

PERFORMANCE OF SOME PEPPER CULTIVARS GROWN  
UNDER HOT WEATHER CONDITION

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” سلوك بعض أصناف الفلفل النامية تحت ظروف الطقس الحار ”

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ملخص البحث

زرع تسعة أصناف من الفلفل وتركت لتنمو وتزهو وتثمر تحت ظروف الطقس الحار خلال العروة الصيفية المتأخرة ( يونيو - يوليو - أغسطس )

تشير النتائج الى أن الأصناف المقاومة للحرارة : نيوكومر وجيبسى أظهرت ثباتاً عن الأصناف الأخرى تحت هذه الظروف ، فالصنف الحريف نيوكومر أعطى أعلى نمو بينما أعطى الصنف الغير حريف ( جيبسى ) أعلى محصول علاوة على ذلك فقد أعطى الصنف المحلى ( بلدى ) نمو ومحصولاً جيداً تحت هذه الظروف الحارة مما أدى الى أن تقترح بأنه صنف على الأقل شبه مقاوم للحرارة . وعلى العكس من ذلك فقد فشلت الأصناف الأخرى فى تحقيق نمواً طبيعياً ومحصولاً اقتصادياً .

وتقترح النتائج بوجه عام على أن الحرارة المرشعة ( فى هذا الوقت من العام ) قد أثرت بصورة واضحة على كل من المحصول ومقات الشمار ولكن أثرت بدرجة أقل على النمو الخضري .

ABSTRACT

Nine pepper cultivars were left to grow, flowering and fruiting under hot weather conditions of late summer season, (June, July and August).

The heat tolerant cultivars, i.e., New Comer and Gypsy showed a good performance under this condition. New Comer (hot cv.) showed the most vigour growth, whereas

Gypsy (sweet cv.) gave the highest yield. On addition, the local cultivar Balady gave a satisfactory growth and yield, which suggest that this cultivar could be at least semi-heat tolerant. Other cultivars, on the other hand, failed to attain full vegetative growth and yield, under this condition.

In general, results suggest that high temperature dramatically reduced fruit yield and quality and to less extent vegetative growth.

## INTRODUCTION

High temperatures limit or prevent field production of pepper during the summer in many regions of the world and can reduce yields in principal production areas. Although, vegetative and fruit ripening stages are strongly modified by temperature, flowering and fruit set are the most sensitive stages to unfavourable temperature. High temperature, especially, at night (24-27 C) caused considerable flower drop (Rylski and Spigelman, 1982) prevented flower development (Blondon, 1978) decreased fruit set (Pet, 1983) and reduced fruit quality (Ali and Kelly, 1982) of peppers.

Pepper (*Capsicum annum* L.) is one of the most common and popular vegetable, in Egypt, it is used in a great variety of ways. Fruits of pepper are abundant in markets nearly all over the year except in months which follow cool (in winter) or hot (in summer) weather. In other words, the growers avoid planting pepper in months which would allow flowering and fruit set to be relevant with high temperature during June, July and August or with low temperature during January and February.

Using plastic greenhouses (which are wide spread now in Egypt) could allow to produce pepper fruits during the cold weather of winter. Whereas, introducing or breeding for high levels of heat tolerance genotypes could be the solve of reduction of pepper crop as a result of high temperature.

Hereat, this experiment was done to study the performance of some pepper cultivars (some of them are heat tolerance) under hot weather of Egyptian's summer.

## MATERIALS AND METHODS

The study was conducted at the Agricultural Experiment Station of the Faculty of Agriculture, Minufiya University, Shebin El-Kom. Evaluation of nine pepper cultivars was carried out during the late summer seasons of 1986 and 1987.

Pepper cultivars used in the study were as follows:

- |                             |         |                                       |
|-----------------------------|---------|---------------------------------------|
| 1- Hong Shan Ho Acc. No. 22 | (Hot)   | Cool tolerant.                        |
| 2- Twist green Acc. No. 19  | (Hot)   | Cool tolerant.                        |
| 3- New Comer Acc. No. 01    | (Hot)   | Heat tolerant.                        |
| 4- Gypsy Acc. No. 21        | (sweet) | Heat tolerant.                        |
| 5- Blue Star Acc. No. 01    | (sweet) | Cool tolerant-semi-heat.<br>tolerant. |

Seeds of the above mentioned cultivars were kindly provided by the Asian Vegetable Research and Development Center. (AVRDC). The variety description was also reported by the AVRDC.

- 6- Zlatan Medal, was imported from Yugoslavia, (sweet).
- 7- Csokros Felallo, was imported from Hungary, (sweet).
- 8- California Wonder, the well known USA cultivar (sweet).
- 9- Balady, is the local-cultivar in Egypt, (sweet).

In both plantings of 1986 and 1987, seeds were sown in seed bed on April 2nd. Seedlings were transplanted about 6 weeks later (about the middle of May). The plants were then left to grow, flowering and fruiting under relatively hot weather condition which was prevailing during June, July and August. Average day temperature (during these months) was commonly about  $35 \pm 3^{\circ}\text{C}$ , while night



temperature was about  $21 \pm 3^{\circ}\text{C}$ . A randomized complete block design with three replicates was used. Each experimental unit (plot) consisted of 3 rows (3 m-long and 60 cm wide). Transplants were set 40 cm apart.

Plants were fertilized with ammonium sulphate, super phosphate and potassium sulphate at the rate of, respectively, 250, 250 and 100 kg/faddan ( $4200 \text{ m}^2$ ). Fertilizers were divided into two equal parts which were applied one month after transplanting and one month later. Other cultural practices were applied as commonly practiced.

Characters studied were the following:

- 1- Plant height, root length, root fresh and dry weights, stem fresh and dry weights and leaves fresh and dry weights were determined at the end of the growing season.
- 2- Early yield (fruit number and weight), i.e., yield harvested up to (August 7) in 1986 planting and up to (August 20) in 1987 planting. Up to these dates about 75% of the yield of the earliest cultivar (Gypsy, Table 2) was harvested.
- 3- Total yield (fruit number and weight).
- 4- Fruit characters, i.e., fruit length, width (at the stem end), pericarp thickness, locule number, fruit colour (using naked eye), T.S.S. content (using an Abbe hand refractometer) and vitamin C content using the 2,6 dichlorophenolindophenol dye (A.O.A.C., 1965).

Fruit chemical and physical properties were determined three times during harvesting season, and the average values were computed.

## RESULTS AND DISCUSSION

### 1- Plant growth:

Results obtained in Table (1) show that the hot cv. New Comer (heat tolerant) gave the most vigorous growth specially in the first season. In the second season, the local cv. Balady (sweet) had plants with the highest values of root length and root and leaves weight. However, the heat tolerant cv., Gypsy and the semi-heat tolerant cv. Blue Star showed an intermediate growth pattern. On the other hand, each of Hong Shan Ho (cool tolerant), Zlaten Medal (imported from Yugoslavia) and Csokros Felallo (imported from Hungary) cvs. showed the lowest values of vegetative growth measurements.

It should be emphasized that high temperature condition of this experiment, reduced plant vegetative growth dramatically. In other study (Khalil *et al.*, in press) but under more favourable condition (under plastic greenhouse in winter season), Zlaten Medal, Csokros Felallo and California Wonder cvs. (at the end of growing season), respectively, produced plants of 114.5, 96.0 and 102.9 cm height (average of the two seasons). The reduction proportion in plant height, as a result of hot weather of this experiment, was 34.1, 39.6 and 42.0% than that of Khalil *et al.* experiment for Zlaten Medal, Csokros Felallo and California Wonder cvs., respectively.

Also, in other experiment (Midan and Gabal, 1986) which was carried out in the same experimental farm, but under more favourable conditions (seedlings were transplanted in the field on March 15<sup>th</sup>) plant height of pepper cv. Balady after 100 days from transplanting was 80.38 cm compared with 61.0 cm in this study. However, leaves dry matter content (%) of Balady cv., (determined after 100 days from transplanting), in that experiment of Midan and Gabal (1986)



Table 1: Vegetative growth characters of studied pepper cultivars, at the end of the growing season.

Characters Cultivars	Root Length (cm)	Plant height (cm)	Root weight/plant (g)		Stem weight/plant (g)		Leaves weight/plant (g)		
			Fresh	Dry	Fresh	Dry	Fresh	Dry	
			Season 1986						
Hong Shan Ho	14.0	68.0	12.85	4.35	77.75	20.75	35.15	7.0	
Twist Green	20.0	67.0	17.5	7.05	137.35	32.2	103.6	22.4	
New Comer	24.0	104.0	49.5	16.25	315.3	90.2	244.2	44.65	
Gypsy	15.0	78.0	18.0	6.3	106.15	23.1	70.2	13.65	
Blue Star	19.0	58.0	20.5	5.55	122.5	19.35	90.15	17.05	
Zlaten Medal	15.0	79.0	11.00	4.05	82.0	12.85	50.8	8.25	
Csokros Felallo	14.0	50.0	5.6	1.9	27.25	5.4	20.35	3.7	
California Wonder	21.0	60.0	31.0	8.65	190.1	33.0	208.0	31.0	
Balady	20.0	62.0	33.3	13.5	160.4	33.0	163.75	32.25	
L.S.D. at P <sub>0.05</sub>	2.3	7.9	4.4	1.6	15.3	4.2	15.4	4.6	
					Season 1987				
Hong Shan Ho	15.0	58.0	8.85	3.70	55.35	13.75	25.4	5.8	
Twist Green	19.0	57.0	10.80	3.32	149.7	29.72	114.70	21.6	
New comer	23.0	100.0	24.30	8.25	263.1	57.0	247.5	42.25	
Gypsy	18.0	72.0	24.5	8.70	140.7	31.0	98.60	19.20	
Blue Star	20.0	69.0	24.15	7.00	159.7	31.8	82.15	15.2	
Zlaten Medal	12.0	72.0	9.65	3.3	62.7	14.3	35.7	6.4	
Csokros Felallo	15.0	66.0	10.25	3.05	88.2	15.5	30.5	5.0	
California Wonder	19.0	59.5	22.32	6.6	187.1	32.7	156.8	25.35	
Balady	25.0	60.0	44.25	11.7	245.3	46.8	274.6	48.65	
L.S.D. at P <sub>0.05</sub>	2.1	7.8	4.0	1.5	13.9	4.0	10.3	4.3	

was quiet lower (13.57%) than our findings (18.7%). Virtually the higher proportion of dry matter content produced under conditions of this experiment was due, in part, to the different age in which dry matter was determined and may be other factors. However, it should be emphasized, that the increase in leaves dry matter content under condition of the recent experiment would be return to the adaptation of cv. Balady plants for high temperature. This discussion was built up on the base of Bidwell (1979) interpretation who reported that mechanisms of heat resistance are in fact mechanisms of drought resistance. In other words, high temperature tolerance involves a retardation of evaporative loss water, this would occur by increase leaves dry matter content.

## 2- Early and total yields:

The sweet heat tolerant cv. Gypsy gave the highest early yield which followed by the local cultivar Balady and the heat tolerant cv. New Comer. On the other hand, Zlaten Medal cv. produced the lowest early yield (Tables 2 and 3) in the two growing seasons.

Number of fruits of early yield showed a different trend than that of their weight (early yield), that is because cultivars varied enormously in in their average fruit weight. Twist green cultivar, which produced fruits with lowest weight, gave the highest number of fruits of early yield (Tables 2 and 3). Gypsy, New Comer, Balady and Hong Shan Ho cvs. gave also high number of early fruits. Blue Star cv., on the other hand, which produced the heaviest fruit, gave the least early fruit number.

Regarding total yield, the heat tolerant cv. Gypsy gave the highest total yield (8.298 and 7.469 kg./plot in the first and second seasons, respectively) among all studied cultivars (Table 3). Twist green (cool tolerant), Balady and New Comer (heat tolerant)



Table 2 . Early and total yield/plant of studied pepper cultivars.

Cultivars	Early yield/ plant		Total yield/ plant	
	Fruit weight (g)	Fruit NO.	Fruit weight (g)	Fruit NO.
		<u>Season 1986</u>		
Hong Shan Ho	61.8	8.43	197.3	20.4
Twist Green	113.1	43.00	286.6	124.6
New Comer	128.0	14.00	228.3	24.2
Gypsy	269.3	14.20	345.7	18.7
Blue Star	50.0	0.70	200.0	4.0
Zlaten Medal	41.8	2.70	120.8	7.7
Csokros Felallo	96.2	5.70	138.7	8.3
California Wonder	54.1	3.00	90.8	4.7
Balady	154.2	13.30	219.5	19.3
L.S.D. at <i>p</i> 0.05	21.8	2.10	40.5	2.9
		<u>Season 1987</u>		
Hong Shan Ho	117.5	15.90	192.4	26.8
Twist Green	94.2	31.70	307.8	109.0
New Comer	111.6	9.71	188.4	17.4
Gypsy	232.1	11.20	311.2	18.2
Blue Star	100.0	1.00	188.0	3.0
Zlaten Medal	66.6	4.30	88.2	6.4
Csokros Felallo	104.0	6.10	141.6	9.5
California Wonder	73.0	3.30	99.1	4.4
Balady	141.7	6.70	227.3	14.0
L.S.D. at <i>P</i> 0.05	19.6	1.80	36.1	2.3



Table 3: Early and total yield/plot of studied pepper cultivars.

Characters Cultivers	Early yield /pbt K.g.	Fruit No. of early yield / plot	Total yield /plot K.g.	Fruit No. /plot
Season 1986				
Hong Shan Ho	1.483	202.3	4.735	681.6
Twist Green	2.714	1032.0	6.878	2990.4
New Comer	3.072	336.0	5.478	580.0
Gypsy	6.463	340.8	8.297	448.8
Blue Star	1.200	16.8	4.800	96.0
Zlaten Medal	1.003	64.8	2.899	184.8
Csokros Felallo	2.309	136.8	3.329	199.2
California Wonder	1.298	72.0	2.395	112.8
Balady	3.701	319.2	5.268	463.2
L.S.D. at P.0.05	0.523	47.8	0.981	65.4
Season 1987				
Hong Shan Ho	2.820	381.6	4.618	643.2
Twist Green	2.261	760.8	7.387	2616.0
New Comer	2.678	233.0	4.522	417.6
Gypsy	5.570	268.8	7.469	436.8
Blue Star	2.400	24.0	4.512	72.0
Zlaten Medal	1.598	103.2	2.117	153.6
Csokros Felallo	2.496	146.4	3.398	228.0
California Wonder	1.769	72.0	2.378	105.6
Balady	3.401	160.8	5.455	336.0
L.S.D. at P 0.05	0.472	39.7	0.872	54.3

cultivars also gave relatively high total yield. Zlaten Medal, Csokros Felallo and California Wonder cvs. on the contrary, gave the lowest total yield.

With regard to total number of fruits, the hot cultivars, i.e., Twist green, Hong Shan Ho and New Comer gave generally the highest number of fruits especially in the first season. Sweet cultivars Gypsy and Balady followed the hot cultivars regarding total number of fruits.

The superiority of heat tolerant cv. Gypsy in yield seems logic. But, the next high yield obtained by cool tolerant cv. Twist green, suggesting that cool tolerant mechanism could involve in heat tolerant also. Again, results under condition of this study, regarding total yield/plant, seems quiet less than that obtained by Khalil et al. (in press) with regard to some cultivars, which were planted under more favourable conditions (in plastic greenhouse). Average of two seasons of yield and number of fruits/plant obtained by Khalil and his Colleagues respectively were 1.198 kg. and 48.7 in Zlaten Medal, 1.327 kg. and 42.8 in Csokros Felallo and 1.060 kg. and 13.0 in California Wonder cvs. Corresponding values of this experiment were 0.104 kg and 7.0 in Zlaten Medal, 0.104 kg and 8.9 in Csokros Felallo and 0.099 kg and 4.5 in California Wonder. The reduction proportions in yield and number of fruits/plant (in the three cvs.) ranged from 91.32 to 90.66% and from 85.63 to 65.40%, respectively. Also yield and number of fruits/plant of Balady cv. were 0.779 kg and 33.08 (average of the two seasons) in Midan and Gabal experiment. Corresponding values in this experiment were 0.223 kg and 16.65; the reduction percentage were 70.1% and 49.67%, respectively.

The reduction proportions between the experiment of Khalil et al. and this experiment were higher than those between that of Midan



and Gabal and our's. This may be due to most favourable conditions under the plastic greenhouse, and also may return to the sensitivity of that particular cultivars to high temperature. This may suggest that Balady cv. is heat tolerant or at least semi-heat tolerant.

Also, the reduction percentage in yield and number of fruits (plant productivity) were quiet higher than those reduction in plant height and dry weight of leaves (vegetative growth) between this experiment and the other two experiments, which were carried out under more favourable conditions. This suggesting that, productivity stage (flowering, fruit set and fruit development) was more sensitive to high temperature than vegetative stage.

The reduction in yield by high temperature condition was also observed by many workers. They reported that this reduction was attributed to flower drop (Rylski and Spigelman, 1982), flower undevelopment (Blondon, 1978) and reducing fruit set (Pet, 1983) and fruit weight (Ali and Kelly, 1982) in pepper.

The good performance of some pepper cultivars under extreme weather condition was also found by Perepadya and Dikanev (1978).

### 3- Fruit physical and chemical properties:

Results in Table (4) indicate that cv. Blue Star followed by California Wonder produced the highest values of fruit weight and width. Also, the thickest pericarp was found in fruits of California Wonder cv. which followed by Blue Star.

Except, Twist Green cv. (which produced small fruit), the other hot cultivars produced the longest fruit. Among sweet cultivars, Zalaten Medal, Gypsy and Blue Star also gave long fruit (Table 4).

General speaking, pericarp thickness and locule number were related to fruit width and to little extent fruit weight (Table 4).

Table 4: Physical and chemical fruit properties of studied peper cultivars.

Characters Cultivars	Fruit weight (g)	Fruit length (cm)	Fruit width (cm)	Pericarp thick. (cm)	Locule number	Fruit colour	T.S.S. content %	Vit.C content mg/100 g.
Hong shen Ho	6.95	8.20	1.39	0.18	2-3	Green	5.2	119.25
Twist Green	2.30	4.98	1.03	0.11	2-3	Light Green	5.5	117.2
New Comer	9.43	9.89	1.68	0.15	3-4	Green	6.2	125.6
Gypsy	18.4	7.30	3.16	0.28	3-4	Yellow	4.6	98.6
Blue Star	50.0	6.92	4.25	0.31	3-4	Green	5.2	95.4
Zlaten Medal	15.7	7.89	1.96	0.23	2-3	Light green	6.0	78.7
Csokros Felallo	16.71	6.51	3.02	0.29	3-4	Waxy	5.0	84.8
California wonder	21.01	5.27	3.62	0.36	3-4	Green	6.2	93.3
Balady	15.9	4.00	3.00	0.24	3-4	Green	5.4	139.5
L.S.D. at $P_{0.05}$	4.3	1.0	0.82	0.06			0.52	16.1
Hong Shan Ho	7.21	8.25	1.32	0.16	2-3	Green	5.1	119.25
Twist Green	2.82	4.94	1.08	0.10	2-3	Light Green	5.4	116.20
New comer	10.83	9.02	1.53	0.15	3-4	Green	6.4	123.9
Gypsy	17.1	6.71	3.04	0.27	3-4	Yellow	4.6	98.1
Blue Star	62.7	7.15	4.39	0.33	3-4	Green	5.0	98.3
Zalaten Medal	13.72	6.50	1.56	0.16	2-3	Light green	6.0	76.5
Csokros Felallo	14.90	6.37	2.75	0.34	3-4	Waxy	5.3	85.5
California Wonder	22.32	5.47	3.80	0.38	3-4	Green	6.0	95.2
Balady	16.2	4.52	3.31	0.25	3-4	Green	5.2	137.0
L.S.D. at $P_{0.05}$	4.1	0.90	0.76	0.06			0.50	14.3



It seems that physical properties of pepper fruit, under condition of this experiment, were degraded comparing with fruits produced under more favourable conditions. The ranges of reduction proportion in fruit weight, length, width and pericarp thickness in fruits of Zalaten Medal, Csokros Felallo and California Wonder cultivars, in this experiment, were from 40.44 to 74.40%, 35.30 to 47.21%, 20.00 to 47.00% and 16.22 to 36.70%, respectively compared with those of Khalil et al. (in press), (the above mentioned percentages were calculated by using the average of the two seasons).

Balady cv. show a slight reduction in average fruit weight in this experiment than those obtained by Midan and Gabal (1986), moreover, pericarp thickness in fruits of that cultivar was similar in both experiments.

The reduction in fruit weight, length, width and pericarp thickness, was also observed by high temperature elsewhere, (Ali and Kelly, 1982). They also added that high temperature increased number of locules/fruit.

Fruit T.S.S., in this study, was found to be positively related to vigour growth and negatively related to fruit weight, yield and number. New Comer cultivar which had the most vigorous growth, produced fruits with highest T.S.S. value. Also, the low yielding cvs. Zlatan Medal and California Wonder, gave high values of T.S.S. Cultivar Gypsy, on the other hand, which approved superiority in yield, gave yellow fruits with lowest T.S.S. content (Table 4).

Comparison studies between results of our's and of other experiments (Khalil et al. in press and Midan and Gabal, 1986) show that T.S.S. content in fruits of California Wonder and Balady cvs was strikingly raised or slightly decreased in fruits of Zalaten Medal and Csokros Felallo, under condition of this experiment.

With regard, to Vit. C content, it seems that this constituent was related to the green and hot fruit (Table 4). The sweet cultivar Balady gave fruits (green) with highest Vit. C content. Hot cultivars i.e. Hong Shan Ho, Twist Green and New Comer followed cv. Balady in Vit. C content. Zalaten Medal (light green fruit) Csokros Felallo (waxy fruit) and Gypsy (yellow fruit) cvs gave the lowest Vit. C. content. These results suggest that high chlorophyll content in the green fruit could increase photosynthesis rate which in turn increase monosuccharides, particularly glucose, which is the precursor of Vit. C.

It should be expected that high temperature could reduce both T.S.S. and Vit. C. since this condition increase respiration rate and hence decrease solubles accumulation. However, the reduction in number of fruit set, in this case, could allow more assimilates which devoted to each fruit. So the difference between the two processes gave the final chemical content of the fruit.

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