*J. Plant Production, Mansoura Univ., Vol. 3 (7): 2057 - 2067, 2012*

# HETEROSIS FOR SOME CHARECTERIBSTICE OF TOMATO FRUIT (LYCOPERSICON ESCULENTUM MILL).

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## ABSTRACT

Six tomato cultivars were used. These cultivars were: (1) Castel Rock (U.S.A) (2) Edkawy (Egypt) (3) Super Marmand (France) (4) Flora-data (U.S.A) (5) B5357 (U.S.A) (6) Fline (France) crossed by using half diallel crosses mating design to obtain 15 crosses. All parent and crosses were evaluated through two seasons 2009and 2010 to evaluate heterosis for some characteristic of tomato.

The results showed that, 6$F_1$ hybrids for 15 ones gave no significant with positive values heterosis over the mid-parent for average of fruit weight in the first year. However, 3$F_1$ hybrids for 15 ones gave significant or highly significant with positive values heterosis over the mid-parents in the second year the largest value as a result of hybrid between 3x5 with value (42.3). While the result showed that significant or highly significant with positive values heterosis over the mid-parent for fruit firmness, the largest value (24.1).

The combined data over the two years showed that highly significant with positive values heterosis over the mid-parent for average of fruit weight trait ranged from (1.72% to 18.16%) came as a result between (2X3 and 3X5), fruit firmness trait ranged from (3.54% to 19.00%) came as a result between (1X4 and 2X3) respectively, total soluble solids trait ranged from (0.41% to 8.90%) came as a result between (1X4 and 4X6). while heterosis value over the better parents for average of fruit weight ranged from (0.76 to 4.06%) for the crosses (4x6 and 1x4) respectively. Also, fruit firmness ranged from (1.88% to 16.35%) for the crosses (2x4 and 2x3).

## INTRODUCTION

Tomato is one of the most consumed and widely grown vegetable crops in the world including Egypt. It is a popular vegetable/fruit and an important source of vitamins and minerals.

Fruit quality is one the most important traits in a breeding program. Quality involves several traits such as average fruit weight (AFW), fruit firmness (FF), total soluble solids (TSS %), number of locules per-fruit (NLF) and fruit thickness.

Estimated heterosis in relation to the average value of the superior parent and named it relative heterosis in contrast to absolute heterosis, where the actual magnitude of a quantitative trait of the F1 generation was considered. The phenomenon of heterosis is not so frequent, and a case in which a progeny is more superior in all traits than a superior parent is even less frequent.

SEKHAR L. (2007). a, b. Reported that, heterosis TSS ranged from –38.8 to 52.19 and –44.25 to 21.95 for mid and better parent respectively. Higher total soluble solids in tomato hybrids are preferable that make them good source for processed products. The highest TSS was recorded in DCHs

US-1080 and NP-5005 which had 7.53 percent total soluble solids. Also, The highest pericarp thickness was recorded by DCHs Pragathi x NP- 5005 (0.64 mm), which showed 55.92 percent heterosis over mid parent.

A study was conducted on a 10×10 diallel set of tomato excluding reciprocals to find out the extent of heterosis. They found positive high significant heterosis for fruit quality traits. Over mid, better and standard parent respectively. *M.M. Hannan, M.B. Ahmed, U.K. Roy et al (2007-1).*

L.Sekhar, *et al* ( 2010 - 3). They found that, the number of significant heterosis hybrids in desirable direction for both mid parent (28 hybrids) and better parent( 24 hybrids) were the highest for number of locules per fruit followed by number of cluster per plant (mid parent-17 hybrids, better parent-11 hybrids).

Naveen Garg *et al.* (2008) and Kansouh *et al.* (2011). studied heterosis on tomato using line x tester analysis and found that, highly significant for average fruit weight, firmness and total soluble soled (T.S.S).

The present study were therefore undertaken to estimate the magnitude of genetic variability and heterosis for yield and its component traits in crosses using six diverse tomato genotypes in half diallel combinations.

So to improve any quantitative traits of economical usefulness information about the nature of gene action of this trait should be investigated with respect to the relative magnitudes of additive and non-additive genetic effects. When the additive gene action represents the main component of the total genetic variation, a maximum progress would be expected in selection programs.

## MATERIALS AND METHODS

Six tomato cultivars used. These cultivars were: (1) Castel Rock (U.S.A) (2) Edkawy (Egypt) (3) Super Marmand (France) all were a large fruit size, growth habit is determinate and maturity is medium. (4) Flora-data (U.S.A) is a large fruit size, growth habit is semi determinate and maturity is late. (5) B5357 (U.S.A) a small fruit size, growth habit is semi determinate and maturity is early and Res. to bacterial Speck and tolerant of early blight. (6) Fline (France) a medium fruit size, growth habit is determinate and maturity is early and Res. to late blight.

All cultivars are belonging to the species Lycopersicon esculentum Mill. Plant from each variety was selfed for three generations to end up with an inbred line from each variety. This work was carried out during 4 successive years. In 2008 all possible combination crosses were executed in a half diallel mating design to produce 15 F1 seeds. In 210, 15 $F_1$ hybrids. Therefore, the genetic materials used in this study were 6 parents, 15 $F_1$ hybrids.

**1. Experiment design:**

In the first and second season (2009, 2010), the experimental design used was a randomized complete block design with three replications. Each replicate or block contained 21 experimental units or plots (6 parents, 15 $F_1$ ). The 21 genotypes were sown in nursery in seeding trays on April 5 $^{th}$ of 2009 and 2010. The seedlings were transplanted on May 5 $^{th}$ 40 cm apart. Each plot was two ridges, each 6m long and 1.25m wide, thus making an area of

15 $m^2$ . The experiment was conducted in. Elwazer village in located on Gamsa Rood were done as needed similar to those used in tomato production.

**2.Fruit quality traits:**

1.Average fruit weight (AFW) 2- Fruit firmness (FF)
3-Total soluble solids (TSS %) 4-Number of locules per-fruit (NLF)
5-Fruit thickness (F.T)

**Statistical procedures:**

**3. Analysis of variance:**

Statistical procedures used in this study were done according to the variance for a randomized complete blocks design as outline by Cochran and Cox (1957).

The form of the analysis of variance and the expectations of mean squares for single year are presented in table (1). Differences between genotypes were tested for significant according to the regular (F) test. The combined analyses of variance were also carried out to estimate the interaction between genotypes and years, the form of the analysis of variance and the expectations of mean squares are show in table (2). The variances of genotypes and the interactions were tested for significance according to the (F) test.

**Table (A): The form of the analysis of variance and expectations of mean squares for single year.**

| S.O.V | d.f | M.S. | E.M.s |
|---|---|---|---|
| Replications | r-1 | $M_3$ | $\sigma^2e+g\sigma^2r$ |
| Genotypes | g-1 | $M_2$ | $\sigma^2e+r\sigma^2r$ |
| Error | (r-1) (g-1) | $M_1$ | $\sigma^2e$ |

**Where:**

**r: number of replications.** **g: number of genotypes.**
**$M_1$: error mean squares.** **$M_2$: genotypes mean squares.**
**$M_3$: replications mean squares.**

**Table (B): The form of combined analysis of variance and expectation of mean squares for all genotypes over years.**

| S.O.V. | d.f. | M.S. | E.M.S. |
|---|---|---|---|
| Years | y-1 | | |
| Rep./year | Y(r-1) | | |
| Genotypes | (g-1) | $M_1$ | $\sigma^2e+r\sigma^2gy+ry\ \sigma^2g$ |
| Geno. X years | (y-1)(g-1) | $M_2$ | $\sigma^2e+r\sigma^2gy$ |
| Error | Y(y-1)(g-1) | $M_3$ | $\sigma^2e$ |

**Where:**

**y: number of years.** **r: number of replications.**
**g: number of genotypes.** **$M_1$: error mean squares.**

**$M_2$: genotypes by years interaction mean squares.** **$M_3$: replications mean squares.**

**4. Heterosis:**

The amount of the heterosis was determined as the percentage deviation of the $F_1$ hybrids mean ($\overline{F_1}$) over the average of two parents ($\overline{M.P.}$) or above the better-parent ($\overline{B.P.}$) as follow:

H (M.P.) %: heterosis from the mid-parents (M.P.) $= \frac{\overline{F_1} - \overline{M.P.}}{M.P.} \times 100$

H(H.P.)%: heterosis from the better-parent $\overline{(B.P.)}$ $= \frac{\overline{F_1} - \overline{B.P.}}{B.P.} \times 100$

The significance of heterosis was determined using the least significant difference value (L.S.D) at 0.05 and 0.01 level of significance. The L.S.D value calculated as follows:

L.S.D. = $T_{Ed.f} \times S_{-d}$ $\quad S_{-d} = \sqrt{\frac{EMS}{r} \times \frac{n_1 + n_2}{n_1 x n_2}}$

Where:

EMS = Error mean square. E.$_{df.}$ = Number of error degrees of freedom.

r = Number of replications. $n_1$= Number of genotypes in first mean.

$n_2$= Number of genotypes in second mean.

## RESULTS AND DISCUSSION

**1. Fruit quality traits:**

The analysis of variance and the mean squares for fruit quality traits which included average fruit weight (AFW), fruit firmness (FF), total soluble solids (TSS %), number of locules per-fruit (NLF) and Fliesh thickness(FT) in the first year are presented in Table (1). Similarly, the results of second year are shown in Table (2). Also, combined analyses of variance over the two year were also obtained for the parents and $F_1$ hybrids for these traits and the results are cleared in Table (3). Tests of significance indicated the mean squares of genotypes were highly significant for all studied traits at two years except Average fruit weight (AFW).

The results which were obtained from the combined analysis of variance over the two years also showed similar results. The analysis of variance indicates highly significant amount of variability among the genotypes and parent for all studied traits except fruit sickness was significant. There is also a significant difference between the crosses for all traits. The mean square of genotypes by years interaction were highly significant for all traits.

**Table 1: The analysis of variance and the mean squares for fruit quality (AFW – FF – TSS % - FT) traits at the first years ( 2009 ) for the parent and $F_1$ hybrids.**

| S. O. V. | d f | AFW | FF | TSS% | NLF | FT |
|---|---|---|---|---|---|---|
| Rep. | 2 | 65.8724 | 0.0465 | 0.6011** | 8.5465** | 0.0452 |
| Geno. | 20 | 730.352** | 0.228* | 0.236** | 4.369** | 2.667** |
| Par. | 5 | 1149.531** | 0.040 | 0.435** | 6.899** | 0.862 |
| Cro. | 14 | 625.104** | 0.215* | 0.165** | 2.028** | 1.873* |
| P. Vr C. | 1 | 107.940** | 1.352** | 0.228** | 24.493** | 22.812** |
| Error | 40 | 73.2311 | 0.1080 | 0.0713 | 8.5465 | 0.6991 |

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

**Table 2: The analysis of variance and the mean squares for fruit quality (AFW – FF – TSS % - FT) traits at the second years ( 2010 ) for the parent and $F_1$ hybrids.**

| S. O. V. | d f | AFW | FF | TSS% | NLF | FT |
|---|---|---|---|---|---|---|
| Rep. | 2 | 353.4031* | 2.3972** | 0.5994** | 5.0306 | 0.0832 |
| Geno. | 20 | 381.676** | 0.274* | 0.347** | 5.773** | 1.892** |
| Par. | 5 | 545.843** | 0.156 | 0.605** | 12.510** | 0.873 |
| Cro. | 14 | 326.711** | 0.220 | 0.240** | 2.058 | 0.710 |
| P. Vr C. | 1 | 330.347 | 1.616** | 0.554** | 24.092** | 23.530** |
| Error | 40 | 99.0929 | 0.1290 | 0.0714 | 2.0040 | 0.7328 |

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

**Table 3: The combined analysis of variance and the mean square for fruit quality (AFW – FF – TSS % - FT) traits for the parent and $F_1$ hybrids.**

| S. O. V. | d f | AFW | FF | TSS% | NLF | FT |
|---|---|---|---|---|---|---|
| R/Y | 4 | 209.638* | 1.222** | 0.600** | 6.789** | 0.064 |
| Year | 1 | 85.706 | 0.146 | 0.429* | 5.027 | 0.441 |
| Geno. | 20 | 840.015** | 0.471** | 0.511** | 9.200** | 3.992** |
| Par. | 5 | 1481.275** | 0.171** | 0.889** | 17.278** | 1.716* |
| Crosses | 14 | 668.83* | 0.400** | 0.360** | 3.501** | 1.781** |
| Par. Vr. C | 1 | 30.3114 | 2.963** | 0.746** | 48.584** | 46.339** |
| G. x Y. | 20 | 272.013** | 0.031 | 0.071 | 0.942 | 0.566 |
| Par. X Y | 5 | 214.099* | 0.026 | 0.151 | 2.131 | 0.018 |
| Cross X Y | 14 | 282.985** | 0.035 | 0.045 | 0.585 | 0.802 |
| P Vr c X Y | 1 | 407.976* | 0.006 | 0.036 | 0.001 | 0.003 |
| Error | 80 | 86.1620 | 0.119 | 0.071 | 1.388 | 0.716 |

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

## 2. Heterosis over mid-parent (MP) and high-parent (HP):

Heterosis is the superiority of $F_1$ hybrid over its parents in given characteristic, assessed not by absolute value and appearance but by its usefulness for evaluation or practical advantage under a given environment. It is a known fact that the phenomena of heterosis is of common occurrence in both cross and self-pollinated crops. The amount of heterosis depends upon the origin of parents involved in hybridization. When the parents are not closely related a fairly large amount of heterosis would be obtained. On the other hand, hybrid between closely related varieties which developed from very narrow germplasm usually yields little or no heterosis.

The heterotic effects are calculated as a deviation from mid-parents (M.P) and better-parent (B.P) value for each cross. Breeding practices are not aimed at the superiority over the parents, but at the superiority over a given standard variety (hybrid) in a given condition. Thus, in the breeding programs the superiority of the new $F_1$ hybrids over the standard varieties (hybrids) must be ensured.

**Fruit quality traits:**

Heterosis value obtained from the (M.P) and the (B.P) form average of fruit weight (AFW), fruit firmness (FF), Total soluble soiled (TSS %), Number of locules (NLF) and flesh thickness (FT) traits. Similarly, heterosis values were also calculated over two years ($Y_1$ and $Y_2$) the results presented in Table (4 and 5), respectively. And the combined results are presented in Table (6).

The results in table (4) showed that, 6$F_1$ hybrids for 15 ones gave no significant with positive values heterosis over the mid-parent for average of fruit weight in the first year. However, 3$F_1$ hybrids for 15 ones gave significant or highly significant with positive values heterosis over the mid-parents in the second year the largest value as a result of hybrid between 3x5 with value (42.3)at table (5). While the result in table (4) showed that significant or highly significant with positive values heterosis over the mid-parent for fruit firmness, the largest value ( 24.1) as a result of hybrid between 2x3. However, 4$F_1$ hybrids for 15 ones gave significant or highly significant with positive values heterosis over the mid-parents in the first year and 5$F_1$ hybrids for 15 ones gave significant with positive values heterosis over the mid-parents in the second year. From table (4) we observed that, the hybrid (4x6) was significant with positive values (8.6) heterosis over the mid-parents for total soluble soiled in the first year but no significant at the second year except two hybrids (5x6 and 4x6) was significant with positive values (7.7 and 9.2) respectively, at the second year. Most of beneficial heterotic effects for plant height were due to over-dominance. Also, the result in table (4) showed that significant and highly significant with negative values heterosis over the mid-parent for number of locules ranged from (-29.5 to -13.4%), this values as a result of hybrid between (3x4 and 4x6) respectively. However, 2$F_1$ hybrids for 15 ones gave no significant with positive values heterosis over the mid-parents in the first year and 5$F_1$ hybrids for 15 ones gave significant with negative values heterosis over the mid-parents in the second year. While, about fruit thickness the result showed that significant and highly significant with positive values heterosis over the mid-parent ranged from (29.7 to 55.6%), this values as a result of hybrid between (1x6 and 4x6) respectively at the first year 6$F_1$ hybrids for 15 ones gave significant and highly significant with positive values heterosis over the mid-parents in the first year and 9$F_1$ hybrids for 15 ones gave significant and highly significant values heterosis over the mid-parents in the second year. Most of beneficial heterotic effects for plant height were due to over-dominance.

the results in table (4 and 5) showed that fife hybrids out of 15 were significant and highly significant with negative values heterosis over the better-parent for average of fruit weight (AFW) ranged from (-27.7, -38.3) for the crosses (3x5 and 4x5) respectively at the first year but significant with positive value for the same trait for the cross 3x5 with (23.0) at the second year. While the result showed that two crosses of 15 hybrids were no significant with negative values heterosis over the better-parent for fruit firmness at two years this crosses (1x4 and 2x5) but all crosses positive value without significant. Also the result showed that no significant for all crosses at two year for the total solid soluble trait except cross (4x5) was significant and highly significant with negative at the first year and second year respectively. Also the result slowed that 13hybrids out of 15 showed significant and highly significant with negative heterosis over the better-parent. Heterosis values over the better parents ranged from (-44.2% to -22.7%) for the cross (2X6 and 1X3) respectively at the first year and ranged from (-46.6% to -34.4) at the second year. Two hybrids out of 15 showed significant or highly significant heterosis over the better-parent for fruit thickness. Heterosis values over the better parents ranged from (39.5% to 43.1% for the cross (3X5 and 4X6 respectively at the first year and 3 $F_1$ significant at the second year ranged from (25.1 and 30.5).

The combined data over the two years presented in table (6) showed that highly significant with positive values heterosis over the mid-parent for average of fruit weight trait ranged from (1.72% to 18.16%) came as a result between (2X3 and 3X5), fruit firmness trait ranged from (3.54% to 19.00%) came as a result between (1X4 and 2X3) respectively, total soluble soiled trait ranged from (0.41% to 8.90%) came as a result between (1X4 and 4X6) respectively. But for number of locules trait was highly significant with negative values heterosis over the mid-parent except three crosses (1x4, 4x5 and 5x6) was highly significant and positive value (1.05%, 6.80%and 0.38%) respectively. Also the result showed that significant and highly significant with positive values heterosis over the mid-parent for flesh thickness trait ranged from (16.74% to 42.94%) came as a result between (4x5 and 3x5) respectively. However, all hybrids gave highly significant with positive value heterosis over the mid-parents.

Four hybrids out of 15 showed highly significant with positive values heterosis over the better parent. Heterosis value over the better parents for average of fruit weight ranged from (0.76 to 4.06%) for the crosses (4x6 and 1x4) respectively. Also, fruit firmness ranged from (1.88% to 16.35%) for the crosses (2x4 and 2x3) respectively. While total soluble soiled ranged from (0.48 to 3.36%) for the crosses (3x4 and 2x4) respectively. However, heterosis value over the better parents for number of locules trait was highly significant with negative values heterosis over the mid-parent for the all crosses. But all hybrids showed highly significant with positive values heterosis over the better parent. Heterosis value over the better parents for fruit firmness ranged from (5.81 to 33.85%) for the crosses (2x6 and 2x4) respectively. In this concern, Metwally *et al.*(1990) found on .

**Table (4): Percentage of heterosis over the mid-parents (M.P) and better-parent (B.P) for fruit quality (AFW – FF – TSS % - FT) traits for the studies crosses at first year (2009).**

| FT | | NLF | | TSS% | | FF | | AFW | | crosses |
|---|---|---|---|---|---|---|---|---|---|---|
| B,P% | M.P% | B,P% | M.P% | B,P% | M.P% | B,P% | M.P% | B,P% | M.P% | |
| 9.5 | 15.9 | -30.3** | -27.1** | 1.2 | 5.8 | 3.0 | 4.1 | -12.6 | -7.4 | 12 |
| 18.5 | 22.2* | -22.7* | -19.2* | -3.5 | 2.7 | 10.0 | 12.9 | -10.2 | -8.6 | 13 |
| 11.2 | 16.7 | -5.3 | 0.7 | -1.2 | -0.1 | -1.5 | 0.8 | 0.4 | 2.4 | 14 |
| 7.3 | 19.3 | -39.1** | -25.2* | -4.5 | 5.0 | 7.7 | 12.0 | -33.7** | -12.2 | 15 |
| 25.1* | 29.7** | -42.3** | -28.8** | -2.1 | 5.1 | 11.8 | 16.9* | -10.3 | -6.6 | 16 |
| 7.2 | 10.0 | -30.9** | -24.6** | -1.2 | 0.7 | 22.2 | 24.1** | -9.8 | -6.0 | 23 |
| 35.3 | 36.4** | -31.0** | -23.5** | 1.6 | 5.0 | 2.5 | 3.8 | -4.9 | -1.1 | 24 |
| 23.9 | 30.6* | -41.6** | -25.8** | -3.1 | 2.2 | -7.0 | -4.4 | -18.1* | 4.1 | 25 |
| 6.1 | 16.1 | -44.2** | -28.8** | -4.9 | -2.2 | 2.8 | 6.3 | -7.3 | 1.9 | 26 |
| 19.4 | 21.6 | -30.8** | -29.5** | 0.4 | 5.6 | 13.5 | 13.9 | 4.2 | 4.4 | 34 |
| 39.5** | 50.7** | -39.0** | -27.6* | -0.1 | 3.5 | 3.0 | 4.4 | -27.7** | -5.4 | 35 |
| 11.9 | 19.5 | -37.8** | -25.9* | -0.8 | 0.2 | 14.5 | 16.7* | -4.6 | 0.9 | 36 |
| 10.2 | 17.0 | -18.1 | -4.3 | -10.0* | -2.1 | 14.1 | 16.0* | -38.3** | -19.3* | 45 |
| 43.2** | 55.6** | -26.2* | -13.4 | 2.3 | 8.6* | 6.9 | 9.4 | -2.8 | 3.1 | 46 |
| 4.6 | 20.1 | -0.4 | 0.2 | -2.2 | 0.3 | 6.9 | 7.6 | -30.4** | -5.3 | 56 |
| 18.2 | 25.4 | -29.3 | -20.2 | -1.9 | 2.7 | 7.4 | 9.6 | -13.7 | -3.7 | Average |
| | | | | | | | | | | L,S.D |
| 1.4 | 1.2 | 1.4 | 1.3 | 0.4 | 0.4 | 0.5 | 0.5 | 14.1 | 12.2 | 0.05 |
| 1.8 | 1.6 | 1.9 | 1.7 | 0.6 | 0.5 | 0.7 | 0.6 | 18.9 | 16.4 | 0.01 |

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

**Table (5): Percentage of heterosis over the mid-parents (M.P) and better-parent (B.P) for fruit quality (AFW – FF – TSS % - FT) traits for the studies crosses at second year (2010).**

| FT | | NLF | | TSS% | | FF | | AFW | | crosses |
|---|---|---|---|---|---|---|---|---|---|---|
| **B,P%** | **M.P%** | **B,P%** | **M.P%** | **B,P%** | **M.P%** | **B,P%** | **M.P%** | **B,P%** | **M.P%** | |
| 24.5 | 29.1* | -31.0* | -27.4* | 2.9 | 7.3 | 3.8 | 9.6 | 0.5 | 1.0 | 12 |
| 28.0* | 32.8** | -37.4** | -29.2* | -4.2 | 3.3 | 4.8 | 13.8 | -1.2 | 3.5 | 13 |
| 16.3 | 22.8* | -5.2 | 1.4 | -1.5 | 0.9 | -0.9 | 6.5 | 8.0 | 21.2* | 14 |
| 7.2 | 19.6 | -37.9* | -24.6 | -5.4 | 5.5 | 0.9 | 10.1 | -3.8 | 15.7 | 15 |
| 25.1* | 29.3** | -42.7** | -29.2 | 5.4 | 5.8 | 7.3 | 17.8* | -13.0 | -10.6 | 16 |
| 25.1 | 25.2* | -34.4** | -29.3* | -1.0 | 2.6 | 10.5 | 13.9 | 4.5 | 9.9 | 23 |
| 30.5* | 33.0** | -37.5** | -29.8* | 5.2 | 7.2 | 1.2 | 3.1 | -18.9* | -8.6 | 24 |
| 24.9 | 34.9** | -25.7 | -6.0 | -3.9 | 3.0 | -6.4 | -3.1 | -16.3 | 1.0 | 25 |
| 5.6 | 12.9 | -37.5** | -19.5 | -5.0 | -1.3 | 3.2 | 7.5 | 3.0 | 5.4 | 26 |
| 19.2 | 21.4 | -39.9** | -27.9* | 0.6 | 6.1 | 12.4 | 13.7 | -1.9 | 5.6 | 34 |
| 25.3 | 35.2** | -46.6** | -28.7 | -1.3 | 2.3 | 3.8 | 4.3 | 23.0* | 42.3** | 35 |
| 10.9 | 18.8 | -43.3** | -23.1 | 0.4 | 7.9 | 14.7 | 16.0* | -10.1 | -3.4 | 36 |
| 9.8 | 16.5 | 3.0 | 18.1 | -10.8** | -2.6 | 15.6 | 17.5* | -5.7 | 2.1 | 45 |
| 8.7 | 18.4 | -26.5 | -14.0 | 7.1 | 9.2* | 13.6 | 16.3* | 4.7 | 20.4* | 46 |
| 14.1 | 31.2** | -1.8 | 0.5 | -3.0 | 7.7* | 14.4 | 15.2* | -21.0* | -2.9 | 56 |
| 18.3 | 25.4 | -29.6 | -17.9 | -1.0 | 4.3 | 6.6 | 10.8 | -3.2 | 6.8 | Average |
| | | | | | | | | | | L,S.D |
| 1.4 | 1.2 | 2.3 | 2.0 | 0.4 | 0.4 | 0.6 | 0.5 | 16.4 | 14.2 | 0.05 |
| 1.9 | 1.6 | 3.1 | 2.7 | 0.6 | 0.5 | 0.8 | 0.7 | 22.0 | 19.0 | 0.01 |

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

**Table (6): Percentage of heterosis over the mid-parents (M.P) and better-parent (B.P) for fruit quality (AFW – FF – TSS % - FT) traits from the combined data.**

| FT | | NLF | | TSS% | | FF | | AFW | | crosses |
|---|---|---|---|---|---|---|---|---|---|---|
| B.P% | M.P% | B.P% | M.P% | B,P% | M.P% | B.P% | M.P% | B.P% | M.P% | |
| 17.10** | 22.61** | -30.65** | -27.25** | 2.04** | 6.57** | 3.35** | 6.76** | -5.90** | -3.26** | 12 |
| 23.29** | 27.55** | -28.20** | -24.61** | -3.89** | 3.00** | 7.40** | 13.38** | -5.89** | -2.94** | 13 |
| 13.76** | 19.77** | -5.27** | 1.05** | -1.37** | 0.41** | -1.20** | 3.54** | 4.06** | 10.96** | 14 |
| 7.23** | 19.45** | -38.49** | -24.87** | -4.94** | 5.25** | 4.34** | 11.08** | -19.46** | 1.79** | 15 |
| 25.11** | 29.51** | -42.52** | -28.97** | 1.33** | 5.48** | 9.54** | 17.35** | -11.54** | -8.50** | 16 |
| 16.26* | 17.72** | -27.24** | -27.17** | -1.06** | 1.64** | 16.35** | 19.00** | 1.39** | 1.72** | 23 |
| 33.85** | 34.62** | -34.21** | -26.62** | 3.36** | 6.09** | 1.88** | 3.42** | -8.12** | -4.61** | 24 |
| 24.41** | 32.78** | -33.68** | -15.93** | -3.50** | 2.58** | -6.71** | -3.75** | -17.16** | 2.51** | 25 |
| 5.81** | 14.50** | -40.84** | -24.18** | -2.14** | -1.79** | 2.96** | 6.92** | -2.44** | 3.65** | 26 |
| 19.31** | 21.50** | -36.09** | -28.65** | 0.48** | 5.87** | 12.96** | 13.83** | 1.38** | 4.93** | 34 |
| 32.39** | 42.94** | -43.41** | -28.22** | -0.66** | 2.90** | 3.41** | 4.33** | -4.27** | 18.16** | 35 |
| 11.40** | 19.16** | -40.99** | -24.32** | 0.77** | 3.88** | 14.60** | 16.39** | -7.18** | -1.08** | 36 |
| 9.98** | 16.74** | -7.70** | 6.80** | -10.38** | -2.37** | 14.80** | 16.71*** | -24.38** | -9.19** | 45 |
| 25.85** | 36.90** | -26.34** | -13.68** | 6.47** | 8.90** | 10.26** | 12.83** | 0.76** | 10.88** | 46 |
| 9.40** | 25.65** | -1.12** | 0.38** | -2.63** | 3.85** | 10.65** | 11.40** | -25.98** | -4.11** | 56 |
| 18.34 | 25.43 | -29.12 | -19.08 | -1.07 | 3.48 | 6.97 | 10.21 | -8.32 | 1.40 | Average |
| | | | | | | | | | | L,S.D |
| 0.01 | 0.01 | 0.014 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 | 0.13 | 0.05 |
| 0.01 | 0.01 | 0.019 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 0.17 | 0.01 |

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

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## قوة الهجين لبعض صفات ثمار الطماطم

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تم إجراء عملية التهجين بنظام التزاوج النصف دائري لستة أصناف هي ( كاسل روك – إدكاوي – سوبر مارمند- B53557- فلاين ) وتم الحصول علي 15 هجين ثم تقييم الأباء و الهجن الناتجة في تجارب أجريت في موسمي 2009، 2010 وتم تقدير قوة الهجين لبعض صفات ثمار الطماطم.

أشارت النتائج إلي أن ستة هجن من بين الخمسة عشر هجينا لم تعطي أي معنوية بقيمة موجبة اعلي من متوسط قوة الآباء وذلك بالنسبة لمتوسط وزن الثمرة في الموسم الأول. في حين وجد أن ثلاثة هجن من بين الخمسة عشر هجينا لم تعطي أي فرق معنوي بالنسبة للقيم الموجبة المسموحة علي أساس متوسط الأباء. وأعطي الهجين ( 3X5) اعلي القيم. أما بخصوص صلابة الثمار فقد أعطت أعلي قيمة موجبة مقارنة بمتوسط الاباء لخمسة هجن من بين الخمسة عشر هجينا.

وأوضحت البيانات المجمعة علي مدار عامين أن هناك معنوية عالية موجبة بالنسبة لصفة متوسط وزن الثمرة مقارنة بمتوسط الاباء وتراوحت بين ( 1.72 ، 18.16%) نتيجة التهجين بين (2X3) ، (5X3). وبالنسبة لصفة الصلابة تراوحت النسبة بين ( 3.54، 19.00% ) وذلك نتيجة التهجين بين الأباء ( 1X4)، (4X6) وتراوحت بين ( 0.41 ، 8.9% ) وذلك لصفة نسبة المواد الصلبة الذائبة. بينما الهجن ( 6X4 ) ، (1X4) بالنسبة لأفضل الأباء وذلك لصفة متوسط وزن الثمرة تراوحت قيمتها بين (0.76 ، 4.06% )وأيضا بالنسبة لصلابة الثمار تراوحت بين (1.88، 16.35%) للتهجينات (2X3)، (4X2).

**قام بتحكيم البحث**

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