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GENETICAL STUDIES ON SOME TOMATO CULTIVARS UNDER HIGH TEMPERATURE CONDITION. II:EVALUATION AND CORRELATION OF SOME CHARACTERS IN TOMATO HYBRIDS UNDER HIGH TEMPERATURE CONDITIONS.

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ABSTRACT

This study was carried out during three successive summer seasons from 2002 to 2004 at Kaha Vegetable Research Station, Kalubia, Egypt. Genetic parameters such as combining ability, heterosis and correlation were studied in 15 F1 hybrids obtained by diallel mating of 6 tomato cultivars viz., Cal Ace; Castle rock; Peto 86; Chico III; Tallalakhin and Super Strain B. Significant differences for general and specific combining ability (GCA and SCA) were obtained for fruit set %, early and total yield, number of fruits per plant, average fruit weight, fruit length, fruit diameter, number of locules per fruit, flesh thickness, fruit firmness and total soluble solids (T.S.S.) content. Results indicated that both additive and non-additive gene action are important for this trait. The GCA: SCA ratios were higher than unity for all the studied characters, indicating that the additive gene action is more important than non-additive gene action in inheritance of these traits. The results showed also the importance of additive gene action in the inheritance of ascorbic acid and fruit acidity content.

The GCA illustrated that the cultivars Chico III, Peto 86 and Super Strain B are the best combiners to improve the fruit set and total yield during the summer season. While the cultivars Peto 86 and Chico III are the best combiners to improve the early yield, flesh thickness, fruit firmness and reduce the number of locules per fruit.

Among the hybrids, Castle rock x Peto 86; Cal Ace x Tallalakhin; Castle rock x Tallalakhin; Peto 86 x Chico III; Castle rock x Chico III and Cal Ace x Super Strain B were recommended for the development of high fruit setting ability. Moreover, the best crosses had the early yielding were (Cal Ace x Chico III; Peto 86 x Chico III; Castle rock x Peto 86; Cal Ace x Peto 86) and for total yield were (Cal Ace x Chico III; Castle rock x Chico III; Tallalakhin x Super Strain B; Peto 86 x Chico III; Castle rock x Peto 86) respectively. The hybrid Peto 86 x Chico III gave the highest value for number of fruits per plant, flesh thickness, fruit firmness and lowest number of locules per fruit.

Higher heterosis was noticed by the crossing with parents having high GCA status for early and total yield, average fruit weight, number of locules per fruit, flesh thickness and fruit firmness.

Positive correlation was found between early yield and fruit set % and between total yield and both of fruit set %, number of fruits per plant, average fruit weight, fruit length and diameter. Also, positive correlation was found between average fruit weight and both of fruit length, fruit diameter and flesh thickness and between flesh thickness and fruit firmness. Moreover, negative correlation was found between average fruit weight and number of fruits per plant and between number of locules per fruits and both of Fruit firmness and flesh thickness.

INTRODUCTION

The goal of most tomato breeding programs is directed mainly towards higher yielding and tolerant to different environmental stresses. Many investigators use diallel analysis on tomato plants to study combining ability to develop and release new single crosses characterized by high yielding ability. In this respect Wang Lei *et al* (1998) reported that general and specific combining ability (GCA and SCA) were highly significant for total yield, number of fruits per plant, fruit weight, fruit length, fruit diameter, fruit flesh thickness, and soluble solids (T.S.S.) content. Similar results were obtained by Gunasekera and Perera (1999) on number of fruits per plant, fruit weight, number of locules, fruit flesh thickness, fruit firmness and fruit acidity.

Additive genetic variance played an important role in the inheritance of number of fruits per plant (Wang Lei *et al* 1998; Gunasekera and Perera, 1999). Moreover, additive gene effect was important for inheritance of fruit quality characters such as fruit weight (Wang Lei *et al* 1998; Chadha *et al* 2001), fruit length and diameter (Wang Lei *et al* 1998); number of locules per fruit (Gunasekera and Perera, 1999; Chadha *et al* 2001; Kaur *et al* 2002), fruit flesh thickness (Wang Fu *et al* 1995; Wang Lei *et al* 1998; Gunasekera and Perera, 1999), fruit firmness (Gunasekera and Perera, 1999; Resende *et al* 1999); T.S.S. (Shrivastava, 1998) and fruit acidity (Gunasekera and Perera, 1999).

On the other hand, non-additive gene action played an important role in the inheritance of total yield (Srivastava *et al* 1998; Wang Lei *et al* 1998; Thakur and Arun Joshi, 2000), number of fruits, fruit length and fruit diameter (Srivastava *et al* 1998), fruit weight (Gunasekera and Perera, 1999), number of locules (Srivastava *et al* 1998; Kaur *et al* 2002), fruit flesh thickness (Chadha *et al* 2001; Kaur *et al* 2002), T.S.S. (Wang Lei *et al* 1998; Bhatt *et al* 2001; Dhatt *et al* 2001), ascorbic acid content (Bhatt *et al* 2001; Dhatt *et al* 2001) and fruit acidity (Dhatt *et al* 2001).

Moreover, both additive and non-additive gene played a major role in the inheritance of yield and yield components (Rai *et al* 1997). Similar results were obtained by Dhaliwal *et al* (2002) on total yield, number of fruits and fruit weight.

Dharmatti *et al* (2001) reported that high heterosis was noticed in tomato by the crosses with parents having high GCA status. Pronounced positive heterosis was observed in tomato for yield (Dod *et al* 1992; Bhatt *et al* 2001; Sekar, 2001), early yield (Dod *et al* 1992), number of fruits per plant (Dod *et al* 1992; Sekar, 2001), fruit weight and acidity (Sekar, 2001), T.S.S. and ascorbic acid (Bhatt *et al* 2001).

Positive correlation was found between total yield and both of fruit set percentage (Dhankar *et al* 2001), number of fruits per plant (Dhankar *et al* 2001; Padma *et al* 2002), average fruit weight (Padma *et al* 2002; Susic *et al* 2002), fruit length (Padma *et al* 2002). Negative correlation was found between fruit weight and number of fruits per plant (Padma *et al* 2002, Susic *et al* 2002).

Makawa *et al* (1989) explained that fruit firmness of some tomato cultivars was due to its thicker flesh. Hewedy *et al* (1994) reported that fruit flesh thickness did not show significant differences between Castle Rock and Peto 86 cultivars. Regarding number of locules, Mahasen and Hewedy (1994) noticed that Talallakin cultivar contained the highest number of locules compared with the other cultivars.

Tomato fruits differed in its contents according to the genotypes (Hewedy, 1988). Nassar *et al* (1982) indicated that Cal Ace cultivar was the highest in T.S.S. (5.7%), while Peto 86 cultivar contained 5.4%.

The main objectives of this investigation were: 1) Evaluating different local F_1 tomato hybrids under field conditions and estimate the heterosis to select the best hybrids under high temperature conditions of summer season. 2) Estimating the general and specific combining ability and type of gene action. 3) Estimating the correlation between different characters under heat stress.

MATERIALS AND METHODS

This investigation was carried out at Kaha Vegetable Research Station, Kalubia, Egypt, during three successive summer seasons of 2002, 2003 and 2004. Six tomato cultivars (*Lycopersicon esculentum* Mill.) viz., Cal Ace; Castle rock; Peto 86 (Petoseed Company, USA); Chico III; Super Strain B (Castle Company) and Tallalakhin (Russia) were used in this study. Selfing on the previous parents was done for three generations before this investigation to insure the purity of each parent before crossing work. In summer 2002 season, parental cultivars were sown on April 22 and transplanted in the greenhouse on May 27 on ridge 1 x 45 m and spacing of 50 cm between rows and 50cm between plants. During this season a half diallel set of crosses was made between the six parents giving a total of 15 F_1 crosses. The twenty-one genotypes, i.e. six cultivars and fifteen single straight crosses, were evaluated in summer 2003 and 2004 at open field conditions. In each year seed were sown on April 6, and transplanting on May 12. A randomized complete-block design with four replications and 25 plants per replication were used. Plants were spaced 35 cm apart within the row with 1 m wide. All cultural operation were similar to those practiced in commercial field production. Data were recorded for the different characters as following:

1- fruit set percentage: this character was determined by scoring flower counts on inflorescences present and fruit produced as described by Abdul-Baki, (1991).
2- yield: early yield measured as the weight of fruits harvested during the first 3 weeks of harvesting period. Total yield (Kg / plant) were measured as the weight of all fruits harvested at the red ripe stage. Number of fruits per plant was recorded from all harvesting fruits.
3- Fruit quality: average fruit weight (gm) was determined as the mean weight of 10 fruits randomly chosen from each replicate. Fruit length, fruit diameter and fruit flesh thickness (cm) were measured by using a caliper. Number of

locules per fruit was determined in a sample of 10 fruits per replicate. Fruit firmness (Kg / cm^2) was measured during red-ripe stage in a sample of 10 fruits per replicate using a needle type pocket penetrometer.

4- Fruit chemical constituents: total soluble solids (TSS) were determined in 4 red-ripe fruits per replicate using a hand refractometer. Ascorbic acid (mg \100g fresh weight) and Titratable acidity content (%) was estimated according to AOAC (1990).

General and specific combining ability (GCA and SCA) based on mean values were estimated according to Griffing (1956) method 2 model 1. Heterosis based on the mid parent was estimated according to the formula given by Mather and Jinks (1982) as follow: Heterosis = $\{(F_1 - MP) / MP\} \times 100$

Where: F_1 = the first hybrid generation, MP = mid parent.

Simple correlation was performed according to Singh and Chaudhary (1979).

RESULT AND DISCUSSION

The differences among genotypes i.e. cultivars and crosses under high temperature conditions were significant as presented in Table (1). Moreover it is clear from Table (2) that cultivars Chico III, Peto 86 and Super Strain B had the highest significant values regarding fruit set %, early and total yield. It may demonstrate their ability to set fruits. Moreover, cv. Chico III produced the highest fruit number per plant.

Table 1. Mean squares for genotypes, general and specific combining ability (GCA and SCA) difference from ANOVA of F1's among six parent cultivars during summer seasons, 2003 and 2004.

Characters	Genotype		GCA		SCA		GCA \ SCA	
	2003	2004	2003	2004	2003	2004	2003	2004
Fruit set %	348.23**	393.28**	286.14**	299.49**	59.39**	74.96**	4.82	4.00
Early yield (Kg\ plant)	0.23**	0.27**	0.15**	0.17**	0.05**	0.06**	3.15	2.75
Total yield (Kg\ plant)	0.96**	0.93**	0.30**	0.32**	0.33**	0.31**	0.91	1.04
Number of fruits / plant	128.81**	150.51**	112.94**	133.58**	19.60**	22.37**	5.76	5.97
Average fruit weight	632.08**	663.85**	536.61**	537.87**	102.05**	115.75**	5.26	4.65
Fruit length	1.15**	1.18**	1.22**	0.81**	0.11*	0.25**	11.36	3.20
Fruit diameter	1.20**	1.38**	1.38**	1.43**	0.07	0.14**	18.38	10.37
Number of locules	1.26**	1.83**	1.17**	1.84**	0.17	0.20*	6.80	9.27
Flesh thickness	0.04**	0.04**	0.03**	0.03**	0.01**	0.01**	5.66	4.98
Fruit firmness	0.19**	0.47**	0.18**	0.52**	0.02	0.03*	7.22	15.17
TSS (%)	0.62**	0.60**	0.65**	0.61**	0.06**	0.06**	10.90	9.47
Ascorbic acid content	2.76**	2.94**	2.76*	2.99*	0.31	0.31	8.97	9.75
Acidity	0.005	0.003	0.016*	0.013*	0.0003	0.0002	13.61	25.08

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

Table 2. Mean performance of six parental cultivars and F_1 crosses for fruit set %, early and total yield and number of fruits per plant during summer seasons, 2003 and 2004.

Genotypes	Fruit set (%)		Early yield (Kg \ plant)		Total yield (Kg \ plant)		Number of fruits per plant	
	2003	2004	2003	2004	2003	2004	2003	2004
Cal Ace (P1)	35.88	30.49	0.35	0.27	1.50	1.43	22.51	19.87
Castle rock (P2)	37.14	37.52	0.40	0.30	1.52	1.38	27.15	26.38
Peto 86 (P3)	60.30	69.16	0.72	0.64	1.73	1.76	30.79	29.36
Chico III (P4)	79.59	73.06	0.66	0.55	1.81	1.88	46.91	49.61
Tallalakhin (P5)	53.95	45.00	0.54	0.44	1.60	1.61	28.26	26.77
Super Strain B (P6)	66.08	65.30	0.57	0.48	1.80	1.81	26.33	25.62
P1 x P2	42.20	42.20	0.43	0.35	1.87	1.86	23.10	22.67
P1 x P3	52.38	59.62	1.00	0.98	1.88	1.87	26.76	27.70
P1 x P4	58.70	61.50	1.06	1.04	3.20	3.20	37.18	38.92
P1 x P5	58.81	65.59	0.45	0.34	1.90	1.83	29.08	27.55
P1 x P6	55.91	60.49	0.49	0.42	2.20	2.32	30.21	29.39
P2 x P3	66.32	66.18	1.05	0.92	2.60	2.43	36.09	37.61
P2 x P4	67.69	66.94	0.79	0.74	3.19	3.17	41.10	43.04
P2 x P5	62.27	66.44	0.53	0.40	2.29	2.19	38.68	35.53
P2 x P6	62.72	63.09	0.64	0.46	3.08	2.97	35.95	31.51
P3 x P4	74.20	74.03	1.36	1.19	2.92	2.89	44.11	39.88
P3 x P5	53.07	65.20	0.85	0.93	2.02	1.98	28.17	27.22
P3 x P6	55.85	66.64	0.99	1.12	2.02	2.00	32.19	31.18
P4 x P5	64.08	62.53	0.99	0.98	2.70	2.60	35.25	32.00
P4 x P6	56.28	59.97	0.99	1.04	2.75	2.72	31.57	29.40
P5 x P6	63.01	56.64	0.87	0.89	2.66	2.65	34.70	33.85
L.S.D (5%)	11.47	6.98	0.12	0.16	0.20	0.18	4.39	1.83
L.S.D (1%)	15.36	9.35	0.17	0.21	0.26	0.24	5.88	2.45

Concerning the fruit characters (Table 3), cultivars of Cal Ace, Castle rock and Super Strain B had the highest fruit weight. Cultivars of Castle rock, Super Strain B had the highest fruit length while, Cal Ace; Tallalakhin cultivars had the highest fruit diameter and number of locules per fruit. Moreover, Chico III and Peto 86 cultivars had the lowest number of locules per fruits. These results agreed with those of obtained by Mahasen and Hewedy (1994) who noticed that Talallakin cultivar contained the highest number of locules. Moreover, Castle rock; Peto 86 cultivars produced the firmest fruits due to there highly flesh thickness. These results coincided with that of Makawa *et al* (1989) who stated that fruit firmness of tomato cultivars were due to their flesh thickness. Also these results agreed with those of Hewedy *et al* (1994) who found that there were no significant differences between Castle Rock and Peto 86 cultivars on flesh thickness.

Fruit chemical analysis of the six cultivars (Table 4) revealed that Cal Ace, Peto 86 and Chico III cultivars had the highest TSS content. This result agreed with that obtained by Nassar *et al* (1982) and Hewedy (1988) who reported that tomato fruits differed in its contents according to the genotypes. Chico III, Castle rock and Cal Ace cultivars had the highest fruit ascorbic acid content while, cultivars Cal Ace and Tallalakhin had the highest acidity content.

Table 3. Mean performance of six parental cultivars and F_1 crosses for fruit characters during summer seasons, 2003 and 2004.

Genotypes	Average fruit weight (gm)		Fruit length (cm)		Fruit diameter (cm)		Number of locules		Flesh thickness (cm)		Fruit firmness (Kg / cm^2)	
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
Cal Ace (P1)	110.46	106.51	4.97	5.17	6.70	5.90	5.31	5.63	0.53	0.60	2.27	2.37
Castle rock (P2)	98.14	99.49	5.77	5.90	5.20	5.63	4.44	4.47	0.67	0.63	2.58	2.73
Peto 86 (P3)	68.51	69.13	5.17	5.27	4.63	4.47	3.73	2.93	0.73	0.80	2.42	2.60
Chico III (P4)	46.88	46.16	5.63	5.60	4.13	3.90	2.81	2.66	0.63	0.53	2.27	2.33
Tallalakhin (P5)	78.40	80.41	4.07	4.10	5.60	5.77	5.14	5.01	0.40	0.40	1.83	1.53
Super Strain B (P6)	95.75	94.18	5.80	5.70	4.70	4.43	4.44	4.78	0.60	0.67	2.53	2.70
P1 x P2	96.90	102.67	5.57	5.27	6.03	5.83	5.56	5.57	0.63	0.70	2.63	3.03
P1 x P3	92.25	103.78	4.87	4.73	5.43	5.53	4.98	4.45	0.83	0.73	2.67	2.83
P1 x P4	97.30	92.38	5.43	5.47	5.43	5.33	4.95	4.90	0.80	0.80	2.27	2.67
P1 x P5	85.70	76.65	4.63	4.43	5.67	5.87	4.70	4.85	0.47	0.57	1.92	1.83
P1 x P6	90.32	90.39	5.70	5.97	5.67	6.60	4.93	5.10	0.70	0.67	2.53	2.87
P2 x P3	88.14	82.62	5.70	5.37	4.90	4.90	4.35	4.45	0.70	0.71	2.67	2.60
P2 x P4	86.41	87.55	6.23	6.37	5.07	5.00	4.48	4.34	0.67	0.73	2.60	2.67
P2 x P5	82.07	82.75	5.37	5.23	5.33	5.77	4.45	4.24	0.57	0.50	2.20	2.02
P2 x P6	81.47	90.11	5.57	5.47	4.80	4.70	4.93	4.71	0.53	0.60	2.37	2.75
P3 x P4	70.21	74.55	5.87	5.90	4.43	4.33	3.21	2.97	0.73	0.80	2.75	2.83
P3 x P5	58.74	57.18	4.47	5.50	5.07	4.73	4.20	3.91	0.70	0.73	2.20	2.00
P3 x P6	71.27	73.91	5.03	4.80	4.47	4.63	4.58	4.69	0.63	0.57	2.58	2.83
P4 x P5	89.87	86.70	4.77	4.73	5.20	5.07	4.85	4.74	0.53	0.60	2.25	2.27
P4 x P6	85.28	89.17	5.90	4.67	4.63	4.57	4.52	4.70	0.70	0.60	2.70	2.84
P5 x P6	79.76	81.22	3.97	3.93	4.17	4.83	4.49	4.48	0.47	0.47	2.37	2.08
L.S.D (5%)	12.09	10.66	0.66	0.54	0.66	0.60	1.00	0.86	0.13	0.13	0.38	0.38
L.S.D (1%)	16.19	14.27	0.88	0.73	0.89	0.80	1.34	1.15	0.17	0.17	0.50	0.51

Concerning the evaluated of tomato hybrids, it is clear from Table (2 to 4) that the fifteen straight crosses exhibited a wide range of differences in different characters. The hybrids of Peto 86 x Chico III, Castle rock x Chico III and Castle rock x Peto 86 had the highest fruit set with no significant between them during the two summer season. Moreover, Peto 86 x Chico III hybrid produced the highest early yield. The hybrids of Cal Ace x Chico III, Castle rock x Chico III and Castle rock x Super Strain B produced the highest total yield. At the same time, Peto 86 x Chico III and Castle rock x Chico III had hybrids the highest values of fruit number per plant.

Concerning the fruit characters, data in Table (3) showed significant differences between different crosses in these respects. The hybrids of Cal Ace x Castle rock, Cal Ace x Peto 86 and Cal Ace x Chico III were produced the highest fruits. In addition, Castle rock x Chico III hybrid had the highest fruit length, while the hybrids of Cal Ace x Castle rock and Cal Ace x Super Strain B had the highest fruit diameter. The hybrids of Cal Ace x Castle rock and Peto 86 x Chico III produced the highest and lowest number of locules per fruit respectively. Moreover, the hybrids of Cal Ace x Peto 86, Cal Ace x

Chico III and Peto 86 x Chico III had the highest fruit flesh thickness, while the hybrids of Peto 86 x Chico III and Chico III x Super Strain B had the highest fruit firmness.

Concerning the fruit chemical analysis of the fifteen hybrids, Table (4) revealed that hybrids Castle rock x Super Strain B and Cal Ace x Castle rock had the highest T.S.S. content. While, the Castle rock x Chico III had the highest value of fruit ascorbic acid content. Moreover, the hybrids of Cal Ace x Tallalakhin and Cal Ace x Super Strain B had the highest acidity fruits.

Table 4.Mean performance of six parental cultivars and F1 crosses for fruit chemical constituents during summer seasons, 2003 and 2004.

Genotypes	TSS (%)		Ascorbic acid (mg \100gm fresh weight)		Titatable acidity %	
	2003	2004	2003	2004	2003	2004
Cal Ace (P1)	5.18	5.39	26.47	27.08	0.55	0.48
Castle rock (P2)	4.46	4.67	27.83	27.82	0.37	0.38
Peto 86 (P3)	5.64	5.83	25.90	26.13	0.44	0.45
Chico III (P4)	5.43	5.61	28.27	28.81	0.45	0.45
Tallalakhin (P5)	4.18	4.36	25.47	25.51	0.48	0.46
Super Strain B (P6)	4.64	4.78	24.83	24.92	0.44	0.43
P1 x P2	5.46	5.58	27.07	27.52	0.44	0.48
P1 x P3	5.09	5.18	26.30	26.68	0.48	0.47
P1 x P4	4.91	5.07	27.80	27.72	0.47	0.48
P1 x P5	4.05	4.20	26.40	26.31	0.52	0.52
P1 x P6	5.30	5.40	25.83	26.00	0.53	0.49
P2 x P3	5.24	5.37	27.23	27.00	0.43	0.42
P2 x P4	5.18	5.32	28.30	28.35	0.41	0.43
P2 x P5	4.80	4.87	26.70	26.72	0.42	0.42
P2 x P6	5.64	5.72	26.13	26.41	0.42	0.42
P3 x P4	5.37	5.50	27.53	27.42	0.43	0.43
P3 x P5	4.50	4.67	27.23	27.49	0.46	0.46
P3 x P6	5.15	5.33	27.33	27.49	0.44	0.45
P4 x P5	5.18	5.38	26.60	27.27	0.44	0.44
P4 x P6	5.45	5.36	27.18	27.18	0.43	0.44
P5 x P6	4.96	4.78	25.33	25.24	0.44	0.45
L.S.D (5%)	0.40	0.44	0.54	0.18	0.04	0.06
L.S.D (1%)	0.54	0.59	0.72	0.24	0.07	0.09

Combining ability and heterosis

Genetic variation among genotypes (Table 1) showed significant differences for GCA (additive gene action) and SCA (non-additive gene action) for fruit set %, early and total yield, number of fruits per plant, average fruit weight, fruit length and diameter, number of locules, flesh thickness, fruit firmness and T.S.S. content. This would indicate that both GCA and SCA (additive and non-additive gene action) are important for this trait therefore, it is suggested that both heterosis breeding (non-additive) and simple recurrent selection (additive) may be used to exploit genetic components of variations

in tomato. These results coincided with that of Rai *et al* (1997) who found that both additive and non-additive gene action played major role in the inheritance of yield and yield components. Similar results were obtained also by Wang Lei *et al* (1998) on total yield, number of fruits per plant, fruit weight, fruit length, fruit diameter, fruit flesh thickness, and TSS content, Dhaliwal *et al* (1999) on fruit thickness, number of locules per fruit and TSS; Gunasekera and Perera (1999) on number of fruits per plant, fruit weight, number of locules, fruit thickness, fruit firmness and fruit acidity.

The results (Table 1) showed also significant differences for GCA than SCA for ascorbic acid and fruit acidity content indicating the importance of additive gene action in the inheritance of this trait.

The GCA: SCA ratios (Table 1) were high than unity for all the studied characters, indicating that the additive gene action is more important than non-additive gene action in inheritance of these traits. These results are in agreement with those obtained by Wang Fu *et al* (1995); Shrivastava, (1998); Wang Lei *et al* (1998); Gunasekera and Perera (1999); Resende *et al* (1999); Chadha *et al* (2001); Kaur *et al* (2002). On the contrary the results disagree with those obtained by Srivastava *et al* (1998); Wang Lei *et al* (1998); Gunasekera and Perera (1999); Bhatt *et al* (2001); Thakur and Arun Joshi (2000); Dhatt *et al* (2001); Chadha *et al* (2001) and Kaur *et al* (2002).

Concerning the fruit set %, the GCA for fruit set (Table 5) ranged from –8.63 (P_1) to 8.92 (P_4) and –8.43 (P_1) to 6.65 (P_4) during the two-summer season respectively. These data indicated significant positive values for high fruits set during the two-summer season. The cultivars Chico III, Peto 86 and Super Strain B showed significant positive value for this character and considered to the best combiners to improve the fruit set during the summer season. SCA for fruit set (Table 5) revealed significant positive values in some crosses. The best crosses for the best fruit set were Castle rock x Peto 86; Cal Ace x Tallalakhin; Castle rock x Tallalakhin; Peto 86 x Chico III; Castle rock x Chico III in the two summer seasons and Cal Ace x Super Strain B in the second summer season only. The previous crosses showed also high heterosis for fruit set %, which estimated as (36.13 and 16.58%); (30.93 and 73.76%); (36.73 and 61.01%); (6.09 and 4.11%); (15.98 and 21.06%) and (21.53 and 22.71%) during the two-summer season respectively (Table 6).

As regard to the early fruit yield, the GCA (Table 5) ranged from –0.14 (P_1) to 0.18 (P_3) and –0.17 (P_2) to 0.19 (P_3) during the two-summer seasons respectively. These data indicated significant positive values for early yield during the two-summer seasons. The cultivars Peto 86 and Chico III showed significant positive values for this character and considered to be the best combiners to improve the early yield during the summer season. These results may be due to the high fruit setting ability in

these cultivars during the summer season. SCA for early yield (Table 5) revealed significant positive values of SCA effects in some crosses. The best crosses for the early yielding were Cal Ace x Chico III; Peto 86 x Chico III; Castle rock x Peto 86 and Cal Ace x Peto 86 in the two summer seasons. All the previous crosses showed also high heterosis for early fruit yield (Table 6) which estimated as (109.18 and 153.66%); (97.11 and

83.75%); (88.66 and 94.35%) and (86.96 and 113.09%) during the two-summer seasons respectively. In general, high heterosis was noticed by the crossing with parents having high GCA status. These results coincided with that of Dharmatti *et al* (2001). High heterosis for early yield was also reported by Dod *et al* (1992).

Table 5. General and specific combining ability (gi and Sij) effects on fruit set %, early and total yield and number of fruits per plant of each of parents and F_1 crosses during summer seasons, 2003 and 2004.

Characters	Fruit set (%)		Early yield (Kg \ plant)		Total yield (Kg \ plant)		Number of fruits per plant	
	2003	2004	2003	2004	2003	2004	2003	2004
Parents	General combining ability							
Cal Ace (P1)	-8.63**	-8.43**	-0.14**	-0.14**	-0.21**	-0.20**	-4.67**	-4.46**
Castle rock (P2)	-4.17*	-5.25**	-0.13**	-0.17**	0.04	-0.02	0.06	0.18
Peto 86 (P3)	3.70**	6.02**	0.18**	0.19**	0.10*	0.10**	0.03	0.08
Chico III (P4)	8.92**	6.65**	0.16**	0.15**	0.33**	0.35**	6.79**	7.60**
Tallalakhin (P5)	0.04	-1.43	-0.06*	-0.05*	-0.12**	-0.13**	-0.79	-1.50**
Super Strain B (P6)	2.14	2.45*	-0.02	0.01	0.07*	0.10**	-1.43*	-1.89**
L.S.D (gi) 5%	3.60	2.19	0.04	0.05	0.06	0.06	1.38	0.57
L.S.D (gi) 1%	5.97	3.63	0.06	0.08	0.10	0.09	2.29	0.95
L.S.D (gi-gj) 5%	5.57	3.39	0.06	0.08	0.10	0.09	2.14	0.89
L.S.D (gi-gj) 1%	9.25	5.63	0.10	0.13	0.16	0.14	3.54	1.47
Crosses	Specific combining ability							
P1 x P2	-3.41	-3.82**	-0.05*	-0.03	-0.21**	-0.14**	-4.97**	-4.71**
P1 x P3	0.91	2.35*	0.21**	0.24**	-0.05	-0.04	-1.27	0.41
P1 x P4	3.01*	3.59**	0.29**	0.35**	0.84**	0.83**	2.38**	4.12**
P1 x P5	9.00**	15.76**	-0.10**	-0.16**	-0.02	-0.06*	1.87*	1.85**
P1 x P6	4.00	6.78**	-0.11**	-0.14**	0.09**	0.21**	3.63**	4.07**
P2 x P3	10.38**	5.72**	0.25**	0.21**	0.42**	0.33**	3.33**	5.68**
P2 x P4	4.54*	5.84**	0.01	0.07**	0.57**	0.62**	1.57*	3.60**
P2 x P5	8.00**	13.42**	-0.03	-0.07**	0.12**	0.12**	6.73**	5.19**
P2 x P6	-6.39**	-1.52	0.07**	0.23**	-0.19**	-0.21**	0.92	1.32**
P3 x P4	5.19**	4.67**	0.27**	0.17**	0.44**	0.42**	7.62**	7.54**
P3 x P5	-7.08**	0.92	-0.02	0.10**	0.01	0.01	-3.74**	-3.03**
P3 x P6	-6.39**	-1.52	0.07**	0.23**	-0.19**	-0.21*	0.92	1.32**
P4 x P5	-3.28	-2.38*	0.14**	0.19**	0.24**	0.16**	-3.43**	-5.77**
P4 x P6	-13.18**	-8.82**	0.10**	0.20**	0.10**	0.05	-6.47**	-7.98**
P5 x P6	2.43	-4.07**	0.20**	0.24**	0.46**	0.47**	4.25**	5.57**
L.S.D. (sij) 5%	3.67	2.23	0.04	0.05	0.06	0.06	1.40	0.58
L.S.D. (sij) 1%	5.11	3.11	0.06	0.07	0.09	0.08	1.96	0.81
L.S.D. (sij-sik) 5%	11.48	6.99	0.12	0.16	0.20	0.18	4.40	1.83
L.S.D. (sij-sik) 1%	27.16	10.06	0.173	0.01	0.01	0.01	3.98	0.69

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

Table 6. Heterosis (%) in fifteen crosses for fruit set %, early and total yield and number of fruits per plant during summer seasons, 2003 and 2004.

Genotypes	Fruit set (%)		Early yield (Kg \ plant)		Total yield (Kg \ plant)		Number of fruits per plant	
	2003	2004	2003	2004	2003	2004	2003	2004
P1 x P2	15.58	24.08	15.56	23.26	24.12	32.78	-6.98	-1.96
P1 x P3	8.92	19.67	86.96	113.09	16.62	17.70	0.39	12.53
P1 x P4	1.66	18.78	109.18	153.66	93.95	93.54	7.11	12.04
P1 x P5	30.93	73.76	1.87	-4.19	22.71	20.39	14.55	18.15
P1 x P6	9.67	26.28	5.42	11.01	33.81	43.36	23.71	29.21
P2 x P3	36.13	16.58	88.66	94.35	60.00	54.73	24.59	34.96
P2 x P4	15.98	21.06	49.06	74.02	91.78	94.88	10.99	13.29
P2 x P5	36.73	61.01	13.57	7.62	46.95	46.10	39.61	33.73
P2 x P6	21.53	22.71	32.41	17.45	85.92	86.21	34.47	21.19
P3 x P4	6.09	4.11	97.11	83.75	64.78	58.90	13.54	1.01
P3 x P5	-7.10	14.23	35.81	71.78	21.40	17.71	-4.61	-3.00
P3 x P6	-11.62	-0.88	52.97	99.41	14.64	12.15	12.72	13.42
P4 x P5	-4.04	5.93	64.44	97.98	58.51	49.00	-6.23	-16.21
P4 x P6	-22.74	-13.32	60.00	102.59	52.82	47.38	-13.79	-21.84
P5 x P6	4.99	2.69	57.23	92.09	56.82	54.63	27.14	29.21

Concerning the total yield (Kg/plant), the GCA (Table 5) ranged from –0.21 (P_1) to 0.33 (P_4) and –0.20 (P_1) to 0.35 (P_4) during the two-summer seasons respectively. These data indicated significant positive values for total yield during the two-summer seasons. The cultivars of Chico III, Peto 86 and Super Strain B showed significant positive values and considered to be the best combiners to improve the total yield during the summer season. These results may be due to the high fruit setting ability in these cultivars during the summer season. Data presented in (Table 5) revealed significant positive values of SCA effects in some crosses. The best crosses for the high total yielding were Cal Ace x Chico III; Castle rock x Chico III; Tallalakhin x Super Strain B; Peto 86 x Chico III and Castle rock x Peto 86 in both summer seasons. Therefore, it could be concluded that these hybrids seemed to be valuable F_1 cross combinations in this respect. All the previous crosses showed also high heterosis for total yield (Table 6), which estimated by (93.95 and 93.54%) and (91.78 and 94.88%) during the two-summer seasons respectively. In general, high heterosis was noticed by the crossing with parents having high GCA status. These results coincided with that of Dharmatti *et al* (2001). High heterosis for total yield was also reported by Dod *et al* (1992), Bhatt *et al* (*2001*) and Sekar (2001).

Regarding number of fruits per plant, the GCA (Table 5) ranged from –4.67 (P_1) to 6.79 (P_4) and –4.46 (P_1) to 7.60 (P_4) during the two-summer seasons respectively. The Chico III cultivar showed significant positive value and considered to the best combiner to improve the number of fruit per plant during the summer season. SCA for total yield (Table 5) revealed significant positive values in some crosses. The best cross produced the highest number of fruits was Peto 86 x Chico III in both summer seasons. The

highest values of heterosis (Table 6) were recorded as (39.61and 33.73%) and (34.47 and 21.19%) for the hybrids of Castle rock x Tallalakhin and Castle rock x Super Strain B during the two-summer season respectively. High heterosis for number of fruits per plant was also reported by Dod *et al* (1992) and Sekar (2001).

Concerning the average fruit weight the GCA (Table 7) ranged from –8.37 (P_3) to 12.35 (P_1) and –8.31 (P_4) to 11.21 (P_1) during the two-summer seasons respectively. These data indicated two significant positive values for highest fruit weight during the two seasons. The cultivars Cal Ace and Castle rock showed high significant positive values and considered the best combiners to improve average fruit weight during the summer season. SCA for average fruit weight (Table 7) revealed significant positive values in some crosses. The best crosses for the highest fruit weight were Cal Ace x Chico III and Cal Ace x Peto 86 in the two summer seasons. All the previous crosses showed also positive heterosis for average fruit weight (Table 8). The highest values of heterosis were recorded as (43.48and 36.99%) and (23.69 and 21.03%) for Chico III x Tallalakhin and Cal Ace x Chico III during the two summer seasons respectively. In general, high heterosis was noticed by the crossing with parents having high GCA status. These results coincided with that of Dharmatti *et al* (2001). High heterosis for average fruit weight was also reported by Sekar (2001).

As regard to the fruit length and diameter, the GCA (Table 7) ranged from –0.69 (P_5) to 0.39 (P_2) and –0.56 (P_5) to 0.37 (P_2) for fruit length and from –0.33 (P_6) to 0.73 (P_1) and –0.48 (P_4) to 0.63 (P_1) for fruit diameter during the two-summer seasons respectively. These data indicated significant positive values for fruit length and diameter during the two-summer seasons. The Castle rock and Chico III cultivars showed significant positive values for the fruit length while, Cal Ace and Castle rock cultivars showed significant positive values for the fruit diameter and considered to the best combiners to improve these characters during the summer season. SCA for fruit length and diameter (Table 7) revealed significant positive values in some crosses. The best crosses for the highest fruit length and diameter were Cal Ace x Super Strain B and Chico III x Tallalakhin in two summer seasons respectively. All the previous crosses showed also positive heterosis for this character (Table 8). The highest values of heterosis for fruit length and diameter were recorded as (9.36 and 10.72%) and (8.57 and 4.90%) for Castle rock x Chico III during the two summer seasons respectively.

Concerning the number of locules per fruit, the GCA (Table 7) ranged from –0.51 (P_4) to 0.51 (P_1) and –0.61 (P_3) to 0.62 (P_1) during the two-summer seasons respectively. These data indicated significant negative values for the lowest number of locules per fruit during the two-summer seasons. The cultivars Peto 86 and Chico III showed significant negative value for this character and considered to be the best combiners to reduce the number of locules per fruit during the summer seasons. SCA for number of locules per fruit (Table 7) revealed significant negative value in some crosses. The best crossing for the lowest number of locules per fruit was Peto 86 x Chico III during the two summer seasons. The highest values of heterosis (Table 8) for number of locules per fruit were recorded as (23.49

and 21.95%) for Castle rock x Chico III during the two summers seasons respectively. In general, high heterosis was noticed by the crossing with parents having high GCA status. These results coincided with that of Dharmatti *et al* (2001).

Table 7. General and specific combining ability (gi and Sij) effects on the average fruit weight, fruit length and diameter and number of locules of each of parents and F_1 crosses during summer seasons, 2003 and 2004.

Characters	Average fruit weight (gm)		Fruit length (cm)		Fruit diameter (cm)		Number of locules	
	2003	2004	2003	2004	2003	2004	2003	2004
Parents	General combining ability							
Cal Ace (P1)	12.35**	11.21**	-0.09	-0.04	0.73**	0.63**	0.51*	0.62**
Castle rock (P2)	5.83**	6.94**	0.39**	0.37**	0.21*	0.19*	0.12	0.13
Peto 86 (P3)	-8.37**	-7.36**	-0.07	0.04	-0.27**	-0.36**	-0.36*	-0.61**
Chico III (P4)	-7.72**	-8.31**	0.33*	0.23*	-0.34*	-0.48*	-0.51*	-0.53**
Tallalakhin (P5)	-3.96*	-5.48**	-0.69**	-0.56**	0.11	0.23	-0.01	0.07
Super Strain B (P6)	1.87	3.00	0.12	-0.04	-0.33**	-0.22	0.25	0.31*
L.S.D (gi) 5%	3.79	3.34	0.21	0.17	0.21	0.19	0.31	0.27
L.S.D (gi) 1%	6.29	5.55	0.34	0.28	0.35	0.31	0.52	0.45
L.S.D (gi-gj) 5%	5.88	5.18	0.32	0.26	0.32	0.29	0.49	0.42
L.S.D (gi-gj) 1%	9.75	8.59	0.53	0.44	0.54	0.48	0.81	0.69
Crosses	Specific combining ability							
P1 x P2	4.79*	3.45*	0.00	-0.28**	0.09	-0.12	0.41*	0.36*
P1 x P3	4.76*	15.75**	-0.24**	-0.48**	-0.14	0.13	0.31	-0.01
P1 x P4	9.16**	5.32**	-0.07	0.06	-0.07	0.05	0.42*	0.36*
P1 x P5	-6.21**	-13.25**	0.15	-0.18*	-0.29*	-0.13	-0.32*	-0.29*
P1 x P6	-7.42**	-7.99**	0.41**	0.83**	0.15	0.05	-0.36*	-0.29*
P2 x P3	7.16**	1.13	0.12	-0.26**	-0.03	-0.07	0.07	0.47**
P2 x P4	4.78*	4.76**	0.25*	0.55**	0.20	0.15	0.34*	0.28*
P2 x P5	-3.32	-2.87	0.40**	0.20*	0.02	0.21*	-0.19	-0.42**
P2 x P6	-5.75**	-5.89**	-0.28*	-0.42**	-0.04	0.08	0.16	0.53**
P3 x P4	2.79	-6.05**	0.35**	0.42**	-0.06	0.04	-0.45**	-0.35*
P3 x P5	-12.44**	-14.15**	-0.04	0.80**	0.12	-0.28**	0.05	-0.01
P3 x P6	-5.75**	-5.89**	-0.28*	-0.42**	-0.04	0.08	0.16	0.53**
P4 x P5	-8.04**	-6.32**	-0.14	-0.15	0.32**	0.26*	0.84**	0.74**
P4 x P6	7.61**	10.31**	0.19	-0.74*8	0.19	0.13	0.24	0.46**
P5 x P6	-1.67	-0.46	-0.73**	-0.69**	-0.72**	-0.32**	-0.28	-0.36*
L.S.D. (sij) 5%	3.86	3.41	0.21	0.17	0.21	0.19	0.32	0.27
L.S.D. (sij) 1%	5.39	4.75	0.29	0.24	0.30	0.27	0.45	0.38
L.S.D. (sij-sik) 5%	12.10	10.67	0.66	0.54	0.66	0.60	1.00	0.86
L.S.D. (sij-sik) 1%	30.18	23.46	0.92	0.76	0.93	0.84	1.39	1.20

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

Regarding flesh thickness and fruit firmness, the GCA (Table 9) ranged from –0.11(P_5) to 0.08 (P_3) and –0.10(P_5) to 0.09 (P_3) for the flesh thickness and from –0.28 (P_5) to 0.15 (P_3) and –0.51 (P_5) to 0.16 (P_3) for the fruit firmness position with significant differences during the two-summer seasons respectively. The cultivars Peto 86 and Chico III showed significant positive values for flesh thickness and fruit firmness and considered to be the best combiners to increase the flesh thickness and fruit firmness during the summer season. SCA for flesh thickness and fruit firmness (Table 9)

revealed significant positive values in some crosses. The best hybrid for the highest flesh thickness and fruit firmness was Peto 86 x Chico III in both two summer seasons. The highest values of heterosis for flesh thickness and fruit firmness (Table 10) were recorded as (37.14 and 41.18%) and (17.44 and 14.86%) for Cal Ace x Chico III and Peto 86 x Chico III during the two summer seasons respectively. In general, high heterosis was noticed by the crossing with parents having high GCA status. These results coincided with that of Dharmatti *et al* (2001).

Table 8. Heterosis (%) in fifteen crosses for average fruit weight, fruit length and diameter and number of locules during summer seasons, 2003 and 2004.

Genotypes	Average fruit weight (gm)		Fruit length (cm)		Fruit diameter (cm)		Number of locules	
	2003	2004	2003	2004	2003	2004	2003	2004
P1 x P2	-7.09	-0.32	3.73	-4.82	1.40	1.16	14.08	10.30
P1 x P3	3.09	18.17	-3.95	-9.27	-4.12	6.75	10.25	4.05
P1 x P4	23.69	21.03	2.52	1.55	0.31	8.84	21.87	18.39
P1 x P5	-9.25	-17.99	2.58	-4.32	-7.86	0.57	-3.59	-6.70
P1 x P6	-12.40	-9.92	5.88	9.82	-0.58	2.74	-5.58	-4.08
P2 x P3	5.78	-2.01	4.27	-3.88	-0.34	-2.97	6.53	20.38
P2 x P4	19.17	20.23	9.36	10.72	8.57	4.90	23.49	21.95
P2 x P5	-7.02	-8.00	9.15	4.67	-1.23	1.17	0.11	-8.33
P2 x P6	-15.96	-6.95	-3.75	-5.75	-3.03	-6.62	2.89	-0.56
P3 x P4	21.70	29.32	8.64	8.59	1.14	3.59	-1.78	6.51
P3 x P5	-20.03	-23.52	-3.25	17.44	-0.98	-7.49	2.90	1.43
P3 x P6	-13.22	-9.48	-8.21	-12.46	-4.29	4.12	3.42	18.24
P4 x P5	43.48	36.99	-1.72	-2.41	6.85	4.83	33.73	27.44
P4 x P6	19.58	27.08	3.21	-17.40	4.91	9.60	13.67	22.58
P5 x P6	-8.40	-6.96	-19.59	-19.73	-19.09	-5.23	-6.19	-8.35

Concerning the fruit chemical constituents, the GCA (Table 11) ranged from–0.43 (P_5) to 0.32 (P_6) and –0.44 (P_5) to 0.27 (P_6) for T.S.S. and from –0.72 (P_6) to 0.84 (P_4) and –0.78 (P_6) to 0.90 (P_4) for ascorbic acid content and from –0.04 (P_2) to 0.19 (P_5) and –0.03 (P_2) to 0.02 (P_5) for acidity content during the two-summer seasons respectively. These data indicated significant positive values for this character during the two-summer seasons. Super Strain B and Chico III cultivars showed significant positive values for T.S.S. and considered to be the best combiners to increase this character during the summer seasons. While, Castle rock and Chico III cultivars showed significant positive values for ascorbic acid content and considered to be the best combiners to increase ascorbic acid content during the summer season. Moreover Tallalakhin cultivar showed significant positive values for acidity content and considered to the best combiner to increase this character during the summer season. SCA for T.S.S., ascorbic acid and acidity content (Table 12) revealed significant positive values in some crosses. The best crosses for the highest T.S.S content were Cal Ace x Castle rock and Chico

III x Tallalakhin in both two summer seasons. Moreover, the best cross for the highest ascorbic acid content was Castle rock x Super Strain B in two summer seasons. While, the best cross for the highest acidity content was Cal Ace x Tallalakhin in both summer seasons. All the previous crosses showed also positive heterosis for this character (Table 13). The highest values of heterosis for T.S.S., ascorbic acid and acidity content were recorded as (13.28 and 11.07%); (7.75 and 7.69%) and (7.07 and 7.64%) for Cal Ace x Castle rock; Peto 86 x Super Strain B and Cal Ace x Tallalakhin during the two summer seasons respectively. High heterosis for chemical of fruits constituents was also reported by Bhatt *et al* (2001) for T.S.S., Bhatt *et al* (2001) for ascorbic acid content and Sekar (2001) for acidity content.

Table 9. General and specific combining ability (gi and Sij) effects for flesh thickness, fruit firmness, TSS, ascorbic acid and Titatable acidity content of each of parents and F_1 crosses during summer seasons, 2003 and 2004.

Characters	Flesh thickness (cm)		Fruit firmness (Kg / cm^2)		TSS (%)		Ascorbic acid (mg \100gm fresh weight)		Titatable acidity %	
	2003	2004	2003	2004	2003	2003	2004	2003	2004	2003
Parents	General combining ability									
Cal Ace (P1)	0.01	0.02	-0.04	0.07	-0.19*	-0.17*	-0.11	0.01	0.05	0.03
Castle rock (P2)	0.00	0.01	0.10	0.14*	0.17*	0.19*	0.48**	0.41**	-0.04	-0.03
Peto 86 (P3)	0.08**	0.09**	0.15*	0.16*	-0.08	-0.06	0.02	0.00	-0.01	0.00
Chico III (P4)	0.04*	0.05*	0.13*	0.14*	0.21*	0.22*	0.84**	0.90**	-0.01	0.00
Tallalakhin (P5)	-0.11**	-0.10**	-0.28**	-0.51**	-0.43**	-0.44**	-0.51**	-0.54**	0.19**	0.02*
Super Strain B (P6)	-0.02	-0.03	0.09	0.14*	0.32**	0.27**	-0.72**	-0.78**	0.00	0.00
L.S.D (gi) 5%	0.04	0.04	0.12	0.12	0.13	0.14	0.17	0.06	0.17	0.02
L.S.D (gi) 1%	0.07	0.07	0.20	0.20	0.21	0.23	0.28	0.09	0.28	0.03
L.S.D (gi-gj) 5%	0.06	0.06	0.18	0.18	0.20	0.22	0.26	0.09	0.26	0.03
L.S.D (gi-gj) 1%	0.10	0.10	0.30	0.31	0.32	0.36	0.44	0.15	0.44	0.05
Crosses	Specific combining ability									
P1 x P2	-0.01	0.03	0.17*	0.33**	0.44**	0.40**	-0.05	0.20**	-0.02	0.02
P1 x P3	0.11**	0.12**	0.19**	0.16*	0.33**	0.25**	-0.36**	-0.23**	-0.01	-0.01
P1 x P4	0.12**	0.12**	-0.13*	0.07	-0.15*	-0.14*	0.33**	-0.09**	-0.02	0.01
P1 x P5	-0.06*	0.01	-0.17**	-0.21**	-0.37**	-0.35**	0.27**	-0.06*	0.18*	0.03**
P1 x P6	0.08**	0.04*	0.07	0.17*	0.13*	0.14*	-0.08	-0.14**	0.03	0.02
P2 x P3	-0.01	0.03	0.06	-0.14*	0.11	0.08	-0.02	-0.32**	0.02	0.00
P2 x P4	0.00	0.07**	0.07	0.00	-0.25**	-0.25**	0.23*	0.13**	0.01	0.01
P2 x P5	0.04*	-0.05*	-0.02	-0.10	0.01	-0.04	-0.02	-0.06*	-0.01	-0.01
P2 x P6	-0.06*	-0.13**	-0.02	0.09	-0.12	-0.03	1.28**	1.36**	-0.01	0.00
P3 x P4	0.11**	0.06*	0.21**	0.20**	0.20**	0.18*	-0.08	-0.39**	-0.01	-0.01
P3 x P5	0.10**	0.11**	-0.03	-0.08	-0.03	0.02	0.97**	1.13**	0.01	0.01
P3 x P6	0.06*	0.13**	-0.02	0.09	-0.12	-0.03	1.28**	1.36**	-0.01	0.00
P4 x P5	-0.02	0.05*	0.09	0.26**	0.36**	0.44**	-0.48**	0.00	-0.01	-0.01
P4 x P6	0.06*	-0.02	0.17*	-0.07	-0.09	-0.28**	0.32**	0.15**	0.00	0.00
P5 x P6	-0.03	-0.04*	0.15*	-0.03	0.03	-0.21**	-0.19*	-0.35**	-0.02	0.00
L.S.D. (sij) 5%	0.04	0.04	0.12	0.12	0.13	0.14	0.17	0.06	0.17	0.02
L.S.D. (sij) 1%	0.06	0.06	0.17	0.17	0.18	0.20	0.24	0.08	0.24	0.03
L.S.D. (sij-sik) 5%	0.13	0.13	0.38	0.38	0.40	0.44	0.54	0.18	0.54	0.06
L.S.D. (sij-sik) 1%	0.00	0.00	0.03	0.03	0.03	0.04	0.06	0.01	0.06	0.00

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

Table 10. Heterosis (%) in fifteen crosses for flesh thickness, fruit firmness, TSS, ascorbic acid and Titatable acidity content during summer seasons, 2003 and 2004.

Crosses	Flesh thickness (cm)		Fruit firmness (Kg / cm^2)		TSS (%)		Ascorbic acid (mg \100gm fresh weight)		Titatable acidity %	
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
P1 x P2	5.56	13.51	8.59	18.95	13.28	11.07	-0.31	0.26	-4.32	10.00
P1 x P3	31.58	4.76	13.88	14.09	11.87	9.56	0.45	0.28	-2.36	1.07
P1 x P4	37.14	41.18	0.00	13.48	-0.64	-1.43	1.58	-0.82	-6.98	3.94
P1 x P5	0.00	13.33	-6.50	-5.98	-6.33	-6.91	1.67	0.07	0.32	9.15
P1 x P6	23.53	5.26	5.56	13.16	4.85	2.83	0.71	0.00	7.07	7.64
P2 x P3	0.00	6.98	6.67	-2.50	6.72	5.54	1.36	0.09	5.35	0.40
P2 x P4	2.56	25.71	7.22	5.26	-2.36	-3.33	0.89	0.12	-0.40	2.81
P2 x P5	6.25	-3.23	-0.38	-5.47	2.49	-0.03	0.19	0.21	-1.96	-0.79
P2 x P6	-15.79	-7.69	-7.49	1.23	4.16	2.05	-0.76	0.15	2.88	3.67
P3 x P4	7.32	20.00	17.44	14.86	6.72	5.74	1.66	-0.21	-3.01	-3.70
P3 x P5	23.53	22.22	3.53	-3.23	1.97	2.26	6.04	6.48	1.46	1.09
P3 x P6	-5.00	-22.73	4.38	6.92	0.23	0.44	7.75	7.69	0.00	0.75
P4 x P5	3.23	28.57	9.76	17.24	7.87	7.92	-0.99	0.41	-5.76	-3.30
P4 x P6	13.51	0.00	12.50	3.31	-0.96	-6.32	2.39	1.17	-2.26	0.00
P5 x P6	-6.67	-12.50	8.40	-1.57	0.98	-6.22	0.73	0.11	-3.65	0.37

Correlation

The correlation coefficients (r) among different characters are presented in Table (11). Highly significant positive correlation was found between early yield or total yield and fruit set %. This result indicating that the increase in early and total yield of tomato fruits would be associated with an increasing in fruit set %. The coefficient of determination (r^2) indicating that 11 to 19% and 23 to 26% of variation in early and total yield respectively can be due to the effect of fruit set %. Similar results were found by Dhankar *et al* (2001) on total yield. Data showed also high significant positive correlation between total yield and each of number of fruits per plant, average fruit weight and fruit dimensions. This result indicating that the increase in total yield of tomato would associated with increasing in number of fruits per plant, average fruit weight, fruit length and fruit diameter. The coefficient of determination (r^2) indicating that 27 to 31%, 17 to 19%, 11 to 13% and 9 to 10% of variation in total yield can be due to the effect of number of fruits per plant, average fruit weight, fruit length and fruit diameter respectively. These results coincided with that of Dhankar *et al* (2001) and Padma *et al* (2002) on number of fruits per plant; Padma *et al* (2002), and Susic *et al* (2002) on average fruit weight and Padma *et al* (2002) on fruit length.

High significant negative correlation was found between average fruit weight and of number of fruits per plant, indicating that the increase in average fruit weight would be associated with a decrease in number of fruits per plant. These results agreed with those of Padma *et al* (2002) and Susic *et al* (2002). Data also showed significant positive correlation between average

fruit weight and each of fruit length, fruit diameter and flesh thickness. This result indicating that the increase in average fruit weight of tomato would be associated with an increasing in fruit length, fruit diameter and flesh thickness. The coefficient of determination (r^2), indicating that 18 to 22%, 8 to 11%. 5 to 6% and 14 to 17% of variation in average fruit weight can be due to the effect of number of fruits per plant, fruit length, fruit diameter and flesh thickness respectively.

High significant negative correlation was found between number of locules per fruits and each of fruit firmness and flesh thickness, indicating the increase in number of locules per fruits would be associated with a decrease in fruit firmness and flesh thickness. The coefficient of determination, indicating that 38 to 43% and 23 to 34% of variation in number of locules per fruits can be due to the effect of fruit firmness and flesh thickness.

High significant positive correlation was found between flesh thickness and fruit firmness. The coefficient of determination, indicating that 35 to 44% of variation in flesh thickness can be due to the effect of fruit firmness.

Table 11. Correlation (r) and Coefficient of determination (r^2) between characters during summer seasons, 2003 and 2004.

Character correlated	r		r^2	
	2003	2004	2003	2004
1-Early yield and:				
Fruit set %	0.44**	0.34**	0.19	0.11
2-Total yield and:				
Fruit set %	0.48**	0.51**	0.23	0.26
Number of fruits per plant	0.52**	0.56**	0.27	0.31
Average fruit weight	0.41**	0.44**	0.17	0.19
Fruit length	0.36**	0.33*	0.13	0.11
Fruit diameter	0.32**	0.30*	0.10	0.09
3- Average fruit weight and:				
Number of fruits per plant	-0.47**	-0.43**	0.22	0.18
Fruit length	0.29*	0.34**	0.08	0.11
Fruit diameter	0.22*	0. 24*	0.05	0.06
Flesh thickness	0.41*	0.37**	0.17	0.14
4- Number of locules per fruits				
Fruit firmness	-0.62**	-0.66**	0.38	0.43
Flesh thickness	-0.58**	-0.48**	0.34	0.23
5- Flesh thickness and:				
Fruit firmness	0.67**	0.59**	0.44	0.35

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

CONCLUSION

In general, it can be concluded that the hybrids Cal Ace x Chico III , Castle rock x Chico III and Castle rock x Super Strain B considered promising hybrids for summer season due to their fruit yield and yield components.

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دراسات وراثية على بعض أصناف الطماطم تحت ظروف درجات الحرارة العالية. ٢- التقييم والارتباط بين بعض الصفات في هجن الطماطم تحت ظروف درجات الحرارة العالية.

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أقيمت هذه الدراسة خلال ٣ مواسم صيفية متتابعة من ٢٠٠٢ حتى ٢٠٠٤ بمحطة أبحاث الخضر بقها - قليوبية- مصر. تم دراسة تقديرات وراثية مثل القدرة على الائتلاف وقوة الهجين والارتباط فى ١٥ هجين ناتجة من التهجين بطريقة الهجن الممكنة (الدياليل) باستخدام ٦ أصناف من الطماطم (كال أس، كاسيل روك، بيتو ٨٦، شيكوIII ، تلاليخين و سوبر استرين بى). وقد وجد أن هناك فروق معنوية لكل من القدرة العامة والخاصة على الائتلاف لكل من نسبة عقد الثمار والمحصول المبكر والكلى وعدد الثمار للنبات ومتوسط وزن الثمرة وطول وقطر الثمرة وعدد الحجرات بالثمرة وسمك اللحم وصلابة الثمار ومحتوى المواد الصلبة. وقد دلت النتائج على أهمية كل من تأثيرات الجينات المضيفة والغير مضيفة على هذه الصفات. وقد كانت النسبة بين القدرة العامة إلى القدرة الخاصة على الائتلاف عالية لهذه الصفات مما يدل على أن التأثيرات المضيفة أكثر أهمية من التأثيرات الغير مضيفة في وراثة هذه الصفات. وقد أوضحت النتائج أيضا أهمية التأثيرات المضيفة في وراثة محتوى حامض الأسكوربيك والحموضة بالثمار. وقد دلت القدرة العامة على الائتلاف على أن الصنف شيكوIII وبيتو ٨٦ وسوبر استرين بى من أفضل التوافيق التي تستخدم لتحسين كل من عقد الثمار والمحصول الكلى خلال الموسم الصيفى. بينما كانت الأصناف بيتو ٨٦ و شيكوIII من أفضل التوافيق لتحسين كل من المحصول المبكر وسمك اللحم وصلابة الثمار وإنقاص عدد الحجرات بالثمرة.

ومن بين الهجن فإن يمكن التوصية بالهجن كاسيل روك x بيتو ٨٦ و كال أس x تلاليخين و كاسيل روك x تلاليخين و بيتو ٨٦ x شيكوIII و كاسيل روك x شيكوIII و كال أس x سوبر استرين بى لزيادة عقد الثمار. بالإضافة إلى ذلك فإن أحسن الهجن فى المحصول المبكر والكلى كانت(كال أس x شيكو IIIو بيتو ٨٦ x شيكوIII و كاسيل روك x بيتو ٨٦ و كال أس x بيتو ٨٦) و (كال أس x شيكوIII و كاسيل روك x شيكوIII و تلاليخين x سوبر استرين بى و بيتو ٨٦ x شيكوIII و كاسيل روك x بيتو ٨٦) بالتتابع. وقد أعطى الهجين بيتو ٨٦ x شيكوIII أعلى قيمة لعدد ثمار النبات وسمك اللحم وصلابة الثمار وأقل عدد من الحجرات للثمرة.

وقد لوحظ أعلى قوة هجين عند التهجين بين الأباء التي تحتوى على القدرة العامة على الائتلاف وذلك لكل من المحصول المبكر والكلى ومتوسط وزن الثمرة وعدد الحجرات للثمرة وسمك اللحم وصلابة الثمار.

وقد وجد ارتباط موجب بين المحصول المبكر و نسبة عقد الثمار وبين المحصول الكلى وكل من نسبة عقد الثمار وعدد الثمار للنبات ومتوسط وزن الثمرة وطول وقطر الثمرة وسمك اللحم وبين سمك اللحم وصلابة الثمار. كما كان هناك ارتباط سالب بين متوسط وزن الثمرة وعدد الثمار بالنبات وبين عدد الحجرات بالثمرة وصلابة الثمار وسمك اللحم.