0.150	0.667**	154.6 **
P_7xP_6	3.50**	6.33	10.50**	-0.050	0.083	-0.317	2.4
P_8xP_6	3.67**	-28.50**	-4.00	-0.217*	-0.250	-0.433*	-89.0 **
P_9xP_6	0.50	21.00**	38.50**	-0.283**	-0.067	-0.433*	83.5 *
P_8xP_7	3.50**	10.00**	-13.00**	0.217*	0.200	0.183	-31.9
P_9xP_7	-3.00**	30.00**	48.50**	0.150	0.217	0.467*	290.4**
P_9xP_8	-1.67**	-15.00**	30.50**	-0.033	-0.233	0.483*	186.7 **
SE (Sij)	0.49	3.47	2.39	0.093	0.182	0.211	33.3

It could be noticed that the excellent cross combinations were obtained from crossing (good x good), (good x poor) and (poor x poor) general combiners. Therefore, it is not necessary that parents having estimates of high GCA effects would also give high estimates of SCA effects in their respective cross combinations. These results suggest the important role of non additive gene action in the inheritance of the studied traits.

Nature of gene action

Based on the analysis of combining ability, the different genetic parameters were estimated and the obtained results are presented in Table 8. The results indicated that the magnitudes of the non additive genetic variance (VD) were larger than those of additive ones (VA) for all studied traits except for fruit diameter and fruit weight. In this direction, Dhankhar and Dhankhar (2001), Prakash et al (2002) and Solankey and Singh (2010) stated that non additive genetic variance was higher than the additive one for days to flowering, plant height, number of branches, number of pods per plant and pod yield per plant. Considerable values of reciprocal effects variance were observed in all studied traits, exhibiting the important role of cytoplasmic factors in the expression of these traits. Furthermore, the broad sense heritability estimates (H^2_b %) were more than 75% and larger than their corresponding narrow sense heritability (H^2_n %) for all studied traits. However, estimates of narrow sense heritability were 13.9%, 32.4, 40.5, 47.1, 76.8 for earliness, fruit length, fruit weight, plant height and fruit diameter, respectively. With respect to yield components, the estimates of narrow sense heritability ranged from 11.3 % to 17.34% for total yield per plant and No. of fruit per plant, respectively. These results verified the predominance of non additive gene action in the inheritance of these traits. These results are in agreement with those obtained by Prakash et al (2002) and Salameh and Kasrawi (2007).

Table 8: Estimates of genetic parameters and heritability in broad (H^2_b%) and narrow (H^2_n%) sense for all studied traits.

Genetic Components	No. of DF	PH (cm)	No. of F/P	FD (cm)	FL (cm)	FW (gm)	TY/P (gm)
VA	0.524	224.1	81.58	0.126	0.102	0.145	1986.174
VD	2.764	227.8	377.47	0.021	0.146	0.125	13364.192
Vr	3.321	546.0	719.55	0.037	0.084	0.180	17169.992
VE	0.482	24.0	11.44	0.017	0.066	0.089	2216.623
$H2_b$%	87.2	94.9	97.57	89.4	78.9	75.3	87.4
$H2_n$%	13.9	47.1	17.34	76.8	32.4	40.5	11.3

In conclusion, it could be noticed that most studied traits were mainly controlled by non additive effects and cytoplasmic factors. Thus, the genetic material used in this study could be used for hybridization for producing promising crosses to improve economic traits in okra.

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القدرة على التآلف وطبيعة فعل الجين فى الباميا

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تم إجراء هذا البحث بمحطة البرامون الزراعية بالمنصورة - معهد بحوث البساتين- مركز البحوث الزراعية. أجري هذا البحث لدراسة القدرة على التآلف وطبيعة الفعل الجيني لبعض الصفات الاقتصادية في الباميا وذلك باستخدام نظام التهجين الدائري الكامل بين تسع سلالات وراثية محلية من الباميا.

ويمكن تلخيص أهم النتائج فيما يلي:

- أوضحت نتائج تحليل التباين وجود فروق معنوية بين التراكيب الوراثية لكل الصفات المدروسة.
- كانت تقديرات القدرة العامة والخاصة علي التالف معنوية جدا لكل الصفات تحت الدراسة مما يؤكد أهمية التباين الوراثي المضيف وغير المضيف في وراثة الصفات تحت الدراسة.
- أوضحت النتائج أن الآباء P_5، P_9 لها قدرة عامة عالية علي التآلف لصفة التبكير بينما كانت الآباء P_1, P_4, P_5 , P_7 ذات قدرة عامة علي التآلف لصفة المحصول الكلي.
- كانت الهجن (P_4xP_6), (P_4xP_3), (P_5xP_9), (P_3xP_6), (P_1xP_7) and (P_5xP_8) ذات قدرة خاصة عالية علي التآلف لصفة التزهير المبكر ومعظم صفات المحصول.
- كانت قيمة التباين الوراثي غير المضيف أكبر من التباين الوراثي المضيف لصفة التبكير، وصفات المحصول ومكوناته.
- كانت أعلي قيم لدرجة التوريث في المدى الواسع أكبر من 75% وكانت أعلي من قيم درجة التوريث في المدي الضيق لكل الصفات قيد الدراسة حيث كانت قيمة درجة التوريث في المدى الضيق (13.9%) لصفة التبكير بينما كانت (11.3%) لصفة المحصول الكلى.
- طبقا لنتائج التحليل الوراثي للصفات تحت الدراسة يمكن إستخدام هذه الهجن المبشرة في الحصول علي أعلى محصول من الباميا.

قام بتحكيم البحث

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