

Fruit Characterization and Influence of Variation Factors in Pepper Kapiya Type Varieties and Breeding Lines (*Capsicum annuum* L.)

V. TODOROVA

Maritsa Vegetable Crops Research Institute, BG - 4003 Plovdiv, Bulgaria

Abstract

TODOROVA, V., 2007. Fruit characterization and influence of variation factors in pepper kapiya type varieties and breeding lines (*Capsicum annuum* L.). *Bulg. J. Agric. Sci.*, 13: 309-315

Six varieties and ten breeding lines from Kapiya type were evaluated by some morphological fruit characters at the Maritsa Vegetable Crops Research Institute – Plovdiv during the period 2002 – 2004. The sources of variation – genotype, environment and interaction between them had a proven effect ($P < 0.001$) on the phenotypic expression of the five studied characters, describing the fruit, but the power of the influence is different. The combination of high yield with high biological value and attractive fruit appearance makes 669/02 line especially suitable for including in future hybridization programs. It was established that the variation of fruit diameter is the lowest while the one of the usable part is the highest

Key words: pepper, kapiya type, quantitative fruit characters, influence, variation

Introduction

Human cultivates a number of plant species with different direction of use – seeds, fruits, roots, leaves etc. Pepper is grown for the fruit possessing high biological value and excellent taste characters. Boosted beta-carotene levels are established in Bulgarian F_1 hybrid – 41.05 mg/100g/dry matter (Tomlekova et al., 2006). Market requirements enforce fruits to be attractive for consumer, traders and for processing industry according to appearance, size and weight. Quantitative fruit characters – length, diameter, pericarp thickness, av-

erage weight and usable part are of great importance in describing of fruits and genotypes (varieties), respectively. They also have strong effect for economic significance of each variety. The Bulgarian Kapiya type varieties are most wanted ones and they take theirs place both in domestic and foreign market. During the past years neighbour countries Serbia and Turkey have offered such type pepper varieties (Jankulovski et al., 1994; Gvozdencic et al., 2002). Different factors of variation influence on the phenotypic expression of the quantitative fruit characters, but pepper studies in this direction are limited

(Stoffella et al., 1995; Todorova, 2003).

The purpose of the present investigation was to study the influence of the variation sources on the expression of quantitative characters describing the fruit and to evaluate Kapiya type varieties and breeding lines according to these characters.

Material and Methods

The experimental work was performed on alluvial meadow type soil at the Maritsa Vegetable Crops Research Institute – Plovdiv during the period 2002–2004. Sixteen genotypes (shown in Tables 2 and 3) – one Serbian, one Turkish, four Bulgarian varieties, and ten Bulgarian breeding lines, created at the Institute were investigated.

The experiment was set on block method in four replications in 70/15 cm sowing scheme (25 plants in replication). The plants were grown according to the mid-early field production technology and the fruits (20 for each genotype) were analyzed in botanical maturity. The fruit length (cm), diameter (cm), pericarp thickness (mm), average weight (g) and usable part (g) were evaluated by Descriptors for *Capsicum* spp. (IPGRI, 1995).

Mathematical processing of data includes variation analysis, two way analysis of variance (Lidanski, 1988) and Duncan's multiple range tests (1955).

Results and Discussion

The data from the two-way analysis of variance show that the sources of variation – genotype, environment and interaction between them have a proven effect ($P < 0.001$) on the phenotypic expression of the five studied characters describing

the fruit (Table 1). This is due to differences between the sixteen studied genotypes as well as to the differences in the meteorological conditions during individual years of investigation and interaction between genotype and growing environment. In red pepper for grinding Todorova (2003) has also established that the systematic factors manifest a proven effect on the phenotypic variability of length, diameter, weight and usable part of the fruit. Stoffella et al. (1995) report similar results for fruit weight in Bell peppers.

The genotypic factor has dominant influence on expression of diameter (50.53 %), weight (50.16 %) and usable part (48.06 %) of fruit. The obtained results give the base for consideration that the phenotype breeding in these characters would be more successful.

The environment has a dominant effect only on the fruit length (34.31 %) and this is due mainly to the differences in the meteorological conditions during the experimental years because the other main components of the environment are comparatively stable (Fig. 1). The amount of rainfalls is the biggest during the period July – September in the first experimental year while the period June – September in the second year is the driest. On the basis of analysis of the obtained results could be concluded that, genotype testing in this character used to be carried out for a longer period ranging different years.

The influence of other two sources of variation – genotype and genotype x environment interaction is 27 % and 23 %, respectively to the determination of the variability by fruit length. It is necessary to be mentioned that the differences between years of the investigation, even with proven effect, have comparatively slight influence (from 2 % to 5 %) on the phe-

Table 1
Two-way analysis of variance of some fruit morphological characters

Sources of variation	Degree of freedom		Fruit length		Fruit diameter		Pericarp thickness		Fruit weight		Usable part weight	
	df	Means squares	Influence, %	Means squares	Influence, %	Means squares	Influence, %	Means squares	Influence, %	Means squares	Influence, %	
Genotype (G)	15	10.61***	26.71	2.10***	50.53	1.76***	38.53	1701.90***	50.16	1149.87***	48.06	
Environment (E)	2	102.20***	34.31	0.88***	2.84	0.76**	2.23	1136.43***	4.46	882.76***	4.92	
Interaction (G x E)	30	4.60***	23.18	0.50***	24.32	0.82***	35.89	456.37***	26.9	334.19***	27.94	
Error	144	0.65		0.1		0.11		65.32		47.54		

* P<0.05 ** P<0.01 *** P<0.001

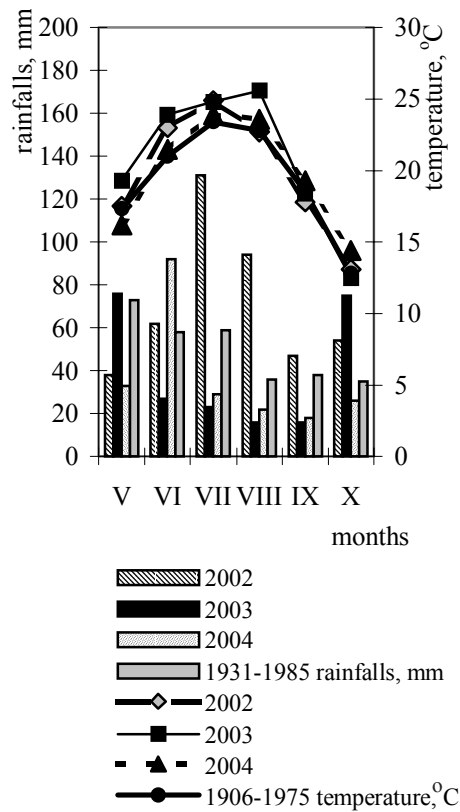


Fig. 1. Meteorological conditions during the experimental period

notypic expression of the remaining analyzed characters. The observed variation of the pericarp thickness is mainly due to the genotypic differences and interaction between genotype and environment.

The fruit length of the studied varieties and breeding lines is on average 12 cm (Table 2) during the three years of the experimental period. It was established that the Turkish kapiya is with the longest fruits (13.56 cm) among the genotypes, followed by Kapiya Novi Sad, breeding lines 715/02, 709/02, 1308/01, variety Kapiya 1300 and 605/02. Lines 584/02, 644/02 and 691/02 have the shortest fruits – from 10.70

to 10.84 cm. The fruit diameter is the biggest in the line 669/02 (5.54 cm), followed by 694/02 and 691/02. This character in all studied varieties is from 4.08 cm for Sofiiska kapiya to 4.52 cm for Kapiya 1300. The breeding line 669/02 differs with the thickest pericarp – 5.16 cm and Kapiya 1300 – with the thinnest one (3.58 cm). The pericarp thickness in the other studied varieties is from 3.63mm for Kapiya Novi Sad to 4.09 mm for Sofiiska kapiya. The line 669/02 has the heaviest fruits – 105.60 g, followed by 709/02 – 89.25 g, 694/02 – 84.50 g and 605/02 0 84.25 g. The fruit weight of the studied varieties is from 58.50 g for Kurtovska kapiya 1619 to 74.45 g for Turkish kapiya. The line 669/02 is on the first place by usable part of the fruit (86.15 g) and 709/02 – on the second. The varieties Kurtovska kapiya 1619 and Kapiya UV have the smallest usable part of the fruits. Nevertheless they could be used as an initial material in breeding for quality because their fruits have high ascorbic acid content – more than 170 mg% (Pevicharova et al., 2006, in press).

On the basis of analysis of the obtained results it could be concluded that the line 669/02 is a perspective one because the fruits of this line have the biggest diameter, pericarp thickness, weight and usable part. In the previous investigation we reported that this breeding line was demonstrated a high yield – 3132 kg/da (Todorova et al., 2006, in press). Most plants of this line have three branches (Todorova, 2006 in press). The main nutritive components were analyzed and it was established that fruits of this line possessed high biological value - ascorbic acid content is over 170 mg% and total sugars content is over 5.40% (Pevicharova et al., 2006, in press). The combination of high yield with high biological value and attrac-

Table 2
Evaluation of pepper Kapiya type varieties and breeding lines by morphological fruit characters

№	Varieties and breeding lines	Fruit length		Fruit diameter		Pericarp thickness		Fruit weight		Usable part weight						
		x	Sx	x	Sx	x	Sx	x	Sx	x	Sx					
1	Kurtovska kapiya 1619	11.40	bcd	0.69	4.40	cde	0.18	3.93	bc	0.15	58.50	i	4.21	46.84	h	4.15
2	Sofiska kapiya	11.78	abcd	0.66	4.08	def	0.21	4.09	bc	0.16	66.67	fghi	4.71	51.83	fgh	5.00
3	Kapiya UV	11.80	abcd	1.17	3.85	f	0.19	3.70	cd	0.39	59.95	hi	7.56	48.92	gh	6.65
4	1308/01	12.81	ab	0.49	4.85	bc	0.27	3.98	bc	0.28	76.55	cdef	7.07	63.00	bcde	6.24
5	Kapiya 1300	12.77	ab	0.61	4.52	cde	0.12	3.58	d	0.22	70.76	defg	3.69	58.17	def	3.64
6	584/02	10.70	d	1.19	4.86	cd	0.23	4.20	bc	0.22	71.25	defg	2.72	56.66	efg	2.55
7	644/02	10.84	d	0.33	4.64	bc	0.10	4.33	bc	0.29	70.18	efgh	4.24	58.50	def	4.34
8	605/02	12.49	abc	0.90	4.46	cd	0.13	4.23	bc	0.11	84.25	bc	7.72	65.75	bcde	6.28
9	1311/02	11.78	abcd	0.76	4.55	cde	0.25	4.33	bc	0.19	80.83	bcde	5.78	68.33	bc	4.46
10	669/02	11.13	cd	1.11	5.54	a	0.33	5.16	a	0.26	105.60	a	7.45	86.15	a	6.77
11	691/02	10.83	d	0.92	5.00	bc	0.16	4.42	b	0.36	81.65	bcd	6.76	65.92	bcde	5.21
12	694/02	10.98	cd	0.42	5.11	ab	0.25	4.40	b	0.27	84.50	bc	4.64	67.42	bcd	3.83
13	709/02	12.91	ab	0.45	4.86	bc	0.22	4.44	b	0.23	89.25	b	7.21	71.00	b	5.58
14	715/02	12.92	ab	0.50	4.57	cd	0.12	4.16	bc	0.24	81.33	bcd	5.23	66.83	bcd	4.29
15	Turkish kapiya	13.56	a	0.90	4.33	cde	0.25	4.06	bc	0.12	74.45	cdefg	8.68	59.92	cdef	7.03
16	Kapiya Novi Sad	12.99	ab	0.78	4.22	ef	0.18	3.63	cd	0.20	65.25	ghi	4.48	52.67	fgh	3.71
	Mean	11.98		4.62				4.16			76.31			61.74		

Sx - error of the arithmetical average value

Average values followed by different letters are statistically significant at $P \leq 0.05$ (Duncan's test)

Table 3
Variability of some morphological fruit characters (CV, %)

Varieties and breeding lines	Length	Diameter	Pericarp thickness	Weight	Usable part
Kurtovska kapiya 1619	12.15	8.19	7.63	14.38	17.71
Sofiiska kapiya	11.23	10.4	8.11	14.12	19.31
Kapiya UV	19.91	9.72	20.94	25.21	27.19
1308/01	7.65	11.1	14.21	18.48	19.82
Kapiya 1300	9.49	5.42	12.18	10.43	12.52
584/02	22.25	9.43	10.38	7.65	9
644/02	6.12	4.31	13.47	12.07	14.85
605/02	14.34	5.93	5.29	18.33	19.09
1311/02	12.87	10.99	8.94	14.31	13.05
669/02	19.89	11.84	10.25	14.12	15.71
691/02	16.92	6.63	16.31	16.56	15.8
694/02	7.62	9.98	12.45	10.98	11.35
709/02	6.97	9.2	10.56	16.15	15.7
715/02	7.78	5.36	11.78	12.86	12.84
Turkish kapiya	13.32	11.55	6.03	23.33	23.46
Kapiya Novi Sad	11.95	8.54	11.02	13.73	14.08
Mean	12.53	8.66	11.22	15.17	16.34

tive fruit appearance makes 669/02 line especially suitable for including in future hybridization programs.

The breeding line 709/02 is also of interest because the fruits demonstrate comparatively high values for the studied characters.

In studying of the character variability, evaluated by coefficient of the variation (CV, %) it was established that the variation of fruit diameter is the lowest while the variability of the usable part is the highest (Table 3). Similar results about the variation rate of the analyzed characters were obtained by Todorova (1999) in evaluating of local Kapiya type population.

It is impressed that, breeding lines 709/02, 715/02 and 1308/01 closely following Turkish kapiya and Kapiya Novi Sad by

fruit length show low variation. The line 644/02 has the slightest variation by fruit diameter, followed by 715/02 and Kapiya 1300. The genotypes with the thickest fruit pericarp – 669/02 and 709/02 have comparatively low variation. The line 605/02 shows the slightest variation by this character, followed by Turkish kapiya. The line 694/02 demonstrates comparatively low variation among all breeding materials that form heavy fruits. By usable fruit part only line 584/02 has low variation.

Conclusions

The genotypic factor has predominant influence on phenotypic expression of diameter (50.53 %), weight (50.16 %) and usable part (48.06 %) of the fruit. The

environment has a dominant effect on the fruit length – 34.31 %. The observed variation of pericarp thickness is due mainly to the genotypic differences (38.53%) and their interaction with the environment (35.89%). The breeding line 669/02 differs from the studied ones by the biggest diameter (5.54 cm), pericarp thickness (5.16 mm), weight (105.60 g) and usable part (86.15 g) of the fruits. The combination of high yield with high biological value and attractive fruit appearance makes 669/02 line especially suitable for including in future hybridization programs.

The variability of the fruit diameter is the slightest (CV = 8.66 %) while the variability of the weight of usable fruit part is the highest (16.34 %).

References

- Duncan D. B.** (1955) Multiple range and multiple F tests, *Biometrics*, **11**:1-42.
- Gvozdencovic D., D. Bugarski, A. Takac, D. Jovicevic and J. Cervenski.** 2002. New pepper varieties in the long and triangular type. Scientific Session of Jubilee 120 Years Agriculture Science in Sadovo, Scientific Reports, vol. I, 139 – 142.
- IPGRI, AVRDC and CATIE.** 1995. Descriptors for Capsicum (Capsicum spp.). International Plant Genetic Resources Institute, Rome, Italy; the Asian Vegetable Research and Development Center, Taipei, Taiwan, and the Centro Agronomico Tropical de Investigacion y Ensenanza, Turrialba, Costa Rica. p. 44.
- Lidansky, T.** 1988 Statistical methods in biology and agriculturae. Sofia, *Zemizdat*. (Bg)
- Stoffella, P. J., S. J. Locascio, T. K. Howe, S. M. Olson, K. D. Shuler, Ch. S. Vavrina,** 1995, Yield and fruit size stability differs among bell pepper cultivars, *Journal Amer. Soc. Hort. Sci.* **120** (2): 325-328.
- Todorova, T.,** 1999. Local pepper (Capsicum annum L.) populations – distribution, evaluation and lines of use. PhD Thesis, IPGR, Sadovo, Bulgaria, (Bg).
- Todorova, V.,** 2003. Influence of variation sources on quantitative characters of red pepper for grinding (C. annum L.). Scientific conference with international participation “Stara Zagora’2003” June 5-6 2003. vol. 1. Agrarian Sciences. Part 1. *Plant Sciences*. pp. 205-208 (Bg).
- Todorova, V., Y. Todorov, I. Ivanova.,** 2006. Study on pepper cultivars and breeding lines kapiya type by yield. *Plant Science* (in press), (Bg).
- Todorova, V.,** 2006. Influence of the variation factors on the expression of some morphological plant characters in pepper kapiya type varieties and breeding lines (*Capsicum annum L.*). Ecology and future. (in press)
- Tomlekova, N., V. Todorova, S. Daskalov, I. Denev.** 2006. Biochemical evaluation of increased beta-carotene levels in pepper mutants. Proceedings of 3rd Central European Congress on Food, 22 – 24 May 2006, Sofia, Bulgaria (in press).
- Pevicharova, G., V. Todorova, J. Todorov,** 2006. Ascorbic acid and total sugars content of Kapiya type pepper depending on cultivars and climatic conditions. *Plant Sciences* (in press), (Bg).
- Jankulovski D., M. Cirkkova-Dordievska, D. Martinovski, J. K. Petrevska.** 1994. Evaluation of autochthonous genfond of peppers (Capsicum annum var. longum) in Macedonia. Symposium with international participation “New technologies in vegetable and flower production” 19 – 20.04.1994 Ohrid. Proceedings of the symposium, v. 1, pp. 165 – 171.

Received February, 12, 2007; accepted April, 15, 2007.