

PHENOTYPIC BEHAVIOUR OF SOME INTRODUCED PEPPER
CULTIVARS UNDER PLASTIC HOUSES IN WINTER SEASON

R.M. Khalil, N.M. Malash and El-Mahdy Metwally
Dept. of Hort., Faculty of Agriculture, Minufiya Univ.
and Tanta Univ.

سلوك بعض أصناف الفلفل المستوردة تحت الصوب البلاستيكية فى العروة الشتوية

رشدى مختار خليل - نبيل محمد ملش - المهدي ابراهيم متولى
كلية الزراعة - جامعة المنوفية وجامعة طنطا

ملخص البحث

تم تقييم عشرة أصناف مستوردة من الفلفل زرعت داخل الصوب البلاستيكية خلال الموسم الشتوي فى عامى ١٩٨٥/١٩٨٦م ، ١٩٨٦/١٩٨٧م ومعها الصنف كاليفورنيا وندر الأكثر انتشارا فى مصر وذلك فى مزرعة التجارب بكلية الزراعة بشبين الكوم .

أخذت البيانات على أربعة عشر صفة تتعلق بالنبات (طول النبات ، تاريخ الأزهار وكمية المحصول المبكر والكلى) والثمرة (متوسط الوزن ، الطول ، القطر ، اللون ، سمك الجدار وعدد الساكن) بالإضافة الى محتوى الثمرة من المواد الصلبة الكلية الذائبة وفيتامين ج . وأوضحت النتائج الآتى :

١ - أعطى الصنفان Szarvasi ، Kyrtoveck Kapiya (من الأصناف الحلوة) والصف Kalocsai (من الأصناف الحريفة) أعلى محصول مبكر :

٢ - الأصناف Csokros Csungo ، Csokros Felallo ، Zlaten Medal (من الأصناف الحلوة) أعطت أعلى محصول كللى - ونوقت فى ذلك على الصنف كاليفورنيا وندر بنسبة تتراوح بين ١٣ - ٢٨% . كما تميزت هذه الأصناف بثمار طويلة بمتوسط وزن يتراوح من ٢٤ الى ٣١ جرام واحتوت على أعلى قيمة من المواد الصلبة الكلية الذائبة وكذلك فيتامين ج ونوصى باستعمالها فى الزراعة تحت البلاستيك ، كما أنها تعتبر مصدر وراثى جيد عند الرغبة فى تحسين الأصناف المحلية لهذه الصفات .

٢ - تميزت الأصناف الأَصناف Paradičsom Zold Szentesi ، Kyrtovcke Kapija ،
بشمار متوسطة الحجم (٤٢ ، ٤٩ جرام تقريبا) وجدار ثمرى سميك (٢٣ ،
٦٩ سم) مما يجعلها مقبولة فى الاستهلاك الطازج والتصنيع . كما
تعتبر مصدر وراثى جيد عند الرغبة فى انتاج أصناف ذات ثمار سميكة
اللحم .

٤ - تميزت الأصناف Csokros Csungo ، Soroksari Hajtato
Csokros Felallo بلون ثمارها الشمعى (أبيض مصفر) .

٥ - وجد ارتباط معنى بين عدد من الصفات التى درست وهذا يساعد عند
الانتخاب لصفات مرغوبة . فليكن الانتخاب لأكثر من صفة فى وقت واحد .

ABSTRACT

Evaluation of ten pepper cultivars with regard to 14-plant and fruit characteristics were made during 1985/1986 and 1986/1987 winter seasons under plastic houses without heating. A randomized complete block design with three replications was used. Highly significant differences were found between cultivars in all characters studied.

Cultivars, Kyrtovcke Kapija, Szarvasi (sweet flesh) and Kalocsai (hot flesh) gave the highest early yield. Csokros Csungo, Csokros Felallo and Zlaten Medal cvs. produced the highest total fruit yield (about 28.0, 25.0 and 13%, respectively, over California Wonder cultivar). The largest weight, width, pericarp thickness and locule number of fruits were produced by Paradičsom Zold Szentesi and Kyrtovcke Kapija cvs. While the cultivars Zlaten Medal, Csokros Felallo and Csokros Csungo gave the longest fruits and the highest fruit total soluble solids and vitamin C content compared with the remaining cultivars.

Plant height ranged from 61.7 to 90.1 cm. in hot cvs., and from 61.2 to 114.5 cm. in sweet ones. The highest plants were observed in Zlaten Medal cv. Fruit colour ranged from waxy to dark green in cultivars studied. Among sweet cvs. Soroksari Hajtato, Csokros Felallo and Csokros Csungo had waxy fruits.

The relationships between traits studied were determined by correlation coefficients. Significant correlations were found between various pairs of characters, indicating possibilities for selection for certain traits based on other ones.

INTRODUCTION

Pepper, *Capsicum annuum*, L. is one of the most important vegetable crops throughout the world including Egypt. Yielding ability and fruit characteristics are important in choosing a cultivar for planting in a certain area. Therefore, attention must be given to improving the cultivars regarding these attributes for grower and consumer. As a result of plant breeding, modern cultivars often have higher crop indices than other ones (Holiday, 1976). Introductions and evaluation of new cultivars is very active and quick method in a crop improvement, since the promising new cultivars are selected and replaced instead of the older outmoded ones.

Significant varietal differences were reported by several investigators among them were: Kirti et al., (1972) and Alieva (1981 & 1984), concerning earliness; Bozzoli and Calzoni (1974) and Arya and Saini (1976), for total yield; Pospislova and Toul (1967), Cambraia et al., (1971), Bozzoli and Calzoni (1974), Panker and Magar (1978) and abu El-Hassan et al., (1986), regarding chemical compositions of fruit.

A number of correlations had been found between various pairs of pepper characters. Total fruit yield was found to be highly correlated with plant height, fruit number, average fruit weight, fruit length, early fruit yield and flesh thickness (Raju, 1980; Suthanthirapandian et al., 1981; Veerappa, 1982; Joshi and Brahma, 1983; Depestre et al., 1981 and Nair et al., 1984). On the contrary, negative correlations was observed between total yield and some other plant and fruit characters, i.e., number of days to first flowering (Jo et al., 1973; and Suthanthirapandian et al., 1981); Plant height, capsaicin content and leaf length (Arya and Saini, 1976). According to Sathe and Phadnavis (1977) ascorbic acid content was positively correlated with fruit length.

Fruit development depends generally on normal seed set, a process occurring under conditions of normal fertilization. Sub-optimal temperatures were found to stop pollen development, pollen germination and fertilization (Tadahiko, 1965 and Rylyski, 1971). Tadahiko, (1965) added that genetic differences in response to sub-optimal temperature do exist in peppers. Over the past few years pepper became an important plastic house crop in Egypt for early production and exportation. Hence, the major purpose of the present study was for determining the most promising genotype(s) with regard to early and total yields, as well as, some fruit characteristics for planting in winter season under plastic green houses.

MATERIALS AND METHODS

The experiments were carried out during the winter seasons of 1985/1986 and 1986/1987 at the Experimental Farm, Faculty of Agriculture, Minufiya University. Ten pepper cultivars namely: Bela Kapija, Hatvani Hajtatasi, Kalocasai, Zlaten Medal, Kyrtovcke Kapija, Paradicsom Zold Szentesi, Soroksari Hajtato, Szarvasi, Csokros Felallo and Csokros Csungo were used in this study. The cultivars were brought, from Hungary, and mentioned for four generations by selfing.

The cultivars were arranged in a randomized complete block design with three replications. Sowing was done in the middle of September and the nursery was covered with plastic tunnel. Seedlings were transplanted about six weeks later, in both plantings, into unheated plastic house in double rows with a spacing of 70x35 cm. California Wonder cultivar, which is widely planted in Egypt was used as control. Cultivation, fertilization, irrigation, disease and insect control programme were followed as commonly practiced. Fruits were picked every two weeks at the green mature stage.

Data were recorded on the following traits:

- 1- Number of days from transplanting to first flower anthesis.
- 2- Early fruit number/plant (the first three harvests).
- 3- Early fruit weight/plant (the first three harvests).
- 4- Total yield (fruit number/plant) in all harvests.
- 5- Total yield (fruit weight/plant) in all harvests.
- 6- Average fruit weight; was determined by dividing total fruit weight by the total fruit number.
- 7- Fruit length and diameter in cm.
- 8- Wall thickness in cm.
- 9- Locule number.
- 10- Vitamin C content, was determined according to the procedure reported by the A.O.A.C. (1975).
- 11- Total soluble solids content (T.S.S.), was determined by the hand refractometer, (Rick, 1974).
- 12- Plant height, in cm.
- 13- Fruit colour.

All data were subjected to statistical analysis according to Snedecor and Cochran (1967). Correlation coefficients were calculated for several pairs of characters (Steel and Torrie, 1960) using character means of the all cultivars evaluated.

RESULTS AND DISCUSSION

1- Number of days from transplanting to first flower:

Data presented in Table (1) show that highly significant differences were found among cultivars in date of first flower anthesis in the two experimental seasons. Combined data indicate that hot cultivars were earlier than sweet ones. Flowering was observed firstly in the cultivar Hatvani Hajtatasi, followed by Kalocsai and

Table 1. Number of days from transplanting to first flower anthesis and early yield of pepper cultivars in 1985/1986 and 1986/1987.

Cultivars	NO. of days to first flower anthesis			Early yield / plant					
				No. of fruits			Weight of fruits kg.		
	1986	1987	mean	1986	1987	mean	1986	1987	mean
Hot cvs.									
Bela Kapija	33.0	29.0	31.0	15.3	9.4	12.4	0.267	0.180	0.224
Hatvani Hajtatas	31.0	26.0	28.5	17.0	9.3	13.2	0.258	0.162	0.211
Kalocsai	39.0	37.0	38.0	17.3	5.1	11.2	0.369	0.115	0.242
Mean	34.3	30.7	32.5	16.5	7.9	12.2	0.299	0.152	0.226
Sweet cvs.									
Zlatan Medal	56.0	56.0	56.0	10.4	2.3	6.4	0.213	0.089	0.151
Kyrtovcke Kapija	41.0	36.0	38.5	7.9	3.1	5.5	0.292	0.173	0.233
Paradicsom Zold Szentesi	45.0	35.0	40.0	6.5	3.0	4.8	0.233	0.146	0.190
SOkrosari Hajtato	43.0	40.0	41.5	11.5	4.3	7.9	0.233	0.144	0.187
Szarvasi	45.0	38.0	41.5	18.4	3.1	10.8	0.247	0.134	0.191
Csokros Felallo	46.0	40.0	43.0	7.6	3.5	5.6	0.253	0.120	0.187
Csokros Csungo	41.0	35.0	38.0	12.2	4.1	8.2	0.245	0.121	0.183
California Wonder	48.0	42.7	45.4	3.5	2.4	3.0	0.305	0.217	0.261
Mean	45.6	40.3	43.0	8.5	3.2	2.9	0.254	0.143	0.192
L.S.D.	5 %	3.7	3.0	2.3	0.7		0.017	0.021	
	1 %	5.0	4.1	3.2	0.9		0.026	0.028	

Csokros Csungo cvs. On the other hand, Zlaten Medal was the latest cv. in flowering. Generally, all hot cvs. and Kyrtovcke Kapija, Paradicsom Zold Szentesi, Csokros Felallo and Csokros Csungo from the sweet group flowered earlier than California Wonder, the standard cv. These results confirmed those of Abou El-Hassan et al. (1986), who mentioned that flowering date varied widely between cultivars.

2- Early yield:

Number and weight of early fruits in the different pepper cultivars are shown in Table (1). All pungent cultivars and six of the sweet cultivars gave higher number of fruits as compared with California Wonder cv. Only Paradicsom Zold Szentesi cv. produced fewer early fruit number than that of the control cv. Among sweet cvs., Szarvasi showed the highest fruit number. Over-all average of hot cvs. significantly exceeded that of the sweet cvs. in both seasons, regarding number of early fruits.

On the other hand, weight of early fruits in all studied cvs. was significantly lower than that of California Wonder in both experimental seasons. However, pungent cvs. showed the highest early yield, followed by the cultivars Kyrtovcke Kapija, Paradicsom Zold Szentesi. The superiority of California Wonder cv. in early fruit weight is due to its large average fruit weight. Alieva (1984) also found that hot cvs. produced early fruit number and weight more than those produced by sweet cvs.

3- Total yield:

Data illustrated in Table (2) indicate that all cvs., without exceptions, significantly exceeded California Wonder cv. in total fruit number per plant. Data also show that overall mean of hot cvs. was higher than that of sweet cvs. over the two seasons. The

Table 2. Total fruit yield and average fruit weight of studied pepper cultivars, 1985/1986 and 1986/1987.

Cultivars	Total fruit yield						Aver. fruit weight			
	No. of fruits			Weight of fruits (kg.)			(gm.)			
	1986	1987	mean	1986	1987	mean	1986	1987	mean	
Hot cvs.										
Bela Kapija	48.0	39.0	43.5	0.837	0.824	0.831	17.5	21.1	19.3	
Hatvani Hajtatasi	61.0	46.3	53.7	0.686	0.869	0.778	14.2	18.8	16.5	
Kalocsai	61.8	44.6	53.2	1.284	1.128	1.206	20.8	25.3	23.0	
Mean	56.9	43.3	50.1	0.936	0.940	0.938	17.5	21.7	19.6	
Sweet cvs.										
Zlaten Medal	50.6	46.7	48.7	1.194	1.201	1.198	23.6	25.8	24.7	
Kyrtovcke Kapija	37.4	28.2	32.8	1.301	1.222	1.262	34.8	43.3	39.1	
Paradicsom Zold Szentesi	29.4	24.3	26.9	1.184	1.088	1.136	40.3	44.8	42.6	
Soroksari Hajtato	46.3	38.1	42.2	1.083	1.044	1.064	23.4	27.4	25.4	
Szarvasi	36.7	26.5	31.6	1.113	0.950	1.032	30.4	35.8	33.1	
Csakros Felallo	41.3	44.3	42.8	1.276	1.378	1.327	30.9	31.1	31.0	
Csakros Csungo	59.8	54.4	57.1	1.298	1.410	1.354	21.8	25.9	23.9	
Calif. Wonder	12.9	13.0	13.0	0.938	1.182	1.060	78.5	91.3	84.9	
Mean	39.2	34.4	36.8	1.173	1.184	1.179	35.5	40.7	38.1	
L.S.D.	5 %	4.0	2.0	0.029	0.040		2.0	1.5		
	1 %	5.4	2.7	0.039	0.054		2.8	2.1		

highest number of fruits was produced by Hatvani Hajtatasi and Kalocsai cvs. (from hot group), as well as, Csokros Csungo and Zlaten Medal cvs. (from sweet group), which were long fruited cvs. But the highest number of fruits obtained in this study was from plants of Csokros Csungo cv.

Total yield by weight was significantly higher in sweet cvs. than hot cvs. This result is due to large average fruit weight in the mild cvs. The highest fruit yield was reflected by cultivars Csokros Csungo, Csokros Felallo, Kyrtocke Kapija and Zlaten Medal. Among pungent cvs., Kalocsai gave the highest yield. On the other hand, the lowest yield was reflected by the cvs. Bela Kapija and Hatvani Hajtatasi. In general, all sweet cvs. outyielded the standard cv., California Wonder. Significant differences in total fruit weight and number per unit area were also observed between pepper cultivars elsewhere (Bozzoli & Calzoni, 1974 and Arya & Saini, 1976).

4- Average fruit weight; length and diameter:

Data concerning average fruit weight are shown in Table (2), and concerning fruit dimensions in Table (3). It is obvious that hot cvs. gave smaller, longer and thinner fruits than those given by sweet cultivars. The largest fruit weight was observed in the Paradicsom Zold Szentesi and Kyrtocke Kapija cvs., while the smallest fruits were observed in Csokros Csungo and Zlaten Medal. Three sweet cvs. i.e., Zlaten Medal, Csokros Felallo and Csokros Csungo produced the longest fruits among the sweet group. However, all pungent cvs. were significantly longer than these cvs. The highest values of fruit diameter were observed in the Kyrtocke Kapija, Paradicsom Zold Szentesi and Szarvasi. As a whole, none of cultivars studied competed California Wonder in either fruit weight or width. The present results regarding fruit weight, length and

Table 3. Fruit dimensions and colour of studied pepper cultivars, 1985/1986 and 1986/1987.

Cultivars	Fruit length in cm.			Fruit diameter in cm.			Fruit colour 1986&1987
	1986	1987	mean	1986	1987	mean	
Hot cvs							
Bela Kapija	13.7	14.0	13.9	2.3	2.6	2.5	Green
Ha tvani Hajtatasi	14.2	14.2	14.2	1.7	1.9	1.8	Green
Kalocsai	12.7	15.1	13.9	3.1	2.9	3.0	Dark green
Mean	13.5	14.4	14.0	2.4	2.5	2.5	
Sweet cvs.							
Zlaten Medal	11.0	14.3	11.7	2.9	3.3	3.1	Light green
Kyrtovcke Kapija	4.2	5.0	4.6	5.2	5.8	5.5	Green
Paradicsom Zold Szentesi.	4.1	4.7	4.4	5.5	5.8	5.7	Green
Soroksari Heitato	3.6	5.2	4.4	4.1	4.4	4.3	Waxy
Szarvasi	4.3	5.7	5.0	5.1	5.3	5.2	Dark green
Csokros Felallo	11.7	12.6	12.2	3.8	3.6	3.7	Waxy
Csokros Csungo	10.8	11.0	10.9	3.8	3.6	3.7	Waxy
Clif. Wonder	7.5	9.1	8.3	5.5	7.0	6.3	Green
Mean	7.2	8.5	7.9	5.5	4.7	5.1	
L.S.E. 5 %	0.33	0.44		0.7	1.1		
L.S.E. 1 %	0.45	0.57		1.0	1.5		

diameter were in harmony with those reported by Zatyko (1979) on the cvs., Paradicsom Zold Szentesi, Szarvasi, Csokros Felallo and Csokros Csungo, in Hungary.

5- Wall thickness, and locule number/fruit:

Data presented in Table (4) show that the thickest wall of fruit was recorded in the fruits of Paradicsom Zold Szentesi and Kyrtocke Kapija cvs. in the two seasons. They significantly exceeded California Wonder and other cvs. . On the other hand, the thinnest flesh values were shown by the three hot cvs., in addition to, the long fruited cvs. (from the sweet group), i.e., Zlaten Medal, Csokros Felallo and Csokros Csungo. Generally, the long fruited cvs. showed lower wall thickness values than those of short fruited ones.

Average locule number per fruit ranged from two to three locules in most studied cvs. Only three cvs.. i.e., Kyrtocke Kapija, Paradicsom Zold Szentesi and Szarvasi gave fruits with three to four locules (Table 4).

6- Plant height and fruit colour:

Data presented in Table (4) show significant differences among cultivars studied in plant height. Average plant height values ranged from 60.7 to 127.7 cm. and from 56.0 to 101.2 cm. in the first and second seasons, respectively. However, the plants of Zlaten Medal cv. showed the maximum height values with average of 127.7 and 101.2 cm. in the first and second seasons, respectively, followed by the cultivar Csokros Felallo (101.5 and 90.5 cm., in the two seasons, respectively). On the other hand, minimum average plant height was recorded in the cultivar Soroksari Hajtato (60.7 and 61.7 cm., respectively, in the first and second seasons).

Colour of fruits was determined by naked eye in relation to the green fruits of the standard cultivar, California Wonder. The

Table 4. Wall thickness, locule number per fruit and plant height of studied pepper cultivars, 1985/1986 and 1986/1987.

Cultivars	Wall thickness in cm.			Locule number			Plant height in cm.		
	1986	1987	mean	1986	1987	mean	1986	1987	mean
	Hot cvs.								
Bela Kapija	0.28	0.27	0.28	2.83	2.71	2.77	67.3	56.0	61.7
Hatvani najtatasi	0.23	0.23	0.23	2.85	2.37	2.61	88.5	81.7	85.1
Kalocsai	0.24	0.25	0.25	2.58	2.56	2.57	95.7	84.5	90.1
Mean	0.25	0.25	0.25	2.75	2.55	2.65	83.8	74.1	79.0
Sweet cvs.									
Zlaten Medal	0.29	0.30	0.30	2.17	2.13	2.15	127.7	101.2	114.5
Kyrtovcke Kapija	0.72	0.66	0.69	3.17	3.11	3.14	79.3	65.0	72.2
Paradicsom Zold Szentesi.	0.78	0.67	0.73	3.22	3.17	3.20	81.7	72.0	76.9
Soroksari Hajtato.	0.52	0.45	0.49	3.17	3.19	3.18	60.7	61.7	61.2
Szarvasi	0.49	0.49	0.49	3.0	3.07	3.04	86.0	80.4	83.2
Csokros Felallo	0.41	0.33	0.37	2.67	2.67	2.67	101.5	90.5	96.0
Csokros Csungo	0.37	0.31	0.34	2.35	2.37	2.36	72.8	68.2	70.2
Calif. Wonder	0.63	0.52	0.58	3.83	3.25	3.54	110.5	95.3	102.9
Mean	0.53	0.47	0.50	2.94	2.87	2.91	90.0	79.3	84.7
L.S.D.	5 %	0.017	0.03	0.38	0.38		10.8	7.1	
	1 %	0.020	0.04	0.51	0.51		14.7	9.7	

studied cultivars could be classified into four groups based on their fruit colour as follows: cultivars with dark green fruits, i.e., Kalocsai, and Szarvasi; cultivars with green fruits, i.e., Bela Kapija, Hatvani Hajtatasi, Kyrtovccke Kapija and Paradicsom Zold Szentesi; cultivars produced waxy fruits, i.e., Soroksari Hajtato, Csokros Felallo and Csokros Csungo; and the light green fruits were produced by Zlaten Medal cv. (Table 3). The waxy colour was also recorded by Zatyko (1979) for the same cultivars, in Hungary.

7- Total soluble solids and vitamin C content:

Data obtained on the total soluble solids (T.S.S.) and vitamin C content in pepper fruits of cultivars under study are presented in Table (5). Differences in total soluble solids and vitamin C content were significant among cultivars in the two seasons. It is obvious that hot cultivars have higher percentage of total soluble solids than the sweet ones in the two seasons. The average values were 6.8 and 5.6% for the two groups, respectively. Of sweet cvs., Zlaten Medal cultivar contained the highest percentage, while Szarvasi cv. contained the lowest percentage, but did not differ significantly from standard cv., California Wonder.

For vitamin C content, combined data over the two seasons revealed that the Zlaten Medal cv. also have the highest content followed by Csokros Csungo and Csokros Felallo cultivars. Slight difference, was observed between the general mean of hot and sweet groups in this respect. In the two seasons, Zlaten Medal, Csokros Felallo and Csokros Csungo cvs. significantly exceeded California Wonder in vitamin C content, while four cvs., i.e., Bela Kapija, Szarvasi, Hatvani Hajtatasi and Kalocsai surpassed it in the first or the second season only (Table 5).

This result confirmed previous results obtained by Bozzoli and Calzoni (1974) and Pankar and Magar (1978), who reported that

Table 5. Fruit total soluble solids and vitamin C content of studied pepper cultivars, 1985/1986 and 1986/1987.

Cultivars	Total soluble solids %			Vitamin C mg/100 gr.		
	1986	1987	mean	1986	1987	mean
Hot cvs.						
Bela Kapija	6.0	7.1	6.5	105.6	105.4	105.6
Hatvani hajtatas	6.1	7.9	7.0	86.7	124.7	105.7
Kalocsai	6.1	7.5	6.8	96.0	127.7	111.9
Mean	6.1	7.5	6.8	96.1	119.3	107.7
Zlatan Medal	5.8	7.7	6.8	138.0	126.3	132.2
Kyrtovcke Kapija	4.9	5.7	5.3	96.0	98.8	97.4
Paradicsom Zold Szentesi.	5.3	5.7	5.5	86.4	97.7	92.1
Soroksari Hajtato	4.4	6.3	5.4	80.0	89.3	84.7
Szarvasi	4.7	5.5	5.1	105.6	112.9	109.3
Csokros Felallo	4.7	6.1	5.4	98.8	126.3	112.5
Csokros Csungo	5.1	5.5	5.3	99.6	127.5	113.6
Calif. Wonder	5.3	5.7	5.5	90.7	105.2	98.0
Mean	5.1	6.0	5.6	99.4	110.8	105.1
L.S.D.	5 %	0.05	0.60	5.6	8.4	
	1%	0.07	0.70	7.6	11.4	

ascorbic acid content varied widely between cultivars. Our results also agreed with former report in which large variation in chemical composition was observed between cultivars due to the variety and weather conditions (Butkevich and Kharkova, 1971).

Correlation coefficients between pairs of characters studied were estimated and listed in Table (6). Correlation values indicated that : 1) High number of early fruits associated with short period to flowering. 2) High number of total fruit yield associated with high number of early fruits. 3) Large fruit associated with few number of fruits in early and total yield. 4) Long fruit character associated with high number of fruits in early and total yield and small fruit. 5) High fruit diameter was associated with each of few number of fruits in early and total yield, short fruit and large fruit weight. 6) Large value of pericarp thickness was associated with each of few number of fruits in early and total yield, short fruit, large fruit and high fruit diameter. 7) High locule number was associated with each of few number of fruits in total yield, short fruit, large width and weight of fruit and higher value of wall thickness. 8) High value of plant height was associated with long period to first flower. 9) High total soluble solids content was associated with each of high early fruit number, long fruit and thin diameter and pericarp of fruit. 10) High vitamin C content was associated with each of long fruit, thin pericarp, few locule number and tall plant. 11) No significant correlation was found between fruit weight in both early and total yield with any of other traits studied.

Previous reports were contradictory regarding the correlation between total yield and other traits in pepper. Positive correlation with plant height, fruit number, average fruit weight, fruit length, early fruit yield and pericarp thickness had been found by

Table 6. Correlation coefficients between pairs of characters studied in pepper.

Character No.	1	2	3	4	5	6	7	8	9	10	11	12	
2		* -0.66											
3		-0.45	0.11										
4		-0.22	0.76	-0.33									
5		0.53	-0.43	-0.19	0.13								
6		0.33	-0.75	0.46	-0.89	0.07							
7		0.06	0.75	-0.09	0.80	-0.03	*						
8		0.36	-0.89	0.19	-0.87	0.28	**	**					
9		0.20	-0.77	0.11	-0.79	0.20	**	**	**				
10		-0.13	-0.51	0.48	-0.87	-0.26	**	**	**	**			
11		0.63	-0.31	-0.06	-0.13	0.33	**	**	**	0.01	-0.21	-0.25	
12		-0.22	0.73	0.06	0.52	-0.44	**	**	**	0.78	-0.72	-0.54	
13		0.41	0.18	-0.33	0.50	0.26	*	*	*	0.67	-0.49	-0.65	
												0.64	
													0.46

* , ** Significant at P 0.05 and 0.01 level, resp actively.

Character NO.: 1, No. of days to first flower.

2, No. of early fruits.

3, Weight of early fruits.

4, No. of total fruits.

5, Weight of total yield.

6, Average fruit weight.

7, Fruit length.

8, Fruit diameter.

9, Wall thickness

10, Locule number

11, Plant height

12, Total soluble solids content.

13, Vitamin C content.

several workers as Raju (1980); Depestre et al. (1981) and Nair et al. (1984). Negative correlation with period to first flower (Suthanthirapandian et al., 1981) and plant height (Arya and Saini, 1976) were found.

It is obvious that each studied character varied in different cultivars, which may be due to difference in their growth, flowering, yield and fruit characteristics as well as chemical constitution. The appearance of certain trait is greatly affected by the environmental conditions during growing period. Moreover, some traits depend upon another ones such as average fruit weight which differs in each cultivar according to fruit dimensions and pericarp thickness. Also, each cultivar has its own germplasm which differs from one to another. In other words, the cultivar performance is mainly controlled by genetical factors.

Based on the results of this study we recommend for cultivation under plastic greenhouses Kalocsai and Hatvani Hajtatas as pungent pepper and Zlatan Medal, Csokros Csungo and Csokros Felallo as mild cultivars. This result does not mean, however, that the remaining cultivars were worthless. In fact, from the plant breeders' point of view, each genotype could provide the breeder with one or more of the characters which could be used in breeding programmes. The correlations observed between various pairs of attributes gave possibilities for selection for certain character based on other ones.

REFERENCES

- Abou El-Hassan, E.A.; R.S. Bekhit and K.A. El-Fadaly (1986). Comparative studies on growth, yield and fruit quality of some pepper cultivars. Bull. Fac. Agric., Univ. of Cairo, Vol. 37, No. 1.

- Alieva, Z.A. (1981). Red pepper varieties for Apsheron. Kartofel i Ovoshchi No. 10, 33-34 (Ru) Institut ovoshchevodstva, Baku. Azerbaijan SSR. (C.F. Plant Breed. Abstr. 1984, Vol. 54. Abstr. No. 6233).
- (1984). Hot pepper in the Apsheron. Kartofel i Ovoshchi No. 9, 23 (Ru) Azerbaidzhanski N, i. Institut Ovoshchevodstva, Baku. Azerbaijan SSR. (C.F. Plant Breed. Abstr. 1986 Vol. 56. Abstr. No. 9206).
- A.O.A.C. (1975). Association of official agricultural chemists. Official methods of analysis. 12th, edn. Washington, D.C.
- Arya, P.S.; and S.S. Saini (1976). Genetic variability and correlation studies in bell peppers. Indian Journal of Agric. Res. 10 (4) 223-228.
- Bozzoli, M.; and G.L. Calzoni (1974). Cultivation trails of sweet pepper for processing. Annali dell' istituto Sperimentale per le Colture Industriali 6 (1) 119-123. ISCI, Bologna, Italy. (C.F. Plant Breed. Abstr. Vol. 47. Abstr. No. 10706).
- Butkevich, S.T.; and A.P. Kharkova (1971). The chemical composition of the fruit of some sweet pepper varieties. Tr. Mold. Nil oroshhaem. zemledeliya i ovoshchevodstva 11 (1) 136-141. (C.F. Plant Breed. Abstr. Vol. 42. Abstr. No. 8601).
- Cambraia, J.; V.W.D. Casali; W. Bruni; and F.A.A. Couto (1971). Vitamin C in sweet and hot peppers (*Capsicum* spp.) Revista Ceres 18(97) 177-194.
- Depestre, T.; O. Gomez; and J.C. Hernandez (1981). Phenotypic correlations in sweet pepper (*Capsicum annuum*). Ciencia y Tecnica en la Agricultura, Viandas, Hortalizas y Granos 4 (1) 83-90. (C.F. Plant Breed. Abstr. Vol. 53. Abstr. No. 2636).
- Holiday, R. (1976). The efficiency of solar energy conversion by the whole crop. Food Prod. and Cons. P. 127-146.
- Jo, Y.K.; I.U. Yu; and S.S.I. (1973). A study on characteristics and correlation between pepper varieties. Research Reports of the Office of Rural Development, Horticulture 15, 1-7.
- Joshi, S.; and Singh Brahma (1983). Genotypic and phenotypic paths to fruit yield in sweet pepper (*Capsicum annuum* L.). Progressive Horticulture 15 (3) 222-225.
- Kirti Singh; Bhoop Singh; Kallo; and Narresh Mehrotra (1972). Genetic variability and correlation studies in chillies. Haryana Agric. Univ. J. of Res. 11 (1) 13-18. (C.F. Plant Breed. Abstr. Vol. 44. Abstr. No. 3999).
- Nair, P.M.; M.K. George; N. Mohanakumaran; V.G. Nairi; and P. Saraswathy (1984). Studied on correlation and path analysis in *Capsicum annuum* L. South Indian Horticulture 32 (4) 212-218.
- Pankar, D.S.; and N.G. Magar (1978). Capsaicine, total colouring matter and ascorbic acid contents in some selected varieties of chilli (*Capsicum annuum* L. J. of Maharashtra Agric. Univ. 3 (2) 116-119. Inst. Sci., Bombay, India.

- Pospisilova, J.; and V. Toul (1967). The variability of the content of ascorbic acid in varieties of fieldgrown sweet pepper. Bull. vyzk. Ustav zelin. Olomouc : No. 11 : 37-46. (C.F. Plant Breed. Abstr. Vol. 40. Abstr. No. 3589).
- Raju, D.N.N. (1980). Correlation and path coefficient analysis in capsicum (*Capsicum annum* L. var. *grossum* Sendt). Mysore J. of Agric. Sci. 14 (2) 278-279.
- Rick, C.M. (1974). High soluble solids content in large fruited tomato lines derived from a wild green-fruited species. Hilgardia. 42 (15) : 493-510.
- Rylski, Irena (1971). Investigations on the influence of suboptimal temperatures on the flowering, fruit setting and development of sweet pepper (*Capsicum annum* L.) Ph.D. Thesis, Hebrew Univ. of Jerusalem, Israel. (C.F. Euphytica 22 1973 : 530-534).
- Sathe, B.V.; and B.N. Phadnavis (1977). Note on variability and correlation studies for quality factors in chillies (*Capsicum annum* L.) J. of Maharashtra Agric. Univ. 2 (2) 165-167.
- Snedecor, G.W., and W.G. Cochran (1967). Statistical Methods. The Lowe State University Press. Ames., Iowa, U.S.A.
- Steel, R.G. and J.H. Torrie (1960). Principles and procedures of statistics Mc-Graw-Hill Company; Inc. New York 481 p.
- Suthanthirapandian, I.R.; M. Elangovan; and P. Rengasamy (1981). Association of metric traits in chillies (*Capsicum annum* L.). South Indian Horticulture 29 (1) 70-71.
- Tadahiko, Hirose (1965). Fundamental study of the crossing of — pepper. Tech. Bull. Fac. Agric. Kyoto. 2:1-85.
- Veerappa, D.B. (1982). Studies on relative performance of different genotypes of sweet pepper (*Capsicum annum* L. var. *grossum* Sendt.) Thesis Abstr. 8 (4) 381-382 Univ. Agric. Sci., Dharwad, India. (C.F. Plant Breed. Abstr. Vol. 53 No. 10 Abstr. No. 8467).
- Zatyko, Lajos (1979). Paprika Termesztes. Mezogazdasagi Kiado, Hungary. 374 p.

ACKNOWLEDGEMENT:

This research work is carried out under Grant No. G.B. 851033 by Foreign Relation Co-Ordination Unit of the Supreme Council of Universities. This grant is pursuant to the University Linkage Project, Grant No.263-0118 dated September 28, 1980 between the Governments of the Arab Republic of Egypt and United States of America.