HETEROSIS FOR YIELD COMPONENTS AND SOME CHARACTERS IN MELON (*Cucumis melo* L.)

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ABSTRACT

These experiments were carried out at the Experimental farm of Hort. Res. Station, El-Kanater El-Khyreia during the two successive summer seasons of 2007 and 2008. The genetic materials used in this study was four parental lines of melon, viz, Topmark (A), Sierra Gold (B), Helepest (C) and Zentei (D). In the 2007 summer season, the four parents were planted in the field and all possible crosses, without reciprocals, were made to generate the experimental materials. The objective of this study was to determine heterosis amount in melon regarding yield components and some fruit traits. This knowledge about the genetic of particular traits is helpful to plant breeder before planning a successful breeding program. Obtained results show that useful hybrid vigour was observed for all studied traits. Comparisons of the hybrids with their respective high parents indicated heterosis in one cross (Topmark x Zentei) in early yield as fruit number, three F_1 hybrids viz, (Topmark x Zentei), (Topmark x Sierra Gold) and (Sierra Gold x Helepest) for early and total yield as fruit weight, two crosses i.e. (Topmark x Sierra Gold) and (Sierra Gold x Helepest) for total yield as fruit number, one cross (Topmark x Helepest) for average fruit weight and vitamin C and four crosses(Topmark x Sierra Gold), (Topmark x Helepest), (Topmark x Zentei) and (Helepest x Zentei) for TSS content.

The high estimated values of heterosis and potence ratio were in accordance with the hybrid vigour concluded. Meanwhile, no hybrid vigour was observed concerning all traits for some crosses. the best combinations were (To Pmark x Sierra Gold), (Topmark x Helepest) and (Topmark x Zentei), since it showed positive heterosis values for four studied traits.

Keywords: Heterosis, Hybrid vigour, TSS.

INTRODUCTION

The utilization of hybrid vigour in the breeding of various crops has a great practical importance. Accordingly, it is very important to increase melon yield per unit area, as well as improve the fruit traits. In Egypt the acreage of melon (*Cucumis melo* L.) in 2007 was 100167 Feddan, total production of melon was 1025752 Tons, with average of 9.245 Tons/ Feddan, according to Ministry of Agriculture.

Several workers had obtained melon F_1 hybrids that performed better in one or more aspects than either parent. Among them were Mishra and Seshadpi (1985), Hatem *et al.*(1996), Jose *et al.* (2005) and Rakhi and Rajamony (2005) who found that the greatest heterosis over the better parent was observed for early yield. According to Ghadha and Nandpuri (1978) and Hatem *et al.* (1996) earliness in melon was a partially dominant trait.

Heterosis for early yield as number of fruits and weight per plant was observed by Shakhanov (1972), Hatem *et al.* (1996) and José *et al.* (2005) in most of the studied crosses evaluated.

Daljeet *et al.* (1976), Abadia *et al.* (1985) and Iria *et al.* (2008) studied the inheritance of yield in crosses between melon varieties and found that yield was inherited as a dominant character.

Several studies were conducted on the inheritance of average fruit weight in melon. Heterosis, dominance and partial dominance for this trait were observed by many workers. According to Abd El-Moneam (1976) and Hatem (1992), the light fruit weight showed partial dominance over the heavy one in melon.

The TSS content of melon fruits was inherited as a quanitative trait with no dominance (Hatem, 1992). On the other hand, Abd El-Moneam (1976), Swamy and Dutta (1985), Rakhi and Rajamony (2005) and Iria *et al.* (2008) found that the high TSS content of the studied crosses in melon was partially dominant and over dominant or dominated the low content.

Few studies have been conducted on the inheritance of vitamin C content in melon. Swamy and Dutta (1985) and Jose *et al.* (2005), reported that both additive and non-additive gene effects were important, the latter being the more important.

Our investigation was carried out to obtain more informations on heterosis effect in melon.

MATERIALS AND METHODS

The present investigation was carried out at the Experimental farm of of Hort. Res. Station, El-Kanater El-Khayria during two successive summer seasons: 2007 and 2008. Four parental lines of melon (*C. melo*) were used in this study. Two namely Topmark (A) and Sierra Gold (B) (is Provided by Vegetable Res. Dep., Hort. Res. Institute, Ministry of Agriculture). A Hungarian lines viz, Helpest (C) and Zentei (D) which were obtained from Prof. Dr. Roshdy M. Khalil. These cvs. belongs to *C. melo* var. *reticulates*. These parental lines were at a high degree of homozygosis since they were previously selfed for three generations.

The characters of these parental lines are shown in Table (1).

In the summer season 2007, the four parents were planted in the field and all possible crosses, without reciprocals, were made to generate the experimental materials.

The 10 entries viz, 4 parental lines and 6F_1 hybrids, were planted in the second season in the field on March 3th for measuring the effect of heterosis for seven traits. A randomized complete block design with three replicates was adopted. Each experimental plot contained 30 plants, distributed rows each rows 5m long. Plants were spaced 50 cm apart with 125 cm between rows. Standard cultural practices of melon were employed throughout the two experimental seasons.

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

Parental lines	Characters	
	Plants	Fruits and flesh
Topmark (A)	Vigorous growing vine which is quite sulphur tolerant	Nearly round, heavily netted, free of ribbing, weighing up to 1.5 kgs. Salmon colored, thick and firm
Sierra Gold (B)	Strong, vigorous vine	Slightly ribbed, well netted, round and weighing 1-1.5 kgs. Salmon orange, firm flesh and sweet
Helpest (C)	Prolific and productive vine	Round, heavily netted and lightly ribbed, weight (1-1.25 kg). Pale orange, very thick and firm, excellent flavou
Zentei (D)	Vigorous and productive vine	Slightly elongated, medium sized (0.750-1.200 kg). Rind is heavily netted and ribbed. Pink orange flesh, very thick, sweetness.

The studied traits were:

1. Early yield (fruit number and weight per plant) in the first two harvestes during two weeks.

2- Total yield (fruit number and weight per plant).

3- Average fruit weight, was determined by dividing the total weight of fruits (kg) by the total number.

4- TSS content; was determined as percentage using a hand refractometer.

5- Vitamin C content; was determined according to the procedure reported by the **A.O.A.C. (1990)**.

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

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

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

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

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

Where, $\overline{MP}$, $\overline{HP}$, $\overline{F}_1$, $\overline{P}_1$ and $\overline{P}_2$ are the mid-parents, mean of high performed parent in the trait, F_1 hybrids, and the mean of the low and high parent, respectively.

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

t for heterosis over mid-paremts value = $\overline{F}_1 - \overline{MP} / \sqrt{(Me/r) \times {}^2/_3}$

t for heterosis over high-paremts value = $\overline{F}_1 - \overline{HP} / \sqrt{(Me/r) \times 2}$

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

RESULTS AND DISCUSSIONS

I) Early yield (fruit number):

Data presented in Table (2) indicate that out of five F_1 crosses whose parents significantly differed in early fruit number, four crosses significantly exceeded their respective mid-parental values, suggesting dominance towards the high number of early fruits. The ADH% values were estimated as 9.09, 9.59, 26.67, 14.94 and 13.58 for the crosses AxB, AxC, AxD, BxC and CxD, respectively, based on mid-parents values.

The mean of the crosses AxB, AxC, BxC and CxD did not differ significantly from the high parents mean, indicating complete dominance for high fruit number. The complete dominance was supported by the estimated ADH% values 3.52, 2.52, 2.25 and 4.23, respectively. The same conclusion regarding heterosis was reported by **Shakhanov (1972), Hatem *et al.* (1996) and Jose *et al.* (2005).**

The cross AxD significantly exceeded its high parent in early yield as fruit number, syggesting hybrid vigour for the high early yield (Table 3).The ADH% was estimated as 9.59%. The high obtained potence ratio value (1.73) is in accordance with the hybrid vigour hypothesis (Table 4).

2) Early yield (fruit weight per plant):

Data presented in Table (2) indicate that out of five F_1 crosses whose parents significantly differed in early fruit weight, four crosses significantly exceeded their respective mid-parental values, suggesting dominance towards the high early fruit weight. Obtained ADH% based on MP ranged from 32.35% in the cross AxD to 7.79% in the cross CxD.

On comparing the observed means for the studied F_1s versus their respective high parents in early fruit weight, the crosses AxB, AxD and BxC significantly exceeded their high parents in early fruit weight, suggesting hybrid vigour for the high early fruit weight. The ADH% values for these crosses were 5.42%, 13.21% and 12.33%, respectively (Table 3). This hybrid vigour was verified by the high estimated potence ratio values (1.48, 1.95 and 1.88, respectively) which were significantly more than one (Table 4).

Partial dominance for the high early fruit weight was detected in the cross CxD, since it showed significant ADH% values as 7.79% and -4.89% based on MP and HP, respectively (Tables 2 and 3). The obtained potence ratio value was moderate (0.71) in accordance with the partial dominance postulated.

Table (2): Estimates of heterosis %, based on mid-parents (MP), for the studied traits.

Characters	Crosses					
	AXB	AxC	AxD	BxC	BxD	CxD
Early yield fruit number per plant	9.09*	9.59*	26.67**	14.94*	Ns	13.58*
Early yield fruit weight per plant	11.11*	15.66*	32.35**	26.32**	Ns	7.79*
Total yield fruit number per plant	17.08**	19.30**	12.05*	Ns	17.85**	8.90*
Total yield fruit weight per plant	22.13**	18.30**	15.20*	Ns	18.50**	12.30*
Average fruit weight (kg)	Ns	16.80**	14.08*	9.80*	12.35*	5.94
TSS%	12.59*	19.35**	20.50**	14.07*	Ns	16.35*
Vitamin C content	8.37	12.55*	14.30*	17.80**	9.35*	9.00*

A: Topmark B: Sierra Gold C: Helpest D: Zentei

* Significant at the 0.05 level. ** Significant at the 0.01 level.

Ns No significant differences were found between the parents.

Similar results were obtained by Mishra and Seshadpi (1985) and Hatem *et al.* (1996), who reported that greatest heterosis over the better parents was observed for early yield.

3) Total yield (fruit number per plant):

Significant differences between the parental lines of five studied crosses were observed concerning total number of fruits per plant. When the obtained means of these crosses were compared with their arithmetic MP means, these crosses significantly exceeded their mid-parental values in this respect, suggesting dominance towards the high number of fruits per plant. On comparing the observed means for the studied F_1s versus their respective high parents in total number of fruits, the crosses AxD and BxD did not differ significantly from their high parental means, indicating complete dominance for the high fruit number. The complete dominance was supported by the estimated ADH values for these crosses (1.98% and 4.63%, respectively). The estimated potence ratio values (1.21 and 1.11, respectively) for these crosses support the complete dominance (Tables 3 and 4).

The two crosses AxB and AxC significantly exceeded their high parents in total fruit number, suggesting hybrid vigour for the high yield. The ADH% was estimated as 8.33% and 11.33%, respectively, in the two crosses. The high obtained potence ratio values (1.56 and 1.68, respectively) were in accordance with the hybrid vigour hypothesis.

Partial dominance for the high yield was detected in the cross CxD since it showed significant ADH% values as 8.90% and -5.39% based on MP and HP, respectively (Tables 2 and 3). The obtained potence ratio value was moderate (0.64) in accordance with the partial dominance postulated (Table 4).

Similar results were obtained by **Hatem *et al.* (1996) and Iria *et al.* (2008).**

4) Total fruit yield weight per plant:

Significant differences between the parental lines of five studied crosses were observed concerning total yield as fruit weight per plant. On comparing the obtained means of theses F_1 hybrids versus their respective mid-parents, five crosses, viz, AxB, AxC, AxD, BxD and CxD siginificantly exceeded their $\overline{MP}$ values with ADH% of 22.13%, 18.30%, 15.20%, 18.50% and 12.30%, respectively, suggesting dominance towards the high yield. On the other hand, none of the studied F_1 crosses exhibited dominance towards the low parents. Whereas, two crosses, viz, BxD and CxD were statistically similar to their respective high parent, indicaticating complete dominance for the high total fruit yield. The potence values were estimated as 1.09 and 1.07, respectively in these crosses (Tables 2,3 and 4).

Table (3): Estimates of heterosis %, based on high parents ($\overline{HP}$), for the studied traits.

Characters	Crosses					
	AXB	AxC	AxD	BxC	BxD	CxD
Early yield fruit number per plant	3.52	2.55	9.59*	2.25	Ns	4.23
Early yield fruit weight per plant	542*	4.83	13.21**	12.33**	Ns	-4.89*
Total yield fruit number per plant	833*	11.33**	1.98	Ns	4.63	-5.39*
Total yield fruit weight per plant	14.54**	9.35*	5.35*	Ns	3.95	2.33
Average fruit weight (kg)	Ns	5.63*	-3.71*	-4.25*	0.38	-3.05
TSS%	4.23*	9.90*	12.50**	1.02	Ns	5.36*
Vitamin C content	-2.63	1.02	-4.61*	5.51*	-5.28*	0.91

A: Topmark B: Sierra Gold C: Helpest D: Zentei

* Significant at the 0.05 level. ** Significant at the 0.01 level.

ns No significant differences were found between the parents

The means of three crosses, viz, AxB, AxC and AxO significantly exceeded their high parents in total yield, suggesting hybrid vigour for the hig yield. The ADH% values were 22.13, 18.30 and 15.20%, respectively, and the potence values were 1.49, 1.58 and 1.98, respectively, for these crosses. These high values support the hybrid vigour postulated. This conclusion confirms the findings of **Abadia *et al.* (1985), Hatem *et al.* (1996).**

5) Average fruit weight:

Data presented in Table (2) showed that out of the five F_1 crosses whose parents significantly differed in average fruit weight, four ones significantly exceeded their respective mid-parental values, suggesting dominance towards the high average fruit weight. The ADH% values were estimated as 16.80, 14.08, 9.80 and 12.35% for the crosses AxC, AxD, BxC and BxD, respectively, based on mid-parents values.

No-dominance for the trait was observed in the cross CxD, it showed insignificant ADH% value (5.94%) as shown in Table (2) and was verified by the low estimated potence ratio. It was 0.22 (Table 4).

Partial dominance for the high fruit weight was observed in the crosses AxD and BxC. The obtained ADH% values were significantly positive values (14.08 and 9.80%, respectively), in relation to mid-parents and significantly negative values (-3.71 and -4.25%, respectively), in relation to the high parents. The obtained potence ratio values (0.73 and 0.66) for the two crosses respectively which support the partial dominance hypothesis.

The mean of the cross BxD did not differ significantly from the high parent mean, indicating complete dominance for high fruit weight. The complete dominance was supported by the estimated ADH% value (0.38%) from the high parent. This complete dominance was verified by the estimated potence ratio, it was 1.00 for this cross (Table 4).

On comparing the observed means for the studied F_1s versus their respective high parents in average fruit weight, the cross AxC significantly exceeded its high parent, suggesting hybrid vigour for the high average fruit weight. The ADH% value for this cross was 5.63%. This hybrid vigour was verified by the high estimated potence ratio value (1.38), which was significantly more than one.

6) Total soluble solids content (TSS):

The significantly means of the studied F_1 hybrids five crosses, viz, AxB, AxC, AxD, BxC and CxD versus their respective mid-parents, exceeded their MP values with ADH% of 12.59, 19.35, 20.50, 14.07 and 16.35%, respectively, suggesting dominance towards the high content, whereas, the cross, viz, BxC statistically similar to their high parent, indicating complete dominance for the high content. The crosses AxB, AxC, AxD and CxD significantly exceeded its high parent in this trait with ADH% of 4.23, 9.90, 5.36 and 12.80%, respectively, suggesting hybrid vigour for the high TSS content. This hybrid vigour was verified by the high estimated potence ratio of 1.31, 1.46, 1.69 and 1.58.

Different degrees of dominance (heterosis and complete and partial dominance) were also found in TSS content in melon by Abd El-Moneam (1976) and Hatem (1992).

7) Vitamin C content:

Significant differences between the parental lines of all studied hybrids were obtained. When the obtained means of these crosses were compared with their mid-parents ($\overline{MP}$), the cross AxB was statistically similar to its mid-parents, indicating no-dominance for the trait. The ADH% value was (8.37%) for this trait. Low potence value (0.32) was also obtained.

Partial dominance was observed for the high vitamin C content in the crosses AxD and BxD. The obtained ADH% values were significantly positive in relation to mid-parents and negative to high parents. This partial dominance was verified by the obtained potence ratio values in these crosses which were 0.61 and 0.78, respectively.

Table (4): Estimates of potence ratio, for the studied traits.

Characters	Crosis					
	AXB	AxC	AxD	BxC	BxD	CxD
Early yield fruit number per plant	1.04	1.02	173	1.04	----	1.12
Early yield fruit weight per plant	1.48	1.22	1.95	1.88	----	0.71
Total yield fruit number per plant	1.56	1.68	1.21	----	1.11	0.64
Total yield fruit weight per plant	1.49	1.58	1.98	----	1.09	1.04
Average fruit weight (kg)	----	1.38	0.73	0.66	1.00	0.22
TSS%	131	1.46	169	1.00	----	1.53
Vitamin C content	0.32	1.00	0.61	1.69	0.78	1.01

A: Topmark B: Sierra Gold C: Helpest D: Zentei

--- No significant differences were found between the parents

On comparing the observed means for the studied F_1s in respect to their high content in vitamin C, the cross BxC significantly exceeded its high parent, suggesting hybrid vigour for the high content of vitamin C. The ADH% value for this cross was 5.51%. This hybrid vigour was verified by the high estimated potence vatio value (1.69). It is noticed that none of the studied F_1 crosses exhibited dominance towards the low content (Tables 2, 3 and 4). This conclusion confirms the findings of Abd El-Moneam (1976), Swamy and Dutta (1985), Hatem, (1992), Rakhi and Rajamony (2005) and Iria *et al.* (2008).

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الملخص العربي

قوة الهجين لمكونات المحصول وبعض الصفات الثمرية فى الشمام

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أجريت هذه الدراسة بمزرعة التجارب بمحطة بحوث البساتين بالقناطر الخيرية خلال موسمى ٢٠٠٧ ، ٢٠٠٨ ذلك لدراسة قوه الهجين فى بعض الصفات فى الشمام واستخدم فى هذه الدراسة ٤ سلالات أبوية هى : (توبمارك ، سيراجولد ، وهلبست ، وزنتاى) ، حيث أجرى التهجين بينها فى اتجاه واحد فى الموسم الأول للحصول على بذور الجيل الأول اللازمة للدراسة ، فى الموسم الثانى زرعت الآباء والهجين فى تجربة مصممة بطريقة القطاعات الكاملة العشوائية فى ثلاث مكررات ، وأخذت القياسات اللازمة للصفات الآتية (المحصول المبكر "عدد ووزن الثمار" ــ المحصول الكلى "عدد ووزن الثمار" ــ متوسط وزن الثمرة ــ المواد الصلبة الذائبة الكلية ــ محتوى الثمار من فيتامين جـ).

وكان أهم النتائج المتحصل عليها :

[١] ظهرت جميع نظم السيادة (عدم سيادة – سيادة جزيئية ، سيادة تامة – قوة الهجين) فى الهجين تحت الدراسة للصفات المختلفة .

[٢] ظهرت قوة الهجين (تفوق الجيل الأول على الأب الأحسن) فى بعض الهجن فى جميع الصفات تحت الدراسة وهذه الهجن هى :

- (توب مارك × زنتاى) وذلك فى صفة عدد ثمار المحصول المبكر .
- (توب مارك × سيراجولد) ، (توب مارك × زنتاى) ، (سيراجولد × هلبست) فى صفة وزن ثمار المحصول المبكر .
- (توب مارك × سيراجولد) ، (توب مارك × هلبست) فى صفة عدد ثمار المحصول الكلى.
- (توب مارك × سيراجولد) ، (توب مارك × هلبست) ، (توب مارك × زنتاى) فى صفة وزن ثمار المحصول الكلى.
- (توب مارك × هلبست) فى صفة متوسط وزن الثمرة .
- (توب مارك × سيراجولد) ، (توب مارك × هلبست) ، (توب مارك × زنتاى) ، (هلبست × زنتاى) فى صفة محتوى الثمار من المواد الصلبة الذائبة الكلية.
- (سيراجولد × هلبست) فى صفة محتوى الثمار من فيتامين ج .

[٣] ظهرت حالة السيادة التامة والسيادة الجزئية للأب الأحسن فى بعض الهجن فى جميع الصفات .

[٤] ظهرت حالة عدم السيادة فى بعض الهجن لبعض الصفات .

[٥] كانت قيم الـ Potence ratio المقدرة متوافقة مع متوسط درجات قوة الهجين لنظم السيادة السابقة .

[٦] أوضحت النتائج أن الهجين (توب مارك × سيراجولد) يليه كل من (توب مارك × زنتاى) ، (توب مارك × هلبست) . كانت أفضل الهجن حيث أعطت قوة هجين فى معظم الصفات المدروسة ، ويشير هذا الى أهمية استخدام هذه الهجن فى الإنتاج التجارى.