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YIELDING AND FRUIT QUALITY OF THREE SWEET PEPPER CULTIVARS FROM ORGANIC AND CONVENTIONAL CULTIVATION

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Summary

The investigations were undertaken to study the effect of cultivar and growing system (organic vs. conventional) on sweet pepper (*Capsicum annum* L.) yielding, fruit morphology and antioxidants content.

Two hybrids Caryca and Roberta and one open pollinated cultivar Mercedes all of the Polish origin were compared during 2007 and 2008 in the field experiments. Conventional production was based on mineral fertilization and chemical plant protection, while organic relied on compost fertilization and stabilized ecosystem with no chemical used according to EU Regulation 2092/91 for organic farming. The results revealed a good response of bell pepper to organic cultivation system. Marketable fruit yield was higher and morphological characters better from organic cultivation. The content of human health beneficial compounds such as acsorbic acid, total flavonoids, soluble phenols and beta- carotene were investigated at the red stage of fruit maturity. Both the cultivar and growing method influenced the level of examined compounds. Pepper fruits obtained from organic cultivation system comprised higher amount of vitamin C, beta-carotene total flavonoids and polyphenols than from the conventional. Roberta F_1 revealed the higher content of vitamin C, beta-carotene than Caryca F_1 and Mercedes. Moreover cultivar Roberta F_1 demonstrated the highest level of polyphenols in both cultivation systems.

key words: pepper, organic cultivation, fruit quality, antioxidants

INTRODUCTION

The nutritive quality of vegetables especially the content of antioxidants play an important role in the prevention of diseases. Some of them like flavonoides are known for their antioxidant, anticancer, antihemorrhagic, antiallergic and antiinflamatory properties. The overall antioxidant status and protection provided by vegetables against diseases may vary considerably from one species to another. Pepper is recognized as one of the best vegetable sources for

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human health beneficial components (Block *et al*. 1992, Lee & Howard 1995, Chu *et al*. 2000, Kaur & Kapoor 2002, Manach *et al*. 2004). The composition and concentration of them may vary in dependence on weather and growing conditions such as the way of fertilization, nutrient accessibility, soil complex and humus content etc. Some authors found higher concentration of health promotion components in organic vegetables than in conventional ones (Brandt & Molgaard 2001, Rembiałkowska *et al.* 2003, 2005).

The aim of research was the evaluation of the quantity and quality of three Polish red pepper cultivars from organic and conventional growing system.

MATERIALS AND METHODS

Three cultivars of sweet pepper Caryca F_1 , Mercedes and Roberta F_1 were cultivated by organic and conventional methods in Research Institute of Vegetable Crops at Skierniewice during 2007-2008. Organic cultivation was conducted on certified organic field designated for this particular production in accordance with EU Regulation 2092/91 for organic production. The transplants were planted at first decade of June on 6 m^{-2} plots, by 10 plants in 3 rows per plot. A forecrop for organic cultivation was a mixture of red clover with grasses, for conventional legume-cereal mixture. In organic cultivation additionally 20 t per hectare of compost was applied before planting. In conventional cultivation a mixture of mineral fertilizers was applied in accordance with soil nutrient analysis up to the level of 100 mg N , 80 mg P, 250 mg K, 1200 mg Ca and 70 mg Mg per 1 liter of soil. Nitrogen fertilization was divided in three doses, one applied before planting and others 3 weeks after planting and couple of weeks later. For the weed control pendimetaline (3 $L \cdot ha^{-1}$) was applied before planting the transplants. During the season the plants were sprayed by 1.0% solution of calcium nitrate against fruit dry-rot and by 0.05% deltametrine for aphid control. In organic cultivation mechanic weeding was used twice and the control against diseases and insects was not necessary. The fruits were harvested in about three week intervals starting on August 19th 2008 and a week later in 2007. There were 4 and 5 harvests respectively in each year. The experiment was set at randomized design in 4 replications.

For chemical analysis ripe fruits were taken in the third decade of August (20 fruits per treatment). Ascorbic acid content was determined by Tillman's method (acc. PN-90A-75101/07), beta-carotene by column chromatography (Bubicz 1965, Davis *et al.* 1970), total flavonoids by colorimetric method acc. Zhishen *et al.* (1999) and Eberhardt *et al.* (2000), total soluble phenols by colorimetric method with the use of the Folin-Ciocalteu reagent (Ragazzi & Veronaze 1973).

The results were statistically analysed by ANOVA and the significance among treatment means were compared with Newmann-Keuls at the P=0.05 level.

RESULTS AND DISCUSSION

During both years of experiment the plants from organic field produced higher marketable yield in comparison to conventional cultivation (Fig. 1). The average yield of organic pepper (first and second class) in both years amounted 32.3 kg·10 m^{-2} in comparison to 21.6 kg from conventional production. A possible explanation for this is the compost application and red clover forecroping on the organic field. Other authors emphasize the positive influence of organic fertilizers on pepper and tomato yield. Clark *et al.* (1999) succeeded in high tomato yielding from organic production owing to compost application. According to Buczkowska (2005) an organic fertilization may increase the yield of sweet pepper by 30-40%.

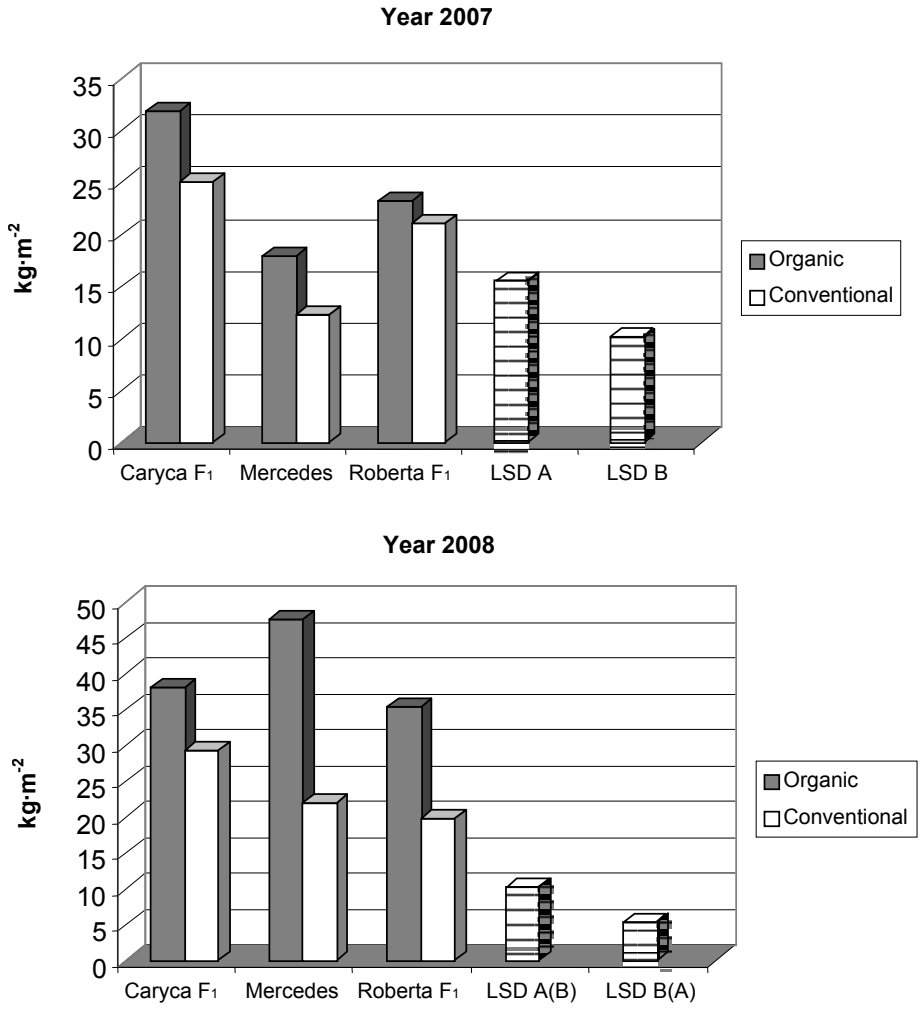


Fig.1. The marketable yield of sweet pepper fruits from organic and conventional cultivation in 2007-2008

The influence of weather conditions on the pepper yield was also pronounced. In 2007 the mean marketable yield of both cultivation methods was 23.3 and in 2008 – 32.0 kg·10 m^{-2}.

Another important factor having an impact on the sweet pepper yielding was the cultivar. The highest crop production revealed cultivar Caryca F_1 especially at less favorable weather condition of the first year of experiment. The average fruit yield of this cultivar irrespectively of the production method was 28.4 kg in the first year and 33.7 kg per 10 m^{-2} in the second year of the experiment. Lower yielding revealed Roberta F_1 with 22.2 kg in 2007 and 27.5 kg in 2008. The cultivar Mercedes, responded very clearly to both the weather conditions and the method of cultivation. It was the most sensitive cultivar among all examined. In the first year the average marketable fruit yield of Mercedes amounted 15.1 kg, but in the second one 34.8 kg. All cultivars stronger responded to the cultivation method in the second year of the experiment. Evaluation of some morphological fruit characteristics revealed some differences between cultivar (Table 1). The biggest fruits developed Caryca F_1, with the average fruit weight amounting 129.1 g in 2007 and 155 g in 2008. This cultivar produced also the highest amount of wastes and demonstrated the thickest fruit walls (over 8 mm). Smaller fruits created Roberta F_1 with the average fruit weight being 126.8 g and 138.9 respectively to the year. The smallest fruits were obtained from cv. Mercedes with the average fruit weight of – 98.9 g and 128.4 in the first and the second year of the experiment. This cultivar produced also the smallest amount of wastes. The pericarp of Mercedes was a little thicker than of Roberta F_1.

Table 1. Morphological features of three sweet pepper cultivars from organic and conventional cultivation

Cultivation method	Cultivar	Mean fruit weight (g)		Waste (g)		Pericarp thickness (mm)	
		2007	2008	2007	2008	2007	2008
Organic	Caryca F_1	156.2	171.3	10.2	15.8	8.6	8.2
	Mercedes	110.2	140.2	6.2	5.8	7.6	6.7
	Roberta F_1	142.0	162.3	9.3	13.4	6.0	6.8
Mean		136.1	157.9	8.6	11.7	7.4	7.2
Conventional	Caryca F_1	102.1	138.6	10.7	13.4	8.1	8.5
	Mercedes	87.6	116.6	9.0	10.1	7.4	7.1
	Roberta F_1	111.6	115.4	12.1	11.6	6.1	5.9
Mean		100.4	123.5	10.6	11.7	7.1	7.2
$LSD_{0.05}$	method	17.8	14.6	ns	ns	ns	ns
	cultivar	ns	19.1	1.7	ns	1.3	1.1

A good health beneficial value of red pepper fruits is mainly determined by high concentration of vitamins and polyphenols (Biacs *et al*. 1989, Kaur & Kapoor 2002, Perucka & Materska 2007). Data in Fig 2,3,4 and 5 show a significant effect of examined factors on the level of health beneficial compounds in sweet pepper. The fruits of Roberta F_1 demonstrated significantly higher

amount of ascorbic acid and beta-carotene than fruits of Caryca F_1 and Mercedes (Fig. 2 & 3).

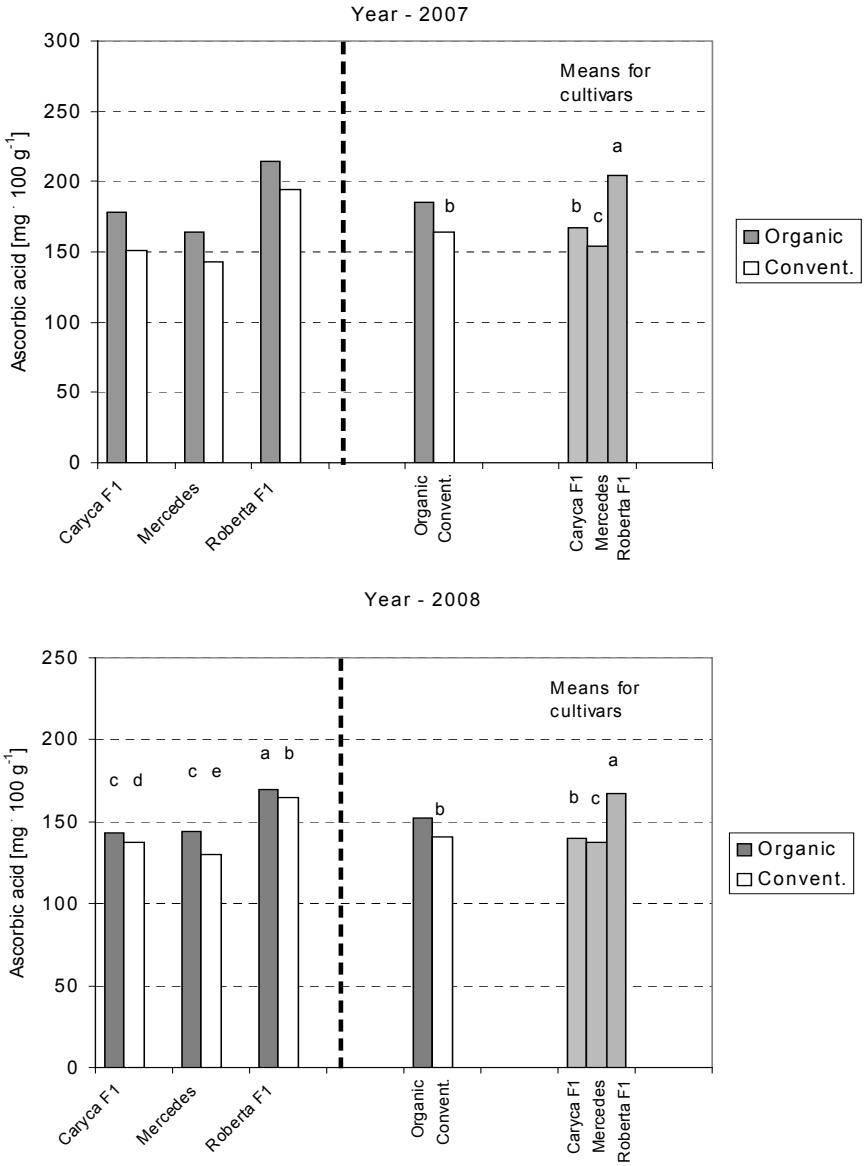


Fig. 2. Ascorbic acid content in pepper fruits from organic and conventional cultivation in 2007-2008

The level of their concentration depended not only on the cultivar but also on the production method. The average amount of ascorbic acid in the cultivars grown by organic method was 169 mg·100 g^{-1} in comparison to 153 mg·100 g^{-1} from the conventional. Similar trends in ascorbic acid concentration were found in corn and strawberry (Asami *et al.* (2003), a Pither & Hall (1990). On the

other hand Rembiałkowska *et al.* (2003) indicated lower content of vitamin C in organic tomato fruits. The beta-carotene level was also significantly higher in the fruits of organic pepper (average 1.1 mg·100 g^{-1}) than in conventional (average 0.8 mg·100 g^{-1}) (Fig.3). Likewise Pither & Hall (1990) and Rembiałkowska *et al.* (2003) in the studies comparing nutritive value of tomatoes produced in organic and conventional farms stated higher beta- carotene content in organic fruits.

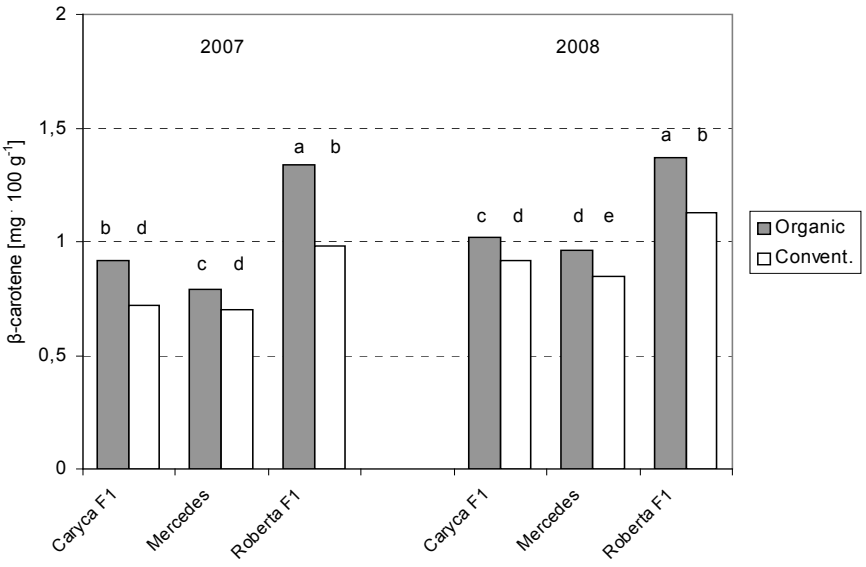


Fig. 3. β-carotene content in pepper fruits from organic and conventional cultivation in 2007-2008

Higher amount of total flavonoids and soluble phenols was found in organic fruits of pepper (Fig. 4 & 5) which confirms the Rembiałkowska *et al.* (2003) results for tomatoes.

It is worth to notice that Roberta F_1 distinguished itself with a higher content of these polyphenols in both cultivation systems. According to Lee & Howard (1995) polyphenol biosynthesis in the pepper fruits depends on the cultivar, harvest time and weather conditions during whole vegetation period. Therefore many authors observed big differences among polyphenols content in various years (Vinson *et al.* 1998). High differences in total flavonoides, soluble phenols, ascorbic acid and beta carotene occurred in our studies in dependence on the year of cultivation. In 2007 a higher level of vitamin C, total soluble phenols was noticed as well as a lower level of beta-carotene and total flavonoids in comparison to 2008. However in both years the content of these compounds was significantly higher for organic pepper.

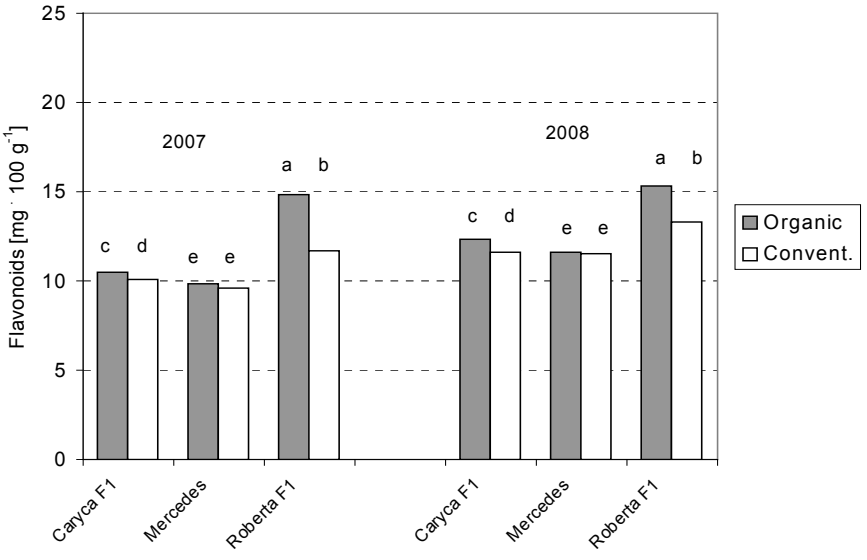


Fig. 4. Total flavonoids content in pepper fruits from organic and conventional cultivation in 2007-2008

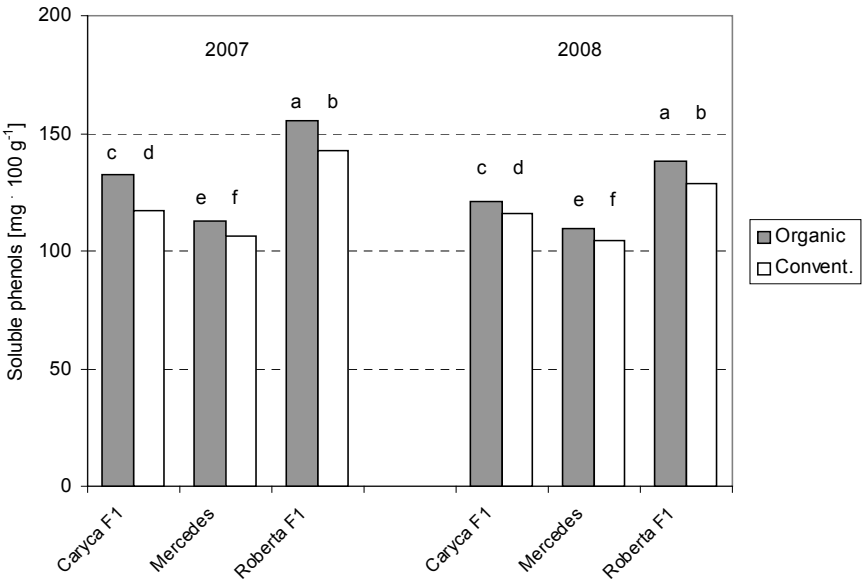


Fig. 5. Total soluble phenols content in pepper fruits from organic and conventional cultivation in 2007-2008

CONCLUSIONS

The comparison of three Polish cultivars grown by organic and conventional method revealed the following conclusions.

1. Higher yielding and better fruit quality of sweet pepper was obtained from organic cultivation than from conventional one.
2. Cultivar Caryca F_1 showed the highest resistance to both the weather conditions and the growing method, while cv. Mercedes exhibited the greatest variability with reference to examined factors.
3. Cultivar Caryca F_1 distinguished itself also for the highest mean fruit weight and the largest pericarp coat .
4. All examined cultivars responded with better antioxidant content, if cultivated by organic growing system. It is worth to notice that cv. Roberta F_1 demonstrated the highest level of all analyzed antioxidants.

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PLONOWANIE I JAKOŚĆ OWOCÓW TRZECH ODMIAN PAPRYKI Z UPRAWY EKOLOGICZNEJ I KONWENCJONALNEJ

Streszczenie

Przeprowadzono badania nad wpływem odmiany i metody uprawy (ekologiczna i konwencjonalna) na plonowanie, cechy morfologiczne owoców oraz zawartość substancji prozdrowotnych w tym antyoksydantów w owocach papryki.

W doświadczeniach polowych prowadzonych w latach 2007-2008 porównywano trzy polskie odmiany: dwa mieszańce Caryca i Roberta oraz odmianę ustaloną Mercedes. W uprawie konwencjonalnej stosowano nawożenie mineralne i ochronę chemiczną odpowiednią dla gatunku. W uprawie ekologicznej paprykę uprawiano na polu o ustabilizowanym ekosystemie zgodnie z Rozporządzeniem RWE 2092/91 dla produkcji ekologicznej, do nawożenia użyto kompost wytworzony na miejscu, nie stosowano żadnych środków chemicznych. Badania wykazały dobrą reakcję papryki na ekologiczny sposób uprawy. Z uprawy ekologicznej uzyskano wyższy plon handlowy owoców o lepszych cechach morfologicznych. Zawartość substancji prozdrowotnych takich jak witamina C, beta-karoten, flawonoidy ogółem oraz rozpuszczalne fenole były określane w owocach czerwonych. Zarówno odmiana jak i sposób uprawy wpłynęły na zawartość wymienionych substancji prozdrowotnych. W owocach papryki pochodzących z uprawy ekologicznej stwierdzono wyższą zawartość witaminy C, beta-karotenu, flawonoidów ogółem i polifenoli niż z uprawy konwencjonalnej. Wśród badanych odmian Roberta F_1 wyróżniała się najwyższym poziomem polifenoli niezależnie od sposobu uprawy.