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INHERITANCE OF SOME IMPORTANT TRAITS IN SWEET PEPPER (*Capsicum annuum* L.)

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ABSTRACT

The present study was conducted at the Experimental Farm, Faculty of Environmental Agricultural Sciences, El Arish, Suez Canal University, Egypt, during three successive summer seasons from 2011 to 2013. The study involved six generations; viz., P_1, P_2, F_1, F_2, Bc_1 and Bc_2 of sweet pepper hybrid (B10-24 x TS 6-3-3). The objective of the present investigation was to study the inheritance of some important traits of sweet pepper. The obtained results showed that difference between the two parents was highly significant for all studied traits. The means of F_1 cross was deviated toward the high parent for most characters, while it was similar to that of high parent for average fruit weight. Segregating populations showed greater coefficient of variability (C.V%) than the non-segregating ones for all studied traits. Additive gene effects (d) were significant in the inheritance of all characters, except fruit length, fruit diameter and pericarp thickness. However, dominance gene action (h) was more importance in the inheritance of all studied traits, except number of fruits/plant. Epistasis gene actions were found to be important in the inheritance of most traits. Heterosis over mid-parents was detected in eight characters. However, heterosis over better parent was found, but only in three traits. Inbreeding depression was observed in six characters. Heritability estimates in broad sense (h_b) were high for all characters. The minimum number of genes controlling the traits were one pair for plant height, fruit diameter, pericarp thickness, T.S.S, ascorbic acid and total yield/plant, while number of genes were estimated as two to three pairs for number of branches, two to four for fruit length, three to seven for number of fruits/plant and two pairs for average fruit weight.

INTRODUCTION

Sweet pepper (*Capsicum annuum* L.) is one of the important vegetable crops in Egypt, it is grown in many locations and different seasons. It's obviously in a recent years high productivity and quality are needed to meet the increasing demand. One effort to improve pepper production and quality is a breeding program. The program is aimed at the use of superior varieties and hybrids with high yields and good qualities that can be accepted by farmers (Kusandriani and Permadi, 1996). However, efforts to improve the crop have been constrained mainly by a lack of adequate information on the genetic and inheritanceplant characteristics. For varietal improvement, the potential of the base populations and selection efficiency can be investigated by evaluating the relative importance of the additive and non-additive effects in determining each important trait and by choosing the breeding procedures which could maximize genetic gains.

The explanation for the relative importance of additive and non-additive gene effects in planning more efficient breeding programs could be obtained from a comparative assessment of the liner component; viz.,

additive (d), dominance (h), additive x additive(i), dominance x dominance (l) and additive x dominance (j) gene effects (Jadhav and Dhumal, 1994).

With respect to studies on gene effects, the non- additivegene effects play the main role in the inheritance of number of branches (Joshi, 1988). The three types of gene action were important in the inheritance of plant height, total fruit number and average fruit weight (Khalil *et al*., 1989b). Mohamed *et al*. (1995) found various types of gene action as, additive and epistasis (addi. x dom. and dom. x dom.) for total fruit number, additive and non- additive for total fruit weight, additive and dominance for average fruit weight. Khereba *et al*. (1995) reported that dominance and non-allelic interaction were important for fruit length, while additive and epistasis for fruit diameter. In another study, Hasanuzzaman and Golam (2011) found that additive, dominance and epistasis were more important for fruit number and total yield/plant. Dominance genetic variance appeared to be important for TSS% (Ibrahim, 2007). Meanwhile Khalil *et al*., (1989b) found additive and dominance x dominance for this trait, also Hatem and salem (2009) found dominance x dominance was important for TSS%. Heterosis over mid-parents and better parent were studied and detected by Farag (2000) and Gouda *et al*. (2003) for plant height, Ahmed *et al*. (1998) for number of branches and Depestre and Espinos (1988) and Mishra *et al*. (1988) for total yield. Heterosis over mid-parents was observed by Khalil *et al*. (1989a) for average fruit weight, while Khallf-Allah *et al*. (1975) showed that the small fruits were partially dominant over the large fruit. The most F_1 crosses produced longer fruits than their mid parents (Kumar and Lai, 2001 and Hasanuzzaman and Golam, 2011). Hybrid vigour was observed in many fruit quality; viz., V.C and TSS% (Ibrahim, 2007 and Khalil and Hatem, 2014). Heritability in broad sense was high for plant height, number of branches, average fruit weight, fruit length and total yield (Chu, 1995), total fruit number and average fruit weight (Legg and Lippert, 1966). However, heritability in narrow sense was high for plant height and number of branches (Chu,1995), average fruit weight, fruit length, fruit diameter and pericarp thickness (Ben-Chaim and Paran, 2000 and Syukur *et al*., 2010) and V.C and TSS% (Farag, 2000), while it was low for total fruit number and total yield (Chu,1995).

The minimum number of genes controlling the traits of pepper was one pairs for plant height and total fruit number(Khalil, 2013) and total yield, fruit length, fruit diameter and average fruit weight (Syukur *et al*., 2010), while it was two pairs of genes for average fruit weight (Khalil ,2013)and fruit length (Khereba *et al*., 1995). Also it was ranged from two to three pairs for total fruit yield and V.C content (Hatem and Salem, 2009), three to four pairs for total fruit number, one to two pairs for average fruit weight, one to three pairs for total yield (Mohamd *et al*., 1995) and three to four pairs for fruit diameter (Khereba *et al*., 1995). Therefore, the present investigation was undertaken aiming to study the inheritance of some important characters of sweet pepper.

MATERIALS AND METHODS

The present study was conducted at the Experimental Farm, Faculty of Environmental Agricultural Sciences, El Arish, Suez Canal University, Egypt, during three successive summer seasons from 2011 to 2013. The study involved six generations; viz., P_1, P_2, F_1, F_2, Bc_1 and Bc_2 of the sweet pepper hybrid (B10-24 x TS 6-3-3), the two parental lineswere widely different in their characteristics. The seeds of parents were obtained from Veg. Res. Dep., Hort. Res. Inst., Agric. Res. Center, Giza, Egypt (Kansouh, 2007). In the first season 2011 the seeds were sown on January 1st in speeding trays and the seedlings were transplanting on Marsh 1st and the crossing was made between the two parents to produce F_1 seeds. In the second season 2012, seeds of F_1 hybrid and their parents were planted, the F_1 plants were selfed to produce F_2 seeds and at the same time backcrossed to both parents to produce Bc_1 and Bc_2.

The six populations; viz., P_1, P_2, F_1, F_2, Bc_1 and Bc_2 were evaluated in the third season 2013 under open field conditions and the transplanting was done on Marsh 1st. The populations were grown in a randomized complete block design, with three replications. Each replicate consisted of 12 rows: one row for non-segregation generation (P_1, P_2 and F_1), three rows for each backcross and five rows for the F_2 populations. Each row was 7m long and 1m wide, and contained 14 plants. The total number of plants included in the study was 630 distributed among the six generations as follows: 42 of each homogenous population (P_1, P_2 and F_1), 252 of F_2 and 126 of each backcross. Dripper lines were used and spaced 1m between each to other.

Data recorded: Data were recorded on individual plants basis from all populations.The characters studied were: plant height and number of branches/plant (after 100 days from transplanting). At the third harvest, at the green mature stage, fruit length (cm), fruit diameter (cm) and pericarp thickness (mm) were measured. Ascorbic acid content was determined according to A.O.A.C. (1975) and total soluble solids (T.S.S%) was determined by a hand refractometer. Total yield/plant (kg) and total number of fruits/plant of all harvested fruits from each plant were recorded. Average fruit weight (g) was calculated by dividing total weight of all harvested fruits over total number of fruits/plant. Conventional culture practices were done as needed in commercial pepper production in the open field in North Sinai region.

Statistical and genetic analysis: Data were statistically analyzed, and T-test was used to test the significance of differences among the various means.

- Arithmetic mean: The formula used for calculation of the arithmetic mean for the different populations were reported by Powers *et al*. (1950).
- Scaling tests 1: The scaling test provides information regarding absence or presence of gene interactions according to the formula of Mather (1949).
- Component of generation means: Six parameters models for estimation various genetic components were used according to Hayman (1958).
- Heterosis percentage: Heterosis over mid-parents (M.P) and better parent (B.P) were determined according to Mather and Jinks (1971) formulae.

- Potence ratio (P) was estimated according to Smith (1952).
- Average degree of dominancewas calculated as follows $(H/D)^{1/2}$ where, H and D are dominance and additive variances, respectively.
- Inbreeding depression (I.D.) %, was calculated as follows = $(F_1-F_2)/F_1)$ x100, where F_1 and F_2 are the mean of F_1 and F_2 generations, respectively.
- Heritability: Heritability in broad (h_b) and narrow (h_n) sense were calculated using the equations of Falconer (1981) and Mather and Jinks (1982), respectively.
- Predicted gain under selection (ΔG): It was calculated as given by Johanson *et al*. (1955).
- Genetic advance under selection ($\Delta G\%$): It was estimated according to Miller *et al*. (1958).
- The minimum number of genes controlling the difference between parents was estimated according to Castle-Wright (1921) and Mather and Jinks (1977).

RESULTS AND DISCUSSION

1. **Mean performance of the studied populations**

The mean values of ten characters in the six populations of the cross (B-10-24 x TS-6-3-3) are shown in Table 1. The obtained results showed that the differences between the two parents were highly significant for all studied traits. Accordingly, genetic differences probable and the genetic studies could be continued for all characters.

The data revealed that the line TS-6-3-3 surpassed B-10-24 in all studied traits, except fruit diameter the line B-10-24 gave the highest value than the other parent.

The means of F_1 cross were deviated toward the high parent (Table1) for number of branches, fruit length, number of fruits/plant, ascorbic acid and TSS % content, indicating partial dominance. These results were supported by the estimated potence ratio, which was less than unity and by estimated heterosis over mid-parents for these traits (Table 4). Similar results were obtained by Mohamed *et al*. (1995), Khereba *et al*. (1995), Farag (2000) and Doshi (2003) who reported partial dominance for these traits.

Also, the mean of F_1 was similar to that of high parent for average fruit weight, indicating complete dominance to the heavier fruit. The mean of $F_1$was exceeded than the better parent in plant height, pericarp thickness and total yield/plant, indicating over dominance for the high parent. The estimated potence ratio confirmed these results, which was more than one (Table 4). Over dominance toward the high parent was observed by Gaffar (1993) and Mohamed *et al*. (1995) for these traits.

Over dominance toward the low parent was observed for fruit diameter where F_1 mean was less than the low parent, this conclusion is supported by the estimated potence ratio (Table 4) which was more than unity with negative sign. The results are agreed with Khalil *et al*. (1989a), Gaffar (1993) and Khereba *et al*. (1995) for fruit diameter.

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Concerning F_2 generations, the means of F_2decreasedfrom their respective F_1 means for all studied traits, except pericarp thickness. This could be due to inbreeding depression (Table 4), because the superiority of F_1plants could be due to an accumulation of favorable dominant alleles.

Differences between means of Bc_1 and Bc_2 were observed for all studied traits, this may be due to increasing alleles associated with parent and decreasing in the other parent. The means of Bc_1 and Bc_2 were higher than the means of F_2 populations for fruit length and diameter. Generally, in all traits the means of backcross to the higher parent exceeded the means of backcross to low parent, except pericarp thickness and fruit diameter as expected.

Variances of the non-segregating populations; viz., P_1, P_2 and F_1 differed. However, they were the least variable comparing with the segregating populations; viz., F_2, Bc_1 and Bc_2 for all studied traits, this indicates that they were more homogenous than the F_2 and both backcross populations, which showed greater coefficient of variability (C.V%) as presented in Table 1. These results were expected because the segregating populations consisted of homozygous and heterozygous plants. Moreover, the results indicated the existence of both genetic and environmental variation affecting these traits. Similar results were observed by many investigators among them Khereba *et al*. (1995), Mohamed *et al*. (1995) and Khalil (2013).

The comparison between the observed and arithmetic means of all populations (Table 1) revealed significant or highly significant differences for T.S.S %, ascorbic acid, total yield/plant, number of fruits /plant and average fruit weight, indicating the presence of dominance. While, no significant differences were observed for the remaining traits in all populations, indicating no dominance or additive gene effects.

2. **Scaling test**

The purpose of scaling test, A, B and C are to determine the adequacy of additive-dominance model for studying types of gene action in the inheritance of different traits.

Data in Table 2 show that one or more of the three scales were significant or highly significant for all traits under study, indicating the presence of non-allelic interaction, and the simple additive-dominance model are insufficient to explain the inheritance of studied traits.

3. **Components of generation means**

The six parameters model of Hyman (1958) was used for further test of the absence or presence and nature of non-allelic gene interaction through the parameters against the respective standard errors following a conventional (t) test. The type of gene effects for the studied traits in the cross B-10-24 x TS-6-3-3 are given in Table 3. Data show that one or more of gene effects were significant or highly significant. Therefore, additive-dominance model is adequate to interpret gene effects for these traits.

Mean effects of parameter (m) that reflects the contribution due to the overall mean plus the locus effects and interaction of the fixed loci for the previous traits, the mean values ranged from 0.285 to 109.504 for pericarp thickness and ascorbic acid, respectively.

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Additive gene effects (d) were significant in the inheritance of all characters under study, except fruit length, fruit diameter and pericarp thickness, since the additive gene actions were not significant. Similar results were observed by Khalil *et al*. (1989b) and Doshi (2003).

All studied traits were controlled by dominance gene action (h), except number of fruits/plant, indicating the importance of dominance in the inheritance of these traits. Many investigators reported similar results, among them Jadhav and Dhumal (1994), Mohamed *et al*. (1995) and Ibrahim (2007).

Regarding additive x additive types of epistasis (i) gene action, they were found to be important in the inheritance of most studied traits, i.e., plant height, fruit length, fruit diameter, pericarp thickness, ascorbic acid, total yield /plant and average fruit weight (Table 3).

Epistasis gene actions of additive x dominance (j) also were important in the inheritance of all studied traits, except plant height which (j) had non - significant value.

With regard to dominance x dominance (l) epistasis gene actions, they were found to be highly significant for all traits, except ascorbic acid, total yield/plant and average fruit weight, indicating the importance of (l)in the inheritance of these traits (Table 3).The results of epistasis gene action are in conformity with those of Joshi (1988), Khalil *et al*. (1989b), Khereba *et al*. (1995), Ahmed *et al*. (1998), Hatem and Salem (2009) and Hasanuzzaman and Golam (2011).

Generally, the results of the present investigation indicated the presence of both additive and non-additive gene actions in all studied traits, suggesting the importance of both selection and heterosis breeding in improving these traits. Also, results indicate that the presence of gene effects additive, dominance and non-allelic interaction (i) in other characters, indicate that, these types of gene effects played major important role in the inheritance of these traits.

4. **Genetic components**

Heterosis and inbreeding depression were estimated, the data of Table 4 show that heterosis over mid-parents was highly significant with positive values for eight characters. The values ranged from 2.13% to 56.79% for ascorbic acid and total yield/plant, respectively. Also, heterosis over better parent was detected with positive and highly significant values in three traits (plant height, pericarp thickness and total yield). Many researchers found similar results among them Khalf-Allah *et al*. (1975), Depester and Espinos (1988), Mishra *et al*. (1988), Khalil *et al*. (1989a), Ahmed *et al*. (1998), Farag (2000), Kumar and Lai (2001), Gouda *et al*. (2003), Hasanuzzaman and Golam (2011) and Khalil and Hatem (2014). While, heterosis over both mid-parents and better parent was not significant or had negative values for the other traits under study.

In all studied traits the F_1 means exceeded the respective F_2 means, except pericarp thickness, indicating inbreeding depression in these traits. Inbreeding depression was positive and highly significant for plant height, number of branches, fruit length, fruit diameter, T.S.S. % and total yield /plant. Similar results were found by Todorov (1995) and Ibrahim (2007). While inbreeding depression was absent for the other traits.

Inbreeding depression measured the reduction in performance of the F_2 generation due to inbreeding. The large amount of inbreeding depression was

observed for fruit length (39.54%), total yield/plant (30.11%), number of branches/plant (29.22%) and plant height (27.89%) as expected since these traits showed large amount of heterosis. The high level of heterosis and inbreeding depression present in this study was an evidence of the relative importance of dominance gene effects in these materials. Therefore, dominance should gives the more attention in any program of breeding for heterosis in the future.

The amount of dominance effects can be seen from the value $(H/D)^{1/2}$. The value $(H/D)^{1/2}$ was less than one (0.94) for pericarp thickness, indicating partial dominance, while it was more than one for the other traits, indicating over dominance (Table 4).

Heritability in both broad and narrow senses are very important and should be recognized as a first step before starting any breeding program. Data presented in Table 4 show that heritability estimates in broad sense (h_b) were high for all characters under study, indicating lesser influence of the environment. Many researchers found high values of heritability in broad sense for most studied traits (Legg and Lippert, 1966; Chu, 1995; Ben-Chaim and Paran, 2000; Syukur *et al*., 2010 and Khalil, 2013).

The estimated values of narrow sense heritability (h_n) were higher for pericarp thickness (65.09) and T.S.S % (51.33), these results agree with those obtained by Farag (2000). However, it was moderate for plant height (47.08), average fruit weight (43.06) ascorbic acid (41.39), fruit length (40.85) number of branches (36.68), fruit number (36.63), total yield (36.29) and fruit diameter (31.85). These were in parallel with those of Ben-Chaim and Paran (2000) and Farag (2000). This could be attributed to that most of the genetic variance was mainly due to additive gene action. As well as, if the estimated value of heritability is high, the selection is done in the early generations. So, the development program for these traits could be done through a selection method.

The values of expected genetic advance (ΔG%) under selection when the top 5% of F_2 plants are selected were high for all studied traits, except ascorbic acid which was low. However, the expected genetic advance ranged from 4.93% to 49.18% for ascorbic acid and pericarp thickness, respectively (Table 4). Similar trend was observed by Khalil (2013) for plant height, average fruit weight and total fruit number/plant.

The predicted gain (ΔG) from selection using individual plant of the best 5 percent of the F_2 plants differ from trait to other (Table 4), it was high for average fruit weight (13.46), plant height (6.85), ascorbic acid (5.40) and number of fruits (3.50), however it was low for the remaining traits.

The minimum number of genes controlling the traits are presented in Table 4, using two equations of Castle-Wright (1921) and Mather and Jinks (1977) showed that there was one pair of genes controlling each of the following traits, plant height, fruit diameter, pericarp thickness, T.S.S, ascorbic acid and total yield/plant based on both equations. These results agreed with those of Hatem and Salem (2009) and Khalil (2013). Using Castle-Wright and Mather and Jinks formulae the number of genes were estimated as 1.18 and 2.61 for number of branches, 1.86 and 3.50 for fruit length, 2.90 and 6.57 for number of fruits/plant and 1.06 and 2.0 for average fruit weight, respectively. Similar results were obtained by many researchers, Mohamed *et al*. (1995) for total fruit number, Khereba *et al*. (1995) for fruit length and Khalil (2013) for average fruit weight. These results indicated that minimum number of genes controlling the difference between the two parents were estimated as two to three pairs for number of branches, two to four for fruit length, three to seven for number of fruits/plant and two pairs for average fruit weight.

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توريث بعض الصفات الهامة في الفلفل الحلو

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قسم الإنتاج النباتي (خضر) – كليه العلوم الزراعية البيئية بالعريش- جامعه قناة السويس - مصر

أجريت هذه الدراسة بمزرعة كليه العلوم الزراعية البيئية بالعريش- جامعه قناة السويس- مصر، خلال الموسم الصيفي في الفترة من ٢٠١١/٢٠١٣. استخدم فى الدراسة سلالتان من الفلفل كآباء (بى ١٠-٢٤ ، تى اس ٦-٣-٣)، حيث أجريت التهجينات بينهما للحصول على بذور الجيل الأول والثاني والتلقيحات الرجعية لكلا الأبوين بهدف دراسة توريث بعض الصفات الهامة فى الفلفل الحلو. وكانت أهم النتائج المتحصل عليها ما يلي:-

وجدت اختلافات معنوية عاليه بين الأبوين فى كل الصفات المدروسة وأظهرت العشائر الانعزالية معامل اختلاف اكبر مما فى العشائر الغيرانعزاليه. اظهر الفعل الجيني المضيف معنويه فى توريث معظم الصفات المدروسة، فى حين تحكم الفعل الجيني السيادي فى توريث كل الصفات المدروسة عدا عدد الثمار/ نبات. وظهرت قوه هجين بالنسبه لمتوسط الابوين فى ثمانى صفات، فى حين لم تظهر قوه هجين بالنسبه للاب الافضل الا فى ثلاث صفات.

كانت درجة التوريث على النطاق الواسع عاليه لكل الصفات المدروسة، وكان عدد الجينات المتحكمة فى الصفات زوج واحد لصفات ارتفاع النبات، قطر الثمرة، سمك اللحم، % T.S.S.، حامض الاسكوربك والمحصول الكلى/ نبات، وزوجين لصفه متوسط وزن الثمرة، فى حين تراوح من زوجين الى ثلاثه ازواج لعدد الافرع / نبات، ومن زوجين الى اربعه ازواج لطول الثمرة ومن ثلاثة الى سبعه ازواج لعدد الثمار/ نبات.

Table 2: Scaling test (A, B and C) and their standard errors for some important traits of sweet pepper for the cross (B-10-24 x TS-6-3-3).

Characters	Scaling test		
	A	B	C
Plant height	-17.548±1.235**	-14.682±1.369**	-43.993±1.980**
No. of branches	-2.068±0.211**	-3.591±0.227**	-6.110±0.330**
Fruit length	-2.129±0.208**	-5.222±0.220**	-11.612±0.326**
Fruit diameter	0.295±0.147*	0.873±0.162**	-2.321±0.231**
Pericarp thickness	0.052±0.017**	-0.048±0.018*	0.175±0.029**
T.S.S %	-2.015±0.132**	-0.229±0.128	-2.342±0.201**
Ascorbic acid content	-14.039±131**	-6.866±1.283**	-35.701±1.880**
Total yield/plant	-0.723±0.077**	0.074±0.091	-0.916±0.127**
Number of fruit /plant	-10.984±0.967**	-0.462±0.946	-10.328±1.436**
Average fruit weight	-13.888±2.587**	5.765±3.335	-22.880±4.587**

Table 3: Mean estimation of six parameter model of gene effects for some important traits of sweet pepper for the cross (B-10-24 x TS-6-3-3).

Characters	Gene effects					
	m ± S.E	d ± S.E	h ± S.E	i ± S.E	j ± S.E	l ± S.E
Plant height	46.456±0.447**	-7.443±0.848**	25.759±2.500**	11.818±2.463**	-1.460±0.894	20.358±3.928**
No. of branches	4.760±0.066**	-0.689±0.130**	1.326±0.384**	0.451±0.372	0.761±0.146**	5.209±0.616**
Fruit length	5.015±0.062**	-0.114±0.120	5.015±0.362**	4.261±0.346**	1.547±0.142**	3.090±0.582**
Fruit diameter	3.191±0.045**	-0.057±0.090	2.488±0.266**	3.489±0.256**	-0.289±0.103**	-4.658±0.429**
Pericarp thickness	0.285±0.007**	0.016±0.012	-0.123±0.036**	-0.170±0.035**	0.050±0.012**	0.166±0.055**
T.S.S %	5.051±0.041**	-1.311±0.077**	0.461±0.234*	0.099±0.227	-0.893±0.087**	2.144±0.369**
Ascorbic acid content	109.504±0.400**	-7.670±0.774**	17.287±2.281**	14.795±2.228**	-3.586±0.847**	6.110±3.623
Total yield/plant	1.334±0.024**	-0.618±0.047**	0.959±0.141**	0.268±0.134*	-0.399±0.056**	0.381±0.227
Number of fruit /plant	29.468±0.293**	4.906±0.575**	-2.817±1.694	-1.117±1.642	-5.261±0.642**	12.563±2.712**
Average fruit weight	46.465±0.960**	-29.744±1.846**	33.086±5.472**	14.758±5.326**	-9.827±1.980**	-6.635±8.694

Table 4: Estimation of genetic parameters for some important traits of sweet pepper for the cross (B-10-24 x TS-6-3-3).

Characters / Genetic parameters	Plant height	No. of branches	Fruit length	Fruit diameter	Pericarp thickness	T.S.S %	Ascorbic acid content	Total yield/plant	Number of fruits/plant	Average fruit weight
Heterosis (%)										
-Over mid parent (M.P)	27.62**	14.96**	10.00**	-23.45**	21.72**	6.65**	2.13**	56.79**	-5.17**	42.60**
-Over better parent (B.P)	14.09**	-7.88**	-9.85**	-27.39**	5.34**	-0.95**	-1.31*	32.86**	-27.55**	-2.52
Inbreeding depression(I.D%)	27.891**	29.219**	39.542**	2.427**	-7.573**	13.179**	8.499	30.113**	5.551	24.262
Potence ratio (PR)	2.33	0.60	0.45	-4.32	1.40	0.87	0.61	3.15	-0.17	0.92
Average degree of dominance $(H/D)^{1/2}$	1.36	1.49	1.18	1.62	0.94	1.06	1.44	1.29	1.53	1.39
Heritability (%)										
-Broad sense	90.88	77.58	69.06	73.64	93.95	80.21	84.12	66.69	79.25	84.93
-Narrow sense	47.08	36.68	40.85	31.85	65.09	51.23	41.39	36.29	36.63	43.06
Genetic advance										
-ΔG	6.85	0.79	0.83	0.47	0.14	0.69	5.40	0.28	3.50	13.46
-ΔG%	14.74	16.64	16.48	14.74	49.18	13.66	4.93	21.24	11.87	28.96
Mini. number of genes										
-Castle-wright (1921)	0.39	1.18	1.86	0.10	0.10	0.24	0.24	0.22	2.90	1.06
-Mather &Jinks (1977)	0.76	2.61	3.50	0.16	0.10	0.40	0.50	0.46	6.57	2.00

Table 1: Mean performance, variance, arithmetic mean and coefficient of variability for some important traits of sweet pepper in parents, F1, F2, Bc1 and Bc2for the cross (B-10-24 x TS-6-3-3).

Characters / Populations	Plant height (cm)				No. of branches			
	X ± S.E	σ^2	Arithmetic mean	C.V(%)	X ± S.E	σ^2	Arithmetic mean	C.V(%)
P_1	44.500±0.361	3.914	-	4.446	4.400±0.091	0.248	-	11.324
P_2	56.467±0.433	5.637	-	4.205	7.300±0.098	0.286	-	7.329
F_1	64.425±0.320	4.097	50.483 ns	3.142	6.725±0.071	0.204	5.850ns	6.724
F_2	46.456±0.447	49.855	57.454ns	15.199	4.760±0.066	1.099	6.288ns	22.022
BC_1	45.689±0.568	34.235	54.463ns	12.806	4.528±0.088	0.823	5.563ns	20.034
BC_2	53.132±0.629	42.001	60.446ns	12.198	5.217±0.096	0.972	7.013ns	18.893
	Fruit length (cm)				Fruit diameter (cm)			
P1	5..880±0.100	0.297	-	9.271	4.504±0.069	0.142	-	8.354
P2	9.201±0.112	0.376	-	6.663	4.040±0.073	0.159	-	9.877
F1	8.295±0.075	0.223	7.541ns	5.687	3.271±0.051	0.106	4.272ns	9.940
F2	5.015±0.062	0.965	7.918ns	19.587	3.191±0.045	0.514	3.771ns	22.469
BC1	6.023±0.083	0.735	7.088ns	14.235	4.035±0.060	0.381	3.887ns	15.306
BC2	6.137±0.087	0.800	8.748ns	14.577	4.092±0.068	0.483	3.655ns	16.985
	Pericarp thickness (mm)				T.S.S %			
P_1	0.184±0.004	0.001	-	12.257	5.037±0.060	0.109	-	6.543
P_2	0.251±0.004	0.001	-	9.675	5.873±0.051	0.079	-	4.794
F_1	0.265±0.005	0.001	0.218ns	11.217	5.818±0.041	0.066	5.455*	4.419
F_2	0.285±0.007	0.011	0.241ns	36.676	5.051±0.041	0.428	5.636**	12.949
BC_1	0.250±0.008	0.007	0.224ns	32.950	4.420±0.055	0.315	5.427**	12.697
BC_2	0.234±0.009	0.008	0.258ns	38.002	5.731±0.055	0.321	5.845**	9.892
	Ascorbic acid content (mg/100g fresh weight)				Total yield/plant(kg)			
P_1	113.100±0.448	6.024	-	2.170	0.998±0.042	0.052	-	22.831
P_2	121.267±0.518	8.064	-	2.342	1.437±0.044	0.058	-	16.801
F_1	119.675±0.353	4.994	117.183**	1.867	1.909±0.029	0.033	1.217**	9.563
F_2	109.504±0.400	40.066	118.429**	5.780	1.334±0.024	0.144	1.563**	28.409
BC_1	109.368±0.535	30.349	116.388**	5.037	1.092±0.029	0.091	1.453*	27.554
BC_2	117.038±0.560	33.199	120.471**	4.923	1.710±0.037	0.145	1.673**	22.238
	Number of fruits/plant				Average fruit weight (g)			
P_1	43.067±0.407	4.961	-	5.172	23.103±0.860	22.164	-	20.378
P_2	22.733±0.398	4.754	-	9.591	62.939±1.145	39.314	-	9.962
F_1	31.200±0.302	3.651	32.900**	6.124	61.350±1.32	42.593	43.021**	10.638
F_2	29.468±0.293	21.471	32.050**	15.724	46.465±0.960	330.222	52.185**	32.655
BC_1	31.642±0.412	18.004	37.133**	13.410	35.283±1.106	129.578	42.227**	32.263
BC_2	26.736±0.401	17.072	26.967**	15.454	65.027±1.479	231.740	62.144**	23.410