HETEROSIS AND COMBINING ABILITY FOR SOME TRAITS OF INTRASPECIFIC AND INTERSPECIFIC HYBRIDIZATION BETWEEN *SOLANUM MELONGENA* AND *SOLANUM MACROCARPON*

M. S. Hamada[1]; A. F. Hamaiel[2]; S. M. Farid[3] and M. M. El-Kady[3]

1- Dept. of Genetics, Fac. of Agric., Damietta University. 2- Vegetables and Floriculture. Dept., Fac. of Agric., Damietta University. 3-3-Horticultural Res. Institute, Agric. Res. Centre, Giza, Egypt

ABSTRACT

Four parents and their 12 F_1 diallel crosses, involving three parents belonging to the species *Solanum melongena* L. and one parent belonging to species *Solanum macrocarpon* L. were used. For heterotic effect, heterosis over mid-parents and better parent were detected in many traits, viz.; plant height(kg), number of branches per plant, and total chlorophyll. Also, heterosis over mid-parents and better parent were detected in early fruit yield per plot(kg), early fruit number per plot and total fruit yield ton/fed. For chemical traits heterosis over mid-parents and better parent were detected in total carotene, anthocyanin content, total nitrogen content, total phosphorus, potassium content and total iron traits. The magnitude of GCA variance was greater than SCA variance suggesting the predominance of additive gene action for most studied traits. Among the varieties, the good general combiner was Balady Dark Long (P_3) for plant height, number of branches per plant, early fruit number per plot, total fruit yield ton/fed and total phosphorus, Balady white Long (P_2) for total chlorophyll, total nitrogen content, potassium content and total iron. Among the varieties, Balady Dark Round (P_1) was the best for early fruit yield per plot and anthocyanin content, In the case of total carotene Gboma (P_4) was the best general combiner. The estimates of specific combining ability effects (SCA) showed superior specific combinations, (P_2xP_3) for plant height, total fruit yield ton/fed and total phosphorus and (P_1xP_2) for number of branches per plant, early fruit yield per plot, early fruit number per plot and total iron. While, (P_1xP_4) was the best for total chlorophyll, total carotene and total nitrogen content, (P_2xP_4) for potassium content. Regarding, reciprocal effect (rij) the results revealed that highest values recorded for (P_4 x P_1) in the case of plant height(cm), total chlorophyll, total carotene and total iron. While, the hybrid (P_3 x P_1) was the best for number of branches, early fruit yield per plot(kg), early fruit number per plot and anthocyanin content and the hybrid (P_4 x P_2) for total fruit yield(ton/fed) and total phosphorus , the hybrid (P_4 x P_3) for total nitrogen content and the hybrid (P_3 x P_2) was the best for potassium content. Therefore, from general and specific combining ability and some genetic parameters suggested the importance of heterosis breeding for effective utilization of additive genetic variances which had the main role for the improvement of the studied traits in eggplant crop.

INTRODUCTION

Eggplant (*Solanum melongena* L.), also known as brinjal, aubergine or Guinea squash, is a non-tuberous species of the family Solanaceae. Other cultivated species of eggplants are known as scarlet eggplant (*S. aethiopicum* L.) and gboma eggplant (*S. macrocarpon* L.). Cultivated eggplants and their wild relatives belong to the subgenus *Leptostenomum* (Dunal) Bitter, which includes more than 450 species distributed among 22 sections (Van Eck and Snyder 2006). Studies on interspecific relation and hybridization are of great significance because sometimes interspecific hybridization may be necessary to incorporate desirable genes to cultivated species. Interspecific hybridization via sexual crosses has illustrated various degrees of limitation to crossability, possibly due to sexual barriers Collonnier *et al*. (2001); Behera and Singh (2002). Hybridization experiments showed that *Solanum melongena* was crossable with several species of the same subgenus *Leptostemonum* Collonnier *et al*. (2001). Interspecific hybrids were produced from crosses between different genotypes of *Solanum melongena* with *Solanum macrocarpon* and *Solanum torvum*. Heterosis breeding as a tool for genetic improvement in eggplant has been studied by several researchers. Heterosis over better parent was detected by Chowdhury *et al.* (2010) for plant height and fruit yield; Patil *et al.*(2011) for number of branches per plant; Makani *et al.* (2013) studied heterosis over mid and better parent for plant height and fruit yield; Chowdhury *et al.* (2010) for early fruit number and yield.

Combining ability analysis helps in identifying of good combining parents and superior F_1 crosses. So many studies on eggplant were made for general combining ability (GCA) and specific combining ability (SCA) effects by Babu *et al.* (2000) for plant height; Salama *et al*. (2005) for plant height, number of primary branches per plant, early yield, total yield; Kumar *et al.*(2012) for plant height, number of primary branches and content of anthocyanins.

Rreciprocal effect (rij) analysis helps to identify if there is cytoplasmic or maternal effects or not. expression of reciprocal in eggplant was detected by Brinda and Sivasubramanian(1993); Babu *et al.* (2000).

Therefore this investigation aimed to produce F_1 intraspecific and interspecific hybrids from hybridization between Egyptian local cultivars of eggplant speciese (*Solanum melongena* L.) and African eggplant (*Solanum macrocarpon*). Present further information dealing with determining of heterosis, general and specific combining ability and their interaction and reciprocal effect over two seasons.

MATERIALS AND METHODS

The experiment work was conducted at private farm in Kafr Saad, Damietta Governorate during the period from 2013 to 2015. The genetic materials used in this study were Balady Dark Round (P_1), Balady white Long (P_2), Balady Dark Long (P_3) and Gboma (P_4). Seeds were obtained from The Vegetable Research Institute, Agricultural Research Center (A.R.C), Egypt.

Table 1: The origin and description of the varieties for important traits

Var.	Origin	Size and shape of fruit	Color of fruits
P_1	A.R.E	Large round	Dark purple
P_2	A.R.E	Long sylenderical	White
P_3	A.R.E	Long sylenderical	Dark purple
P_4	West Africa	Small round	Yellow

In 2013 growing season (summer), the four parental varieties were crossed according to a complete diallel crosses mating design to obtain six F_1 hybrids and their corresponding six F_{1r} (reciprocal) hybrids. In addition, the four parents were also self-pollinated to obtain enough seeds from each parental variety. In the growing season of 2014 and 2015, all the 16 genotypes which included the four parents, the six F_1 hybrids and six F_{1r} (reciprocal) hybrids were evaluated in a field trail experiment. The experimental design was the randomized complete blocks design (RCBD) with three replications. Each block consisted of 16 plots. All the genotypes were randomly distributed in each block. Each plot was represented by a single row 4 m apart to insure 10 plants per row. All agricultural practices were carried out as recommended for eggplant plantation according to the Egyptian Ministry of Agriculture recommendations.

Data were recorded on five plants randomly chosen per plot for all entries for the following traits: plant height in centimeters, number of branches per plant, total chlorophyll (mg), early fruit yield per plot (kg), early fruit number per plot, total fruits yield(ton/fed), total carotene, anthocyanin content, total nitrogen content, total phosphorus content, potassium content and total iron.

Data were calculated and statistically analyzed as outlined by Cochran and Cox (1957). Heterosis was estimated as a percent increase or decrease of F_1 performance from the mid-parents (m.p) and better parent (p.b). General combining ability (GCA) and specific combining ability (SCA) were analyzed according to the method of Griffing (1956).

RESULTS AND DISCUSSION

Mean performance

The performances of the parental varieties versus their hybrids (F_1 and F_{1r}) are presented in Tables 2 and 3. The results illustrated that the parental genotype Balady dark long (P_3) showed the highest means for plant height, number of branches, early fruit yield per plot (kg), early fruit number, total fruit yield(ton/fed) and total iron (61.63, 8.27, 6.89, 115.5, 44.93 and 3.995, respectively). While, the parental genotype Balady white long (P_2) showed the highest means for total chlorophyll and total nitrogen content (2.48 and 3.6234), the parental genotype Balady dark round (P_1) for anthocyanin content and potassium content (14.3102 and 4.0617) and the parental genotype Gboma (P_4) obtained the highest means for total carotene and total phosphorus (0.0215 and 0.06034).

Through the hybrids the results showed that the hybrid (P_3 x P_1) obtained the highest means for plant height(cm) and total fruit yield(ton/fed) with values (60.73 and 58.03). While, the hybrid (P_1 x P_3) showed the highest means for number of branches, early fruit yield(kg) and anthocyanin content (8.93, 9.40 and 15.6907, respectively), However, the hybrid (P_2 x P_3) was the best for early fruit number and potassium content (107.83 and 4.145). While, the hybrids (P_3 x P_2), (P_4 x P_1), (P_4 x P_2), (P_4 x P_3) and (P_2 x P_1) obtained the highest means for: total chlorophyll, total carotene, total nitrogen content, total phosphorus and total iron, respectively (2.2124, 0.0248, 3.735, 0.0993 and 4.1033, respectively).

Heterosis degree

Data presented in Table 4 showed that the hybrid (P_2xP_1) exhibited positive and highly significant heterosis values relative to their mid-parents and better parent for plant height, number of branches, early fruit yield and total fruit yield(ton/fed). While, the hybrid (P_1xP_4) had the largest heterosis values relative to their mid-parents and (P_1xP_3) relative to their better parent for total chlorophyll and also the same hybrid (P_1xP_3) relative to their mid-parents had the largest heterosis value for early fruit number and (P_2xP_1) relative to their better parent for the same trait. These results were in agreement with those of Chowdhury *et al.* (2010) who showed heterosis over better parent for fruit yield and Makani *et al.* (2013) who studied heterosis over mid-parents and better parent for yield and its components in eggplant.

Obtained data from Table 5 showed that the hybrid (P_3xP_2) exhibited positive and highly significant heterosis values relative to their mid-parents and better parent for total carotene, (P_1xP_3) for anthocyanin content, (P_3xP_4) for total nitrogen content**,** (P_3xP_1) for total phosphorus**,** and (P_1xP_4) for total iron. In case of potassium content the hybrid (P_4xP_3) relative to their mid-parents and the hybrid (P_2xP_3) relative to their better parent had the best heterosis values.

Combining ability and reciprocal effects

Results of the analysis of variance for combinig ability (Tables 6 and 7) revealed that GCA, SCA and reciprocal were significant or highly significant for most of the studied traits indicating the importance of both additive and non-additive genetic variance and the cytoplasmic factors which play a major role in the genetic expression of these traits. On the other hand, the magnitude of GCA variance was higher than that of SCA variance for all the characters except total nitrogen content and total phosphorus indicating the preponderance of additive gene action for their genetic control. Furthermore, the interaction of GCA with seasons and reciprocal with seasons was not significant for most studied traits which indicated that these parameters are highly stable with different environments. While, SCA was significant or highly significant for most studied traits which indicated that this parameter is unstable with different environments. The results were in conformity with Babu *et al.* (2000)**,** Salama *et al*. (2005) and Sharaf Uddin *et al.* (2015) who reported that GCA variance was higher than that of SCA variance for all the studied traits indicating that additive gene action was predominant and play the main role in the inheritance of traits under study.

The estimates of GCA effects provide a measure of general combining ability of each parental genotype, thus aids in selection of superior parents for breeding programs. The estimates of general combining ability effect (gi) for each parental genotype for all studied traits are shown in Tables 8 and 9. The obtained data revealed that, none of the parents was the best general combiner for all traits. Among, parental genotypes, the good general combiner was Balady Dark Long (P_3) for plant height, number of branches, early fruit number, total fruit yield(ton/fed) and total phosphorus. However, Balady white Long (P_2) was the good combiner for total chlorophyll, total nitrogen content, potassium content and total iron and Balady Dark Round (P_1) for early fruit yield(kg) and anthocyanin content, the parental genotype Gboma (P_4) was the best for total carotene. Similar results were obtained by Babu *et al.* (2000) and Salama *et al*. (2005).

The estimates of specific combining ability effects (Tables 10 and 11) showed that , the hybrid (P_2xP_3) exhibited positive and highly significant specific combining ability for plant height, total fruit yield(ton/fed) and total phosphorus (5.46, 22.45 and 0.0177, respectively). The hybrid (P_1xP_2) was good specific combiner for number of branches, early fruit yield, early fruit number and total iron

(0.9438, 2.0629, 13.4896 and 0.8226, respectively). For total chlorophyll, total carotene and total nitrogen content traits (P_1xP_4) exhibited positive and highly significant specific combining ability with values (0.1206, 0.0046 and 0.3712, respectively), the hybrid (P_1xP_3) was the best one for anthocyanin content (4.167) and (P_2xP_4) for potassium content trait (0.1389).

Although these hybrids were not the superior but it obtained positive highly significant or significant specific combining ability: (P_1xP_2) for plant height with value 4.7625, (P_1xP_3) for plant height, number of branches and early fruit yield (2.0167, 0.6896 and 1.086) , (P_2xP_3) for total chlorophyll, total carotene and total iron (0.065, 0.0035 and 0.1668) , (P_2xP_4) for total carotene, anthocyanin content, total nitrogen content and total phosphorus (0.0003, 2.6965, 0.1737 and 0.0002, respectively), (P_1xP_4) for total iron 0.3876 and (P_3xP_4) for total carotene, total nitrogen content and total phosphorus (0.0016, 0.2345 and 0.0062, respectively).

Regarding, reciprocal effect (rij) the results revealed that highest positive values recorded for (P_4xP_1) in the case of plant height, total chlorophyll, total carotene and total iron with values (0.2, 0.1187, -0.0002 and 1.5683, respectively), the hybrid (P_3 x P_1) was the best for number of branches, early fruit yield, early fruit number and anthocyanin content (0.4833, 1.8784, 26.1667 and 1.1843, respectively). Also the same hybrid (P_3 x P_1) obtained positive highly significant specific combining ability for total chlorophyll and total iron (0.1083 and 0.4383). While, the hybrid (P_4xP_2) was the highest for total fruit yield(ton/fed) and total phosphorus (1.745 and 0.0066, respectively) and (P_4xP_3) for total nitrogen content trait with value (0.3417), also the hybrid (P_4xP_2) obtained positive highly significant specific combining ability for number of branches and total iron (0.2667 and 0.5825) and (P_2 x P_1) for total nitrogen content with value 0.1258. These results were in agreement with those of Babu *et al.* (2000) and Salama *et al*. (2005).

In conclusion, the results obtained from general and specific combining ability and some genetic parameters indicated the importance of heterosis breeding for effective utilization of additive genetic variances which had the main role for the improvement of the studied traits in eggplant crop.

Table 2: Mean performance of parental genotypes and their hybrids for yield and its components in eggplant

Genotypes	Plant height(cm)	Number of branches	Total chlorophyll	Early fruit yield(kg)	Early fruit number	Total fruit yield(ton/fed)
P_1	57.13	7.27	2.081	4.83	37.33	41.69
P_2	53.4	6.5	2.48	5.39	97.17	33.48
P_3	61.63	8.27	2.1494	6.89	115.5	44.93
P_4	28.23	4.8	1.7315	0	0	13.04
Crosses						
$P_1 \times P_2$	58.63	8	2.0902	7.77	80.67	52.67
$P_1 \times P_3$	58.77	8.93	2.1949	9.40	105.67	52.44
$P_1 \times P_4$	21.27	3.43	2.0329	0	0	1.05
$P_2 \times P_1$	58.77	8.13	1.945	8.87	91.17	56.57
$P_2 \times P_3$	58.7	7.27	2.2103	6.55	107.83	44.71
$P_2 \times P_4$	10.3	3.17	1.6552	0	0	0.76
$P_3 \times P_1$	60.73	7.97	1.9782	5.64	53.33	58.03
$P_3 \times P_2$	60.53	7.17	2.2124	4.84	88.5	49.51
$P_3 \times P_4$	12.4	3.03	1.6183	0	0	2.09
$P_4 \times P_1$	20.87	3.37	1.7955	0	0	1.83
$P_4 \times P_2$	10.97	2.63	1.6384	0	0	0.63
$P_4 \times P_3$	20.67	3.57	1.7067	0	0	1.89

Table 3: Mean performance of parental genotypes and their hybrids for chemical traits in eggplant

Genotypes	Total carotene	Anthocyanin content	Total nitrogen content	Total phosphorus	Potassium content	Total iron
P_1	0.01067	14.3102	3.0017	0.053835	4.0617	1.9783
P_2	0.00683	0.2309	3.6234	0.056335	3.99	2.9667
P_3	0.01167	8.754	2.5267	0.049835	3.57	3.995
P_4	0.0215	0.3714	2.3317	0.06034	2.45	1.3234
Crosses						
$P_1 \times P_2$	0.00917	1.2009	2.945	0.0485	3.0217	4.045
$P_1 \times P_3$	0.011	15.6907	2.5617	0.044	3.5467	3.4384
$P_1 \times P_4$	0.0245	0.87	3.24	0.061	3.1234	3.5467
$P_2 \times P_1$	0.0105	1.0447	2.6934	0.0572	3.875	4.1033
$P_2 \times P_3$	0.01567	2.9923	3.0017	0.0852	4.145	2.8517
$P_2 \times P_4$	0.0185	0.2642	3.0833	0.07584	3.3467	1.7317
$P_3 \times P_1$	0.012	13.3222	3.2883	0.0982	3.3717	2.5617
$P_3 \times P_2$	0.01583	1.9565	2.98	0.09467	3.5817	3.8817
$P_3 \times P_4$	0.0225	1.3303	3.5017	0.063	2.7	0.38
$P_4 \times P_1$	0.02483	0.588	3.6467	0.07667	3.2284	0.41
$P_4 \times P_2$	0.01967	0.4049	3.735	0.06267	3.485	0.5667
$P_4 \times P_3$	0.0235	0.489	2.8184	0.09934	3.4917	0.545

Table 4: Heterosis relative to the mid parents (m.p) and better parent (b.p) for yield and its components in eggplant hybrids

Crosses	Plant height(cm)		Number of branches		Total chlorophyll		Early fruit yield(kg)		Early fruit number		Total fruit yield(ton/fed)	
	m.p	b.p	m.p	b.p	m.p	b.p	m.p	b.p	m.p	b.p	m.p	b.p
1x2	6.0918**	2.6254**	16.2229**	10.092*	-8.3469**	-15.7198**	52.0068**	44.1527**	19.9502**	-16.9812**	40.0112	26.2287**
1x3	-1.0390**	-4.6517**	15.0219**	8.0649	3.7668**	2.1169	60.358**	36.3723**	38.2766**	-8.5139**	21.0866**	25.7909**
1x4	-50.1763**	-62.7775**	-43.0936**	-52.752**	6.6413**	-2.3138**	0	0	0	0	-96.1633**	-97.4815**
2x1	6.3334**	2.8591**	18.1595**	11.9264**	-14.7117**	-21.5726**	73.6704**	64.697**	35.5636**	-6.175**	50.4895**	35.6756*
2x3	2.0572**	-4.7596**	-1.5803**	-12.0968**	-4.5093**	-10.875**	6.6385	-5.0053**	1.4109**	-6.6377**	14.0416**	-0.4863**
2x4	-74.7653**	-80.7116**	-43.9522**	-51.2815**	-21.3986**	-33.2601**	0	0	0	0	-96.7244**	-97.7242**
3x1	2.2734**	-1.4602**	2.5751**	-3.6290**	-6.4782**	-7.9652**	-3.7397**	-18.1379**	-30.2077**	-53.8242**	33.9829**	29.1528**
3x2	5.245**	-1.7847**	-2.9347**	-13.3065**	-4.4207**	-10.7923**	-21.1617**	-29.7701**	-16.7711**	-23.3766**	26.2869**	10.1991**
3x4	-72.4037**	-79.8811**	-53.5711**	-63.3062**	-16.6007**	-24.7075**	0	0	0	0	-92.7985**	-95.3539**
4x1	-51.1123**	-63.4768**	-44.1991**	-53.6698**	-5.8098**	-13.7194**	0	0	0	0	-93.3077**	-95.607**
4x2	-73.1311**	-79.4625**	-53.392**	-59.4869**	-22.1964**	-33.9375**	0	0	0	0	-97.3026**	-98.1259**
4x3	-54.0065**	-66.4687**	-45.4083**	-56.855**	-12.0476**	-20.5969**	0	0	0	0	-93.4954**	-95.8035**
LSD 0.05 0.01	4.2024 5.5892	4.8525 6.4538	1.497 1.9910	1.7286 2.299	0.4074 0.5419	0.4704 0.6257	1.2482 1.6601	1.4413 1.9169	18.5946 24.7309	21.4712 28.5567	5.1379 6.8334	5.9327 7.8905

* Significant at 0.05%,**Significant at 0.01%

Table 5: Heterosis relative to the mid parents (m.p) and better parent (b.p) for chemical traits in eggplant hybrids

Crosses	Total carotene		Anthocyanin content		Total nitrogen content		Total phosphorus		Potassium content		Total iron	
	m.p	b.p	m.p	b.p	m.p	b.p	m.p	b.p	m.p	b.p	m.p	b.p
1x2	4.7627**	-14.0621**	-83.4833**	-91.6084**	-11.0943**	-18.7216**	-11.9543**	-13.9079**	-24.9426**	-25.605**	63.6013**	36.3491**
1x3	-1.4933**	-5.7129**	36.0614**	9.6474**	-7.3241**	-14.6569**	-15.1153**	-18.2688**	-7.0548**	-12.6807**	15.124**	-13.9337**
1x4	52.3300**	13.9535**	-88.1483**	-93.9204**	21.4996**	7.9406**	6.8582**	1.1022**	-4.0696**	-23.1024**	114.8411**	79.2777**
2x1	19.9966**	-1.5656**	-85.631**	-92.6996**	-18.6913**	-25.6669**	3.78506**	1.4822**	-3.7470**	-4.5966**	65.9592**	38.3143**
2x3	69.3676**	34.2862**	-33.3923**	-65.8179**	-2.3854	-17.1582**	60.4314**	51.176**	9.6561**	3.8847	-18.0755**	-28.6195**
2x4	30.5875**	-13.9535**	-12.2717**	-28.8676**	3.5525**	-14.9047**	29.9991**	25.6899**	3.9332**	-16.1241**	-19.2681**	-41.6278**
3x1	7.4619**	2.8586**	15.5230**	-6.9038**	18.9624**	9.5498**	89.3894**	82.3535**	-11.6409**	-16.9892**	-14.23**	-35.8786**
3x2	71.173**	35.7177**	-56.4489**	-77.6502**	-3.0894**	-17.7557**	78.3272**	68.0394**	-5.2474**	-10.2343**	11.5152**	-2.8373**
3x4	35.6791**	4.6512**	-70.8439**	-84.8035**	44.1498**	38.5887**	14.3687**	4.4170**	-10.299**	-24.3697**	-85.7099**	-90.4881**
4x1	54.4036**	15.5047**	-91.9899**	-95.891**	22.4725**	21.4882**	34.2997**	27.0656**	-0.8446**	-20.5173**	-75.1639**	-79.2751**
4x2	38.8251**	-8.5256**	34.457**	9.0211**	25.4398**	3.0814	7.4227**	3.8618**	8.2298**	-12.6566**	-73.5804**	-80.8976**
4x3	41.7093**	9.3023**	-89.2826**	-94.414**	16.0209**	11.5449**	80.3304**	64.6391**	16.0017**	-2.1947**	-79.5049**	-86.3579**
LSD 0.05 0.01	0.0065 0.0086	0.0075 0.01	1.8935 2.5183	2.1864 2.9079	0.8525 1.1339	0.9844 1.3093	0.0273 0.0363	0.0315 0.042	1.1546 1.5356	1.3332 1.7731	1.2711 1.6906	1.4678 1.9522

* Significant at 0.05%,**Significant at 0.01%

Table 6: Analysis of variance and mean squares for yield and its components of genetic variances in eggplant over two seasons

Source of variation	d.f	Plant height(cm)	Number of branches	Total chlorophyll	Early fruit yield(kg)	Early fruit number	Total fruit yield(ton/fed)
Hybrids	15	2759.738**	31.8549**	0.3921**	79.5954**	13885.91*	5110.404**
GCA	3	10187.06**	111.6525**	1.1829	302.5267**	55158.81**	13157.86
SCA	6	1767.718**	23.0431**	0.3225**	38.6015**	5523.967**	5813.021**
Reciprocal	6	38.0944**	0.7678	0.0662	9.1235**	1611.403	384.0589
Seasons	1	82.14**	2.7338*	0.5426**	14.1834**	656.2604**	513.7158**
Hybrids x S	15	37.244**	1.3293*	0.0746	2.5998**	749.0604**	246.8706**
GCA x S	3	58.0806	2.2903	0.2047**	3.7786	639.3403	202.3728
SCA x S	6	59.2131**	1.5992*	0.0158	1.7239**	805.0781**	225.2563**
Reci x S	6	4.8567	0.5789	0.0683	2.8862**	747.9028**	290.7338**
Error	60	4.4138	0.5603	0.0415	0.3895	86.4417	25.12351

* Significant at 0.05%,**Significant at 0.01% levels of probability

Table 7: Analysis of variance and mean squares for chemical traits of genetic variances in eggplant over two seasons

Source of variation	d.f	Total carotene	Anthocyanin content	Total nitrogen content	Total phosphorus	Potassium content	Total iron
Hybrids	15	0.000219**	187.7526**	1.071922**	0.00197**	1.3157**	11.9668**
GCA	3	0.000801**	655.0564**	0.782763	0.00112	3.7490*	29.3379*
SCA	6	0.000145**	138.0962**	1.4640**	0.00196*	0.5482*	8.72002**
Reciprocal	6	0.0000026	3.7571**	0.8244**	0.00242**	0.8665	6.52799**
Seasons	1	0.0000034	27.3547**	1.7308**	0.00079*	4.5632**	2.6567*
Hybrids x S	15	0.0000078	6.61698**	0.231022	0.00060**	0.4037	0.6587
GCA x S	3	0.0000063	20.0468*	0.4332	0.0007	0.5451*	0.5316
SCA x S	6	0.00001	5.4432**	0.1742	0.00083**	0.1841	0.9555*
Reci x S	6	0.0000063	1.0759	0.1868	0.00033	0.5527	0.4252
Error	60	0.000011	0.8964	0.181693	0.00019	0.3333	0.40398

* Significant at 0.05%,**Significant at 0.01% levels of probability

Table 8: Estimates of general combining ability effects for parental genotypes for yield and its components over two seasons

Parents	Plant height(cm)	Number of branches	Total chlorophyll	Early fruit yield(kg)	Early fruit number	Total fruit yield(ton/fed)
P1	8.35**	0.95208**	0.05484**	1.40608**	2.11458	-4.76261
P2	4.775**	0.32708**	0.11895**	1.08913**	21.73958*	10.30965**
P3	8.57083**	0.96458**	0.05745**	1.26551**	24.71875**	15.63857**
P4	-21.6958**	-2.24375**	-0.23124*	-3.76073**	-48.5729**	-21.1856**
S.E(gi)	0.26261	0.09356	0.02546	0.07801	1.16218	0.62654

* Significant at 0.05%,**Significant at 0.01% levels of probability

Table 9: Estimates of general combining ability effects for parental genotypes for chemical traits over two seasons

Parents	Total carotene	Anthocyanin content	Total nitrogen content	Total phosphorus	Potassium content	Total iron
P1	-0.00198**	3.67834**	-0.01385	-0.00626**	0.09948**	0.3624**
P2	-0.00327**	-2.94811**	0.14948**	-0.00082**	0.24260**	0.49385**
P3	-0.00067**	2.67239**	-0.16052**	0.00509**	0.06031	0.31073**
P4	0.00592**	-3.40261**	0.0249	0.00199**	-0.4024**	-1.16698**
S.E(gi)	0.00041	0.11835	0.05328	0.00171	0.07216	0.07945

* Significant at 0.05%,**Significant at 0.01% levels of probability

Table 10: Specific combining ability effects for each cross (Sij) and reciprocal effects (rij) for yield and its components over two seasons

Crosses	Plant height(cm)	Number of branches	Total chlorophyll	Early fruit yield(kg)	t number	Total fruit yield(ton/fed)
1x2	4.7625**	0.9438**	-0.1262**	2.0629**	13.4896	6.5316
1x3	2.0167*	0.6896**	0.0042	1.086**	4.0938	1.0266
1x4	-6.4**	-1.1521**	0.1206**	-1.4061**	-2.1146	-0.2181
2x1	-0.0667	-0.0667	0.0726**	-0.552**	-5.25	-0.8325
2x3	5.4583**	0.0813	0.065**	-0.4215**	3.1354	22.4543**
2x4	-13.2583**	-1.0271**	-0.2109**	-1.0891**	-21.7396	-25.7921**
3x1	-0.9833	0.4833**	0.1083**	1.8784**	26.1667*	-0.5923
3x2	-0.9167	0.05	-0.001	0.8537**	9.6667	-7.9083*
3x4	-11.1542**	-1.2646**	-0.1337**	-1.2655**	-24.7188	-22.2602**
4x1	0.2	0.0333	0.1187**	0	0	-11.1901**
4x2	-0.3333	0.2667**	0.0084	0	0	1.745
4x3	-4.1333**	-0.2667**	-0.0442**	0	0	-0.4242
S.E(Sij)	0.4795	0.1708	0.0465	0.1424	2.1218	1.1439
S.E(rij)	0.3714	0.1323	0.0360	0.1103	1.6436	0.8861

* Significant at 0.05%,**Significant at 0.01% levels of probability

Table 11: Specific combining ability effects for each cross (Sij) and reciprocal effects (rij) for chemical traits over two seasons

Crosses	Total carotene	Anthocyanin content	Total nitrogen content	Total phosphorus	Potassium content	Total iron
1x2	-0.0011**	-3.5962**	-0.3776**	-0.008**	-0.3305**	0.8226**
1x3	-0.002**	4.167**	0.0382	0.0043**	-0.1374*	-0.0684
1x4	0.0046**	-3.5355**	0.3712**	0.0052**	0.042	0.3876**
2x1	-0.00067**	0.0781	0.1258**	-0.0043**	-0.4267**	-0.0292
2x3	0.0035**	-1.2386**	-0.0593	0.0177**	0.1237	0.1668*
2x4	0.0003**	2.6965**	0.1737**	0.0002**	0.1389*	-0.5730**
3x1	-0.0005**	1.1843**	-0.3633**	-0.0271**	0.0875	0.4383**
3x2	-0.00008**	0.5179**	0.0108	-0.0048**	0.2817**	-0.515**
3x4	0.0016**	-2.3488**	0.2345**	0.0062**	0.0012	-1.0766**
4x1	-0.0002**	0.141	-0.2033**	-0.0078**	-0.0525	1.5683**
4x2	-0.0006**	-0.0703	-0.3258**	0.0066**	-0.0692	0.5825**
4x3	-0.0005**	0.4207**	0.3417**	-0.0182**	-0.3958**	-0.0825
S.E(Sij)	0.0007	0.2161	0.097279	0.0031	0.1318	0.1451
S.E(rij)	0.0006	0.1674	0.0754	0.0024	0.1021	0.1124

* Significant at 0.05%,**Significant at 0.01% levels of probability

REFERENCES

Babu S., Chezhian P. and Ganesan J. (2000). Combining Ability Studies in Eggplant *(Solanum melongena* L,.). Tropical Agricultural Research Vol. 12:394-397.

Behera T.K., Singh Narendra (2002). Inter-specific crosses between eggplant (*Solanum melongena* L.) with related Solanum species. Scientia Horticulturae 95 : 165–172.

Brinda, N. and Sivasubramanian, V. (1993). Studies on combining ability reciprocal differences through diallel analysis in sesame. Plant Breeding Newsletter, 2.2.

Chowdhury M. J., S. Ahmad, M. Nazim Uddin, A. K. M. Quamruzzaman and M. M. A. Patwary(2010). Expression of Heterosis for Productive Traits in F1 Brinjal (*Solanum melongena* L.) Hybrids.

A Scientific Journal of Krishi Foundation *The Agriculturists 8(2): 8-13*.

Cochran, W.G. and G.M. Cox (1957). Experimental Designs. 2nd ed., John Willey and Sons, New York, USA. 611p.

Collonnier C, Fock I, Kashyap V, Rotino GL, Daunay MC, Lian Y, Mariska IK, Rajam MV, Servaes A, Ducreux G, Sihachakr D (2001) Applications of biotechnology in eggplant. Plant Cell, Tissue Organ Cult 65:91–107.

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

Kumar Ajay, Bharat Bhushan, A.S. Sidhu and A.S. Dhatt (2012). Studies on combining ability for yield and quality traits in brinjal (*Solanum melongena* L.). J. Hortl. Sci. Vol. 7(2): 145-151.

Makani A. Y., A. L. Patel , M. M. Bhatt and P. C. Patel (2013). Heterosis for Yield and Its Contributing Attributes In Brinjal *(Solanum melongena* L.). An international quarterly journal of life science 8(4): 1369-1371.

Patil. S.A., Nalini A. Dharwad and Salimath P. M. (2011). Heterosis and combining ability analysis for productivity traits in brinjal (*Solanum melongena* L.). Karnataka J. Agric. Sci.,24 (5) : (622-625) 2011.

Salama G.M., Melad. H. Z.; Faten and S. Saleeb (2005). Combining Ability and Correlation Between Yield and Different Characters in Eggplant for Producing High Quality of Local Hybrids. J. Agric. Sci. Mansoura Univ., 30 (1): 513-532.

Sharaf Uddin.M , M.M. Rahman, M.M. Hossain, M.A. Khaleque Mian(2015).

Combining Ability of Yield and Yield Components in Eggplant (*Solanum melongena* L.) During Summer. Universal Journal of Plant Science 3(4): 59-66.

Van Eck J and Snyder A. (2006). Eggplant (*Solanum melongena* L.). Methods Mol Biol.,343:439-47.

قوة الهجين والقدرة على التألف لبعض الصفات الناتجة عن التهجين داخل النوع النباتي وبين الأنواع في الباذنجان

محمد سعد حمادة[1] , علي فتحي حمايل2 ,سيف الدين محمد فريد3 ومها مجدي القاضي3

1- قسم الوراثة - كلية الزراعة - جامعة دمياط. 2- قسم الخضر والزينة - كلية الزراعة – جامعة دمياط . 3- قسم بحوث الخضر- معهد بحوث البساتين – مركز البحوث الزراعية – الجيزة- مصر

أجريت هذه الدراسة خلال الفترة من 2013 حتى 2015 بهدف دراسة قوة الهجين بالنسبة لمتوسط الأبوين والأب الأفضل وتقدير القدرة العامة والخاصة على التألف لبعض صفات المحصول والصفات الكيماوية في الباذنجان باستخدام 4 أباء (3 آباء محلية + أب افريقي) وتم التهجين بينهم من خلال نظام التهجين التبادلي (الدائري) الكامل في مزرعة خاصة بمدينة كفر سعد – محافظة دمياط , تحت إشراف قسم الوراثة بكلية الزراعة جامعة دمياط ونتجت عن ذلك (6) هجن و(6) هجن عكسية .

ظهرت قوة الهجين بالنسبة لمتوسط الأبوين والأب الأفضل لصفات طول النبات, عدد الأفرع, نسبة الكلوروفيل الكلية, المحصول المبكر, عدد الثمار المبكر وكذلك المحصول الكلي بالطن/الفدان. كذلك ظهرت قوة الهجين بالنسبة لمتوسط الأبوين والأب الأفضل للصفات الكيماوية وهي نسبة الكاروتين الكلي, محتوى الانثوسيانين, النيتروجين الكلي, الفوسفور الكلي, محتوى البوتاسيوم وكذلك الحديد الكلي. تفوق تباين القدرة العامة على تباين القدرة الخاصة على التألف لمعظم الصفات تحت الدراسة, مما يشير الي اهمية الفعل الجيني المضيف في توريث الصفات المدروسة. أوضحت نتائج تأثيرات القدرة العامة أن (الأب3) بلدي أسود طويل ذو قدرة ائتلافية عالية لصفات طول النبات, عدد الأفرع ,عدد الثمار المبكر, المحصول الكلي بالطن/الفدان وكذلك الفوسفور الكلي و(الأب2) بلدي ابيض طويل لصفات نسبة الكلوروفيل الكلية , النيتروجين الكلي, محتوى البوتاسيوم والحديد الكلي. بينما أظهر (الأب1) بلدي أسود مستدير(رومي) قدرة ائتلاف عالية لصفتي المحصول المبكر ومحتوى الأنثوسيانين و(الأب4) جابوما لصفة نسبة الكاروتين الكلي. أما تأثيرات القدرة الخاصة على التالف فأظهرت تفوق الهجن بلدي أبيض طويل x بلدي أسود طويل لصفات طول النبات ,المحصول الكلي بالطن/الفدان وكذلك الفوسفور الكلي , بلدي أسود مستدير x بلدي أبيض طويل لصفات عدد الأفرع, المحصول المبكر, عدد الثمار المبكر و الحديد الكلي, بلدي أسود مستدير x جابوما لصفات , نسبة الكلوروفيل الكلية, نسبة الكاروتين الكلي وكذلك النيتروجين الكلي بينما بلدي أبيض طويل x جابوما كان الأفضل بالنسبة لصفة محتوى البوتاسيوم. اما بالنسبة للهجن العكسية اشارت النتائج الى ان جابوما x بلدي أسود مستدير كان الأفضل لصفات طول النبات, نسبة الكلوروفيل الكلية, نسبة الكاروتين الكلي الحديد الكلي وبلدي أسود طويل x بلدي أسود مستدير لصفات عدد الأفرع ,المحصول المبكر, عدد الثمار المبكر ومحتوى الأنثوسيانين والهجين جابوما x بلدي أبيض طويل لصفتي المحصول الكلي بالطن/الفدان و الفوسفور الكلي. بينما الهجين العكسي جابوما x بلدي أسود طويل لصفة النيتروجين الكلي بلدي أسود طويل x بلدي أبيض طويل كان الأفضل لصفة محتوى البوتاسيوم. أوضحت تقديرات القدرة العامة والخاصة على التألف أن الفعل الجيني المضيف يلعب الدور الرئيسي في توريث معظم الصفات المدروسة مؤكدا أهمية طريقة التربية بالإنتخاب لتحسين هذه الصفات في محصول الباذنجان.