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PRODUCTION OF SUPERIOR EGGPLANT HYBRIDS (*SOLANUM MELONGENA* var. *ESCULENTA*) SUITABLE TO NORTH SINAI CONDITIONS

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ABSTRACT

This study was carried out at the Experimental Farm, Faculty of Environmental Agricultural Sciences, Suez Canal University, El-Arish, during 2009 to 2010 seasons, to produce some new promising hybrids of eggplant, suitable to North Sinai region and similar area, and to determine some useful genetic parameters. Six cultivars of eggplant; viz., Spa-3, Spa-6, Black Beauty (B.B.), Ma-1, PIG-4 and Jor-3 were used as parental genetic materials. These cultivars were used to produce the all 15 possible hybrids among them in one way. The six parents, 15 F_1's and the "Classic" F_1 (a check hybrid) were evaluated in winter seasons 2009/2010 under unheated plastic houses. The obtained results cleared that the over all F_1 means surpassed those of parents and check hybrid in most studied characters. The highest total fruit yield was produced by the crosses Spa-6 x B.B, Spa-3 x Ma-1 and PIG-4 x Jor-3. Heterosis over mid-parents were significant or highly significant, with positive values for most traits. Average heterosis over the better parent and check hybrid was insignificant for most traits. Correlations among the studied traits exhibited significant or highly significant positive or negative correlation values.

Keywords: Eggplant, cultivars, hybrids, heterosis, early and total yield.

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INTRODUCTION

The F_1 hybrids are now widely used in commercial production of most vegetables, especially under protected cultivation. In addition, hybrids are preferred for their uniformity, earliness, and high yielding ability, tolerance to environmental stresses and diseases. These may be the main reasons for the high considerable demand for eggplant hybrids. Both yielding ability and fruit characteristics are important in choosing cultivars and hybrids for planting in a certain area. Therefore, more attention should be focused upon the subject of improving the cultivars regarding these attributes for grower and consumer. As a result of plant breeding, modern cultivars often have higher yield than the older ones (Prakash *et al.*, 2008).

Heterosis in eggplant was observed for most characters by many investigators (Prabhu *et al.*, 2005; Kailash and Singh, 2008 for vegetative traits, Kamalakkannan *et al.*, 2007; Shafeeq *et al.*, 2007 and Prakash *et al.*, 2008) for early and total yield as a number and weight of fruits; (Quamruzzaman *et al.*, 2004 and Ibrahim 2007) for fruit characteristics). Correlation coefficients in eggplant were observed for most characters by many investigators. (Patel and Sarnaik, 2004; Reena and Mehta, 2007; Prabhu *et al.*, 2008) for all traits).

MATERIALS AND METHODS

The experiments were carried out at the Experimental Farm of the Faculty of Environmental Agricultural Sciences at El-Arish, Suez Canal University, from 2009 to 2010 season. The genetic parental materials used in this study included the six eggplant cultivars; Spa-3 (p1), Spa-6 (p2), Black Beauty (B.B.) (p3), Ma-1 (p4), PIG-4 (P5) and Jor-3 (P6). The widely spread hybrid in North Sinai "Classic" F_1 was used as a check hybrid. Crosses among the parental cultivars were done to produce 15 $F_{1's}$ in the first year. All genetic populations; viz., 6 parents, 15 $F_{1's}$ and the check hybrid were evaluated under unheated plastic houses, during the season of 2009/2010, where transplanting was done on November 11^{th}. The experimental design was the complete randomized block design, with three replications. Each replicate contained 22 plots with a plot area of 6.0 m^2. The distance between plants was 50 cm apart and the number of plants /plot was 14 plants. A drip irrigation system was used and fertigation was carried out according to the common recommendations. Routine cultural practices were done as needed and as usually used for the commercial eggplant production in plastic houses in the North Sinai region.

Observations and measurements were recorded for all evaluated genetic populations, regarding the following characters:

a. Vegetative traits; viz., plant height, number of branches / plant, days to 1st flower anthesis,

b. Early yield as the weight of fruits /plant in the first three harvestings,

c. Total yield as the number and weight of fruits /plant in all harvested fruits, and

d. Fruit characteristics; viz., average fruit weight, fruit length, fruit diameter, and total soluble solids percentage.

Statistical analysis of data was done according to Cochran and Cox (1957). Duncan's Multiple Range Test was used for the comparisons among genotype means (Duncan, 1955). The amount of heterosis was expressed as the deviation percentage of the F_1 mean performance from the mid-parents (M.P), better parent (B.P) and check hybrid (C.H). Phenotypic (rph) and genotypic (rg) correlations among pairs of studied traits were calculated as outlined by Steel and Torrie (1980).

RESULTS AND DISCUSSION

The Performance of Parents and their F_1

Vegetative and earliness traits

For Plant height, data presented in Table 1 show that mean of F_1 hybrids exceeded the mean of parents and check hybrid. The cross Ma-1 x PIG-4 gave the tallest plants. Similar results were reported by Biswajit *et al.* (2005), Shafeeq *et al.* (2007) who found that the mean sum of squares due to parents were highly significant for plant height and indicated that there are large amounts of variability among them.

Data in Table 1 show that parents Spa-6 and Jor-3 had the highest number of branches/plant. The crosses Spa-6 x Black Beauty (B.B.), Black Beauty (B.B.) x Ma-1 and Ma-1 x PIG-4 had the highest

Table 1. Means for studied vegetative and earliness traits in the parents, F_1 and check hybrid cultivar population of eggplant grown in winter season of 2009/2010

Genotypes	Plant height (cm)	No. of branches/plant	Days to 1st flower anthesis
1-Spa-3	82.90 fgh	3.33 bc	35.33 c
2-Spa-6	84.30 efg	4.67 ab	35.67 c
3-Black Beauty(B.B.)	66.80 I	3.67 abc	49.00 a
4-Ma-1	78.10 gh	4.33 ab	30.67 fg
5-PIG-4	75.80 ghi	4.00 abc	35.33 c
6-Jor-3	93.60 cde	4.67 ab	34.33 cd
$\bar{X}$	80.25	4.11	36.72
F_1's			
Spa-3 x Spa-6	108.50 b	4.33 ab	30.67 fg
Spa-3 x B.B.	100.00 bcd	3.67 abc	35.00 c
Spa-3 x Ma-1	90.20 def	4.67 ab	28.33 h
Spa-3 x PIG-4	97.20 cd	4.00 abc	34.00 cd
Spa-3 x Jor-3	98.80 bcd	3.67 abc	32.33 def
Spa-6 x B.B.	96.80 cd	5.00 a	29.33 gh
Spa-6 x Ma-1	104.40 bc	4.67 ab	31.67 ef
Spa-6 x PIG-4	97.70 cd	4.00 abc	40.00 b
Spa-6 x Jor-3	108.20 b	2.67 c	34.00 cd
B.B. x Ma-1	97.70 cd	5.00 a	34.00 cd
B.B. x PIG-4	96.80 cd	4.00 abc	35.00 c
B.B. x Jor-3	73.90 hi	4.00 abc	32.33 def
Ma-1 x PIG-4	118.50 a	5.00 a	28.33 h
Ma-1 x Jor-3	103.70 bc	4.00 abc	34.00 cd
PIG-4x Jor-3	94.20 cde	4.00 abc	41.00 b
$\bar{X}$	99.11	4.18	33.33
Check hybrid (Classic)	94.00 cde	3.67 abc	32.67 de

Means followed by the same alphabetical letter(s) within each column are not significantly different at 5% level according to Duncan's Multiple Range Test.

number of branches/ plant. The population means of F_1 hybrids exceeded those of parents and check hybrid in this trait. The present results are in agreement with Umaretiya *et al.* (2008).

For days to 1st flower anthesis, data presented in Table 1 show that the parent Ma-1 was the earliest parent because it had the fewest days from transplanting to the first flower anthesis (30.67). Therefore, two crosses which included Ma-1 cultivar; viz., Spa-3 x Ma-1 and Ma-1 x PIG-4 were earlier than other crosses. On the contrary, Black Beauty (B.B.) cultivar was the latest one because it had the highest number of days from transplanting to first flower anthesis (49.00). Most F_1 crosses were earlier than the check hybrid and other parents. The mean of check hybrid was earlier than mean of parents and F_1 mean populations for number of days to first flower anthesis. The present results are in agreement with Mishra *et al.* (2008).

Early yield/plant

It is evident from Table 2 that the mean of check hybrid exceeded parents and F_1 hybrids in early fruit weight/plant. The cross Spa-3 x Black Beauty (B.B.) had the highest early fruit weight/plant. Three crosses (Spa-3 x Spa-6, Spa-6 x Black Beauty (B.B.) and Spa-3 x Black Beauty (B.B.) exceeded the check hybrid in early fruit weight. The parent PIG-4 exceeded the check hybrid in early fruit weight but this increase was not significant. This agrees with the results of Mishra *et al.* (2008).

Total yield/plant

Data presented in Table 2 show that F_1 means exceeded each of the parents and the check hybrid means for fruit number/plant. The highest number of fruits/plant was produced by the cross Spa-6 x Ma-1. Meanwhile, Spa-3 cultivar produced the lowest number of fruits/plant.

For total fruit weight, data presented in Table 2 show that F_1 means exceeded the means of parents. The highest yield was produced by the crosses Spa-6 x Black Beauty (B.B.) and Spa-6 x Ma-1. On the other hand, the check hybrid did not significantly differ from the crosses Spa-3 x Ma-1 and PIG-4 x Jor-3. So, the crosses Spa-6 x Black Beauty (B.B.), Spa-6 x Ma-1, Spa-3 x Ma-1 and PIG-4 x Jor-3 could be used for the commercial cultivation for eggplant production in El-Arish region and similar areas. Regarding parents, Spa-6 and Jor-3 cultivars produced the highest total fruit weight /plant, while PIG-4 cultivar had the lowest value for total fruit weight/plant.

Table 2. Means for early and total yield in the parents, F_1 and check hybrid population of eggplant grown in winter season of 2009/2010

Genotypes	Early fruit weight (kg) /plant	Total yield / plant	
		No. of fruits	Fruit weight (kg)
1-Spa-3	0.10 bc	10.86 f	0.84 gh
2-Spa-6	0.04 bc	13.82 ef	1.946 cd
3-Black Beauty(B.B.)	0.07 bc	11.12 f	0.97 fgh
4-Ma-1	0.03 c	21.30 bcd	1.11 e-h
5-PIG-4	0.12 bc	12.12 ef	0.77 h
6-Jor-3	0.05 bc	13.72 ef	1.95 cd
X¯	0.07	13.82	1.26
F_1's			
Spa-3 x Spa-6	0.15 abc	17.03 def	2.05 cd
Spa-3 x B.B.	0.26 a	13.67 ef	1.18 efg
Spa-3 x Ma-1	0.11 bc	25.24 b	2.25 bc
Spa-3 x PIG-4	0.06 bc	16.89 def	1.78 d
Spa-3 x Jor-3	0.07 bc	17.28 def	2.08 cd
Spa-6 x B.B.	0.18 ab	24.84 bc	2.86 a
Spa-6 x Ma-1	0.10 bc	36.90 a	2.55 ab
Spa-6 x PIG-4	0.05 bc	18.53 cde	1.41 e
Spa-6 x Jor-3	0.07 bc	16.98 def	1.38 e
B.B. x Ma-1	0.07 bc	16.89 def	1.08 e-h
B.B. x PIG-4	0.11 bc	15.92 def	2.18 c
B.B. x Jor-3	0.09 bc	12.83 ef	1.21 ef
Ma-1 x PIG-4	0.09 bc	16.74 def	1.01 fgh
Ma-1 x Jor-3	0.01 c	15.17 def	0.97 fgh
PIG-4x Jor-3	0.08 bc	17.77 def	2.28 bc
X¯	0.096	18.98	1.75
Check hybrid	0.11 bc	16.74 def	2.21 bc

Means followed by the same alphabetical letters within each column are not significantly different at 5% level according to Duncan's Multiple Range Test.

Fruit characteristics

Data in Table 3 show that the Spa-6 cultivar had the highest average fruit weight (103.6g) and did not significantly differ from the check hybrid. While, Ma-1 had the lowest average fruit weight (61.97g). The F_1 means exceeded the parent means. The highest average fruit weight (115.6 g) was produced by the cross Black Beauty (B.B.) x PIG-4. Similar results were reported by Mishra *et al.* (2008).

Data presented in Table 3 show that the mean of parents exceeded F_1 means for fruit diameter. Black Beauty (B.B.) cv. had the highest value of fruit diameter (8.95cm) followed by Spa-3 and Jo-3.

For fruit length it is clear from Table 3 that Spa-6 cultivar had the longest fruits among all parents, these fruits exceeded F_1 and check hybrid means, while; Cross PIG-4 x Jor-3 produced the longest fruits.

Regarding T.S.S.%, data in Table 3 show that the F_1 means exceeded that of their parents and the check hybrid. As regard to parents, the highest T.S.S. % values were found in two parents (Spa-6 and Jor-3). The highest T.S.S. % were recorded in the crosses Black Beauty (B.B.) x Jor-3 and PIG-4 x Jor-3. This agrees with the results of Metwally *et al.* (2005) on pepper. who found that the F_1 crosses exceeded the parental cvs. in TSS% content.

Heterosis

Vegetative traits

For plant height, data presented in Table 4 show that 14 crosses, out of 15 ones, exhibited significant or highly significant positive heterosis values over the mid-parents. The cross Ma-1 x PIG-4 had the highest value (54.00%). In general, heterosis over mid-parents as an average was highly significant with a value of 23.50%. This result suggest dominance towards the long plant. Meanwhile, the cross (B.B x Jor-3) showed insignificant heterosis value (-7.86), indicating no-dominance for the character. This coincides with Khalil (1992) on pepper and Shafeeq *et al.* (2007), who found heterosis over mid-parents on eggplant.

Concerning heterosis over the better parent, 11 crosses out of 15 ones showed significant or highly significant positive values of heterosis over the better parent, indicating over-dominance for the long plant. Generally, average heterosis over the better parent was

Table 3. Means of some fruit characteristics for parents, F_1 and check hybrid populations eggplant grown in winter season (2009/2010)

Genotypes	Average fruit weight (g)	Fruit diameter (cm)	Fruit length(cm)	T.S.S. %
1-Spa-3	90.78 a-f	7.17 b	11.83 gh	3.23 fg
2-Spa-6	103.6 a-d	3.68 g	17.70 a	4.53 abc
3-Black Beauty(B.B.)	98.85 a-e	8.95 a	11.30 hi	3.01 g
4-Ma-1	61.97 gh	2.00 h	16.43 b	3.93 b-f
5-PIG-4	77.64 e-h	3.63 g	11.30 hi	3.83 b-g
6-Jor-3	102.2 a-e	6.82 bc	10.00 k	5.20 a
$\bar{X}$	89.17	5.36	13.093	3.96
F_1's				
Spa-3 x Spa-6	108.9 ab	4.96 e	13.67 cd	3.23 fg
Spa-3 x B.B.	107.0 abc	6.99 b	12.50 fg	3.20 fg
Spa-3 x Ma-1	77.46 e-h	5.54 de	12.50 fg	3.67 c-g
Spa-3 x PIG-4	92.96 a-e	5.34 de	12.80 ef	4.15 b-e
Spa-3 x Jor-3	107.5 abc	5.96 cd	10.87 ij	4.40 a-d
Spa-6 x B.B.	92.59 a-e	7.05 b	13.04 def	3.60 d-g
Spa-6 x Ma-1	55.91 h	3.54 g	13.50 cde	4.11 b-e
Spa-6 x PIG-4	80.89 d-g	3.94 fg	13.54 cd	4.10 b-e
Spa-6 x Jor-3	88.67 b-f	4.61 ef	12.60 f	4.15 b-e
B.B. x Ma-1	83.55 c-g	4.65 ef	13.56 cd	4.15 b-e
B.B. x PIG-4	115.6 a	5.27 de	11.50 hi	4.61 ab
B.B. x Jor-3	109.6 ab	6.75 bc	10.40 jk	4.70 ab
Ma-1 x PIG-4	64.42 gh	3.90 fg	12.30 fg	4.43 a-d
Ma-1 x Jor-3	67.27 fgh	3.87 fg	13.97 c	3.45 efg
PIG-4x Jor-3	107.1 abc	4.92 e	14.12 c	4.67 ab
$\bar{X}$	90.63	5.15	12.725	4.04
Check hybrid	102.2 a-e	5.49 de	12.97 def	3.03 g

Means followed by the same alphabetical letters within each column are not significantly different at 5% level according to Duncan's Multiple Range Test.

Table 4. Percentage of heterosis over mid-parents (M.P.), better parent (B.P.) and check hybrid (C.H.) for vegetative and earliness traits in F_1 generation of eggplant grown in winter season 2009/2010

Crosses	Plant height (cm)			No. of branches/plant			Days to 1st flower anthesis		
	Heterosis (%)			Heterosis (%)			Heterosis (%)		
	M.P.	B.P.	C.H.	M.P.	B.P.	C.H.	M.P.	B.P.	C.H.
Spa-3 x Spa-6	29.78**	28.71**	15.43**	13.16	-4.44	17.27	-13.62**	-13.13**	-6.12**
Spa-3 x B.B.	33.60**	20.63**	6.38*	11.43	0.00	6.36	-17.00**	-0.85	7.14**
Spa-3 x Ma-1	12.05*	8.81*	-4.04	28.77	11.90	28.18*	-14.14**	-7.71**	-13.27**
Spa-3 x PIG-4	22.50**	17.25**	3.40	21.13	7.50	17.27	-3.77	-3.68*	4.08*
Spa-3 x Jor-3	11.95**	5.56	5.11	-7.89	-22.22*	-4.55	-7.18**	-5.73**	-1.02
Spa-6 x B.B.	28.13**	14.83**	2.98	19.05	11.11	36.36**	-30.71**	-17.83**	-10.20**
Spa-6 x Ma-1	28.57**	23.84**	11.06**	3.45	0.00	22.73	-4.52	3.15	-3.06
Spa-6 x PIG-4	22.05**	15.90**	3.94	-8.24	-13.33	6.36	12.68**	13.31**	22.45**
Spa-6 x Jor-3	21.64**	15.60**	15.11**	-37.78**	-37.78**	-23.64	-2.86	-0.87	4.08*
B.B. x Ma-1	34.85**	25.10**	3.94	23.46	19.05	36.36**	-14.64**	10.75**	4.08*
B.B. x PIG-4	35.76**	27.70**	2.98	-3.80	-5.00	3.64	-17.00**	-0.85	7.14**
B.B. x Jor-3	-7.86	-21.05**	-21.38**	4.76	-2.22	20.00	-22.40**	-5.73**	-1.02
Ma-1 x PIG-4	54.00**	51.73**	26.06**	14.63	11.90	28.18*	-14.14**	-7.71**	-13.27**
Ma-1 x Jor-3	20.79**	10.79**	10.32**	-8.05	-11.11	9.09	4.62	10.75**	4.08*
PIG-4x Jor-3	11.22*	0.64	0.21	-1.18	-6.67	14.55	17.70**	19.53**	25.51**
Average	23.50**	5.88	5.43	4.13	-6.67	14.55	-9.23**	8.58**	2.04
L.S.D.									
0.05	7.80	6.37		1.07	0.88		1.60	1.30	
0.01	10.43	8.52		1.43	1.17		2.14	1.74	

*,** Significant at 0.05 and 0.01 levels of probability, respectively

absent, where it had insignificant positive value of heterosis. Similar results were reported by Ahmed *et al.* (1998) and Doshi *et al.* (2001).

Seven crosses exhibited significant or highly significant positive heterotic effects with the check hybrid. Such estimates varied from 6.38 to 26.06 % for the crosses Spa-3 x Black Beauty (B.B.) and Ma-1 x PIG-4, respectively.

Average heterosis over the check hybrid was absent, where it had insignificant positive value. Similar results were obtained by Chezhian *et al.* (2000) and Biswajit *et al.* (2005).

For number of branches/plant, data presented in Table 4 show that heterosis over both mid-parents or better parent were absent, while four crosses (Spa-3 x Ma-1, Spa-6 x Black Beauty (B.B.), Black Beauty (B.B.) x Ma-1 and Ma-1 x PIG-4) had significant or highly significant positive values of heterosis over the check hybrid. Both crosses Spa-6 x Black Beauty (B.B.) and Ma-1 x Black Beauty (B.B.) had the highest value of heterosis over the check hybrid (36.36 %). Generally, average heterosis over the check hybrid was absent, where it had insignificant positive value. The present results are in agreement with Doshi *et al.* (2001) and Prabhu *et al.* (2005).

Data presented in Table 4 show that 9 crosses out of 15 ones exhibited highly significant negative values of heterosis over the mid-parents for days to the first flower anthesis, suggesting dominance towards the early parent. The cross Spa-6 x Black Beauty (B.B.) had a highly significant negative value (-30.71 %), indicating that this cross was very early compared to its parents. Average heterosis over the mid-parents had a highly significant negative value.

As for days to first flower anthesis, seven crosses from 15 ones had highly significant negative values of heterosis over the better parent, suggesting over-dominance of the early parent. The cross Spa-6 x Black Beauty (B.B.) had the highest negative value of heterosis over the better parent (-17.83%). However, the cross Spa-3 x PIG-4 had the lowest one (-3.68%), average heterosis over the better parent was highly significant. The present results are in agreement with Aswani and Khandelwal (2003) and Kailash and Singh (2008) who recorded significant values of heterosis over better parent for early flowering.

From 15 crosses only four ones had highly significant negative values of heterosis over the check hybrid for days to first flower anthesis. The cross Ma-1 x PIG-4 had the shortest negative value of heterosis over the check hybrid (-13.27%). Generally, average heterosis over the check hybrid was absent.

Early yield/plant

For fruit weight, it is clear from Table 5 that two crosses exhibited significant or highly significant positive values of heterosis over the mid-parents. The highest significant value (230.38 %) was obtained from the cross Spa-6 x Black Beauty (B.B.). Generally, average heterosis over the mid-parents was absent. Similar results were reported by Sousa and Maluf (1998).

The same tow crosses from 15 ones showed highly significant positive values for heterosis over the better parent. These values were 154.82 % and 144.20 % for the crosses Spa-3 x Black Beauty (B.B.) and Spa-6 x Black Beauty (B.B.), respectively. Average heterosis over the better parent was absent, where it has negative value with insignificant.

Highly significant positive value for heterosis over the check hybrid (144.95 %) was obtained from the cross Spa-3 x Black Beauty (B.B.), when compared with the check hybrid. Average heterosis over the check hybrid was absent. So this cross coud replace after further evaluation the check hybrid in early commercial production of eggplant, under North Sinai conditions.

Total yield/plant

For number of fruits, data presented in Table 5 show that five crosses showed significant and highly significant positive values of heterosis over the mid-parents indicating dominance total fruit number. The highest significant value (110.16 %) was obtained from the cross Spa-6 x Ma-1. Average heterosis over the mid-parents was absent where it has insignificant positive value. In this concern, Kaur *et al.* (2001 a) studied 35 F1 and found that the extent of heterosis for number of fruits exhibited by the hybrids over their mid parents varied from -26.86 to 168.85 per cent in eggplant. Similar results were reported by Kailash and Singh (2008).

Five crosses exhibited significant or highly significant positive heterotic effects over the better parent. Such estimates varied from 29.54% to 79.77 % for the crosses PIG-4 x Jor-3 and Spa-6 x Black

Table 5. Percentage of heterosis over mid-parents (M.P.), better parent (B.P.) and check hybrid (C.H) for early fruit weight and total yield in F_1 generation of eggplant grown in winter season of 2009/2010

Crosses	Early Fruit weight (kg) Heterosis (%)			Total No. of fruits Heterosis (%)			Total Fruit weight (kg) Heterosis (%)		
	M.P.	B.P.	C.H.	M.P.	B.P.	C.H.	M.P.	B.P.	C.H.
Spa-3 x Spa-6	120.08	48.13	42.38	38.07	23.25	1.77	53.42**	27.92**	9.79
Spa-3 x B.B.	206.17**	154.82**	144.95**	24.40	35.08	-18.32	30.01*	21.03**	-19.93**
Spa-3 x Ma-1	68.10	-1.65	-5.47	57.00**	18.50	50.81**	74.37**	56.46**	12.84*
Spa-3 x PIG-4	-52.94	-55.06	-52.48	47.01*	39.38*	0.93	66.86**	63.61**	-6.38
Spa-3 x Jor-3	-21.24	-42.94	-45.15	40.61	25.96	3.25	54.59**	30.11**	8.57
Spa-6 x B.B.	230.38*	144.20**	64.31	99.27**	79.77**	48.44**	79.54**	58.85**	36.33**
Spa-6 x Ma-1	266.73	147.67	-4.77	110.16**	73.24**	120.47**	55.16**	42.94**	22.68**
Spa-6 x PIG-4	-41.31	-60.75	-58.50	42.90*	34.11*	10.73	25.96*	3.40**	-11.26
Spa-6 x Jor-3	74.28	42.77	-31.38	23.30	22.85	1.44	6.31	4.76	-10.09
B.B. x Ma-1	67.71	2.87	-30.78	4.17	-20.73	0.89	19.95	14.91*	-17.13**
B.B. x PIG-4	9.44	-10.97	-5.87	37.01	31.37	-4.87	81.07**	65.53**	9.51
B.B. x Jor-3	53.31	24.58	-16.18	3.33	-6.46	-23.32	7.10	-4.25	-20.10**
Ma-1 x PIG-4	46.13	-13.97	-9.04	0.16	-21.42	0.00	1.08	-10.84	-35.70
Ma-1 x Jor-3	-74.82	-83.81	-92.22*	-13.36	-28.77	-9.35	-21.27*	-26.65*	-38.80**
PIG-4x Jor-3	1.98	-27.04	-22.85	37.53	29.54*	6.19	61.03**	33.40**	11.31
Average	51.63	-13.18	-8.20	36.34	-11.52	12.60	38.40**	12.76	-3.22
L.S.D.									
0.05	0.10	0.08		5.40	4.41		0.26	0.21	
0.01	0.14	0.11		7.22	5.90		0.34	0.28	

*,** Significant at 0.05 and 0.01 levels of probability, respectively

Beauty (B.B.), respectively suggesting over dominance to high parent. Average heterosis over the better parent was absent. Similar results were obtained by Aswani and Khandelwal (2003), who studied the exploitation of hybrid vigour in eggplant using a diallel cross, involving 10 parents (excluding reciprocals). All the forty five hybrids showed negative and significant heterosis over better parents for total fruit yield plant. The better parent heterosis ranged from 21.05% to 166.03%. Similar results were reported by Timmapur *et al.* (2008).

Three crosses were superior to the check hybrid in total fruit number/plant. Therefore, heterosis over the check hybrid was highly significant with positive values in these crosses. Heterosis values ranged from 48.44% to 120.47 % for the crosses Spa-6 x Black Beauty (B.B.) and Spa-6 x Ma-1, respectively. This agrees with the results of Ahmed *et al.* (1998) who revealed that the maximum heterosis of 93.57% over special parent (SP) was manifested coupled with highest fruit number of 26.78 by sel-4 x LL followed by Sel-4 x PPL (63.86%), AS x LL (58.64%) and AS xJG (53.41%). Average heterosis over the check hybrid for all crosses was absent.

For fruit weight, data presented in Table 5 show that 10 crosses exhibited significant or highly significant positive values of heterosis over the mid-parents, suggesting dominance towards the B.P. The highest value for heterosis over the mid-parents was 81.07% resulted from the cross Black Beauty (B.B.) x PIG-4. Average heterosis over the mid-parents was highly significant with a value of 38.40% for this trait.

Concerning heterosis over the better parent, data in Table 5 show that 11 crosses exhibited significant or highly significant positive values of heterosis over the better parent, indicating over dominance for this trait. These values ranged from 3.40% to 65.53% for the crosses Spa-6 x PIG-4 and Black Beauty (B.B.) x PIG-4, respectively. Average heterosis over the better parent was absent. The present results are in agreement with Shafeeq *et al.* (2007) and Prakash *et al.* (2008).

Three crosses exhibited significant or highly significant values over the check hybrid. Average heterosis over the check hybrid for all crosses was absent.

Fruit characteristics

For average fruit weight, data in Table 6 show that only one cross, Black Beauty (B.B.) x PIG-4 showed highly significant positive values (30.95%) of heterosis over the mid-parents, this cross exceeded the B.P. in fruit weight with 16.9% suggesting over dominance for the heavy fruit. Average heterosis over the mid-parents was absent, where it had insignificant value. This agrees with the results of Kaur *et al.* (2001 b) who studied 35 F_1 in eggplant and found heterosis over the mid parent for average fruit weight which ranged from -54.93 to 100.02 %. Average heterosis over the better parent was absent. Similar results were reported by Saraswathi (2003) and Suneetha and Kathiria (2006).

Data in Table 6 showed all crosses revealed insignificant heterosis values over the check hybrid. So, average heterosis over the check hybrid for all crosses was absent for average fruit weight. In these connections Ahmed *et al.* (1998) studied the manifestation of heterosis over both B.P. and SP and found that heterosis was maximum to an extent of 23.49% over BP and to an extent of only 7.20% over SP. As well as, only one cross AS x PPL recorded higher fruit length (18.19 cm) than parents and other hybrid combinations.

It is evident from Table 6 that fruit length in five crosses out of 15 ones had highly significant positive values of heterosis over the mid-parents, indicating dominance towards the long fruit. The cross PIG-4 x Jor-3 had the highest value (46.32 %). The estimated average heterosis over the better parent was highly significant in three crosses. The largest one (26.07%) resulted from the cross PIG-4 x JOR-3. Average heterosis over the better parent was highly significant with a value of 31.96%, indicating over dominance to fruit length.

Data in Table 6 show that from 15 crosses only three ones revealed highly significant positive values of heterosis over the check hybrid for this trait. Heterosis over the check hybrid ranged from 5.26 to 7.52 % for the crosses Spa-3 x Spa-6 and Ma-1 x Jor-3, respectively. Average heterosis over the check hybrid was significant with a value of 4.33%. The present results are in agreement with Timmapur *et al.* (2008).

The same data illustrate that five crosses from 15 ones had significant or highly significant values of heterosis over the mid-parents for fruit diameter. Suggesting dominance to this trait the cross Ma-1 x PIG-4 had the largest value (48.23 %).

Table 6. Percentage of heterosis over mid-parents (M.P.), better parent (B.P.) and check hybrid (C.H.) for some fruit characteristics in the F_1 generation of eggplant grown in winter season of 2009/2010

Crosses	Average fruit weight (g)			Fruit length (cm)			Fruit diameter (cm)			Tss %		
	Heterosis (%)			Heterosis (%)			Heterosis (%)			Heterosis (%)		
	M.P.	B.P.	C.H.	M.P.	B.P.	C.H.	M.P.	B.P.	C.H.	M.P.	B.P.	C.H.
Spa-3 x Spa-6	12.02	5.09	6.55	-7.28**	-25.13**	5.26**	-11.90*	-36.83**	-9.60*	-16.05	-27.99**	5.28**
Spa-3 x B.B.	12.87	8.27	4.73	9.25**	7.83**	-6.77**	16.66**	7.37**	82.77**	0.65	-2.21	2.31
Spa-3 x Ma-1	0.71	-15.27	-24.73**	-12.59**	-26.90**	-6.02**	8.25	-29.50**	0.90	6.73	-0.54	20.46**
Spa-3 x PIG-4	10.39	2.40	-9.03	11.89**	10.43**	-4.51*	-0.80	-32.17**	-2.93	13.65	7.28	26.40**
Spa-3 x Jor-3	11.43	5.21	5.21	10.20**	-6.09**	-18.80**	-18.76**	-24.10**	8.63	9.05	-10.20	45.21
Spa-6 x B.B.	-8.54	-10.64	-9.39	-12.78**	-30.27**	-1.95	10.64*	-24.50**	28.53**	-3.77	-19.41**	17.82
Spa-6 x Ma-1	-32.46**	-46.04**	-45.28**	-24.58**	-27.81**	1.50	22.54*	3.99	-35.41**	-6.17	-14.22*	25.41*
Spa-6 x PIG-4	-10.74	-21.93**	-20.84**	-9.43**	-27.59**	1.80	25.33*	15.73*	-28.12**	-5.25	-14.45*	25.08
Spa-6 x Jor-3	-13.83	-14.42*	-13.23	-5.97**	-32.62**	-5.26**	-10.13	-32.61**	-16.23**	-12.33	-16.53**	34.98**
B.B. x Ma-1	3.91	-15.47*	-18.24*	-4.17*	-20.70**	1.95	-20.62**	-50.21**	-15.25**	24.32**	12.81	36.63**
B.B. x PIG-4	30.95**	16.90*	13.08	1.79	1.79	-14.29**	-13.86**	-43.62**	-4.02	39.63**	28.29**	51.16**
B.B. x Jor-3	9.04	7.26	7.26	4.66	-9.82**	-24.06**	-16.56**	-27.82**	22.88**	19.14*	-4.08	55.12**
Ma-1 x PIG-4	-7.71	-17.02	-36.96**	-13.07**	-28.07**	-7.52**	48.23**	35.14**	-28.92**	20.72*	19.07*	44.22**
Ma-1 x Jor-3	-18.04	-34.17**	-34.17**	13.49**	-16.37**	7.52**	-16.05*	-43.40**	-29.65**	-19.72*	-29.80**	13.53**
PIG-4x Jor-3	19.13	4.82	4.82	46.32**	26.07**	6.17**	1.46	-27.80**	-10.26*	10.27	-4.69	54.13*
Average	1.59	-12.56	-11.35	-1.87	31.96**	4.33*	-1.73	-42.69	-2.44	4.39	-57.66**	30.52**
L.S.D.												
0.05	17.70	14.45		0.57	0.46		0.62	0.51		0.65	0.53	
0.01	23.68	19.34		0.76	0.62		0.83	0.68		0.87	0.71	

*,** Significant at 0.05 and 0.01 levels of probability, respectively

Average heterosis over the mid-parents was absent. Concerning heterosis over the better parent, data show that three crosses exhibited significant or highly significant positive values of heterosis over the better parent. These values ranged from 7.37 to 35.14 % for the crosses Spa-3 x Black Beauty (B.B.) and Ma-1 x PIG-4, respectively, Indicating over-dominance for wide fruit. Average heterosis over the check hybrid for all crosses was absent.

Data listed in Table 6 show that three crosses exhibited significant or highly significant positive values of heterosis over the check hybrid. The highest significant value (82.77 %) was obtained from the cross Spa-3 x Black Beauty (B.B.). Average heterosis over the check hybrid was absent. Similar results were reported by Timmapur *et al.* (2008)

For total soluble solids percentage, data in Table 6 show that The crosses Black Beauty (B.B.) x Ma-1 and Black Beauty (B.B.) x PIG-4 had highly significant heterosis over the mid-parents. Indicating dominance to this trait. Average heterosis over the mid-parents for all crosses was absent. This agrees with the results of Ibrahim (2007).

The crosses, Black Beauty (B.B.) x PIG-4 and Ma-1 x PIG-4 revealed significant or highly significant values of heterosis over the better parent. Indicating over-dominance to high parent. Generally, average heterosis over the better parent was absent, where it had a highly significant negative value.

Eleven crosses from 15 ones had positive and significant or highly significant values of heterosis over the check hybrid for T.S.S. %. The highest value (55.12 %) was resulted from the cross Black Beauty (B.B.) x Jor-3. Average heterosis over the check hybrid was highly significant with a positive value of 30.52 %.

Phenotypic and Genotypic Correlation Coefficients

A negative significant correlation was found between plant height and days to first flower anthesis. Surbhi and Mehta (2008) found the same result. Moreover, a negative significant correlation was found between days to first flower anthesis and total number of fruits/plant (Table 7).

Total fruit number/plant had highly significant positive correlation with total fruit weight

Table 7. Phenotypic (rph) and genotypic (rg) correlation coefficients among 18 characters of eggplant grown in winter season of 2009/2010

Characters		2	5	8	9	10	11	12	13	14
1-Plant height (cm)	rph	0.053	-0.420*	0.178	0.347	0.343	-0.170	0.095	-0.290	0.121
	rg	-0.060	-0.442*	0.208	0.394	0.404	-0.206	0.099	-0.304	0.117
2-No. of branches/plant	rph		-0.340	0.062	0.370	0.268	-0.214	0.215	-0.125	0.228
	rg		-0.468*	0.066	0.473*	0.346	-0.315	0.323	-0.163	0.304
5-Days to1st flower anthesis	rph			-0.195	-0.434*	-0.270	0.311	-0.060	0.282	-0.044
	rg			-0.318	-0.487*	-0.319	0.332	-0.071	0.292	-0.035
8-Early Fruit weight (kg)	rph				0.062	0.271	0.296	-0.224	0.396	-0.369
	rg				0.189	0.402	0.168	-0.313	0.586**	-0.621**
9-Total No. of fruits	rph					0.673**	-0.493*	0.293	-0.350	-0.014
	rg					0.665**	-0.539**	0.325	-0.390	-0.042
10-Total Fruit weight (kg)	rph						0.240	0.240	0.059	0.155
	rg						0.278	0.278	0.074	0.170
11-Average fruit weight (g)	rph							-0.318	0.590**	0.198
	Rg							-0.352	0.674**	0.252
12-Fruit length (cm)	Rph								-0.648**	-0.129
	Rg								-0.675**	-0.147
13-Fruit diameter (cm)	Rph									-0.174
	Rg									-0.199
14-TSS %	Rg									
	Rph									

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

(Table 7), While negative significant correlation was found between this trait and average fruit weight. Similar results were reported by Surbhi and Mehta (2008) and Prabhu *et al.* (2008).

Average fruit weight had highly significant positive correlation value with fruit diameter. On the other hand, highly significant negative correlation was observed between fruit length and fruit diameter (Table 7). This agrees with the results of Chung *et al.* (2003), Sunita and Bandhyopadhya (2005).

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إنتـــاج هجـن من الباذنجـــان تلائـم ظـروف شمال سيناء

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أجريت هذه الدراسة بالمزرعة التجريبية بكلية العلوم الزراعية البيئيـة بـالعريش – جامعة قناة السويس خلال الفترة من عام ٢٠٠٩ إلى ٢٠١٠ لإنتاج هجن مـن الباذنجـان تلائم منطقة شمال سيناء والمناطق المماثلة، و كذلك لتقدير بعض الثوابت و القيم الوراثية الهامة، حيث استخدم في هذه الدراسة ستة أصناف من الباذنجان هي بلاك بيـوتي و إم أ-١و بي أي جي-٤ و جا أو أر-٣ و إس بـي أ-٣ و إس بـي أ-٦، واسـتعملت هـذه الأصناف الابوية في إنتاج خمسة عشر هجيناً و هي كل الهجن الممكنة بينهـا فـي اتجـاه واحد، وقيمت الآباء الستة وعشائر الجيل الأول والهجين التجاري "كلاسيك" (للمقارنة) تحت ظروف الزراعة المحمية في الصوب البلاستيكية خلال موسمي ٢٠٠٩/٢٠١٠ م.

تفوق المتوسط العام للهجن علي المتوسط العام للآباء و الهجين التجاري في صـفات ارتفاع النبات، وعدد الأفرع / النبات، وعدد الأوراق / النبات، وعدد الثمار الكلي، ونسـبة المواد الصلبة الذائبة الكلية، وصلابة الثمار، أما باقي الصفات تحت الدراسة فكان المتوسط العام للهجن أقل من متوسط الآباء و الهجين التجاري، ولكن ذلك لم يمنع من تفوق بعـض الهجن علي الهجين التجاري أو متوسط الآباء في كل الصفات المدروسة.

كانت قوة الهجين عند حسابها كمتوسط عام علي أساس متوسط الأبـوين موجبـة و معنوية أو عالية المعنوية لصفات ارتفاع النبات، والمحصول الكلي (وزن الثمـار)، بينمـا كانت سالبة أو غير معنوية لباقي الصفات تحت الدراسة، وكانت قوة الهجين عند حسـابها كمتوسط عام علي أساس الأب الأفضل سالبة أو غير معنوية لكل الصفات تحت الدراسة ما عدا عدد الأيام حتى تفتح أول زهرة حيث كانت عالية المعنوية و لم يمنع ذلك مـن وجـود هجن متفوقة على الأب الأفضل لكل الصفات تحت الدراسة. كانت قوة الهجين عند حسـابها كمتوسط عام علي أساس الهجين التجاري موجبة ومعنوية أو عالية المعنوية لصفات طول الثمرة، ونسبة المواد الصلبة الذائبة الكلية، بينما كانت قيمها غير معنوية أو سالبة لبـاقي الصفات تحت الدراسة، و لكن هذا لم يمنع من وجود بعض الهجن المتفوقة علي الهجـين التجاري في معظم الصفات تحت الدراسة.

وجد ارتباط سالب ومعنوي بين عدد الأيام حتي تفتح أول زهرة وعدد الثمار فى المحصول الكلي وأظهر عدد الثمار في المحصول الكلي ارتباطا موجبا وعالي المعنويـة مـع وزن الثمـار الكلي في حين أرتبط عدد الثمار بالمحصول الكلي ارتباطا سالباً مع متوسط وزن

الثمرة، بينما أظهر متوسط وزن الثمرة ارتباطاً موجباً وعالي المعنويـة مـع قطـر الثمرة، و أظهرت صفة قطر الثمرة ارتباطا سالبا وعالي المعنوية مع طول الثمرة.