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A Study of Yield and Yield Components of Different Ornamental Pepper (*Capsicum* sp.) Species and Lines in Cukurova Ecological Conditions

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Abstract: This study examined some phenological, morphological and pomological features of different ornamental pepper (*Capsicum* sp.) species and lines under the conditions of Cukurova Region, Turkey. The field trials used a randomized complete block design with three replications. Different ornamental pepper species and lines varied depending on testing years, in terms of plant height (cm), the number of branches (number/plant), the number of fruits (number/plant), the weight of fresh fruit (g plant⁻¹), the yield of fresh fruit (kg ha⁻¹) and the breadth and length of fruit. Fresh yields of different ornamental pepper species and lines varied between 9412 -24418 kg ha⁻¹ in the testing years. The highest fresh yield was observed from line *C. frutescens* 26 (24418 kg ha⁻¹). It was determined that the fresh yield from the first harvest was higher than the others.

Key words: *Capsicum*, Cukurova, red pepper, fruit yield, phenological and pomological features

INTRODUCTION

There is increasing interest in herbal medicines and other herbal raw materials. Some plants have greater importance for such uses, due to their fields of use, their yield and their approved beneficial effects (Yaldiz *et al.*, 2010). Ornamental pepper (*Capsicum* sp.) which has been used for centuries as both food and medicine, is one of the plants that is increasingly important in herbal applications (Castillo-Sanchez *et al.*, 2010).

The *capsicum* genus within the Solanaceae familia comprises approximately 20 species growing at tropical and subtropical regions of the New World (Basu and De, 2003). It has different types such as long green, bell, charleston, big square and conical. Bitterness depends on the capsaicin (C₁₈H₂₇O₃N) content and composition of the fruit and it is located in the placenta section. Capsaicin in the fresh red *Capsicum* fruits is two to three fold more than in green *Capsicum* fruits. It is a good food vegetable for its food value. It is especially very rich for vitamin C (103 mg 100 g⁻¹). *Capsicum* sp. composition also contains volatile oil and fixed oil (Hayoglu *et al.*, 2005; Batlang, 2008; Sener and Sahin, 2010; Aminifard *et al.*, 2010; Olorunsanya *et al.*, 2009).

Bitter red *Capsicum* stimulates gastric secretions and induces salivary flow when taken fresh. Besides its appetitive characteristic, it also has a disinfecting agent characteristic in the digestive system. It increases body temperature, alleviates the cramps, eases digestion,

beautifies the skin, eliminates drunkenness, helps for headache, may be used for gout disease, helps for cough and throat ache, settles down the temper and efficient in rheumatismal pains. Moreover, the red carotenoid substance in the composition of the capsaicin has a cancer-preventing characteristic (Bosland, 1994).

Grown in Turkey, pepper is mostly desiccated and processed to be used as a spice and then consumed both domestically and abroad. In Turkey, cultivation area of ornamental pepper in 2009 covered 913.72 ha and production was 196.900 tonnes. Turkey has no stability in the dried ornamental pepper export. In 2009, total national sales of 510.492 kg generated an income of 1.61 million U.S. dollars (Anonymous, 2010).

This study examined the yield and yield components of different foreign ornamental pepper species and lines, grown under the conditions of Cukurova region; the study sought ways to increase the variety and seed quality of pepper lines which are two of the most important problems of ornamental pepper agriculture in Turkey.

MATERIALS AND METHODS

The study was conducted in the crop-trial area of the Department of Field Crops, Agricultural Faculty, Cukurova University in 2003 and 2004. The experiments used a randomized complete block design with three replications. Each plot had 5 rows (50 plants in total,

Table 1: Detailed work schedule of field experiments

Works performed	2003	2004
Seed sowing in the greenhouse	22.03.2003	07.03.2004
Transplantation of seedlings to the field	04.05.2003	01.05.2004
Base fertilizer application	04.05.2003	01.05.2004
Top fertilizer application	31.05/22.06.2003	24.05/22.06.2004
Harvest 1	22.08.2003	21.08.2004
Harvest 2	12.09.2003	17.09.2004
Harvest 3	16.10.2003	23.10.2004

70 plants with the edge effect), row spacing was 70 cm and intra row spacing was 40 cm. Each plot in the trial has an area of $4 \times 3.5 = 14 \text{ m}^2$ and total trial area was $21 \times 18.4 = 386.4 \text{ m}^2$ including access paths.

Average climatic data of the experimental area in the vegetation period (May-October) were 26.2°C temperature, 48.8 mm rainfall and 68.4% humidity in 2003 and 25.3°C temperature, 31.8 mm rainfall and 68.1% humidity in 2004 (Anonymous, 2004). Research area soils had a clay-loamy texture with 7.50 pH. The useful phosphor value, total nitrogen and lime content were in the ranges of $55.3\text{-}96.2 \text{ kg ha}^{-1}$, 0.10-0.15% and 24-28%, respectively (Ortas, 1996).

Seed materials of six *Capsicum* species and local lines (*Capsicum frutescens* 12, *Capsicum frutescens* 26, *Capsicum frutescens* 35, *Capsicum chinense* 38, Aci Sus Biberi 48 and Aci Cicek 52) used in the present study were obtained from different countries and local farmers. Detailed work schedules of the field studies are given in Table 1 and Herbal features of all of these six species has been presented in Table 10.

Seedlings used in the study were grown under greenhouse conditions and transplanted to fields. During the vegetation period in the experimental years, all required agricultural practices were carried out. Before transplantation of the seedlings, 30 kg ha^{-1} DAP (Diamonium Phosphate) was applied to the plots as a base fertilizer. After transplantation, nitrogenous fertilizer as Urea (in total 50 kg ha^{-1}) was applied to the plants in two splits in May and June. According to weather conditions, irrigation was performed by 4-5-day interval until flowering and by 6-7-day interval after flowering. The irrigation of the plants was performed by sprinkling until flowering and by furrow irrigation during later periods. No chemicals were applied in the experiments.

Examined features schedules of the field studies are given in below.

Phenological features:

Date of flowering, fruit setting and fruit maturity: Dates of first flowering, first fruit setting and first fruit maturity of the trial species and lines were determined.

Pomological features:

- **Flower color:** The colors of flowers were determined as white-yellow, light yellow-green and green
- **Fruit shape:** The fruits were classified according to their shapes (thin sharp, thick sharp, conical and fit for stuffing) and according to their types of fruit ends (sharp ended and blunt ended)
- **Fruit length (cm):** Ten plants were selected randomly from each parcel after the harvest. The average fruit length was calculated by measuring all of the fruits from the stem to the end of the fruit
- **Fruit breadth (cm):** Ten plants were selected randomly from each parcel after the harvest. The fruit widths were determined by measuring all of the fruits at the widest point, close to the stem

Herbal features and yield

Position of the fruit according to plant or stem: The positions of the fruits were determined as vertical, horizontal or lateral to the main stem or on the main branch, as a single or multiple fruit formation.

- **Plant length (cm):** The values taken by measuring the range from the soil to the top of ten plants randomly selected from each parcel after the harvest by a meter was averaged
- **Number of branches (piece/plant):** The number of main branches coming out of the stem was determined and averaged for 10 plants randomly selected from each parcel after the harvest
- **The number of fruits (number/plant):** The number of fruits was established as the number/plant after the harvest by counting all of the fruits from 10 plants, randomly chosen from each plot and calculating the average of that number
- **The weight of fresh fruit per plant (g/plant):** After the harvest, 10 plants were randomly chosen from each plot, the weights of all fresh fruits on those plants were established and the average was calculated as g/plant
- **Fresh fruit yield (kg ha^{-1}):** Weights of all fruits harvested from each plot were established and then the total yields were calculated for the plot field as kg ha^{-1}

Experimental design and statistical analysis: Different ornamental species and lines were designed as main plots and the sub-plots were designed as harvest times. Total annual yield (the weight of fresh fruit per plant, fresh fruit yield per ha), total number of fruits, length of plants and number of branches per plant were subject to analysis of

variance according to the randomized block experimental design, while the breadth of fruit, length of fruit, number of fruits, weight of fresh fruit per plant and fresh fruit yield per ha were subject to analysis of variance according to the split plots experimental design.

Statistical analysis of the experimental data was conducted with the MSTATC statistical program. Differences between the average values were compared by LSD (Least Significant Differences) at a 5% probability level.

RESULTS AND DISCUSSION

Phenological features: The first flowering, fruit setting and fruit maturity dates of different ornamental pepper species and lines in the trial years are shown in Table 2. In both trial years, different ornamental pepper species and lines showed differing flowering, fruit setting and fruit maturity times. First blossoms in the species and lines appeared between 01-16 June, fruit setting occurred between 06-20 June and fruit maturity occurred between 22 July-03 August (Table 2). This range of dates indicates that different ornamental pepper species and lines require different temperatures.

As shown in Table 2, in both trial years, the line with the earliest flowering was Aci Cicek 52. This was followed by *C. frutescens* 12, *C. frutescens* 35 and Aci Sus Biberi 48 lines. The line with the latest flowering, fruit setting and maturity times was *C. frutescens* 26.

Pomological features

Length of fruit: Examination of the fruit lengths of different ornamental pepper species and lines according to harvests shows that, in the first year the longest fruit length was obtained from the first harvest of Aci Cicek 52 (6.41 cm) while in the second year it was obtained from the first harvest of *C. frutescens* 12 (6.28 cm). Although the variations in the fruit lengths of species and lines were not statistically significant in the second year, fruit lengths decreased with the harvest times. The shortest fruit length was obtained from the third harvest of *C. chinense* 38 (respectively 2.07 and 2.73 cm) line in both years (Table 3).

Fruit lengths among different ornamental pepper species and lines varied in 2.91-6.12 cm range, on average. When the different ornamental pepper species are examined, the fruit lengths of *C. frutescens* (*C. frutescens* 12, *C. frutescens* 26, *C. frutescens* 35) ranged between 4.66 and 6.12 cm and similar fruit lengths were observed among the lines. Average fruit lengths of Aci Sus Biberi 48 and Aci Cicek 52 lines which constitute the Kahramanmaras populations were between 4.27 and 5.61 cm and were similar to the lines of *C. frutescens*. Average fruit length of the *C. chinense* 38 line of the *C. chinense* species varied between 2.91 and 2.94 cm and differed from the Kahramanmaras populations and *C. frutescens* species.

In the study, it was reported that the lengths of the Kahramanmaras peppers fresh red fruits were 7.5-12 cm on average and the fruit lengths of the first

Table 2: First flowering, fruit setting and fruit maturity dates of different ornamental pepper species (*Capsicum* spp.) and line

Species/line	First flowering dates		Fruit setting dates		Fruit maturity dates	
	2003	2004	2003	2004	2003	2004
<i>C. frut.</i> 12	07.06.2003	05.06.2004	11.06.2003	10.06.2004	24.07.2003	22.07.2004
<i>C. frut.</i> 26	16.06.2003	12.06.2004	20.06.2003	17.06.2004	03.08.2003	30.07.2004
<i>C. frut.</i> 35	10.06.2003	07.06.2004	16.06.2003	13.06.2004	30.07.2003	26.07.2004
<i>C. chin.</i> 38	11.06.2003	09.06.2004	16.06.2003	13.06.2004	01.08.2003	26.07.2004
Aci Sus. 48	10.06.2003	09.06.2004	14.06.2003	12.06.2004	29.07.2003	28.07.2004
Aci Cic. 52	03.06.2003	01.06.2004	07.06.2003	06.06.2004	22.07.2003	22.07.2004

Table 3: Harvest×Species and lines interaction regarding fruit length (cm) of ornamental pepper species and lines

Species/line	2003				2004			
	Harvest				Harvest			
	1	2	3	Avr.	1	2	3	Avr.
<i>C. frutescens</i> 12	6.14 ^{abc}	6.12 ^{abc}	5.91 ^{bcd}	6.06	6.28	6.07	6.03	6.12 ^a
<i>C. frutescens</i> 26	5.59 ^{ab}	5.08 ^f	5.00 ^f	5.22	5.71	4.76	4.68	5.05 ^{bc}
<i>C. frutescens</i> 35	6.01 ^{abc}	5.70 ^{cd}	4.86 ^f	5.52	5.41	4.30	4.27	4.66 ^c
<i>C. chinense</i> 38	3.67 ^g	3.10 ^h	2.07 ⁱ	2.94	3.12	2.90	2.73	2.91 ^d
Aci Sus bib. 48	5.65 ^{cd}	4.03 ^g	3.13 ^h	4.27	5.32	4.57	4.56	4.82 ^c
Acicicek 52	6.41 ^a	5.25 ^{ef}	5.17 ^f	5.61	6.00	5.10	5.09	5.40 ^b
Average	5.58	4.88	4.37	4.94	5.31 ^a	4.62 ^b	4.56 ^b	4.83

LSD (5%): 2003 harvest×species and line: 0.42, 2004 species and line avg.: 0.51 harvest avg.: 0.28, No. within a column with same letter (s) are not significantly different at 5% level

harvest were greater than those of other harvests (Trenning, 1971; Dogantan and Tuncer, 1989). In a study of *Capsicum* species, it was established that fruit lengths among the species varied between 1.5-16 cm (Green and Kim, 1991; Alegbejo and Orakwue, 2002). Previous studies reported that the fruit lengths of *Capsicum* species were higher in the first blossoms (Dewitt and Bosland, 1996). Alparslan (2007) reported that the fruit lengths of *Capsicum frutescens* populations were 4.35-6.85 cm on average. In their study of 38 *Capsicum* sp. lines and species, Yaldiz and Ozguven (2011) reported that fruit lengths were between 1.77 and 10.67 cm.

In the present study, the highest fruit lengths were obtained from the *C. frutescens* and Kahramanmaras populations and the fruit lengths among the lines varied according to the genetic features of the lines. It was observed that there was no significant difference between the fruit lengths of the lines. The highest fruit lengths were obtained from the first harvest in both year. These results are in agreement with those of Trenning (1971) and Dogantan and Tuncer (1989). This difference may be based on genetic features.

Breadth of fruit: Examination of the fruit breadths of different ornamental pepper species and lines according to harvest times shows that the highest fruit breadth was obtained from the first harvest of *C. chinense* 38 (2.16 cm) line in the first year while in the second years it was obtained again from the first two harvests of *C. chinense* 38 (1.9 cm). The lowest fruit breadths in the first year were obtained from the third harvest of *C. frutescens* 35 (0.46 cm) line while it was obtained from the third harvest of Aci Sus Biberi 48 (0.43 cm) line in the second year (Table 4).

As shown in Table 4, fruit breadths of different ornamental pepper species and lines varied between 0.51-2.03 cm on average. Examination of different ornamental pepper species shows that fruit breadths of the lines belonging to *C. frutescens* (*C. frutescens* 12, *C. frutescens* 26, *C. frutescens* 35) ranged between 0.52

and 0.88 cm on average and similar fruit breadths were observed among the lines. Average fruit breadths of the Aci Sus Biberi 48 and Aci Cicek 52 lines which are Kahramanmaras populations, were between 0.51 and 0.72 cm and were similar to the lines of *C. frutescens*. Average fruit breadth of the *C. chinense* line varied between 1.71 and 2.03 cm and differed from the Kahramanmaras populations and *C. frutescens* species.

Green and Kim (1991) indicated that fruit breadths of the *Capsicum frutescens* lines were between 0.5 and 3.0 cm. In their study of 42 *Capsicum* species, Alegbejo and Orakwue (2002) reported fruit breadths were between 0.8 and 2.3 cm. In their study of the 38 *Capsicum* sp. lines and populations, Yaldiz and Ozguven (2011) reported that fruit breadths were between 0.27 and 2.40 cm. Alparslan (2007) reported that the fruit breadths of *Capsicum frutescens* populations were 0.68-0.95 cm on average.

In the present study, the highest fruit breadth (2.16 cm) was obtained from *C. chinense* 38 line and the lowest fruit breadth (0.46 cm) was obtained from *C. frutescens* 35 line (Table 4). The fruit breadths recorded in the present study are similar to the findings of other researchers.

Herbal features and yield

Length of plant: During the trial years, the longest plant length was obtained from the *C. chinense* 38 line both in the first year (as 96.13 cm) and the second year (as 93.83 cm). The shortest plant length was obtained from the Aci Cicek 52 (50.90 cm) line in the first year and from the Aci Sus Biberi 48 (45.90 cm) line in the second year (Table 5).

Average plant lengths of different ornamental pepper species and lines ranged from 51.02 to 94.98 cm during the trial years. While the plant lengths showed no significant difference by years, it was observed that the plant lengths were higher in the first year. It is known that night temperature below 16°C slows the growth of pepper plants. Therefore, it is thought that the difference in average plant lengths between the two study years is the

Table 4: Harvest×Species and lines interaction regarding the fruit breadths (cm) of ornamental pepper species and lines

Species/line	2003				2004			
	Harvest				Harvest			
	1	2	3	Avr.	1	2	3	Avr.
<i>C. frutescens</i> 12	0.70 ^{ef}	0.66 ^{ef}	0.53 ^{gh}	0.63	0.63 ^{fg}	0.60 ^{gh}	0.50 ^{hij}	0.57
<i>C. frutescens</i> 26	0.86 ^e	0.73 ^{de}	0.60 ^{fg}	0.73	1.00 ^c	0.86 ^d	0.80 ^{de}	0.88
<i>C. frutescens</i> 35	0.63 ^{efg}	0.53 ^{gh}	0.46 ^h	0.54	0.60 ^{fg}	0.50 ^{hij}	0.46 ^j	0.52
<i>C. chinense</i> 38	2.16 ^a	2.00 ^b	1.93 ^b	2.03	1.90 ^a	1.90 ^a	1.50 ^b	1.71
Aci sus bib.48	0.63 ^{efg}	0.60 ^{fg}	0.60 ^{fg}	0.61	0.56 ^{gh}	0.53 ^{ghij}	0.43 ^j	0.51
Aci cicek 52	0.83 ^{cd}	0.70 ^{ef}	0.63 ^{efg}	0.72	0.70 ^{ef}	0.60 ^{gh}	0.53 ^{ghij}	0.61
Average	0.97	0.87	0.79	0.88	0.90	0.83	0.70	0.81

LSD (5%): 2003 harvest×species and line: 0.11, 2004 harvest×species and line: 0.11, No. within a column with same letter (s) are not significantly different at 5% levels

Table 5: Average plant lengths (cm) of different ornamental pepper species (*Capsicum* sp.) and lines

Species/line	Experimental years		
	2003	2004	Average
<i>C. frutescens</i> 12	86.90 ^a	79.47 ^b	83.19
<i>C. frutescens</i> 26	74.87 ^b	73.47 ^{bc}	74.14
<i>C. frutescens</i> 35	63.73 ^c	64.20 ^c	63.97
<i>C. chinense</i> 38	96.13 ^a	93.83 ^a	94.98
Aci sus biberi 48	57.97 ^{cd}	45.90 ^d	51.94
Aci cicek 52	50.90 ^d	51.13 ^d	51.02
Grand average	71.75	67.80	

LSD (5%): 2003 species and line: 10.39, 2004 species and line: 13.03, No. within a row with same letter(s) are not significantly different at 5% levels

result of higher night temperatures in 2003 (12.3°C in May and 15.8°C in June) compared to 2004 (10.9°C in May and 14.7°C in June).

Studies conducted with *Capsicum* species indicated that the plant lengths ranged between 40.3 and 83.6 cm (Alegbejo and Orakwue, 2002; Aman *et al.*, 2002; Gajc-Wolska and Skapski, 2002). Gunay (1992) reported that the length of *C. frutescens* species were between 50 and 100 cm. Hatwar *et al.* (2003) reported that *C. annum* var javanti species had the average highest plant length of 70.36 cm. Alparslan (2007) reported that the plant lengths of *Capsicum frutescens* populations were 44.60-70.77 cm on average. Yaldiz and Ozguven (2011) reported that the plant lengths of *Capsicum* sp. lines and populations were 37.67-117.7 cm on average. The results of the present study are in agreement with the results of previous studies.

Number of branches: Table 6 shows that the highest number of branches was obtained in *C. frutescens* 26 in both years of the study (12.03 per plant in 2003; 12.17 per plant in 2004). In both years, the lowest number of branches was found in Aci Cicek 52 (8.90 per plant in 2003; 5.60 per plant in 2004).

Average number of branches per plant for different ornamental pepper species and lines ranged between 7.25 and 12.10 per plant in the trial years. The number of branches per plant differed between years and was higher in the first year of the study. This is the result of suitable night and day temperatures for the growth of pepper species during 2003. Aman *et al.* (2002) examined the effect of different fertilizers and row spacing on *Capsicum* species. They found that the number of branches per plant ranged between 7.78 and 9.13. In a study of *C. annum* var javanti, Hatwar *et al.* (2003) reported that the maximum average branch number was 11.2 per plant. Yaldiz and Ozguven (2011), in their study of 38 *Capsicum* sp. lines and populations, reported that the number of branches per plant was 5.0-14.67 on average. Alparslan (2007) reported that the number of branches per plant was between 5.44 and 8.44 on *Capsicum frutescens*

Table 6: No. of branches (number/plant) of ornamental pepper species and lines per plant

Species/line	Experimental years		
	2003	2004	Average
<i>C. frutescens</i> 12	11.50 ^{ab}	6.87 ^{bc}	9.18
<i>C. frutescens</i> 26	12.03 ^a	12.17 ^a	12.10
<i>C. frutescens</i> 35	9.70 ^{bc}	10.20 ^{ab}	9.95
<i>C. chinense</i> 38	9.20 ^{bc}	6.87 ^{bc}	8.04
Aci sus biberi 48	9.73 ^{abc}	9.03 ^{abc}	9.38
Aci cicek 52	8.90 ^c	5.60 ^c	7.25
Grand average	10.18	8.46	

LSD (5%): 2003 species and line: 2.319, 2004 species and line: 4.051, No. within a row with same letter(s) are not significantly different at 5% levels

populations. Aminifard *et al.* (2010) examined the effect of different row spacing on *Capsicum annum* L. They reported that the number of branches per plant was 10.0-11.51 on average. The results of the present study are similar to those of other studies.

Number of fruits: Examination of fruit numbers of different ornamental pepper species and lines according to harvest times shows that the maximum number of fruits in the first year occurred in the second harvest of Aci Sus Biberi 48 (215.6 number/plant) line while in the second year, the maximum number occurred in the first harvest of the Aci Sus Biberi 48 (278.6 number/plant) line. Minimum number of fruits was obtained in the first harvest of *C. chinense* 38 (43.6 number/plant) line in the first year while in the second year, it was obtained from the third harvest of Aci Sus Biberi 48 (15.2 number/plant) line (Table 7).

The fruit numbers of different ornamental pepper species and lines ranged between 175.4 and 460.4 per plant. In the trial years (2003 and 2004), maximum total fruit number was obtained in the Aci Sus Biberi 48 (respectively 460.4 and 430.4 per plant) line. Also minimum fruit number was obtained in the *C. chinense* 38 line both in the first year (as 246.9 number/plant) and the second year (as 175.4 number/plant).

It was indicated that more than 100 blossoms grew in the *Capsicum* species and the number of mature fruit reflected the number of flowers (Dewitt and Bosland, 1996). They reported, in their study of chili peppers, that the average number of fruit was 51.0-107.8 per plant (Mahalakshmi *et al.*, 1999; Munshi *et al.*, 2000). Hatwar *et al.* (2003), in their study of *C. annum* var javanti species, determined as the maximum number of fruit as 184.12 per plant. They reported, in their study of 38 *Capsicum* sp. lines and populations, that the average number of fruit was 2.0-370.7 per plant (Yaldiz and Ozguven, 2011). Alparslan (2007) reported that the number fruits of *Capsicum frutescens* populations were 75.93-156.93 per plant on average.

Table 7: Harvests×Species and lines interaction regarding the fruit numbers of different ornamental pepper species and lines

Species/line	2003				2004			
	Harvest				Harvest			
	1	2	3	Total	1	2	3	Total
<i>C. frutescens</i> 12	69.9 ^a	122.1 ^{ef}	138.0 ^{ab}	330.1 ^d	125.5 ^{fg}	114.3 ^e	29.3 ^j	269.2 ^b
<i>C. frutescens</i> 26	112.7 ^f	176.6 ^b	145.4 ^{cd}	434.7 ^{ab}	151.3 ^{cd}	113.0 ^f	36.0 ^{ij}	300.3 ^b
<i>C. frutescens</i> 35	116.4 ^f	160.5 ^{bc}	81.5 ^{hi}	358.4 ^e	225.8 ^g	156.5 ^e	43.1 ⁱ	425.4 ^a
<i>C. chinense</i> 38	43.6 ^c	93.1 ^{gh}	110.2 ^{fg}	246.9 ^e	75.2 ^h	65.5 ^h	34.7 ^{ij}	175.4 ^e
Aci sus bib. 48	124.2 ^{ef}	215.6 ^a	120.6 ^{ef}	460.4 ^e	278.6 ^a	136.7 ^{ef}	15.2 ^k	430.4 ^e
Aci cicek 52	135.0 ^{gh}	144.2 ^{ab}	134.7 ^{ab}	413.9 ^e	235.8 ^g	142.0 ^{gh}	29.1 ^j	406.9 ^e
Average	100.30	152.03	121.73	374.07	182.04	121.33	31.2	331.83
Grand average	124.69				111.54			

LSD (5%): 2003 harvest×species and line: 18.17, Total harvests: 27.4, 2004 harvest×species and line: 12.54, Total harvests: 42.99, No. within a column with same letter (s) are not significantly different at 5% levels

The results of this study conflicts with the results of Mahalakshmi *et al.* (1999), Munshi *et al.* (2000), Hatwar *et al.* (2003) and Alparslan (2007). It is known that plants divaricate further and produce more fruits at the ground conditions which contain sufficient nutrients for plant growth. As the vegetation period was extended due to the nutrient-rich bottom earth of the experimental plot and suitable weather conditions and the most appropriate plantation frequency for pepper growing (70×40 cm) was applied, the number of fruits per plant increased.

Weight of fresh fruit per plant: Examination of the species and lines in terms of the fresh fruit weights per plant shows that the highest fresh fruit weight was obtained from the first harvest of *C. frutescens* 26 (300.8 g/plant) line in the first year while in the second year it was again obtained from the first harvest of *C. frutescens* 26 (404.3 g/plant) line. The lowest fresh fruit weight was obtained in the first year from the third harvest of *C. frutescens* 35 (18.9 g/plant) line while in the second year it was obtained from the third harvest of Aci Sus Biberi 48 (4.29 g/plant) line (Table 8).

Fresh fruit weights per plant varied according to the harvest times. The highest fresh fruit weight was obtained in the first year from the first two harvests while in the second year it was obtained from the first harvest.

In the trial years, fresh fruit yields per plant in different ornamental pepper and lines ranged between 253.9 and 657.5 g/plant. In both years, the highest total fresh fruit weight was obtained from *C. frutescens* 26 (respectively 657.5, 566 g/plant) line. The lowest total fresh fruit weight was obtained from *C. frutescens* 12 (253.9 g/plant) line in the first year of the trial and from *C. frutescens* 35 (279.9 g/plant) in the second year. While there was no significant difference among the fresh fruit yields by years, fresh fruit yield per plant was higher in the first year. This outcome is related to the temperature differences between the years.

Padem and Alan (1994), in their study on the yields of pepper plants, indicated that the yield per plant was between 128 and 437 g/plant. Cho *et al.* (2003) found the average fresh fruit yield per plant was 437 g in the Saeng-ryeog 216 line of the *C. annuum* species. Munshi *et al.* (2000), in their study of 30 chili pepper genotypes, reported the highest fruit weight as 210.68 g/plant. Fresh fruit weight per plant in the present study was slightly higher than reported in other studies. Fresh fruit weight per plant is directly affected by yield elements such as the number of branches per plant and number of fruits. Increases in the yield elements in suitable conditions affect the fruit weight per plant positively. Providing optimum growth conditions has a positive impact on yields.

Fresh fruit yield: Examination of total fresh fruit yields among different ornamental pepper species and lines shows that the highest yield was obtained from *C. frutescens* 26 (respectively, 24418, 20290 kg ha⁻¹) line in both years. The lowest total fresh fruit yield was obtained from the Aci Cicek 52 (9412 kg ha⁻¹) line in 2003 while it was obtained from the *C. frutescens* 35 (9998 kg ha⁻¹) line in 2004 (Table 9).

In the trial years, the total fresh fruit yield ranged between 9412 and 24418 kg ha⁻¹ among the lines. In the first year of the trial, high yield was obtained in the first two harvests while in the second year the highest yield was obtained from the first harvest. In both trial years, the lowest yield was obtained from the third harvest. *C. frutescens* 26 was defined as having the highest total fresh yield while *C. frutescens* 35 had the lowest yield.

Previous studies of the yields of different ornamental pepper species and lines showed that yields ranged between 23.9 and 27.6 t ha⁻¹ (Uher and Balogh, 2001) and 20.17 to 25.98 t ha⁻¹ (Aman *et al.*, 2002). In a study of 20 Chili pepper species, They reported that the yield was between 2476 and 4663 kg ha⁻¹ (Bayraktar, 1970; Seniz,

Table 8: Harvest×Species and lines interaction regarding the fresh fruit weight (g plant⁻¹) in the harvests of ornamental pepper species and lines

Species/line	2003				2004			
	Harvest				Harvest			
	1	2	3	Total	1	2	3	Total
<i>C. frutescens</i> 12	62.20 ^{hi}	137.0 ^{hif}	54.7 ^h	253.9 ^f	241.8 ^d	97.60 ^e	18.2 ^k	357.5 ^e
<i>C. frutescens</i> 26	300.83	272.2 ^b	84.5 ^e	657.5 ^a	404.3 ^a	125.00 ^f	36.4 ⁱ	566.0 ^e
<i>C. frutescens</i> 35	119.50 ^f	145.3 ^d	18.9 ^g	283.7 ^g	207.8 ^g	63.70 ^h	8.46 ^{jk}	279.9 ^g
<i>C. chinense</i> 38	122.00 ^{ef}	134.5 ^{def}	79.7 ^{gh}	336.2 ^d	201.2 ^e	100.00 ^g	20.12 ^j	321.8 ^d
Aci Sus Bib. 48	129.04 ^{df}	190.0 ^e	76.7 ^{gh}	395.5 ^e	276.9 ^e	67.00 ^h	4.29 ^k	348.2 ^d
Aci Cicek 52	265.80 ^b	206.3 ^e	140.4 ^e	612.4 ^b	358.2 ^b	116.00 ^f	13.5 ^k	487.7 ^b
Average	166.53	180.78	75.79	424.11	281.69	95.02	16.82	393.52
Grand average	141.03			131.18				

LSD (5%): 2003 harvest×species and line: 20.02, Total harvests: 20.71; 2004 harvest×species and line: 15.01, Total harvests: 28.22, No. within a column with same letter (s) are not significantly different at 5% levels

Table 9: Harvest×Species and lines interaction regarding the fresh fruit yield (kg ha⁻¹) in the different harvests of different ornamental pepper species and lines

Species/line	2003				2004			
	Harvest				Harvest			
	1	2	3	Total	1	2	3	Total
<i>C. frut.</i> 12	2768 ^{gh}	6000 ^e	2612 ^{sh}	11380 ^d	8634 ^d	3485 ^h	650 ^k	12770 ^f
<i>C. frut.</i> 26	10360 ^a	10600 ^a	3458 ^f	24418 ^e	14520 ^e	4475 ^f	1299 ^j	20290 ^a
<i>C. frut.</i> 35	5690 ^d	5670 ^d	1247 ⁱ	12607 ^e	7421 ^e	2274 ⁱ	302 ^k	9998 ^e
<i>C. chin.</i> 8	4355 ^e	5300 ^d	2443 ^h	12098 ^{cd}	7187 ^e	3586 ^{gh}	718 ^k	11490 ^d
Aci Sus B.48	5138 ^b	6902 ^b	2217 ^h	14257 ^b	9888 ^e	2394 ⁱ	153 ^k	12430 ^{cd}
Aci Cic.52	3039 ^{gh}	3340 ^g	3033 ^{gh}	9412 ^e	12790 ^b	4147 ^g	481 ^k	17420 ^b
Average	5225.3	6302	2501.4	14028	10073	3393.5	600.6	14067
Grand average	4676.1				4689.2			

LSD (5%) : 2003 harvest×species and line: 654.8, Total harvests: 1065; 2004 harvest×species and line: 841.1, Total harvests: 1090, No. within a column with same letter (s) are not significantly different at 5% levels

Table 10: Certain herbal features of ornamental pepper species (*Capsicum* sp.) and lines used in the trial

Species and line	Flower color	Fruit type	Position of the fruit according to plant or stem	Fruit color
<i>C. frutescens</i> 12	Light yellow-green	Thick pointed, partitioned blunt-pointed	Horizontal and single over the main and side branches	Red
<i>C. frutescens</i> 26	White-yellow	Thin long, sharp-pointed	Vertically erect and multiple over the main and side	Red
<i>C. frutescens</i> 35	White-yellow	Thin long, sharp pointed	Vertically erect and multiple over the main and side	Red
<i>C. chinense</i> 38	White-yellow	Bell, partitioned-pointed	Vertically erect and single over the main and side	Red
Aci Sus Bib. 48	White-yellow	Thin long, sharp pointed	Vertically erect and multiple over the main and side	Red
Aci Cicek 52	White-yellow	Thin long, sharp pointed	Vertically erect and single over the main and side	Red

1992). Yaldiz and Ozguven (2011), in their study on the yields of pepper plants were between 416.0 and 64270 kg ha⁻¹. Gencoglan *et al.* (2006) reported that the yields of Kahramanmaraş red peppers were 284-1358 kg ha⁻¹ on average. The results of the present study are similar to those of other studies.

CONCLUSION

Although most regions of Turkey have suitable weather conditions for ornamental pepper agriculture, there is a decrease in the ornamental pepper cultivation areas and production rates; the main reasons for this are the variety and the seed. Therefore, it is necessary to introduce foreign species to be used for dried capsicum, to facilitate their adaptation to growing conditions in Turkey and to establish their yield and quality features. In this study, the yield components of various foreign

ornamental pepper species and lines were found to exceed the world average.

Although the species and lines showed variation in terms of phenological, morphological and pomological features, the plants thrived well. It was established that components of the lines belonging to the same species showed similarities. It was observed that the foreign ornamental pepper species and lines could adapt well to the growing conditions of Cukurova and the fresh fruit yield among the species and lines ranged between 9412 and 24418 kg ha⁻¹. In both trial years, the highest total fresh fruit yield was obtained from *C. frutescens* 26 (respectively 24418 and 20290 kg ha⁻¹).

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