GENERAL AND SPECIFIC COMBINING ABILITIES IN PEPPER, Capsicum annuum, L.

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القدرة العامة والخاصة على الائتلاف فى الفلفل

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ملخص البحث

أجريت هذه الدراسة بمزرعة كلية الزراعة بشبين الكوم فى شتاء ١٩٨٦/٨٥ ، ١٩٨٧/٨٦ بهدف قياس القدرتين العامة والخاصة على الائتلاف . أستخدم فى هذه الدراسة عشرة أصناف أجنبية من الفلفل حيث أجرى التهجين بينها (فى اتجاه واحد) للحصول على ٤٥ هجين فردى وذلك فى العام الأول .

زرعت نباتات الجيل الأول مع آبائها (٥٥ تركيب وراثى) فى شتاء الموسم الثانى داخل الصوب البلاستيكية فى تجربة مصممة بطريقة القطاعات الكاملة العشوائية بثلاثة مكررات . ثم سجلت البيانات على ١٤ صفة مرتبطة بالنبات (طول النبات ـ نسبة العقد ـ كمية المحصول المبكر والكلى ـ عدد الأيام اللازمة من الشتل للازهار) والثمرة (الوزن ـ القطر ـ الطول ـ عدد المساكن ـ سمك اللحم) بالاضافة الى محتوى الثمرة من المادة الصلبة الكلية الذائبة وفيتامين جـ . وتم تحليل البيانات طبقا للموديل الأول ـ الطريقة الثانية التى اقترحها (Griffing, 1956) وأوضحت النتائج الآتى :ـ

ـ كان تباين كل من القدرة العامة والخاصة معنوى جدا فى جميع الصفات مشيرا الى أهمية كل من الفعل التجميعى والغير تجميعى (السيادة والتفوق)

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للجينات الخاصة بوراثة هذه الصفات ـ وأشارت النسب بين متوسط مربعات الانحرافات لكلا القدرتين أن الدور الذى تلعبه التأثيرات المضيفة (التجميعية) أهم فى جميع الصفات ولكن بدرجات متفاوتة ، حيث كانت أكثر وضوحا فى وراثة طول وقطر الثمرة وسمك اللحم ـ وأقل وضوحا فى صفتى المحصول المبكر والكلى .

ـ وأظهرت الأصناف التالية أعلى القيم بالنسبة للصفات المختلفة فالصنف Csokros Felallo بالنسبة للمحصول الكلى والصنف Kyrtovcke Kapija بالنسبة للمحصول المبكر وسمك اللحم ، والصنف Hatvani Hajtatas بالنسبة لفيتامين (ج) والصنف Zlaten Medal للمواد الصلبة الكلية الذائبة.

ـ وحسابات القدرة الخاصة على الائتلاف أوضحت أن أفضل الهجن هى : Bela kapija x Kalocsai ، Kyrtovcke Kapija x Csokros Fel. فى عدد الثمار الكلية ووزنها على التوالى . بينما الهجن Kyrtovcke K. x Kalocsai فى المحصول المبكر ، والهجن Bela Kapija x Soraksari فى متوسط وزن الثمرة ، والهجن Zlaten M. x Bela Kapija Hajtato فى المادة الصلبة الكلية الذائبة ، والهجن Kyrtovcke K. x Hatvani Hajtatas فى فيتامين (ج) ـ حيث أعطت هذه الهجن أعلى تأثيرات بالنسبة للقدرة الخاصة على الائتلاف .

ABSTRACT

Ten homozygous pepper cultivars and their 45 possible crosses were used in this investigation. The general and specific combining abilities were estimated in 14 plant and fruit attributes. The variances for both general and specific combining abilities were significant for all attributes, indicating that the 14 traits involved both additive and non-additive gene action in their genetic mechanism. However, the additive gene effects are more important in the inheritance of all traits. This was reflected by the high estimated values for the ratio of GCA/SCA mean squares.

Csokros Felallo cv. was the best combiner for total yield, while Kyrtovcke Kapija was the best combiner for early yield and wall thickness. The cv. Hatvani Hajtatas was the best combiner for less number of days to flowering and vitamin C content. The best combiner cvs. for total

soluble solids, both average fruit weight and diameter, and fruit set were Zlaten Medal, Paradicsom Zold Szentesi and Csokros Felallo, respectively. For fruit length, Bela Kapija was the best combiner parent.

Estimates of SCA effects showed that the best crosses were: "Bela Kapija x Kalocsai" in total fruit number,while "Kyrtovcke Kapija x Csokros Csungo" in total yield; "Kyrtovcke Kapija x Kalocsai" in early yield; "Bela Kapija x Soroksari Hajtato" in average fruit weight. "Zlaten Medal x Bela Kapija" and "Kyrtovcke Kapija x Hatvani Hajtatas" crosses in T.S.S. and vitmain C content, respectively. These combinations showed the highest SCA effect values and mean performances.

INTRODUCTION

Studying the type of gene action responsible for heterosis are essential in planning programmes for the development of improved varieties of pepper. If the estimates of general combining ability (additive genetic variance) is of major importance, intrapopulation selection methods will be a most effective procedure. On the other hand, if the non additive genetic variance (specific combining ability) is the major components of genetic variation, inbred and hybrid programme may be the appropriate choice.

Most available evidence on peppers refers to additive and dominance effects as the major components of genetic variance. Additive gene effects were found to control earliness (Dulgikh and Sviridova, 1983); number of fruits per plant (Singh and Singh,1982); plant height (Soh et al., 1977); fruit diameter and length (Khem et al., 1980 and Setiamihardja and Knavel, 1982); vitamin C (Nowaczyk, 1981 and Khalil and Omran, 1982); average fruit weight (Ahmed et al., 1982 and Rao and Chhonkar, 1984); wall thickness (Singh and Singh, 1978 and Silvetti and Giovannelli, 1980), and total soluble solids content (Khalil and Omran, 1982).

Non additive (dominance and epistasis) gene effects were important in the inheritance of number of days to first flower (Chung and Chang, 1979 and Thakur et al., 1980); fruit number per plant (Singh & Singh, 1977 and Uzo, 1984); plant height (Sharma and Saini, 1977 and Singh and Singh, 1978); fruit diameter (Chung and Chang, 1979); fruit length (Mishra et al., 1976); and wall thickness (Velaskes and Milkova, 1981).

On the other hand, both additive and non-additive effects were involved in the inheritance of earliness (Thakur et al., 1980);fruit number per plant (Rao and Chhonkar, 1984 and Singh and Singh, 1982); fruit weight (Milkova, 1979); plant height (Ahmed et al., 1982 and Khadi, 1984); vitamin C content (Khadi, 1984); and fruit length and diameter (Khadi, 1984).

The present study was undertaken to determine and compare the general and specific combining ability effects in ten pepper cultivars, regarding some plant and fruit attributes. These informations are an important to planning breeding programmes of pepper.

MATERIALS AND METHODS

The experiments reported herein were carried out at the Experimental Farm, Faculty of Agriculture, Minufiya University under unheated plastic house conditions. The experimental materials consisted of 10 cultivars of pepper, introduced from Hungary and Yugoslavia, and their 45 diallel crosses. These cultivars were; Zlaten Medal (1), Kyrtovcke Kapija (2), Paradicsom Zold Szentesi (3), Bela Kapija (4), Hatvani Hajtatas (5), Soroksari Hajtato (6), Kalocsai (7), Szarvasi (8), Csokros Felallo (9) and Csokros Csungo (10). They being maintained in pure form by selfing.

In 1984/85's winter season, the parental cultivars were planted and all possible combinations, excluding reciprocals, were made to generate the required F_1 seeds. In the winter season of 1986/1987, the 55 entries, i.e., 10 parents and 45 F_1 crosses were planted in field trail experiment for estimating the general and specific combining abilities for some plant and fruit attributes. The sowing was in middle of September and the transplanting was at the end of October, 1986.

A randomized complete block design with three replicates was used. Each replicate consisted of 55 2-row plots. The row contained six plants spaced at 70 cm and 35 cm between and within row, respectively. Fertilization, irrigation, disease and insect control programes were carried out as usual in the commercial production of peppers. Green fruits were harvested every two weeks.

Observations were recorded on the following characters: Number of days from transplanting to first flower anthesis, number and weight of fruits in early yield (the first three harvests), number and weight of fruits in total yield, average fruit weight, fruit length and diameter, wall thickness, locule number, total soluble solids and vitamin C contents, fruit set, and plant height. Total soluble solids content were determined using an Abbe hand refractometer, and vitamin C content by 2,6 dichlorophenolindophenol dye (A.O.A.C., 1965).

The analysis of experimental data were done according to Griffing (1956), method (2) model (1).

RESULTS AND DISCUSSION

Estimates of mean squares for general (GCA) and specific (SCA) combining abilities, general combining ability effects ($\hat{g}i$) and

specific combining ability effects (Sij) for all studied attributes are shown in Tables (1,2,3&4). Highly significant differences for both general and specific combining abilities concerning all traits were observed, indicating that genes with additive and non-additive effects are important in the inheritance of these attributes.

However, the estimated GCA/SCA ratios revealed that GCA effects were considerably higher than the SCA ones, suggesting that the additive gene effects are more important in the inheritance of all studied traits. The highest estimated ratio (78.55) between GCA and SCA mean squares was observed in fruit length, while the lowest one (1.30) was observed in early yield by weight (Table 1).

These findings are in agreement with those of Thakur et al., (1980), Rao and Chhonkar (1982), Khadi (1984) and others, who reported that general and specific combining ability effects are involved in the inheritance of earliness, fruit number per plant, total yield, plant height, fruit length and vitamin C content in pepper. On the other hand, these results are not in agreement with those obtained by Soh et al. (1977), Khem et al. (1980), Nowaczyk (1981) and Dulgikh and Sviridova (1983), who mentioned that the additive gene effects control some characters, i.e., plant height, fruit diameter and length, vitamin C and earliness.

Estimates of general combining ability effects for each studied parental cultivars are presented in Tables (2 a&b). The best general combiner cultivar for each character was as follows: Zlaten Medal(1) for high T.S.S. content and plant height; Kyrtovcke Kapija (2) for early yield; Paradicsom Zold Szentesi (3) for average fruit weight, fruit diameter and wall-thickness; Bela Kapija (4) for fruit length, while it was the second best combiner for less number of days to flowering and early yield; Hatvani Hajtatas (5) for less number of days to flowering ($\hat{g}i$ value being negative), early fruit number and

Table 1. Mean squares for general combining ability (GCA) and specific combining ability (SCA) for studied traits.

Traits	S.V.	S.S.	M.S.	F.E.	GCA/SCA
No. of days to first flower	GCA	1855.22	206.14	63.68**	3.65
	SCA	2603.78	57.86	17.88**	
Fruit set %	GCA	3686.12	409.57	122.59**	3.34
	SCA	7222.46	160.499	48.04**	
Plant height(cm.)	GCA	14274.00	1586.00	104.06**	16.18
	SCA	4415.50	98.12	6.44**	
Early fruit No.	GCA	500.45	55.61	264.79**	10.98
	SCA	227.78	5.07	24.11**	
Early fr.weight (g.)	Gca	0.072	0.008	61.28**	1.30
	SCA	0.276	0.006	47.14**	
Total fruit No.	GCA	7325.97	814.00	706.57**	8.69
	SCA	4217.83	93.73	81.36**	
Total fr.weight (kg.)	GCA	2.893	0.321	253.28**	2.76
	SCA	5.241	0.117	91.78**	
Aver.fruit weight (g.)	GCA	6187.93	687.55	916.73**	34.10
	SCA	907.03	20.16	26.88**	
Fruit length (cm.)	GCA	1944.77	216.09	714.96**	78.55
	SCA	123.62	2.75	21.80**	
Fruit diameter (cm.)	GCA	170.63	18.96	250.28**	78.02
	SCA	10.92	0.243	3.20**	
Wall thickness (mm)	GCA	1.95	0.217	517 .41**	78.04
	SCA	0.125	0.003	6.63**	
Locule No.	GCA	9.58	1.065	43.64**	17.07
	SCA	2.81	0.062	2.557**	
T.S.S. %	GCA	56.68	6.30	102.34**	8.41
	SCA	33.70	0.749	12.17**	
Vitamin C (mg/ 100g fr. wt.)	GCA	10449.09	1161.010	54.66**	3.83
	SCA	13646.04	303.245	14.28**	

- Degree of freedoms are 9 and 45 for GCA and SCA , respectively.
- F.T. for GCA are 1.96 and 2.65 at .0.05 and 0.01 levels,respectively.
  SCA are 1.50 and 1.80 at 0.05 and 0.01 level,respectively.

** Significant at 0.01 level of probability.

Table 2-a. Estimates of general combining ability effects ($\hat{g}i$) of parental cultivars for studied plant characteristics.

Parents \ Traits	No. of days	Fruit set %	Plant height (cm)	Early yield: Fruit No.	Early yield: Fruit weight (g)	Total yield: Fruit No.	Total yield: Fruit weight (kg)
1	12.32	8.27**	38.74**	-3.74	-0.089	8.98**	0.186**
2	-1.43**	-15.14	- 6.93	-2.11	0.060**	-18.16	0.144**
3	2.23	-17.25	-13.20	-3.35	0.026**	-25.28	-0.073
4	-9.02**	-2 .49	-11.76	6.09**	0.046**	7.22**	-0.302
5	-12.52**	1.96**	3,36**	6.57**	0.028**	11.75**	-0.433
6	- 1.52**	8.53**	-34.97	-1.22	0.000	- 7.46	-0.257
7	0.57	2.04**	6.20**	1.90**	0.006	11.11**	0.084
8	4.98	-2.75	5.65**	-3.09	-0.044	-11.67	-0.124
9	6.07	15.14**	19.09**	-0.69	-0.021	11.33**	0.378**
10	- 1.68**	1.69**	- 6.18	-0.36	-0.007	12.18**	0.396**
$\hat{g}i-\hat{g}j$ (5%)	1.21	1.10	3.16	0.37	0.009	0.38	0.029
(1%)	1.60	1.47	4.18	0.49	0.012	0.50	0.038

able 2-b. Estimates of general combining ability effects ($\hat{g}i$) of parental cultivars for studied fruit characteristics.

Parents \ Traits	Aver. fruit weight (g)	Fruit length (cm)	Fruit diam. (cm)	Wall thic. (cm)	Locule No.	T.S.S. %	Vitamin C (mg/100 g fr.wt.)
1	-3.24	6.51**	-1.11	-0.12	-0.82	2.08**	10.60**
2	19.99**	-7.90	2.76**	0.34**	0.61**	-0.79	-13.11
3	22.22**	-8.83	2.94**	0 .34**	0.65**	-1.05	-22.16
4	-14.23	7.18**	-2.40	-0.22	-0.22	0.66**	-16.63
5	-18.96	6.95**	-3.18	-0.29	-0.46	1.16**	19.33**
6	- 2.40	-8.39	1.35**	0.15**	0.48**	0.70	-23.66
7	- 6.37	7.90**	-1.85	- 0.21	-0.20	1.36**	14.33**
8	5.49**	-7.73	2.11**	0.17**	0.44**	-1.04	8.33**
9	-0.50	3.08**	-2.35	-0.07	-0.04	-0.39	15.92**
10	-2.01	1.23**	-4.42	-0.09	-0.44	-1.27	7.35**
$\hat{g}i-\hat{g}j$ 5%	0.70	0.29	0.22	0.017	0.13	0.20	3.73
1%	0.92	0.37	0.29	0.22	0.16	0.27	4.93

*, ** Significant at 0.05 and 0.01 level, of probability, respectively.

vitamin C content; Csokros Felallo (9) for high fruit set percentage; and the cultivar Csokros Csungo (10) for total yield.

Furthermore, Zlaten Medal cv. showed high significant GCA effects for fruit set, total fruit number and weight, fruit length and vitamin C. Kyrtovcke Kapija cv. for number of days to first flower, total fruit weight, average fruit weight, wall thickness and high fruit diameter; Paradicsom Zold Szentesi exhibited for early fruit weight and large locule number, while the cultivar Hatvani Hajtatas (5) showed high significant effects for fruit set, plant height, early fruit weight, total fruit number, fruit length and total soluble solids. Also this cultivar showed significant effects of GCA for the most desirable attributes. Sorokszari Hajtato cv. (6) gave significant GCA effects for less number of days to first flower, fruit set, fruit diameter, wall thickness and locule number per fruit. Significant GCA values were obtained for fruit set, plant height, early fruit number, T.S.S. and vitamin C content in Kalocsai cv. (7), while the cultivar Szarvasi (8) exhibited high effects for plant height, average fruit weight, locule number, wall thickness and vitamin C content. Csokros Felallo cv. gave significant effects for total yield, fruit length and vitamin C, whereas Csokros Csungo cv. (10) revealed significant effects for less number of days to flowering, fruit set, fruit length and vitamin C content. These results lead to suggest that each cultivar can be considered a good combiner for more than one character.

Of the 45 evaluated crosses, significant specific combining ability effects were observed in 26, 19, 16, 21, 23, 17, 27, 23, 8 18, 13, 16, 14 and 20 crosses for number of days to flowering, fruit set, plant height, early fruit number and weight, total fruit number and weight, average fruit weight, fruit diameter, fruit length, wall thickness, locule number, T.S.S. and vitmain C content, respectively (Tables 3 and 4).

Table 3. Estimates of specific combining ability effects (Sij) of crosses for studied plant characteristics.

Crosses	Traits						
				Rarly yield		Total yield	
	No. of days to 1st fl.	Fruit set %	Plant height (cm)	Fruit No.	Fruit weight (g)	Fruit No.	Fruit weight (kg)
1 x 2	-10.72**	-4.95	12.72**	2.12**	0.067**	-15.90	-0.249
1 x 3	-17.57**	-23.19	16.49**	3.36**	0.061**	20.08**	1.140**
1 x 4	- 6.32**	-35.76	1.56	-2.07	-0.080	-11.69	-0.493
1 x 5	-29.82**	-24.11	-5.57	4.94**	0.111**	19.48**	0.328**
1 x 6	-6.82**	31.30**	0.27	1.86**	0.145**	- 2.46	0.074**
1 x 7	-7.91**	8.95**	1.10	-4.51	-0.113	6.55**	0.134**
1 x 8	-16.32**	4.82**	-11.86	0.72	0.023*	5.90**	0.314**
1 x 9	18.35	-4.65	0.70	-4.92	-0.159	-18.53	-0.142
1 x 10	- 3.65**	14.75**	26.47**	1.75**	0.093**	- 4.24	0.229**
2 x 3	14.18	- 1.62	8.16*	-1.63	-0.121	- 5.06	-0.711
2 x 4	4.43	-16.06	30.22**	-2.32	0.048**	-13.14	-0.124
2 x 5	3.93	3.57*	- 5.4	-2.18	0.041**	- 3.96	0.285**
2 x 6	-18.07**	1.32	14.93**	1.36*	-0.029	15.40**	0.574**
2 x 7	-15.15**	4.28*	2.27	9.87**	0.369**	2.55*	-0.278
2 x 8	11.43	41.59**	-0.19	- 2.39	-0.120	0.04	0.119
2 x 9	- 8.65**	-16.38	-10.13	1.42*	0.042**	-9.17	0.278**
2 x 10	-4. 90**	-38.82	23.64**	-1.75	-0.049	30 .47**	1.385**
3 x 4	7.77	-13.67	- 8.51	-5.21	-0.093	15.41**	0.779**
3 x 5	8.27	29.28**	10.37**	-2.68	-0.050	- 2.27	0.085*
3 x 6	-6.74**	- 7.08	- 7.80	05.98**	0.313**	1.09	0.345**
3 x 7	9.19	-17.20	2.54	-3.78	-0.079	-18.34	-0.435
3 x 8	-4.77**	8.01**	2.08	-0.41	-0.031	- 1.27	-0.178
3 x 9	-17.32**	-17.01	-16.61	1.18*	0.048**	-8.91	0.271
3 x 10	-7.57**	8.43**	2.41	3.37**	0.223**	-4.27	00.135**

(Cont.).....

Table 3. Cont.

Crosses	No. of days	Fruit set %	Plant height cm.	E. fruit No.	E. fruit weight g.	T. fruit No.	T. fruit weight kg.
4 x 5	-0.49	18.79**	6.43	2.50**	0.001	12.96**	0.117**
4 x 6	-0.49	-35.17	10.24	1.04*	0.047**	0.60	0.661**
4 x 7	-3.57*	55.26**	39.60**	-2.22	-0.108	35.45**	0.389**
4 x 8	-14.99**	- 0.40	2.64	6.28**	0.221**	3.67**	0.095**
4 x 9	- 0.07	13.44**	-6.30	4.25**	0.165**	-3.20	0.080*
4 x 10	3.66	1.35	7.48*	-1.95	-0.082	-1.62	0.141**
5 x 6	-9.99**	-22.03	14.14**	-0.82	0.041**	-25.65	-0.367**
5 x 7	0.93	28.87**	1.97	4.31	0.105**	27.21**	0.629**
5 x 8	-5.49**	- 6.19	12.02**	-0.57	0.001	- 3.43	-0.011
5 x 9	2.43	-11.00	3.58	5.28**	0.102**	23.78**	0.541**
5 x 10	20.18	-21.92	-20.15	-8.06	-0.167	-35.57	-0.808
6 x 7	- 3.07	-13.24	-24.19	-2.52	-0.051	-22.87	-0.328
6 x 8	1.52	-36.06	2.35	-2.90	-0.143**	-6.07	-0.453
6 x 9	- 3.37*	3.42*	12.91**	-2.68	-0.080	35.05**	0.836**
6 x 10	- 0.82	15.32**	-18.31	0.24	-0.068	-9 .94	-0.827
7 x 8	9.43**	-24.39	- 8.82	1.33*	0.091	13 .63**	1.101**
7 x 9	-3.65 **	7 .01**	2.24	3.44**	0.092**	-3.09	0.048
7 x 10	-7.90**	9,21**	-4.99	3.60**	0.054**	-20.80	-0.514
8 x 9	9.93	2.12	16.79**	-4.95	-0.120	9.99**	-0.050
8 x 10	-10.32**	-4.21	18.56**	3.22**	0.138**	14.99**	0.902**
9 x 10	- 7.40**	27.98**	25.12**	5.44**	0.147**	-3.31	0.279**
Sij-Sik)							
5%	4.00	4.90	10.46	1.23	0.031	2.87	0.100
1%	5.29	6.47	13.83	1.62	0.039	4.03	0.130
Sij-Skl)							
5%	3.19	3.24	6.91	0.81	0.020	1.90	0.063
1%	4.22	4.27	9.14	1.07	0.030	2.50	0.084

* , ** Significant at 0.05 and 0.01 level of probability, respectively.

Table 4. Estimates of specific combining ability effects (Sij) of crosses for studied fruit characteristics.

Crosses	Traits						
	Aver. fruit weight g	Fruit length cm	Fruit diam. cm	wall-thick. mm	Locule No.	T.S.S. %	Vitamin C mg/100g fr.wt
1 x 2	8.38**	-2.30	-0.31	-0.057	-0.16	1.37**	30.37**
1 x 3	5.50**	-0.02	-0.34	-0.033	-0.43**	-2.16	- 0.99
1 x 4	-3.03	-0.05	-0.93	-0.087	0.05	4.72**	4.09
1 x 5	-2.76	4.18**	-0.36	0.039*	0.01	1.62**	-38.81
1 x 6	3.89**	-3.41	1.61**	0.187**	-0.24	-2.51	-8.45
1 x 7	-2.06	-0.17	-0.17	0.004	0.56**	-1.58	28.02**
1 x 8	1.71*	-3.41	0.43	0.034	-0.38**	-1.18	-41.13
1 x 9	10.01**	2.89**	0.49	0.028	-0.26	0.97**	31.79**
1 x 10	8.50**	3.13**	0.25	-0.006	0.11	-1.94	-26.79
2 x 3	-7.19	2.02**	0.27	0.144**	0.33*	0.51*	16.59**
2 x 4	6.76**	-0.59	0.17	-0.071	-0.21	-3.41	-59.92
2 x 5	5.21**	0.06	0.39	-0.125	-0.53**	-2.11	21.35**
2 x 6	1.15	4.33**	-0.44	-0.027	-0.21	-0.04	60.90**
2 x 7	0.46	-2.34	-0.01	-0.060	-0.54**	1.29**	1.15
2 x 8	-0.11	1.39**	-0.15	-0.050	0.91**	0.49*	35.10**
2 x 9	0.25	-2.33	0.11	0.040	-0.12	0.44	- 9.09
2 x 10	2.81**	-1.39	0.98	0.010	-0.25	0.92**	- 48.23
3 x 4	1.76*	0.20	0.74	-0.107	-0.28	-0.34	28.56**
3 x 5	-3.43	-2.63	0.80	-0.101	-0.54**	-1.24	-20.6
3 x 6	11.91**	3.16**	0.41	-0.032	-0.06	0.02	-15.59
3 x 7	2.39**	-0.33	-0.44	-0.136	-0.12	-0.84	- 2.33
3 x 8	0.25	3.45**	-0.46	0.105**	0.29	1.56**	26.12**
3 x 9	-0.01	-5.10	0.20	0.009	-0.15	0.31	-11.51
3 x 10	6.43**	-3.71	1.45**	-0.125	-0.07	0.59*	- 2.85

(Cont.).....

ıble 4. Cont.

ɔsses	Aver.fruit Weight g.	Fruit length cm.	Fruit diam. cm.	Wall-thick. mm.	Locule No.	T.S.S. %	Vitamin C mg/100 g fr.wt.
x 5	-1.40	0.15	-0.71	0.095**	0.03	-0.56	- 2.42
x 6	12.65**	-0.65	1.21**	-0.007	-0.27	-1.49	13.19**
x 7	- 8.50	0.77*	-0.37	0.060**	-0.13	-0.16	- 6.87
x 8	- 1.42	-1.36	0.37	-0.060	-0.58**	-0.76	-21.26
x 9	4.80**	4.11**	0.29	0.064**	-0.39**	-0.14	26.61**
x 10	2.10	2.69**	-0.50	0.050	-0.04	-0.13	12.42**
x 6	7.43**	-2.08	1.64**	0.294**	-0.12	-0.99	- 3.24
x 7	0.70	1.17**	0.19	0.006	0.23	1.94**	28.81**
x 8	-0.79	-2.41	-0.18	-0.053	-0.03	-0.86	37.29**
x 9	-1.32	3.71**	0.02	0.001	0.04	-2.31	23.43**
x 10	4.96**	0.98**	-0.63	-0.073	0.21	-1.43	-24.26
x 7	9.57**	-0.71	0.42	0.034	-0.53**	0.62**	- 5.08
x 8	-6.48	5.49**	-0.79	-0.135	-0.01	-0.19	48.88**
x 9	-5.14	-5.19	1.33**	0.079**	-0.07	0.16	12.41**
x 10	-11.60	-4.85	0.45	0.135**	-0.36*	1.04	-40.00
x 8	12.64**	-1.75	1.42**	0.022	-0.12	-1.46	-43.75
x 9	1.94*	2.39**	-0.89	-0.045	0.07	-1.11	-49.74
x 10	3.02**	2.42**	-0.03	0.132**	0.36*	-1.03	34.30**
x 9	-9.99	-4.77	0.64	0.066**	-0. 36*	1.89**	-35.14
x 10	8.75**	-1.40	1.07**	0.163**	- 1.01**	0.57*	42.74**
x 10	8.49**	1.48**	- 0.17	-0.064	0.44**	0.12	10.51**
Sij-Sik)							
5%	2.32	0.95	-0.74	0.05	0.41	0.66	12.34
1%	3.07	1.26	0.97	0.07	0.55	0.89	16.32
Sij-Skl)							
5%	1.53	0.63	0.49	0.04	0.28	0.44	8.16
1%	2.02	0.84	0.64	0.05	0.37	0.58	10.79

* , ** Significant at 0.05 and 0.01 level of probability, respectively.

However, the best combinations in studied characters were: 1 x 5 (number of days to flowering), 4 x 7 (fruit set, plant height and total fruit number), 2 x 7 (both early fruit number and weight), 2 x 10 (total yield), 4 x 6 (average fruit weight), 6 x 8 (fruit length), 5 x 6 (fruit diameter and wall thickness), 2 x 8 (locule number), 1 x 4 (T.S.S.) and the cross 2 x 5 for (vitamin C content). Accordingly, these superior and prospective new pepper materials can be used for pepper improvement through breeding programmes.

In an attempt to determine the relationship of SCA for all combinations and the GCA effects of the parents involved, no particular relationships were observed. The cross with the highest SCA effects in average fruit weight, i.e., 4 x 6 was the combination of poor and poor general combining parents, while the cross with the highest SCA effects in fruit set, i.e., 4 x 7 was the combination of poor x medium general combining parents. The cross with the highest SCA effects in vitamin C, i.e., 2 x 5 was the combination of poor x high general combining ability parents. The cross with the highest SCA effects in number of locules per fruit, i.e., 2 x 8 was the combination of medium x medium general combining ability parents. The cross with the highest SCA effects in total yield 2 x 10 was the combination of medium x high general combining ability parents. However, all types of combinations, i.e., poor x poor, poor x medium, poor x high, medium x medium and medium x high GCA parents showed significant SCA effects, but the most of significant values were observed in the combinations which had at least one parent with high or medium GCA effects. Similar results were reported by Surjan et al. (1972) and Khalil et al. (1987) in tomato.

These results indicate that estimates of specific combining ability effects are important in order to determine the best combiner parental cultivars. The GCA and SCA estimates had revealed the importance of additive and non-additive type of gene action, with

relatively high ratios of GCA/SCA mean squares. However, reccurent selection in handling such population is recommended.

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