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BEHAVIOUR OF SOME ECONMIC CHARACTERISTICS IN OKRA (*Abelmoschus esculentus* (L.) Moench)

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ABSTRACT: *These experiments were carried out at Barrage Experimental Station of Hort. Res. Institute, during the two successive summer seasons of 2005 and 2006. Five parental inbred lines viz., Baladi, Eskandrani, Ismailiy, Parbhani Kranti and Golden Coast were used in the study. In 2005 were the parental lines planted in the field during summer season, all possible crosses, without reciprocals, were made to generate the experimental materials. In 2006, F_1 and the parents were evaluated for some characters . The objective of this study was to determine the different types of gene effects in terms of general and specific combining ability (GCA and SCA), in addition to average degree of heterosis regarding some traits viz., number of days to flowering, early and total edible pods yield, dry matter of pods, average pod weight and relative growth rate (RGR). The results indicated that genes with additive and non-additive effects are involved in the inheritance of these characteristics. The estimated ratio between GCA and SCA mean squares indicated that the additive gene effects have the main role in the inheritance of these traits. Obtained values of GCA for the studied characters in each of the studied parental lines showed that Golden Coast is the best of all parents, since it showed significant GCA values for the most studied traits followed the Parbhani Karnti. Obtained data on SCA effect for F_1 hybrids showed that certain crosses had high SCA effect values for certain studied characters, but not for all of them. The best crosses were "Ismailiy x Golden Coast", "Parbhani Kranti x Golden Coast", "Eskandrani x Parbhani Kranti", and "Ismailiy x Parbahani Kranti" since they showed significant SCA effect values for most evaluated traits.*

Accordingly, these superior and prospective materials can be used in okra improvement through breeding programs. Different degrees of dominance (hybrid vigour, completed and partial dominance) were found in most studied traits in okra. The obtained potence ratio was in accordance with the average degree heterosis values (ADH %) in these crosses.

Key words: *General and specific combining ability, average degree heterosis, potence ratio, parental lines.*

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) is an important vegetable crop in the tropical and subtropical regions of the world. The genus *Abelmoschus* of Asiatic origin, but the ancestral home of cultigen *A. esculentus* is disputed, where India, Ethiopia, West Africa and tropical Asia have been suggested (Sharma, 1993). It is now grown in many other areas of the world.

The genetical information would assist the breeders to develop sound programs for improving various vegetable crops. General combining ability (GCA) and specific combining ability (SCA) have been widely used to evaluate the performance of different genotypes, for helping breeder to select parents for breeding programs of almost all economic crops.

Number of days to flowering, was found to be controlled by additive gene effects as reported by Partap *et al.* (1981), whereas Elongovan *et al.* (1981 a) stated that this trait was predominated by non-additive gene expression. Meanwhile, Vijay and Manohar (1986), Metwally and El-Sawy (1988) and Ragaa *et al.* (1997) reported that both additive and non-additive gene effects were involved, and stated that additive effects were played the main role in the inheritance of this trait.

Many investigations were conducted on the combining ability in okra for early and total yield and average pod weight. Among them Vijay and Manohar (1986), Shukla *et al.* (1989), Ragaa *et al.* (1997) and Rajani *et al*, (2001), who reported that additive effects played the main role in the inheritance of these traits. They added that both general and specific combining abilities were significant.

In some studied characters in okra, such as earliness, average pod weight and total yield, Rajani *et al.* (2001) found that the parents with high GCA effects produced F_1 hybrids with low SCA effects. This may be due to the lack of complementation of the parental genes. On the other hand, the poor parents in GCA effects produced hybrids with high SCA effects which can be attributed to complementary gene action.

Regarding average degree of heterosis, over-dominance was observed for many traits, (earliness, average pod weight and total yield) in okra by Sharma and Mahajan (1978), Elongovan *et al.* (1981 b), Shukla *et al.* (1989), Ragaa *et al.* (1997) and Neeta *et al.* (2004). Meanwhile, the estimated ADH % values based on HP were insignificant, indicating complete dominance for the large pod weight, (Ragaa *et al.* 1997). They added that some crosses may be characterized by dominance towards the low parent, since they had significant negative average degree of heterosis relative to both MP and HP. On the other hand, no dominance was observed in some studied crosses,

which showed insignificant ADH values, based on MP for the earliness, average pod weight and total yield, (Ragaa *et al.* 1997).

Therefore, this study was conducted to obtain more information on combining ability effects and degree of heterosis concerning some plant and fruit characteristics in okra.

MATERIALS AND METHODS

The present investigation was Carried out at Barrage Experimental Station of Hort. Res. Institute, during two successive summer seasons (2005 and 2006). Five pure parental lines of okra (*A. esculentus* [L] Moench) were used in this study. These parental lines namely, i.e. Baladi (BA), Eskandrani (ES), Ismailiy (IS), Parbhani Kranti (PK) and Golden Coast (GC) were provided by Vegetable Research Department, Hort. Res. Institute, Ministry of Agriculture. The pod characters of these lines are shown in Table (1).

Table (1): Main characters of the parental lines.

Parental lines	Pod characters
1- Baladi (BA)	Dark green, thick and hard spiny pods.
2- Eskandrani (ES)	Medium to light green, thick and mid spiny, pods.
3- Ismailiy (IS)	Medium to light green, and non spiny pods.
4- Parbhani karanti (PK)	Dark green with red spots thin and medium spiny.
5- Golden Coast (GC)	Light green, thin and medium spiny.

These parental lines were at a high degree of homozygosity sine they were previously selfed for two generations.

The five parents were planted in the field in summer, 2005 and all possible crosses, in one direction were made to generate the experimental materials.

Seeds of the 15 entries viz, 5 parental lines and 10 F_1 crosses, were planted in the field on March 8th of 2006 season. A randomized complete block design with three replicates was adopted each plot contained 5 rows each of 4.0 m length and 0.70m width. Twelve, plants were cultivated in each row. Standard cultural practices of okra were employed throughout the two experimental seasons.

Harvesting period began from mid May and continued to mid Sept., pods were picked with their pedicels in the morning every three days .

The studied traits were:

1- Number of days from planting to the first flower anthesis: It was counted as the mean of 15 plants per replicate.

2- Early edible pods yield (number and weight/plant) in the first 21 days of harvesting.

3- Total edible pods yield (g/plant): It was calculated by the total edible weight of pods during the for 4 months throughout the okra harvesting season.

4- Dry matter% in the edible pods were determined for 30 edible pods from each genotype in each replicate. These pods were kept in an oven at 70 C° for 5 days till drying.

5- Relative growth rate (RGR), which is dry weight accumulated per unit of plant dry weight per unit of time, is given by the formula cited after Watson (1952).

$$RGR = \frac{(\text{Log}_e We_2 - \text{Log}_e W_1)}{(t_2 - t_1)} \text{ (g/week)}$$

Where: W_1 and W_2 are total dry weight at time t_1 and t_2, respectively; and t_2-t_1 equals period in unit of time between two consecutive samples.

Analysis of variance was done in order to test the significance of differences among the means of tested populations as shown by Cochran and Cox (1957). Differences among means for all studied traits were tested for significance according to the least significance differences (L.S.D).

The analysis of general and specific combining abilities (GCA and SCA) was done according to Griffing's method 2 model 1 (1956).

The average degree of heterosis (ADH%) was calculated as percent increase or decrease of the F_1 performance above the mid parents (MP) value and the high parent (HP) value (Sinha and Khanna, 1975):

$$\text{ADH\% (in relation to MP)} = (\overline{F_1} - MP) / MP \times 100$$

$$\text{ADH\% (in relation to HP)} = \overline{(F1} - \overline{HP}) / \overline{HP} \times 100$$

Potence ratio (PR) was calculated by using the following formula:

$$PR = (\overline{F_1} - MP) / \frac{1}{2}(\overline{P_2} - \overline{P_1})$$

Where, Mp, Hp, F_1, P_1 and P_2 are the mid- parents, mean of high performed parent in the trait, F_1 hybrids, and the means of the low and high parent, respectively.

Significance of the estimates was tested with "t" test at error degrees of freedom by Chaudhary *et al.* (1978).

$$\text{T for heterosis over mid parent value} = \frac{\overline{F_1} - MP}{\sqrt{\underline{Me} \times \frac{2}{3}}}$$

$$\text{T for heterosis over high parent value} = \frac{\overline{F_1} - \overline{HP}}{\sqrt{\underline{Me} \times 2}}$$

Where, Me = error variance; r = number of replications.

RUSULTS AND DISCUSSION

Combining ability:

General and specific combining abilities were measured to determine the additive and non-additive effects for the studied traits. The analysis of variance for GCA and SCA for the studied characters is given in Table 2.

Table (2): Mean squares for general and specific combining abilities for all studied traits.

Traits and source of variation	SS	MS	F	GCA/SCA
1- Number of days from planting to the first flower anthesis:				
GCA	9.631	3.178	318.41**	26.932
SCA	0.742	0.118	12.69**	
2- Early number edible pods yield/plant				
GCA	8.738	2.892	299.01**	28.634
SCA	0.621	0.101	106.69**	
3- Early weight edible pods yield/plant				
GCA	6.425	2.135	219.16**	36.810
SCA	0.362	0.058	6.23**	
4- Total edible pods yield (g/plant)				
GCA	10.060	3.352	338.92**	20.820
SCA	1.002	0.161	17.15**	
5- Dry matter in the edible pods				
GCA	14.790	4.898	68.21**	9.456
SCA	3.215	0.518	56.42**	
6- Average edible pod weight				
GCA	18.091	5.995	103.52**	10.372
SCA	3.582	0.578	62.35**	
7- Relative growth rate (RGR)				
GCA	0.953	0.320	32.82**	5.818
SCA	0.342	0.055	9.87**	

* Significant at 0.05 level of probability according to the "T" test.

** Significant at 0.01 level of probability according to the "T" test.

a- *General combining ability* (GCA):

The variance associated with both GCA and SCA were highly significant for all traits. This result suggest that genes with additive and non-additive effect are involved in the inheritance of these traits. The ratio between the mean squares of GCA and SCA showed that the additive component of genetic variance played the main role in the inheritance of all characters. These ratios ranged from 5.818 to 36.810. these results are in agreement with those obtained by Vijay and Manohar (1986), Metwally and El-Sawy (1988), Shukla *et al.* (1989), Ragaa *et al.* (1997) and Rajani *et al.* (2001).

Estimates of GCA for the studied parents are presented in Table (3). Highly significant negative GCA effects (-2.15, and -0.861) were shown by the parents GC and PK, respectively for the early flowering, indicating that these parents may by considered the best combiners for breeding to early flowering. On the other hand, highly significant positive GCA effects (1.367, 1.067) were shown by the parents IS and BA, respectively, and states that these parents were the latest flowering one and the poorest parents for breeding to early flowering .

Significant positive GCA effects were achieved by the parent GC followed by the parents PK (Table 3). Their values were 1.858 and 0.364, respectively for early weight of edible pods yield, proving that they were the best combiners for breeding to this character. Meanwhile, the parents BA, Is and ES reflected significant negative GCA values (-0.950, -0.740 and -0.532, respectively), indicating that they were the worst concerning for this trait.

Estimated GCA effects for total edible pods yield are presented in Table (3). Highly significant positive GCA values are shown by the parents PK and GC, these values were (1.873 and 1.857, respectively). Based on these results, these two parents proved to be the best combiners for total yield.

Concerning the dry matter in the edible pods, the parent GC showed highly significant positive GCA effects (1.859) indicating that this parent was the best for the high dry matter content in the edible pods.

Regarding the relative growth rate (RGR), highly significant positive value (0.892) was shown by the parent GC. Meanwhile, significant negative GCA value (-1.137) was shown by the parent PK. These results suggesting that this parent is poor for this trait.

b- *Specific combining ability* (SCA):

Regarding number of days from planting to the first flower anthesis, the combinations BA × ES, BA × IS, ES × IS, ES × PK, ES × GC, IS × PK, IS × GC and PK × GC showed significant negative SCA values (-0.180, -0.156, -0.413, -0.358, -0.221, -0.562 and -0.435, respectively). These results suggest that these hybrids were good combinations for early flowering trait (Table 3).

Table (3): Estimates of general and specific combining ability effects for the studied traits.

Parents Designation and Name	characters	SCA effects					GCA effects
		BA	ES	IS	PK	GC	
1- Baladi (BA)	1- Number of days from planting to the first flower anthesis.		-0.180*	-0.156*	-0.062	-0.071	1.067**
	2- Early number edible pod yield/plant.		-0.215**	-0.185**	0.116*	0.159*	-1.332**
	3- Early weight edible pod yield/plant.		0.141*	-0.058	0.151*	0.021	-0.950**
	4- Total edible pod yield (g/plant).		0.273**	0.351**	-0.141*	0.538**	-1.568**
	5- Dry matter in the edible pods.		0.079	0.142*	-0.091*	0.235**	0.235*
	6- Average edible pod weight.		0.153*	0.221**	-0.131*	-0.159*	0.548*
	7- Relative growth rate (RGR).		-0.694**	-0.651**	1.013**	0.351*	0.213
2- Eskandrani (ES)	1- Number of days from planting to the first flower anthesis.			-0.413*	-0.358**	-0.211*	0.578*
	2- Early number edible pod yield/plant.			0.046	0.111*	0.051	-0.671**
	3- Early weight edible pod yield/plant.			0.188**	0.121*	0.019	-0.532*
	4- Total edible pod yield (g/plant).			1.351**	2.351**	3.151**	-0.953**
	5- Dry matter in the edible pods.			0.931**	-0.045	0.121*	-1.362**
	6- Average edible pod weight.			-0.312**	-0.415**	0.056	0.072
	7- Relative growth rate (RGR).			6.541**	3.211**	-1.112**	0.093
3- Ismailiy (IS)	1- Number of days from planting to the first flower anthesis.				-0.221**	-0.562**	1.367**
	2- Early number edible pod yield/plant.				-0.251**	0.171*	-0.895**
	3- Early weight edible pod yield/plant.				0.361**	0.314**	-0.740**
	4- Total edible pod yield (g/plant).				1.241**	0.635**	-1.210**
	5- Dry matter in the edible pods.				1.025**	0.395**	-0.853**
	6- Average edible pod weight.				0.081	0.162*	-0.983**
	7- Relative growth rate (RGR).				2.351**	1.735**	-0.063
4-Parbhani Kranti (PK)	1- Number of days from planting to the first flower anthesis.					-0.435**	-0.861**
	2- Early number edible pod yield/plant.					0.120*	0.975**
	3- Early weight edible pod yield/plant.					0.182*	0.364*
	4- Total edible pod yield (g/plant).					2.007**	1.873**
	5- Dry matter in the edible pods.					0.428**	-0.051
	6- Average edible pod weight.					0.145*	-0.888**
	7- Relative growth rate (RGR).					2.162**	-1.137**
5- Golden Coast (GC)	1- Number of days from planting to the first flower anthesis.						-2.151**
	2- Early number edible pod yield/plant.						1.923**
	3- Early weight edible pod yield/plant.						1.858**
	4- Total edible pod yield (g/plant).						1.857**
	5- Dry matter in the edible pods.						2.030**
	6- Average edible pod weight.						1.251**
	7- Relative growth rate (RGR).						0.892**

* Significant at 0.05 level of probability according to the "T" test.
** Significant at 0.01 level of probability according to the "T" test.

Concerning early number of edible pods yield, four crosses, viz, BA x PK, BA × GC, ES × PK and IS × GC had significant positive SCA values (0.116, 0.159, 0.111 and 0.120, respectively). With respect to early weight edible pods seven crosses, viz, BA × ES, BA × PK, ES × IS, Es × PK, IS × PK, IS × GC and PK × GC, reflected significant positive SCA values (0.141, 0.151, 0.188, 0.121, 0.361, 0.314 and 0.182, respectively). These results suggest that these hybrids were good combinations for early weight edible pods yield (Table 3).

Regarding total edible pods yield, the nine F_1 hybrids BA × ES, BA × IS, BA × GC, ES × IS, ES × PK, ES × GC, IS × PK, IS × GC and PK × GC showed the highest positive SCA effect values (0.273, 0.351, 0.538, 1.351, 2.351, 3.151, 1.241, 0.635 and 2.007, respectively. These results indicate that they were the best combinations in high yield. On the other hand, the cross BA × PK exhibited significant negative SCA value (-0.141), indicating that this cross was poor combiner for this trait (Table 3).

Of the 10 F_1 hybrids, the crosses BA × IS, BA × GC, ES × IS, ES × GC, IS × PK, IS × GC and PK × GC showed significant positive SCA values regarding dry matter in the edible pods. Their SCA values were 0.142, 0.235, 0.931, 0.121, 1.025, 0.395 and 0.428, respectively as shown in Table (3). These results suggest that these hybrids are the best combinations concerning this trait. Meanwhile, the cross BA × PK showed significant negative SCA value (-0.091), indicating that this cross is poor combinator for this trait.

For average edible pod weight, four F_1 hybrids, viz, BA × ES, BA × IS, IS × GC and PK × GC reflected significant positive SCA values (0.153, 0.221, 0.162 and 0.145, respectively). These results indicate that these hybrids are the highest weight combination.

Regarding relative growth rate (RGR), seven F_1 hybrids, viz, BA x PK, BA × GC, ES × IS, ES × PK, IS × PK, IS × GC and PK × GC, showed significant positive SCA values (1.013, 0.351, 6.541, 3.211, 2.351, 1.735 and 2.162, respectively) as shown in Table (3). These results suggest that they were the best combinations for the high relative growth rate. Meanwhile, significant negative SCA values (-0.694, -0.651 and -1.112) were shown by the crosses BA x ES, BA x IS and ES x GC, respectively. These results suggesting that these crosses are the poor combinations for this trait.

It could be concluded that the parent Golden Coast was the best one among used parents, since it showed significant GCA values for the most studied traits, followed by the Parbhani Kranti.

Obtained data on SCA effects for the evaluated F_1 the evaluated hybrids showed that certain crosses had high SCA effect values for certain studied traits, but not for all of them. These results are agree with those reported by Ragaa *et al.* (1997) and Rajani *et al.* (2001).

The best crosses were "Ismailiy × Golden Coast", "Parbhani Kranti × Golden Coast" "Eskandrani × Parbhani Kranti" and "Ismaily × Parbahani

Kranti" since they showed significant SCA effect values for most evaluated traits. These superior and prospective materials can be used in okra improvement through breeding barograms.

c- *Average degree of heterosis*:

The average degree of heterosis as percent based on the mid-parents (MP) and high-parent (HP), in addition to potence ratio for the studied characters are tabulated in Table (4).

Regarding number of days to flowering, the four crosses, viz, BA × GC, ES × GC, IS × GC and PK × GC gave high significant negative hetrosis values relative to both MP (-15.07%, -10.45%, -11.76% and -15.15%, respectively) and HP "earliest parent" (-6.06%, -9.09%, -9.09% and -6.67%, respectively). The obtained high potence values for the four crosses (-1.57, -7.00, -4.00 and -5.00, respectively), suggested over-dominance to the earliest parent. Five crosses viz, BA × ES , BA × IS, BA × PK, ES × PK and IS × PK showed significant negative heterosis values relative to MP (-5.41%, -6.67%, -11.43%, -6.25% and -7.69%, respectively). The obtained ADH% values based on the high parent were insignificant and potence ratio values (-0.67, -1.00, -0.80, -1.00 and -1.00, respectively), thus a complete dominance for the few number of days in these crosses could be suggested . Meanwhile, the cross ES x IS showed insignificant differences between its parents. Therefore the ADH % did not estimated . Over dominance and dominance was observed for the few number of days to first flowering by Mandal and Dona (1993), Ragaa *et al.* (1997) and Neeta *et al.* (2004).

For early yield as pods number, two crosses exhibited over-dominance. These hybrids were IS × GC and PK × GC, which showed highly significant positive ADH% (20.51% and 12.36%, respectively) in relation to MP and (11.91% and 6.38%, respectively) in relation to the HP. They gave also high values of potence ratio; viz, 2.67 and 2.20, respectively. The cross BA x PK had significant positive ADH% based on MP (18.99%) and insignificant ADH% based on HP with potence value (1.00), indicating complete dominance for high early pod yield. However, three crosses (BA × ES, ES × PK and IS × PK) gave significant positive ADH% values (5.86%, 5.88% and 8.43%, respectively) in relation to MP and significant negative ADH% values (-5.26%, -4.26% and -4.26%, respectively) based on HP, with low potence values (0.63, 0.56 and 0.64, respectively). This figure suggest partial dominance for the high early yield . In this regard, Sinah and Mandal (1993), Ragaa *et al.* (1997) and Neeta *et al.* (2004) found heterosis over both mid and better parental values for early yield in okra .

Table (4): Average degree of heterosis (ADH%), based on mid-parents (MP) and high parent (HP), as well as potence ratio for some traits in okra.

Crosses	No. of days to flowering			Early edible pod yield (pods number/plant)			Early edible pod yield (pods weight/plant)			Total edible pod yield/plant		
	ADH%		Potence	ADH%		Potence	ADH%		Potence	ADH%		Potence
	MP	HP	ratio	MP	HP	ratio	MP	HP	ratio	MP	HP	ratio
BA x ES	-5.41*	2.94	-0.67	5.86*	-5.26*	0.63	10.53*	-4.55*	0.67	13.64**	0.01	1.07
BA x IS	-6.67**	0.0	-1.00	0.00	-3.56	0.00	2.33	-7.0*	0.30	6.67**	-4.00*	0.60
BA x PK	-11.43**	3.33	-0.80	18.99**	0.00	1.00	33.33**	7.69**	1.40	33.33**	11.11**	1.67
BA x GC	-15.07**	-6.06**	-1.57	0.00	-11.91*	0.00	23.00**	2.50	1.15	24.14**	5.89*	1.40
ES x IS	.....	.....	.....	.....	.....	.....	2.86	-1.82	0.6	.....	.....	.....
ES x PK	-6.25*	0.00	-1.00	5.88*	-4.26*	0.56	16.67**	7.69**	2.0	13.43**	5.56*	1.80
ES x GC	-10.45**	-9.09**	-7.00	2.50	-2.38	0.30	7.83*	3.33	1.2	9.23**	4.41*	2.00
IS x PK	-7.69**	0.00	-1.00	8.43**	-4.26*	0.64	26.09**	11.54**	2.0	11.82**	2.50	1.30
IS x GC	-11.76**	-9.09**	-4.00	20.51**	11.91**	2.67	18.18**	8.33**	2.0	12.50**	5.88*	2.00
PK x GC	-15.15**	-6.67**	-5.00	12.36**	6.38**	2.20	16.0**	11.54**	2.67	12.14**	9.03**	3.25
	Dry matter in the edible pods			Average pod weight			Relative growth rate (RGR)					
BA x ES	.....	.....	.....	0.01	-7.80*	0.10	22.58**	2.70	1.17			
BA x IS	7.53**	-.1.96	0.78	3.45	-4.80	0.40	26.32**	12.50**	2.14			
BA x PK	4.35	-4.0*	0.40	5.63*	-15.73**	0.52	20.00**	-2.50	0.87			
BA x GC	14.14**	-0.01	0.93	6.77*	-11.25**	0.61	30.00**	11.43**	1.80			
ES x IS	5.26*	-2.96*	0.71	0.01	-3.13	0.20	4.35	-2.70	0.60			
ES x PK	-2.13	-8.0*	-0.33	3.30	-11.24**	0.20	9.10*	3.00	1.33			
ES x GC	10.89**	-1.75	0.85	8.33**	-2.50	0.75	13.89**	10.81**	5.0			
IS x PK	.....	.....	.....	2.70	-14.61**	0.13	13.89**	2.50	1.25			
IS x GC	-0.01	-3.14*	-0.17	6.47**	-7.50**	0.63	13.43**	8.57*	3.00			
PK x GC	4.67*	-1.75	0.71	1.78	-3.37	0.33	14.67**	7.50*	2.20			

* Significant at the 0.05% level.
** Significant at the 0.01% level.
..... No significant differences were found between the parents

In respect of the early edible pods yield as pod weight, five crosses showed hybrid vigour for the early yield (pod weight/plant) as shown in Table (4), because they gave highly significant positive heterosis over the mid and high parental values which accompanied with high potence ratio values. These crosses were BA × PK, ES × PK, IS × PK, IS × GC and PK × GC. Meanwhile, the crosses BA × GC and ES × GC displayed a complete dominance for the high parent because its have significant positive values (23.00% and 7.83%, respectively) based on MP, and insignificant heterosis based on HP, with relatively higher values (1.15 and 1.2, respectively) of potence ratio. On the other hand, the cross BA × ES displayed a partial dominance for the high parent because it had significant value (10.53%) based on MP and significant negative value (-4.55%) based on HP. The estimated potence ratio (0.67) was in accordance with postulated hypothesis . Thaker *et al.* (1982), Singh and Mandal (1993), Ragaa *et al.* (1997) and Neeta *et al.* (2004) found heterosis over mid and high parental values, with respect to early yield.

Regarding total edible pod yield, six crosses BA × PK, BA × GC, ES × PK, ES × GC, IS × GC and PK × GC significantly exceeded their high parents in total yield, suggesting hybrid vigour for the high yield. The ADH% was estimated as 11.11%, 5.89%, 5.56%, 4.41%, 5.88% and 9.03%, respectively. The high obtained potence ratio values (1.67, 1.40, 1.80, 2.00, 2.00 and 3.25, respectively) were in accordance with the hybrid vigour hypothesis. On comparing the observed means for the studied F_1s versus their respective high parents in total yield, the crosses BA × ES and IS × PK did not differ significantly from their high parental means, indicating complete dominance for the high yield. The complete dominance was supported by the estimated ADH% values for these crosses (0.01% and 2.50%, respectively). The estimated potence ratio values (1.07 and 1.30, respectively) support the complete dominance. Partial dominance for the high total edible pods yield was detected in the cross BA x IS, since it showed significant ADH% as 6.67% and 4.00% based on MP and HP, respectively. The obtained potence ratio value was moderate (0.60) in accordance with the partial dominance postulated. The same conclusion regarding heterosis was reported by Elongovan *et al.* (1981 b), Shukla *et al.* (1989), Ragaa *et al.* (1997) and Neeta *et al.* (2004).

For dry matter in the edible pods, significant differences between the parental lines of nine studied crosses were observed. When the obtained means of these crosses were compared with their arithmetic MP means, five ones significantly exceeded their mid-parental values in this respect, suggesting dominance towards the high rate of dry matter in the edible pods. Comparing the observed means for the studied F_1s versus their respective high parents, the crosses BA x IS, BA × GC, ES × GC and PK × GC did not

differ significantly from their high parental means, indicating complete dominance for the high parents. The complete dominance was supported by the estimated ADH% values for these crosses (-1.96%, -0.01%, -1.75% and -1.75%, respectively). The estimated potence ratio values (0.78, 0.93, 0.85 and 0.71, respectively) support the complete dominance.

Partial dominance for the high dry matter in the edible pods was detected in the cross ES × IS, since it showed significant ADH values as 5.26% and -2.96% based on MP and HP, respectively (Table 4). The obtained potence ratio value was moderate (0.71) in accordance with the partial dominance postulated. Incomplete dominance was observed in the crosses BA × PK, ES × PK and IS × GC, since there means and their mid-parents did not differ significantly. Low heterosis values (4.35%, -2.13% and -0.01%, respectively) and low potence ratio values (0.40, -0.33 and -0.17, respectively), were found .

Concerning average pod weight, data in Table (4) showed that the cross ES × GC had significant positive heterosis value relative to MP (8.33%). Meanwhile, their ADH% values based on HP were insignificant, indicating complete dominance for the large pod weight. However, three crosses (BA × PK, BA × GC and IS × GC) gave significant positive ADH% values (5.63%, 6.77% and 6.46%, respectively) in relation to MP and significant negative ADH% values (-15.73%, -11.25% and -7.50%, respectively) in relation to the HP, suggesting partial dominance for the high weight. This partial dominance was verified by the obtained potence ratio values (0.52, 0.61 and 0.63), respectively. It is noticed that none of the studied F_1 crosses exhibited hybrid vigour or dominance for the low parent.

Regarding relative growth rate, the crosses (BA × IS, BA × GC, ES × GC, IS × GC and PK × GC) gave significant positive heterosis over both MP values (26.32%, 30.00%, 13.89%, 13.43% and 14.67%, respectively) and HP values (12.50%, 11.43%, 10.81%, 8.57% and 7.50%, respectively), accompanied with high potance ratio values (2.14, 1.80, 5.00, 3.00 and 2.20, respectively), indicating hybrid vigour for the high rate. Complete dominance for the high content was observed in the crosses BA × ES, BA × PK, ES × PK and IS × PK. The obtained ADH% were significantly positive in relation to mid-parents values (22.58%, 20.00%, 9.10% and 13.89%, respectively), and insignificant in relation to high parents. This complete dominance was verified by the obtained potence ratio values in these crosses which were 1.17, 0.87, 1.33 and 1.25, respectively.

Different degrees of dominance (hybrid vigour, completed and partial dominance) were also found in most studied traits in okra by Sharma and Mahajan (1978), Shukla *et al.* (1989), Ragaa *et al.*, (1997) and Neeta *et al.* (2004).

It could be concluded that the parents Eskandrani, Parbhani Kranti and Golden Coast gave the best crosses in most characters, in addition to their high GCA, so, these lines may be considered the best combiner lines for improving the okra through breeding programs. Furthermore, hybrid vigour was found in the crosses IS × GC, PK × GC, ES × GC and BA × GC for most studied traits. This suggestion was evident by the high estimated average degree of heterosis and potence ratio.

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السلوك الوراثى لبعض الصفات الإقتصادية في الباميا

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الملخص العربى

هذه الدراسة بمزرعة محطة بحوث البساتين بالقناطر الخيرية خلال الموسم الصيفى لعامي ٢٠٠٥، ٢٠٠٦ بهدف الحصول على المزيد من المعلومات الخاصة بوراثة بعض صفات الباميا، حيث تساعد هذه المعلومات المربى عند وضع وتنفيذ برامج التربية لتحسين محصول الباميا، واستخدم في هذه الدراسة ٥ أصناف هي البلدي، والاسكندراني والإسماعيلي، وباراباهان كرانت، وجولدن كوست، وأجريت التربية الداخلية لهذه الأصناف لعدة أجيال لتنقيتها وراثياً، وأجرى التهجين بينهم في موسم ٢٠٠٥ للحصول على بذور الجيل الأول اللازمة للدراسة، وفي موسم ٢٠٠٦ زرعت الآباء والهجن العشرة في تجربة مصممة بطريقة القطاعات الكاملة العشوائية في ثلاث مكررات- والصفات التي تناولتها هذه الدراسة عبارة عن ٧ صفات هي عدد الأيام اللازمة لظهور أول زهرة النبات، وعدد ووزن المحصول المبكر، ووزن المحصول الكلي، محتوى القرون من الماده الجافة، متوسط وزن القرن، معدل النمو النسبي .

وكانت أهم النتائج المتحصل عليها هي:

١- التباين لكل من القدرة العامة والخاصة على الإئتلاف كان معنوياً لكل الصفات التي تم دراستها، وهذا يوضح أهمية كل من الفعل المضيف والغير مضيف للجينات في وراثة الصفات تحت الدراسة .

٢- أظهرت النسب المحسوبة بين متوسط مربعات الإنحرافات للقدرة العامة، والخاصة على الإئتلاف أن الفعل المضيف للجينات كان يلعب دوراً أكثر أهمية من الفعل غير المضيف في وراثة جميع الصفات المدروسة .

٣- أختلفت الآباء في تأثيرات القدرة العامة على الإئتلاف- فكل سلالة أبوية أظهرت قدرة عالية لعدد من الصفات- وعموماً فإن الأصناف جولدن كوست، وبارباهان كرانت يليهما اسكندراني كانوا أفضل الآباء من حيث إظهار قيم عالية للقدرة العامة في معظم الصفات المدروسة .

٤- أوضحت حسابات تأثيرات القدرة الخاصة على الإئتلاف للهجن المختلفة أن الهجن الفردية التي يدخل في تكوينها هذه الآباء أعطت تقديرات عالية للقدرة الخاصة على الإئتلاف لمعظم الصفات- ومن هذا يمكن إعتبار هذه السلالات الثلاثة صالحة وراثياً للاستفادة منها في برامج التربية والتحسين في الباميا .

٥- ظهرت كل نظم السيادة (عدم سيادة، سيادة جزئية، سيادة تامة، قوة الهجين) في الهجن تحت الدراسة للصفات المختلفة .

٦- ظهرت قوة الهجين لغالبية الصفات المدروسة في الهجن (اسكندراني × جولدن كوست)، (بارباهان كرانت × جولدن كوست)، (اسماعيلي × جولدن كوست)، (اسكندراني × بلدي) مما يشجع على استخدام الهجن الفردية لهذه السلالات الآبوية في الإنتاج التجاري على نطاق واسع .