J. Agric. Chem. and Biotechn., Mansoura Univ. Vol. ٣(٧): ١٩٥ - ٢٠٥, ٢٠١٢

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

El-Gendy, Soher E. A.[١] ; H. A. Obiadalla-Ali[٢] ; E. A. Ibrahim[١] and M. H. Z. Eldekashy [٣]

[١] Vegetable Res. Dept., Horticultural. Res. Inst., ARC, Egypt
[٢]Dept. of Horticulture, Fac. Agric., Sohag University, Sohag, Egypt
[٣]Dept. of Horticulture, Fac. Agric., Assuit University, Assuit, Egypt

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 ($P_{٥}$) and ($P_{٩}$) were the best general combiners for earliness, while ($P_{١}$), ($P_{٤}$), ($P_{٥}$) and ($P_{٧}$) were found to be good general combiners for total yield per plant. The crosses ($P_{٥}xP_{٦}$), ($P_{٥}xP_{٩}$), ($P_{٥}xP_{٨}$) ang ($P_{٩}xP_{٢}$) were the earliest crosses in comparison with the other crosses. Meanwhile, the cross ($P_{١}xP_{٩}$) had the highest mean value for fruit diameter, plant height and fruit weight. In addition, the crosses, ($P_{١}xP_{٦}$), ($P_{١}xP_{٧}$), ($P_{٥}xP_{٩}$) and ($P_{٦}xP_{٤}$) had the highest mean values for No. of fruit/plant and total yield /plant. Therefore, these promising crosses among $F_{١}$ hybrids and $F_{١}$ reciprocal ($F_{١r}$) 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 ($\sigma^{٢}A$) were positive and lower than those of non additive ($\sigma^{٢}D$) 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 ($H^{٢}_{b}$ %) were more than ٧٥% and larger than their corresponding narrow sense heritability ($H^{٢}_{n}$ %) for all studied traits. However, estimates of narrow sense heritability were ١٣,٩٪, ٣٢,٤, ٤٠,٥, ٤٧,١, ٧٦,٨ for earliness, fruit length, fruit weight, plant height and fruit diameter, respectively. The estimates of narrow sense heritability ranged from ١١,٣ % to ١٧,٣٤٪ 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 (١٩٩٩), El-Gendy and El-Sherbeny (٢٠٠٥) and El-Sherbeny *et al* (٢٠٠٥) found that the magnitudes of additive genetic variance ($\sigma^{٢}A$) were larger than those of non-additive ones ($\sigma^{٢}D$) for most okra economic traits. On the other hand, Dhankhar and Dhankhar (٢٠٠١), Prakash *et al* (٢٠٠٢) and Solankey and Singh (٢٠١٠) 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* (٢٠٠٢), liou *et al* (٢٠٠٢), El-Gendy and El-Diasty (٢٠٠٤) and Singh *et al* (٢٠١١) 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 ٢٠٠٩ (Elgendy,Soher ٢٠١٢). These genotypes are: line ١ ($P_{١}$), line ٢ ($P_{٢}$), line ٣ ($P_{٣}$), line ٤ ($P_{٤}$), line ٥ ($P_{٥}$), line ٦ ($P_{٦}$), line ٧ ($P_{٧}$), line ٨ ($P_{٨}$) and line ٩ ($P_{٩}$). The present study was conducted at El-Baramoon research Station, Horticulture Research Institute, ARC, Egypt during the summer seasons of ٢٠١٠ and ٢٠١١. In the summer season of ٢٠١٠, 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 ٣٦ $F_{١}$ and ٣٦ $F_{١}$ reciprocal ($F_{١r}$) hybrids. In the summer season of ٢٠١١, ٧٢ $F_{١}$ hybrids were evaluated in a randomized block design with three replications. Each block contains ٧٢ plots. Each plot was ٣ rows, ٣٫٥ m. long and ٦٠ cm. wide. Hills were spaced ٣٠ cm. Apart. All other agricultural practices were applied as recommended for okra production.

Data were recorded on ١٠ plants chosen at random from each plot for the following traits: Number of days to ٥٠٪ 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 ٧٢ F١ and $F_{١}$ reciprocal hybrids according to Cochran and Cox (١٩٥٧).

Sum squares of studied genotypes was partitioned according to Griffing`s (١٩٥٦) as method ٣ into sources of variations due to GCA and SCA.

The variances of GCA ($\sigma^{٢}g$) and SCA ($\sigma^{٢}s$) were obtained on the basis of the expected mean squares for all studied traits. Additive ($\sigma^{٢}A$) and non-additive ($\sigma^{٢}D$) genetic variances were estimated according to Matzinger and Kempthorne (١٩٥٦) as follows:

$\sigma^{٢}A \quad = \quad ٢ \sigma^{٢}g$

$\sigma^{٢}D \quad = \quad \sigma^{٢}s$

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

$h^{٢}b\% = [(\sigma^{٢}A + \sigma^{٢}D) / (\sigma^{٢}A + \sigma^{٢}D + \sigma^{٢}e)] \times ١٠٠$

$h^{٢}n\% = [(\sigma^{٢}A) / (\sigma^{٢}A + \sigma^{٢}D + \sigma^{٢}e)] \times ١٠٠$

RESULTS AND DISSCUSION

Genotypic variations

Analyses of variance for all genotypes are presented in Table ١ 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* (٢٠٠٥) and Abdelmageed (٢٠١٠).

Table ١: 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	٢	٣٢,٣١	١٢,٠	١٠٢,٠	٠,٤٠	١,٧٨	٤,٨٤	١١٠٠٣٠,٨**
Geno.	٧١	٢٠,٩٦**	٢٩٣٧,١**	٣٥٣٢,٩**	٠,٥٢**	١,١٣**	١,٥٣**	١٠٣١١٢,٩**
Error	١٤٢	١,٤٥	٧٢,١	٣٤,٣	٠,٠٥	٠,٢٠	٠,٢٧	٦٦٤٩,٩

Mean performance

Mean performance of the ٣٦ $F_{١}$ hybrids for all studied traits are shown in Table ٢. The results showed considerable variation were obtained among all $F_{١}$ hybrids for all studied traits. The crosses ($P_{٥}xP_{٦}$), ($P_{٥}xP_{٩}$) and ($P_{٥}xP_{٨}$) were the earliest crosses in comparison with the other crosses. Meanwhile, the cross ($P_{١}xP_{٩}$) had the highest mean value for fruit diameter, plant height and fruit weight. In addition, the crosses, ($P_{١}xP_{٦}$), ($P_{١}xP_{٧}$) and ($P_{٥}xP_{٩}$) had the highest mean values for No. of fruit/plant and total yield /plant.

Mean performance of the ٣٦ $F_{١}$ reciprocal crosses ($F_{١r}$) for all studied traits are presented in Table ٣. No specific reciprocal hybrid showed superiority over other crosses for all studied traits. The best combination for earliness was ($P_{٩}xP_{٢}$) with mean of ٥٣,٧. The crosses ($P_{٨}xP_{٦}$), ($P_{٩}xP_{٣}$) and ($P_{٤}xP_{١}$) were the highest combinations for plant height, fruit diameter and fruit weight with mean of ٢٨٠, ٦,١٧ and ٥,٩٧, respectively. Moreover, the cross ($P_{٦}xP_{٤}$) was the best for no. of fruit per plant, fruit length and total yield per plant with the mean of ٢٣٩, ٤,٥٧ and ١٠٣٥,٧, respectively. Therefore, these promising crosses among $F_{١}$ hybrids and $F_{١}$ reciprocal combinations could be used for further breeding studies to improve the economic traits in okra.

Table ٢: Mean performance of $F_{١}$ hybrids for all studied traits

Hybrids		No. of DF	PH (cm)	No. of F/P	FD (cm)	FL (cm)	FW (gm)	TY/P (gm)
١	$P_{١}xP_{٢}$	٦٠,٧	١٧٥	١٣٦	٥,٣٣	٣,٤٣	٤,٦٠	٦٢٥,٩
٢	$P_{١}xP_{٣}$	٦٠,٧	١٩٠	١٨١	٥,٥٣	٣,٠٣	٤,٠٠	٧٢٤,٤
٣	$P_{١}xP_{٤}$	٥٩,٧	٢٣٠	١٠٤	٤,٩٣	٣,٨٣	٣,٥٧	٣٧٠,٧
٤	$P_{١}xP_{٥}$	٥٥,٧	١٩٠	١٩٠	٥,٦٧	٢,٦٧	٣,٨٣	٧٢٨,١
٥	$P_{١}xP_{٦}$	٥٩,٧	٢٢٠	٢١١	٥,٤٠	٤,٥٧	٥,٠٠	١٠٥٢,٣
٦	$P_{١}xP_{٧}$	٦١,٠	٢٣٠	١٨٠	٥,٧٣	٤,٤٠	٦,٠٠	١٠٨٠,٢
٧	$P_{١}xP_{٨}$	٦١,٠	١٩٥	١١٤	٥,٩٧	٤,٤٣	٥,٤٠	٦١٥,٩
٨	$P_{١}xP_{٩}$	٥٩,٣	٢٠٥	٨٤	٦,١٣	٣,٦٣	٦,٢٠	٥٢٢,٣
٩	$P_{٢}xP_{٣}$	٦٢,٠	١٩١	٩٢	٥,٥٠	٣.٥٣	٤,٤٧	٤١٠,٩
١٠	$P_{٢}xP_{٤}$	٥٦,٧	٢١٨	١٣٣	٤,٩٧	٣,٢٧	٣,٨٧	٥١٥,٦
١١	$P_{٢}xP_{٥}$	٥٨,٧	١٨٨	١٩٠	٥,٥٧	٣,٤٠	٣,٨٣	٧٢٦,٩
١٢	$P_{٢}xP_{٦}$	٥٨,٣	٢٣٨	١٧٩	٤,٧٠	٤,٠٣	٤,٠٠	٧١٦,٥
١٣	$P_{٢}xP_{٧}$	٥٨,٠	١٩٥	١٤٩	٥,٠٧	٤,٤٧	٤,٥٣	٦٧٥,٣
١٤	$P_{٢}xP_{٨}$	٥٦,٧	٢٠٦	١٦٨	٤,٦٧	٣,٦٣	٣,٦٠	٦٠٤,٨
١٥	$P_{٢}xP_{٩}$	٥٧,٣	٢١٧	١٧٠	٤,٨٣	٣,٦٠	٣,٦٠	٦١٢,٨
١٦	$P_{٣}xP_{٤}$	٥٨,٧	٢٠٥	١٦٧	٥,٦٣	٣,٤٠	٤,٦٣	٧٧١,٩
١٧	$P_{٣}xP_{٥}$	٥٧,٠	١٨٧	١٥٣	٥,٤٧	٤,١٠	٣,٩٧	٦٠٦,٦
١٨	$P_{٣}xP_{٦}$	٥٧,٣	١٩٠	١٦٨	٤,٩٧	٦,٠٠	٥,٤٠	٩٠٧,٢
١٩	$P_{٣}xP_{٧}$	٥٨,٧	٢٣٠	١٥٠	٥,١٣	٣,٠٣	٣,٤٧	٥٢٠,٠
٢٠	$P_{٣}xP_{٨}$	٥٩,٧	٢١٥	١١٠	٥,١٣	٣,٣٧	٣,٨٠	٤١٦,٧
٢١	$P_{٣}xP_{٩}$	٥٧,٠	١٧٠	١٠٤	٥,١٧	٣,٥٧	٣,٨٠	٣٩٤,٥
٢٢	$P_{٤}xP_{٥}$	٥٨,٧	١٩٠	١٦٩	٥,١٧	٣,٥٧	٤,٢٠	٧١٠,٢
٢٣	$P_{٤}xP_{٦}$	٥٨,٠	٢١١	١٤٨	٤,٨٧	٥,٧٠	٥,٠٧	٧٤٩,٩
٢٤	$P_{٤}xP_{٧}$	٦٣,٣	٢٢٥	١٥١	٥,٥٠	٣,٩٠	٥,٢٠	٧٨٤,٥
٢٥	$P_{٤}xP_{٨}$	٥٧,٧	١١٣	١٥٦	٥,٠٧	٣,٤٧	٤,٢٠	٦٥٥,٥
٢٦	$P_{٤}xP_{٩}$	٥٥,٠	٢٥٣	١٥٩	٥,٢٠	٣,١٠	٤,٢٣	٦٧١,٨
٢٧	$P_{٥}xP_{٦}$	٥٣,٠	٢١٢	١١٢	٤,٨٠	٣,٧٠	٣,٨٧	٤٣٢,٥
٢٨	$P_{٥}xP_{٧}$	٥٥,٣	١٨٥	٩٣	٥,٨٣	٣,٥٣	٥,٥٣	٥١٤,٠
٢٩	$P_{٥}xP_{٨}$	٥٤,٧	١٢١	١٨٠	٥,٢٧	٣,٧٣	٤,٧٣	٨٥٣,٠
٣٠	$P_{٥}xP_{٩}$	٥٤,٣	٢١٠	١٧٩	٥,٧٠	٣,٢٠	٥,٧٧	١٠٣١,٩
٣١	$P_{٦}xP_{٧}$	٦٣,٣	٢٥٢	١٥٢	٥,١٠	٣,٣٣	٤,١٧	٦٣٣,٣
٣٢	$P_{٦}xP_{٨}$	٦٣,٧	٢٢٣	١٦١	٥,٠٣	٣,٣٧	٤,٠٧	٦٥٤.٩
٣٣	$P_{٦}xP_{٩}$	٦٣,٠	٢٧٠	١٨٠	٤,٤٣	٣,٢٣	٣,٣٣	٥٩٩,٧
٣٤	$P_{٧}xP_{٨}$	٦٢,٧	٢٣٢	١٤٢	٥,٧٣	٣,٨٣	٤,٩٣	٧٠٢,٩
٣٥	$P_{٧}xP_{٩}$	٥٦,٠	٢٤٠	١٧١	٦,٠٠	٣,١٠	٥,٢٧	٩٠٠,٦
٣٦	$P_{٨}xP_{٩}$	٥٨,٣	٢٣٢	١٤٠	٥,٢٣	٣,٠٧	٤,٨٧	٦٨١,٣
LSD	٠,٠٥	١,٩٤	١٣,٧	٩,٥	٠,٣٧	٠,٧٢	٠,٨٣	١٣١,٦٢
	٠,٠١	٢,٥٦	١٨,١	١٢,٥	٠,٤٩	٠,٩٥	١,١٠	١٧٣,٨٤

Table ٣: Mean performance of $F_{١}$ reciprocal hybrids ($F_{١r}$) for all studied traits

Hybrids		No. of DF	PH (cm)	No. of F/P	FD (cm)	FL (cm)	FW (gm)	TY/P (gm)
١	$P_{٢}xP_{١}$	٥٨,٧	٢٢٣	١٥١	٤,٩٠	٣,٨٠	٣,٣٠	٤٩٨,٥
٢	$P_{٣}xP_{١}$	٥٩,٧	١٩٠	١٢٤	٥,٩٧	٣,٥٣	٤,٧٣	٥٨٦.٥
٣	$P_{٤}xP_{١}$	٦١,٣	٢٣٥	١٧٠	٥,٨٣	٣,٣٧	٥,٩٧	١٠١٣,٧
٤	$P_{٥}xP_{١}$	٥٤,٣	٢١٠	١٤٨	٥,٧٣	٣,٨٣	٤,٨٧	٧٢٣,٣
٥	$P_{٦}xP_{١}$	٥٤,٣	١٩٤	٤٩	٥,٤٣	٣,٨٧	٤,٨٧	٢٣٧,٥
٦	$P_{٧}xP_{١}$	٥٨,٣	٢٥٥	١٤٨	٥,٨٣	٣,١٧	٥,٢٧	٧٨٠,٣
٧	$P_{٨}xP_{١}$	٥٩,٠	٢٨٥	١٩٠	٥,٤٧	٣,١٧	٤,٣٧	٨٢٧,٣
٨	$P_{٩}xP_{١}$	٥٦,٧	٢٤٠	١٥٩	٥,٩٧	٢,٩٧	٤,٦٧	٧٤٢,٣
٩	$P_{٣}xP_{٢}$	٥٧,٧	١٩٥	١٣٩	٤,٩٠	٣,٩٧	٣,٧٠	٥١٤,٨
١٠	$P_{٤}xP_{٢}$	٥٩,٣	٢٢٠	١٦١	٥,١٣	٤,١٣	٤,١٣	٦٦٥,٥
١١	$P_{٥}xP_{٢}$	٥٧,٠	٢٣٠	١٤٠	٤,٩٣	٤,٣٧	٤,١٠	٥٧٤,٠
١٢	$P_{٦}xP_{٢}$	٥٩,٠	٢٣٠	١٥٩	٤,٤٠	٥,٤٣	٣,٨٣	٦٠٩,٤
١٣	$P_{٧}xP_{٢}$	٦٠,٠	٢١٢	١٥٠	٥,٣٧	٣,٧٧	٤,٨٣	٧٢٥,٠
١٤	$P_{٨}xP_{٢}$	٥٨,٣	٢١٢	١٥٩	٤,٨٧	٣,٦٣	٣,٣٣	٥٢٩,٠
١٥	$P_{٩}xP_{٢}$	٥٣,٧	٢١٠	١٠٢	٥,١٠	٣,٨٠	٣,٩٠	٣٩٨,٠
١٦	$P_{٤}xP_{٣}$	٥٩,٣	٢١٥	١٩١	٥,٥٣	٢,٩٧	٣,٩٠	٧٤٥,٠
١٧	$P_{٥}xP_{٣}$	٥٥,٧	١٨٠	١٤١	٥,٨٠	٣,٧٧	٤,٦٠	٦٤٨,٩
١٨	$P_{٦}xP_{٣}$	٥٩,٠	٢٣٥	١٥٧	٥,٢٣	٤,٢٧	٤,٧٧	٧٤٨,٣
١٩	$P_{٧}xP_{٣}$	٥٦,٧	١٧٥	٧٩	٦,٠٧	٣,١٣	٥,٥٠	٤٣٦,٥
٢٠	$P_{٨}xP_{٣}$	٦٠,٣	٢٢٨	١٧١	٥,٩٧	٤,٠٧	٥,١٧	٨٨٣,٤
٢١	$P_{٩}xP_{٣}$	٥٥,٠	٢٤٥	١٢٠	٦,١٧	٣,٣٠	٥,٦٧	٦٨٠,٠
٢٢	$P_{٥}xP_{٤}$	٥٤,٧	٢٢٥	١٣٠	٥,٤٠	٣,٧٠	٤,٨٠	٦٢٤,٩
٢٣	$P_{٦}xP_{٤}$	٥٤,٠	٢٥١	٢٣٩	٤,٧٣	٤,٥٧	٤,٣٣	١٠٣٥,٧
٢٤	$P_{٧}xP_{٤}$	٦١,٣	٢٧٠	١٧٢	٥,٩٧	٣,٨٧	٥,٩٠	١٠١٥,٠
٢٥	$P_{٨}xP_{٤}$	٥٧,٠	٢٧٥	١٦٢	٥,٠٣	٣,٩٣	٣,٧٣	٦٠٥,٣
٢٦	$P_{٩}xP_{٤}$	٥٧,٧	٢٤١	١٥٠	٥,١٧	٣,١٠	٣,٩٧	٥٩٥,٧
٢٧	$P_{٦}xP_{٥}$	٥٩,٧	٢١٦	١٥٠	٤,٩٠	٣,٥٠	٣,٨٣	٥٧٥,٠
٢٨	$P_{٧}xP_{٥}$	٥٩,٣	١٩٧	١٥٠	٥,٥٧	٣,٣٠	٥,١٣	٧٦٩,٤
٢٩	$P_{٨}xP_{٥}$	٦٣,٧	٢٣٠	١٩٣	٥,٣٧	٤,٠٣	٤,٩٠	٩٤١,٠
٣٠	$P_{٩}xP_{٥}$	٥٧,٣	٢٣٠	١٦٣	٥,٤٣	٢,٩٠	٤,٤٣	٧٢٢,٦
٣١	$P_{٧}xP_{٦}$	٥٦,٣	٢٣٩	١٣١	٥,٢٠	٣,١٧	٤,٨٠	٦٢٨,٦
٣٢	$P_{٨}xP_{٦}$	٥٦,٣	٢٨٠	١٦٩	٥,٤٧	٣,٨٧	٤,٩٣	٨٣٢,٩
٣٣	$P_{٩}xP_{٦}$	٦٢,٠	٢٢٨	١٠٣	٥,٠٠	٣,٣٧	٤,٢٠	٤٣٢,٦
٣٤	$P_{٨}xP_{٧}$	٥٥,٧	٢١٢	١٦٨	٥,٣٠	٣,٤٣	٤,٥٧	٧٦٦,٧
٣٥	$P_{٩}xP_{٧}$	٦٢,٠	١٨٠	٧٤	٥,٧٠	٢,٦٧	٤,٣٣	٣١٩,٨
٣٦	$P_{٩}xP_{٨}$	٦١,٧	٢٦٢	٧٩	٥,٣٠	٣,٥٣	٣,٩٠	٣٠٧,٩
LSD	٠,٠٥	١,٩٤	١٣,٧	٩,٥	٠,٣٧	٠,٧٢	٠,٨٣	١٣١,٦٢
	٠,٠١	٢,٥٦	١٨,١	١٢,٥	٠,٤٩	٠,٩٥	١,١٠	١٧٣,٨٤

Combining ability analysis

Mean squares of general, specific combining ability and reciprocal effects for all studied traits are given in Table ٤. 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* (٢٠٠٢), Rewale *et al* (٢٠٠٣), El-Sherbeny *et al*., (٢٠٠٥), El-Gendy and El-Sherbeny (٢٠٠٥), Sinthil *et al* (٢٠٠٦) and Singh *et al* (٢٠٠٦).

Table ٤: 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	٨	٩,٦٨**	٢٠٤٨,٢**	١٣٣٧,٤**	٠,٩٣٩**	١,٠٧٠**	١,٣٥٥**	٤٢٨٤٨,٢**
SCA	٢٧	٦,٠١**	٤٧٩,٧**	٧٦٦,٤**	٠,٠٥٩**	٠,٣٥٩**	٠,٣٣٨**	٢٨٩٤٥,٠**
Reciprocal	٣٦	٧,١٢**	١١١٦,٠**	١٤٥٠,٥**	٠,٠٩١**	٠,٢٣٥**	٠,٤٤٩**	٣٦٥٥٦,٦**
Error	١٤٢	٠,٤٨	٢٤,٠	١١,٤	٠,٠١٧**	٠,٠٦٦	٠,٠٨٩	٢٢١٦,٦

GCA effects (gi)

Estimates of general combining ability effects (g_i) of each parent for all studied traits are presented in Table ٥. ($P_{٥}$) was the best general combiner for all studied traits except fruit length, fruit weight and plant length. While ($P_{١}$) was good general combiner for fruit diameter, fruit weight and total yield per plant. ($P_{٢}$) was good general combiner for fruit length. ($P_{٣}$) was good general combiner for fruit diameter. ($P_{٤}$) was good general combiner for plant length, number of fruit per plant and total yield. ($P_{٦}$) was good general combiner for fruit length, plant length and number of fruit per plant. ($P_{٧}$) was the best general combiner for all studied traits except fruit length, number of fruit per plant and earliness. ($P_{٨}$) was the best general combiner for plant length and number of fruit per plant. ($P_{٩}$) was the best general combiner for fruit diameter, plant length and earliness. Generally, the results showed that ($P_{٥}$) and ($P_{٩}$) were the best general combiners for earliness, while ($P_{١}$), ($P_{٤}$), ($P_{٥}$) and ($P_{٧}$) 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 ٥: 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)
$P_{١}$	٠,٤٣٤*	-٠,١٢	-٢,٢٥**	٠,٣١٢ **	-٠,٠٧٦	٠,٣٢٧**	٣٤,٤ **
$P_{٢}$	-٠,١٣٨	-٧,٧٩**	٠,٥٤	-٠,٣٧٣ **	٠,٢٥٠ **	-٠,٦٠١**	-٨٨,٩ **
$P_{٣}$	٠,٠٢٩	-١٦,٢٦**	-٨,٨٢**	٠,١٩٣ **	٠,٠١٩	-٠,٠٣٥	-٤٦,٦ **
$P_{٤}$	-٠,١١٤	٧,٧٤**	١٣,٦٨**	-٠,٠٩٥ **	٠,٠٧٨	-٠,٠٢٥	٦٣,١ **
$P_{٥}$	-١,٧٨٠**	-١٩,١٤**	٧,٩٠**	٠,٠٨١ *	-٠,١٠٥	٠,٠٢٥	٣٨,٢ **
$P_{٦}$	٠,٢٢٠	١٥,٧٦ **	٦,٩٧**	-٠,٤١٤ **	٠,٥١٤ **	-٠,١١٣	١٤,٢
$P_{٧}$	١,٠٠٥**	٤,٣٣ **	-٧,٨٩**	٠,٢٦٠ **	-٠,١٩١ **	٠,٥٢٧**	٤٣,٢ **
$P_{٨}$	٠,٨٨٦**	٣,٧٤ **	٦,٥٤**	-٠,٠٤٢	-٠,٠١٥	-٠,١١١	١٦,٥
$P_{٩}$	-٠,٥٤٢**	١١,٧٤ **	-١٦,٦٧**	٠,٠٧٧ *	-٠,٤٧٤ **	٠,٠٠٦	-٧٣,٩ **
SE(gi)	٠,١٧٥	١,٢٤	٠,٨٥	٠,٠٣٣	٠,٠٦٥	٠,٠٧٥	١١,٩

SCA effects (Sij)

Estimated specific combining ability effects (S_{ij}) of each cross combination for all studied traits are found in Table ٦. The results revealed that the cross combination ($P_{١}xP_{٦}$), ($P_{٢}xP_{٨}$), ($P_{٣}xP_{٧}$), ($P_{٤}xP_{٦}$), ($P_{٤}xP_{٨}$), ($P_{٧}xP_{٨}$), 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 ٦: 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)
$P_{١}xP_{٢}$	١,٠٠*	-٩,٨٩**	-٢,٩٥	-٠,١٦٤ *	-٠,٢٣٠	-٠,٢٧٩	-٤٨,٨
$P_{١}xP_{٣}$	١,٣٣**	-١٠,٤١**	١٥,٤١**	-٠,٠٩٧	-٠,٣٣٢*	-٠,٤٢٩**	٢,٢
$P_{١}xP_{٤}$	١,٨١**	٨,٠٩**	-٢٢,٥٩**	-٠,١٧٦ *	-٠,٠٧٥	-٠,٠٣٩	-٧٠,٨*
$P_{١}xP_{٥}$	-٢,٠٢**	٢,٤٧	١٥,٢٠**	-٠,٠٣٥	-٠,٢٤٢	-٠,٥٠٥**	-١٢,٤
$P_{١}xP_{٦}$	-٢,٠٢**	-٢٥,٤٣**	-٢٢,٨٨**	٠,١٧٧ *	٠,١٠٦	٠,٢١٦	-٦٩,١ *
$P_{١}xP_{٧}$	-٠,١٤	٢١,٤٩**	٢٥,٩٨**	-٠,١٣٠	٠,٣٧٧*	٠,٢٧٦	١٨٧,٢ **
$P_{١}xP_{٨}$	٠,٣١	١٩,٥٩**	-٠,٤٥	٠,١٠٥	٠,٢١٨	٠,١٦٤	٥,٣
$P_{١}xP_{٩}$	-٠,٢٦	-٥,٩١*	-٧,٧٣**	٠,٣٢٠ **	٠,١٧٧	٠,٥٩٧**	٦,٣
$P_{٢}xP_{٣}$	١,٥٧**	٠,٢٦	-٢٤,٣٨**	٠,٠٣٩	-٠,١٩٢	٠,٢١٦	-٦٧,١*
$P_{٢}xP_{٤}$	-٠,١٢	٢,٢٦	-١٥,٣٨**	٠,١٧٧ *	-٠,٣٠١	٠,١٢٣	-٤٩,١
$P_{٢}xP_{٥}$	١,٣٨**	١٨,٩٧**	٨,٤١**	٠.٢٠١ *	٠,٠٦٥	٠,٠٤٠	٣٥,٧
$P_{٢}xP_{٦}$	٠,٢١	٩,٢٣**	١٣,٣٤**	-٠,٠٠٤	٠,٢٩٦	٠,١٢٨	٧٢,٢ *
$P_{٢}xP_{٧}$	-٠,٢٤	-٩,٨٤**	٨,٧٠**	-٠,٠١١	٠,٣٨٥*	٠,٢٥٤	٨٠,٤ **
$P_{٢}xP_{٨}$	-١,٦٢**	-٣,٧٤	٨,٢٧**	-٠,١٥٩*	-٠,٢٧٥	-٠,٣٢٤	-٢٦,١
$P_{٢}xP_{٩}$	-٢,١٩**	-٧,٢٤*	٣,٩٨	-٠,٠٧٨	٠,٢٥١	-٠,١٥٨	٢,٧
$P_{٣}xP_{٤}$	٠,٧١	١,٧٣	٢٥,٩٨**	٠,١٤٣	-٠,٥٨٧**	-٠,١٧٧	٧٦,٥ **
$P_{٣}xP_{٥}$	-٠,٢٩	٢,١١	-٠,٢٣	٠,٠١٧	٠,٣٤٦*	-٠,٢١٠	-٢٩,٣
$P_{٣}xP_{٦}$	-٠,٤٥	-٣,٧٩	١٦,٢٠**	-٠,٠٢١	٠,٩٢٧**	٠,٧٢٨**	١٩٤,٧ **
$P_{٣}xP_{٧}$	-١,٧٤**	-٢,٣٦	-١٦,٩٥**	-٠,١٩٥ *	-٠,٤١٨**	-٠,٥١٢**	-١٨٣,٨ **
$P_{٣}xP_{٨}$	٠,٧١	١٧,٢٣**	-٥,٣٧**	٠,٠٥٨	٠,٠٣٩	٠.١٢٦	١٤,٧
$P_{٣}xP_{٩}$	-١,٨٦**	-٤,٧٧	-١٠,٦٦**	٠,٠٥٥	٠,٢١٥	٠,٢٥٩	-٧,٨
$P_{٤}xP_{٥}$	٠,١٩	٢,١١	-٢٠,٢٣**	-٠,٠٤٥	-٠,٠١٣	-٠,٠٠٣	-٩٩,١ **
$P_{٤}xP_{٦}$	-٢,٤٨**	-٩,٢٩**	٢٤,٧٠**	-٠,٠٣٣	٠,٨٦٨**	٠,٣٣٥	١٥٠,١ **
$P_{٤}xP_{٧}$	٣,٠٧**	١٨,٦٤**	٧,٥٥**	٠,٢٢٧ **	٠,٣٢٣*	٠,٥٤٥**	١٢٨,١ **
$P_{٤}xP_{٨}$	-١,٨١**	-٣٤,٢٧**	-٩,٣٧**	-٠,١٥٤	-٠,٠٣٧	-٠,٤٠١*	-١١٤,٧ **
$P_{٤}xP_{٩}$	-١,٣٨**	١٠,٧٣**	٩,٣٤**	-٠,١٤٠	-٠,١٧٧	-٠,٣٨٤*	-٢١,٠
$P_{٥}xP_{٦}$	-٠,٤٨	٠,٥٩	-٣٢,٠٢**	-٠,١٥٩ *	-٠,٤٨٢**	-٠,٥٦٥**	-٢١٤,١ **
$P_{٥}xP_{٧}$	-٠,٢٦	-١٠,٩٨**	-٢٦,٦٦**	٠,٠١٧	٠,٠٣٩	٠,٢٧٨	-١٠٥,١ **
$P_{٥}xP_{٨}$	١,٦٩**	-٢٥,٨٩**	٢٣.٩١**	-٠,٠٦٤	٠,٣٣٠*	٠,٣٩٩*	١٧٦,٩ **
$P_{٥}xP_{٩}$	-٠,٢١	١٠,٦١**	٣١,٦٣**	٠,٠٦٧	-٠,٠٤٤	٠,٥٦٦**	٢٤٧,٥ **
$P_{٦}xP_{٧}$	٠,٢٤	٨,٧٨**	-٥,٧٣**	-٠,٠٣٧	-٠,٧٤٦**	-٠,٤٣٤*	-٩١,٩ **
$P_{٦}xP_{٨}$	٠,٥٢	١٥,٢١**	٣,٣٤	٠,٣٦٥ **	-٠,٥٥٦**	٠,٢٢١	٤٧,٨
$P_{٦}xP_{٩}$	٤,٤٥**	٤,٧١	٣,٠٥	-٠,٢٨٨ **	-٠,٤١٣**	-٠,٦٢٩**	-٨٩,٧ **
$P_{٧}xP_{٨}$	-١,١٠**	-٢,٨٦	٨,٢٠**	-٠,٠٤٢	٠,١٦٥	-٠,١٧٠	٩,٦
$P_{٧}xP_{٩}$	٠,١٧	-٢٢,٨٦**	-١,٠٩	٠,١٧٢ *	-٠,١٢٥	-٠,٢٣٦	-٢٤,٦
$P_{٨}xP_{٩}$	١,٢٩**	١٤,٧٣**	-٢٨,٥٢**	-٠,١٠٩	٠,١١٥	-٠,٠١٥	-١١٣,٥**
SE (Sij)	٠,٤٣	٣,٠٠	٢,٠٧	٠,٠٨١	٠,١٥٧	٠,١٨٢	٢٨,٨

Specific combining ability effects (S_{ij}) of each reciprocal cross combination ($F_{١r}$) for all studied traits are found in Table ٧. 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 ٧: Estimates of specific combining ability effects (Sij) of each reciprocal cross ($F_{١r}$) for all studied traits

Crosses	No. of DF	PH (cm)	No. of F/P	FD (cm)	FL (cm)	FW (gm)	TY/P (gm)
P٢xP١	١,٠٠*	-٢٤,٠٠**	-٧,٥٠**	٠,٢١٧*	-٠,١٨٣	٠,٦٥٠**	٦٣,٧
P٣xP١	٠,٥٠	٠,٠٠	٢٨,٥٠**	-٠,٢١٧*	-٠,٢٥٠	-٠,٣٦٧	٦٨,٩ *
P٤xP١	-٠,٨٣	-٢,٥٠	-٣٣,٠٠**	-٠,٤٥٠**	٠,٢٣٣	-١,٢٠٠**	-٣٢١,٥**
P٥xP١	٠,٦٧	-١٠,٠٠**	٢١,٠٠**	-٠,٠٣٣	-٠,٥٨٣**	-٠,٥١٧*	٢,٤
P٦xP١	٢,٦٧**	١٣,٠٠**	٨١,٠٠**	-٠,٠١٧	٠,٣٥٠	٠,٠٦٧	٤٠٧,٤ **
P٧xP١	١,٣٣**	-١٢,٥٠**	١٦,٠٠**	-٠,٠٥٠	٠,٦١٧**	٠,٣٦٧	١٥٠,٠ **
P٨xP١	١,٠٠*	-٤٥,٠٠**	-٣٨,٠٠**	٠,٢٥٠**	٠,٦٣٣**	٠,٥١٧*	-١٠٥,٧ **
P٩xP١	١,٣٣**	-١٧,٥٠**	-٣٧,٥٠**	٠,٠٨٣	٠,٣٣٣	٠,٧٦٧**	-١١٠,٠ **
P٣xP٢	٢,١٧**	-٢,٠٠	-٢٣,٥٠**	٠,٣٠٠**	-٠,٢١٧	٠,٣٨٣	-٥١,٩
P٤xP٢	-١,٣٣ **	-١,٠٠	-١٤,٠٠**	-٠,٠٨٣	-٠,٤٣٣*	-٠,١٣٣	-٧٤,٩ *
P٥xP٢	٠,٨٣	-٢١,١٧**	٢٥,٠٠**	٠,٣١٧**	-٠,٤٨٣**	-٠,١٣٣	٧٦,٤ *
P٦xP٢	-٠,٣٣	٤,٠٠	١٠,٠٠**	٠,١٥٠	-٠,٧٠٠**	٠,٠٨٣	٥٣,٥
P٧xP٢	-١,٠٠*	-٨,٥٠*	-٠,٥٠	-٠,١٥٠	٠,٣٥٠	-٠,١٥٠	-٢٤,٩
P٨xP٢	-٠,٨٣	-٣,٠٠	٤,٥٠	-٠,١٠٠	٠,٠٠٠	٠,١٣٣	٣٧,٩
P٩xP٢	١,٨٣**	٣,٥٠	٣٤,٠٠**	-٠,١٣٣	-٠,١٠٠	-٠,١٥٠	١٠٧,٤**
P٤xP٣	-٠,٣٣	-٥,٠٠	-١٢,٠٠**	٠,٠٥٠	٠,٢١٧	٠,٣٦٧	١٣,٥
P٥xP٣	٠,٦٧	٣,٥٠	٦,٠٠*	-٠,١٦٧	٠,١٦٧	-٠,٣١٧	-٢١,١
P٦xP٣	-٠,٨٣	-٢٢,٥٠**	٥,٥٠*	-٠,١٣٣	٠,٨٦٧**	٠,٣١٧	٧٩,٥ *
P٧xP٣	١,٠٠*	٢٧,٥٠**	٣٥,٥٠**	-٠,٤٦٧**	-٠,٠٥٠	-١,٠١٧**	٤١,٨
P٨xP٣	-٠,٣٣	-٦,٥٠	-٣٠,٥٠**	-٠,٤١٧**	-٠,٣٥٠	-٠,٦٨٣**	-٢٣٣,٤**
P٩xP٣	١,٠٠*	-٣٧,٥٠**	-٨,٠٠**	-٠,٥٠٠**	٠,١٣٣	-٠,٩٣٣**	-١٤٢,٧ **
P٥xP٤	٢,٠٠**	-١٧,٥٠**	١٩,٥٠**	-٠,١١٧	-٠,٠٦٧	-٠,٣٠٠	٤٢,٦
P٦xP٤	٢,٠٠**	-٢٠,٠٠**	-٤٥,٥٠**	٠,٠٦٧	٠,٥٦٧**	٠,٣٦٧	-١٤٢,٩ **
P٧xP٤	١,٠٠*	-٢٢,٥٠**	-١٠,٥٠**	-٠,٢٣٣*	٠,٠١٧	-٠,٣٥٠	-١١٥,٢ **
P٨xP٤	٠,٣٣	-٨١,٠٠**	-٣,٠٠	٠,٠١٧	-٠,٢٣٣	٠,٢٣٣	٢٥,١
P٩xP٤	-١,٣٣**	٦,٠٠	٤,٥٠	٠,٠١٧	٠,٠٠٠	٠,١٣٣	٣٨,١
P٦xP٥	-٣,٣٣**	-٢,٠٠	-١٩,٠٠**	-٠,٠٥٠	٠,١٠٠	٠,٠١٧	-٧١,٣ *
P٧xP٥	-٢,٠٠**	-٦,٠٠	-٢٨,٥٠**	٠,١٣٣	٠,١١٧	٠,٢٠٠	-١٢٧,٧**
P٨xP٥	-٤,٥٠**	-٥٤,٥٠**	-٦,٥٠**	-٠,٠٥٠	-٠,١٥٠	-٠,٠٨٣	-٤٤,٠
P٩xP٥	-١,٥٠**	-١٠,٠٠**	٨,٠٠**	٠,١٣٣	٠,١٥٠	٠,٦٦٧**	١٥٤,٦ **
P٧xP٦	٣,٥٠**	٦,٣٣	١٠,٥٠**	-٠,٠٥٠	٠,٠٨٣	-٠,٣١٧	٢,٤
P٨xP٦	٣,٦٧**	-٢٨,٥٠**	-٤,٠٠	-٠,٢١٧*	-٠.٢٥٠	-٠,٤٣٣*	-٨٩,٠ **
P٩xP٦	٠,٥٠	٢١,٠٠**	٣٨,٥٠**	-٠,٢٨٣**	-٠,٠٦٧	-٠,٤٣٣*	٨٣,٥ *
P٨xP٧	٣,٥٠**	١٠,٠٠**	-١٣,٠٠**	٠,٢١٧*	٠,٢٠٠	٠,١٨٣	-٣١,٩
P٩xP٧	-٣,٠٠**	٣٠,٠٠**	٤٨,٥٠**	٠,١٥٠	٠,٢١٧	٠,٤٦٧*	٢٩٠,٤**
P٩xP٨	-١,٦٧**	-١٥,٠٠**	٣٠,٥٠**	-٠,٠٣٣	-٠,٢٣٣	٠,٤٨٣*	١٨٦,٧ **
SE (Sij)	٠,٤٩	٣,٤٧	٢,٣٩	٠,٠٩٣	٠,١٨٢	٠,٢١١	٣٣,٣

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 ٨. 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 (٢٠٠١), Prakash et al (٢٠٠٢) and Solankey and Singh (٢٠١٠) 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 ($H^{٢}_{b}$ %) were more than ٧٥٪ and larger than their corresponding narrow sense heritability ($H^{٢}_{n}$ %) for all studied traits. However, estimates of narrow sense heritability were ١٣,٩٪, ٣٢,٤, ٤٠,٥, ٤٧,١, ٧٦,٨ 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 ١١,٣ % to ١٧,٣٤٪ 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 (٢٠٠٢) and Salameh and Kasrawi (٢٠٠٧).

Table ٨: Estimates of genetic parameters and heritability in broad ($H^{٢}_{b}$%) and narrow ($H^{٢}_{n}$%) 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	٠,٥٢٤	٢٢٤,١	٨١,٥٨	٠,١٢٦	٠,١٠٢	٠,١٤٥	١٩٨٦,١٧٤
VD	٢,٧٦٤	٢٢٧.٨	٣٧٧,٤٧	٠,٠٢١	٠,١٤٦	٠,١٢٥	١٣٣٦٤,١٩٢
Vr	٣,٣٢١	٥٤٦,٠	٧١٩,٥٥	٠,٠٣٧	٠,٠٨٤	٠,١٨٠	١٧١٦٩,٩٩٢
VE	٠,٤٨٢	٢٤,٠	١١,٤٤	٠,٠١٧	٠,٠٦٦	٠,٠٨٩	٢٢١٦,٦٢٣
$H^{٢}_{b}$%	٨٧,٢	٩٤,٩	٩٧,٥٧	٨٩,٤	٧٨,٩	٧٥,٣	٨٧,٤
$H^{٢}_{n}$%	١٣,٩	٤٧,١	١٧,٣٤	٧٦,٨	٣٢,٤	٤٠,٥	١١,٣

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.

REFERENCES

Abdelmageed, A. H. A. (٢٠١٠): Inheritance studies of some economic characters in okra (*Abelmoschus esculentus* (L.) Moench). Tropical and Subtropical Agroecosystems, ١٢: ٦١٩ - ٦٢٧.

Cochran, W. G. and G. M. Cox (١٩٥٧): Experimental designs. ٢nd ed., John Wily and Sons, New York, USA.

Dhankhar, B. S. and S.K. Dhankhar (٢٠٠١): Heterosis and combining ability studies for some economic characters in okra. Haryana J. of Horti. Sci., Hisar, India, ٣٠ (٣/٤): ٢٣٠-٢٣٣.

El-Gendy, Soher, E.A. (٢٠١٢): Selection of some promising lines through pedigree method in okra. J. of Agric. Chem.and Biotechn., Mansoura Univ., ٣(٢): ٤١- ٤٨.

El-Gendy, Soher, E.A. and Z.M. El-Diasty (٢٠٠٤): Identification of genetic variability produced through radiation in okra. J. of Agric. Sci., Mansoura Univ., ٢٩ (١٢): ٧٤٥١- ٧٤٦٤.

El-Gendy, Soher, E.A., and G.A.R. El-Sherbeny (٢٠٠٥): Nature of gene action for some economical traits on okra. J. agric. Sci., Mansoura Univ., ٣٠ (٦): ٣١٣٥- ٣١٤٥.

El-Sherbeny, G.A.R., Obiadalla-Ali, H.A. and El-Gendy, S.E.A. (٢٠٠٥). Estimates of genetic parameters using line by tester analysis for some economic traits in Okra (*Abelmoschus esculentus* L.) under different nitrogen levels. Assuit Journal Agriculture Science, ٣٦, (٥), ١٢١-١٣٤.

Griffing, B. (١٩٥٦): Concept of general and specific combining ability in relation to diallel crosses systems. Aust. J. Biol. Sci., ٩: ٤٣٦ – ٤٩٣.

Liou, M., G. J. Wei and W. S. Tu (٢٠٠٢): Combining ability analysis of yield components in okra. J. of Agric. And forestry, College of Agric., National Chung Hsing Univ., Taichung, Taiwan. ٥١ (٢): ١-٩.

Matzinger, D.F. and O. I. kempthorne (١٩٥٦): The modified diallel table with partial inbreeding and interactions with environment. Genetics, ٤١: ٨٢٢ – ٨٣٣.

Prakash, M.; M.S.Kumar; K. Saravanan; K. Kannan and J. Ganesan (٢٠٠٢): Line x tester analysis in okra. Annals of Agric. Res., Indian Society of Agric. Sci., New Delhi, India, ٢٣ (٢): ٢٣٣-٢٣٧.

Ramesh, P. and A.K. Singh (١٩٩٩): Genetics of quantitative traits in okra [*Abelmoschus esculentus* (L.) Moench] Horticultural Experiments and Training Centre, Chaubattia, India.٣١ (١/٢): ٦٤-٦٧.

Rewale, V.S., V. W. Bendale, S.G. Bhave, R.R. Madav and B.B. Jadhav (٢٠٠٣): Combining ability of yield and yield components in okra. Journal of Maharashtra Agricultural Universities, ٢٨ (٣): ٢٤٤ – ٢٤٦.

Salameh, N. M. and M. A. Kasrawi (٢٠٠٧): Inheritance of fruit length, diameter and number of fruit ridges in okra (*Abelmoschus esculentus* L.) landraces of Jordan. Jordan Journal of Agricultural Science, ٣ (٤): ٤٣٩-٤٥٢.

Solankey, S.S. and A.K. Singh (٢٠١٠): Studies on combining ability in okra [*Abelmoschus esculentus* (L.) Moench]. Asian Journal of Horticulture, ٥ (١): ٤٩-٥٣.

Singh, S.. B. Singh and A. K. Pal (٢٠٠٦): Line x tester analysis of combining ability in okra. Indian Journal of Horticulture, ٦٣ (٤): ٣٩٧- ٤٠١.

Singh, B.; S. K. Singh, and K. V. Singh (٢٠١١) : Study on combining ability in okra (Abelmoschus esculentus L. Moench). Indian Journal of Horticulture, ٦٧: ١٥٤- ١٥٩.

Sinthil, K. P., P. Sriram and P. Karuppiah (٢٠٠٦): Studies on combining ability in okra (*Abelmoschus esculentus* L.). Indian Journal of Horticulture, ٦٣ (٢): ١٨٢-١٨٤.

Vagish, T., S. K. Arora and R. K. Samnotra (٢٠٠٢): Triple test cross in okra [*Abelmoschus esculentus* (L.) Moench] Environment and Ecology. MKK Publication, Calcutta, India. ٢٠ (٢): ٢١٩-٢٢٣.

القدرة على التآلف وطبيعة فعل الجين فى الباميا

سهير السيد عبده الجندي[١]، حازم عبد الرحمن عبيد الله علي[٢]، إيهاب عوض الله إبراهيم[١]، محمد حمام زين العابدين الدقيشى[٣]

[١]قسم بحوث الخضر- معهد بحوث البساتين - مركز البحوث الزراعية- مصر.

[٢]قسم البساتين- كلية الزراعة - جامعة سوهاج- مصر.

[٣]قسم البساتين- كلية الزراعة - جامعة اسيوط- مصر.

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 ٧٥% وكانت أعلي من قيم درجة التوريث في المدي الضيق لكل الصفات قيد الدراسة حيث كانت قيمة درجة التوريث في المدى الضيق (١٣,٩%) لصفة التبكير بينما كانت (١١,٣%) 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

أ.د / ممدوح محمد عبد المقصود	**كلية الزراعة – جامعة المنصورة**
أ.د / جلال احمد رزق الشربينى	**كلية الزراعة – جامعة سوهاج**