

## Cultivar influence on the production of tomatoes, cultivated in an organic system

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**Abstract** Tomato fruits are consumed in innumerable forms, both fresh and processed: sauces, pasta, ketchup, dehydrated, being highly appreciated due to their taste and nutritional qualities. In 100 g of fresh fruit there are 0.8-0.9 mg vitamin A, 0.12-0.13 mg vitamins B, 20-60 mg vitamin C, 0.10-0.25 mg vitamin PP (8).

In order to achieve early productions, protected crop of tomatoes is used and cultivars with a shorter period of vegetation are used. Timing of production is ensured by appropriate technology as well as by the proper choice of cultivars. Tomato varieties and hybrids are variable and growing from one year to the next in number, created by various researchers in the country and abroad. In Romania, over 40 varieties of tomatoes are approved, and more than 500 varieties are known in the world (2).

Experience was carried out in 2015-2016, in an ecological, organic certified vegetable microfarm, in the village of Husasau de Tinca in Bihor County.

### Key words

tomatoes, cultivar, production, organic system

From cultivated vegetable species, tomatoes are among the first places (cultivated as well as production) in most of the countries where they grow. Due to high demand on the market, both field crops and in protected areas (greenhouses, polyethylene tunnels) are practiced. Tomato fruit is largely consumed fresh, all year round. Large quantities are intended for processing in the form of juice and tomato paste, which is used for meals. Tomatoes are considered to be a complex foodstuff, nourishing because of its carbohydrate content, rich in vitamins and mineral salts, and occupies an important place in human nutrition (2,10).

Tomatoes are an important source of numerous antioxidants: carotenoids (lycopene,  $\beta$ -carotene), flavonoids, phenolic acids (chlorogenic acid, gallic acid) and ascorbic acid (4). They provide valuable protection for human body. To prevent oxidative stress, a diet based on the consumption of antioxidants (5) is required.

Dry matter content of ripe fruit ranges from 5.5-7.5%, 3-4% glucose and fructose, 1-1.3% antide and 0.5-0.7% minerals, from the fresh substance (1).

Richness and variety of vitamins make fresh tomato fruits as well as derived products (juice, paste) an important source of food. Fresh fruits contain vitamin C (15-30 mg/100g), carotenoids (0.8 mg/100g), vitamins in group B (B<sub>1</sub> 0.06 mg, B<sub>2</sub> 0.04 mg, B<sub>6</sub> 0.1 mg) and P, vitamin K (24 mg/100g). Tomato fruits have a high content of mineral substances and organic

acids (0.3-0.5%), mainly represented by citric acid and malic acid (3). Inadequate substances for nutrition or pollutants that can cause food drawbacks are tomatine (4-7 mg/100g) and purine (4mg/100g) as well as Cu and Hg residues on the fruit's surface.

Diet based on high consumption of tomatoes reduces risk of prostate cancer due to anticancer effect of lycopene and other carotenoids (9). Tomato components, such as lycopene, phenolic substances, flavonoids and vitamins C and E, are responsible for the antioxidant action of these vegetables both fresh and processed (7, 12, 14).

Tomato assortment is very varied and dynamic, and varieties and hybrids with superior agrop productive qualities are grown every year and can be grown in different systems. In the assortment there are different fruit cultivars (most of them are red, but they are also green, brown, black, yellow, pink or even tigrated). Chemical composition of fruits differs significantly from one color type to another (6).

In order to achieve early productions, protected tomato crops are used and cultivars with a shorter period of vegetation are used. Production time is also ensured through balanced nutrition. Nitrogen nutrition should be controlled so as to avoid excess because, especially under unfavorable conditions (insufficient light, low K and Mg supply), causes foliar apparatus to grow excessively and delays fruit formation and maturation (2). If in conventional agricultural system the possibility of nutrition management is ensured by the

diversity of fertilizers that have complex composition with macro and microelements, organic farming system mainly involves the fertilization with organic fertilizers. According to requirements of Reg.EU 834/2007, maximum amount of N coming from organic and mineral fertilizers should not exceed 170 kg per hectare/ha/year (13). Organic crops use varieties or hybrids of tomatoes whose seed has been certified organically and which have genetic resistance to diseases and pests (13).

Cultures of tomatoes in protected areas are carried out between 25 March and 15 September, with the aim of producing early productions from the end of May under a lower cost price than the greenhouse crop (10,11).

## Material and Method

Experience was carried out between 2015 and 2016, being located in an ecologically certified vegetable micro-farm from Husasau de Tinca, in Bihor county, in the western part of Romania.

Purpose of the experience was to determine how some cultivars of tomatoes cultivated in polyethylene tunnels behave under specific conditions of organic farming. Cultivars Ananas, Potiron Ecarlate, Double Rich, Brandywine Pink, Merveille des Marchés, Caroten de Plovdiv, Estiva F1 and Blue Beautz have been used in the experience, seeds being certified for organic crops.

*Ananas* is highly appreciated by consumers for the qualities it has: it has few seeds, the pulp is firm, dense, sweet, juicy, very fragrant and with an incomparable flavor. Color of the pulp resembles that of the pineapple. The fruits are large (200-400 g, sometimes they can reach 1 kg) yellow marked in red. It is a late variety, with indeterminate growth, with leaves similar to potatoes.

*Potiron Ecarlate* grows indefinitely, with large fruits of 250-600g, red in mixture with a little yellow, dense, acidic, tasty, very fragrant pulp, ideal for filling.

*Double Rich* is an cultivar with indeterminate growth, adapted to short summers or cooler summers. The fruits of 300-500g, are red, firm pulp, with few seeds and sweet sour taste. They have double the content of vitamin C than the average of other tomato varieties.

*Brandywine Pink* is a very old variety considered to be one of the best varieties, with undetermined growth, with potato-like leaves. The fruits are large (500-900g), slightly flattened, dark pink, with a very fine flavor. Fruits are sensitive to cracking.

*Merveille des Marchés* is a very old variety with undetermined growth, vigorous and compact growth, with large fruit production. The fruits are red, with pink pulp, medium-sized (180-200g) with few seeds.

*Giant Belgium* has undetermined growth, with few but large fruits, can exceed 1 kg, pink color, very tasteful.

*Muscat* is a variety with undetermined growth, with many uneven fruits (some are bigger other small ones)

red colored, nice good taste. Fruits are sensitive to cracking.

*Rose de Berne* is a very popular breed in organic farming, originating in Switzerland. It has undetermined growth, with pink fruit, fine skin, succulent pulp with pleasant taste. The fruits are 180-240 g, sensitive to transport and cracking.

*Osu Blue* was created at University of Oregon USA, is a variety with undetermined growth, with medium 70-90 g fruit, purple blue, and mature black dark red, with pink pulp and great taste. It has a high content of anthocyanins.

*Caroten de Plovdiv* is a variety obtained in Bulgaria by researchers from the Maritza Institute of Vegetable Culture in Plovdiv.

*Estiva F1* is an undetermined growth hybrid, producing medium fruits (180-220g), red in colour, tasty fruits.

*Blue Fog* is an undetermined growing variety with medium-sized indigo fruits with high anthocyanin content. It exhibits great variability in shapes, sizes, taste and colors. It was obtained in San Francisco from a line of *Osu Blue* variety.

*Midnight Select* is a newly created variety, with undetermined growth, with green violet leaves, medium to small fruits, indigo color with green surfaces, at maturity at the base appears a small indigo surface with reddish tones. Pulp is dark pink with great taste. It contains anthocyanins with antioxidant effect.

*Blue Beauty* is a variety with undetermined growth that produces fruit weighing 200-250g with dense pulp. Color is a mixture of red and indigo. The fruits are resistant to cracking and sunburn. Fruits are rich in anthocyan with antioxidant capabilities.

Experience was placed in a polyethylene tunnel-type (autumn fertilized with 40 t/ha of semi- decomposed manure), crop being set up with seedlings produced in biofuel-heated hotbeds, sowing was done on 6-10 February. Seedlings were transplanted in pots of 9x9x9.5 cm and planted in polyethylene tunnel on 16-20 April. During seedlings production, specific works and two treatments with nettle macerate (to fortify plants and prevent disease attack) have been applied. First treatment was performed immediately after emergence and the second after 10 days from transplant. During vegetation period, the usual maintenance work was carried out. To prevent disease attack, nettle treatments were performed and in June, two treatments were done to combat aphids using a mixture of fern macerate and black soap (vegetable soap made from olive oil). Breaking of growing tip was performed after 8 inflorescences. Fruit picking started in June and lasted until September.

Observations have been made on plant growth, quantitative and qualitative production.

## Results and Discussions

From the data presented in table 1 it can be seen that the production harvested in June represented a

relatively low percentage from total production achieved, being between 1.01% (Caroten de Plovdiv) and 11.36% (Giant Belgium). In July the harvest volume ranged between 32.32% for Estiva hybrid and 60.53% for Roze de Berne variety. In August,

harvested production accounted for 26.12% (Muscat) and 49.85% (Estiva F1) of total production. In September the volume of harvested production accounted for 1.82% to 13.86% from total production.

Table 1

**Distribution of crop production by calendar months to tomato crops grown in a polyethylene tunnel, in an ecological system (Husasău de Tinca, 2015-2016)**

Cultivar	June		July		August		September		Total production kg/m <sup>2</sup>
	kg/m <sup>2</sup>	% total production	kg/m <sup>2</sup>	% total production	kg/m <sup>2</sup>	% total production	kg/m <sup>2</sup>	% total production	
Rose de Berne	-	-	4.08	60.53	2.12	31.45	0.54	8.02	6.74
Merveille de Marchés	0.13	1.57	3.67	44.59	3.81	46.29	0.62	7.55	8.23
Double Rich	0.77	8.63	3.41	38.22	3.87	43.38	0.87	9.77	8.92
Muscat	0.40	6.92	3.44	59.51	1.51	26.12	0.43	7.45	5.78
Brandywine Pink	0.94	10.85	3.37	38.91	3.98	45.95	0.37	4.29	8.66
Giant Belgium	0.81	11.36	3.21	45.02	2.53	35.48	0.58	8.14	7.13
Osu Blue	0.18	2.74	3.91	59.60	2.03	30.94	0.44	6.27	6.56
Blue Fog	-	-	2.96	47.28	2.90	46.32	0.40	9.36	6.26
Caroten de Plovdiv	0.08	1.01	3.65	46.20	3.88	49.11	0.29	3.68	7.90
Blue Beauty	0.71	9.11	4.24	54.42	2.70	34.65	0.14	1.82	7.79
Ananas	0.12	1.62	3.04	41.24	3.19	43.28	1.02	13.86	7.37
JL Midnight Select	-	-	3.53	46.08	3.27	42.70	0.82	11.22	7.66
Estiva F1	0.65	6.33	3.32	32.32	5.12	49.85	1.18	11.50	10.27
Potiron Ecarlate	0.10	1.19	3.87	46.34	4.02	48.14	0.36	4.33	8.35

Depending on the cultivar used, early production, considered until the end of July, (Table 2) was between 2.96 kg/m<sup>2</sup> (Blue Fog) and 4.85 kg/m<sup>2</sup> (Blue Beauty). The largest production was at Blue Beauty variety of 4.79 kg/m<sup>2</sup>, 22.82% above average, production difference being very significant. Large production was also obtained at Brandywine Pink variety of 4.31 kg/m<sup>2</sup>, followed by Double Rich variety with a

production of 4.17 kg/m<sup>2</sup>, Osue Blue (4.15 kg/m<sup>2</sup>), Rose of Berne (4.13 kg/m<sup>2</sup>), the registered production differences being significant. Early production over the average of the experience were recorded also for Giant Belgium, Estiva F1 and Potiron Ecarlate varieties without significant differences compared to the witness of the experience.

Table 2

**Cultivar influence upon early tomato production (Husasău de Tinca, 2015- 2016)**

No.	Cultivar	Early production		Difference compared to control (kg/m <sup>2</sup> )	Difference significance
		kg/m <sup>2</sup>	%		
1	Rose de Berne	4.13	105.89	0.23	*
2	Merveille de Marchés	3.80	97.43	-0.10	-
3	Double Rich	4.17	106.92	0.27	*
4	Muscat	3.85	98.71	-0.05	-
5	Brandywine Pink	4.31	110.51	0.41	*
6	Giant Belgium	4.01	102.82	0.11	-
7	Osu Blue	4.15	106.41	0.25	*
8	Blue Fog	2.96	75.89	-0.94	ooo
9	Caroten de Plovdiv	3.73	95.64	-0.17	-
10	Blue Beauty	4.79	122.82	0.89	***
11	Ananas	3.17	81.28	-0.73	oo
12	JL Midnight Select	3.67	94.10	-0.23	o
13	Estiva F1	3.97	101.79	0.07	-
14	Potiron Ecarlate	3.98	102.05	0.08	-
	Average	3.90	100.00	-	-

LSD P 5% - 0.22; LSD P 1% - 0.46; LSD P 0.01% - 0.80

From all 14 varieties tested in two experimental years, just three cultivars registered early productions with negative significant differences (distinctly significant,

respectively very significant) were compared to the average of experience (JL Midnight Select, Ananas, Blue Fog).

Table 3

**Cultivar influence on total production of tomatoes (Husasão de Tinca, 2015-2016)**

No.	Cultivar	Early production		Difference compared to control (kg/m <sup>2</sup> )	Difference significance
		kg/m <sup>2</sup>	%		
1	Rose de Berne	6.74	87.76	-0.94	oo
2	Merveille de Marchés	8.23	107.16	0.55	*
3	Double Rich	8.92	116.14	1.24	***
4	Muscat	5.78	75.26	-1.90	ooo
5	Brandywine Pink	8.66	112.76	-0.41	*
6	Giant Belgium	7.13	92.83	-0.55	o
7	Osu Blue	6.56	85.41	-1.12	oo
8	Blue Fog	6.26	81.51	-1.42	ooo
9	Caroten de Plovdiv	7.90	102.86	0.22	-
10	Blue Beauty	7.79	101.43	0.11	-
11	Ananas	7.37	95.96	-0.31	-
12	JL Midnight Select	7.66	99.73	-0.18	-
13	Estiva F1	10.27	133.72	2.59	***
14	Potiron Ecarlate	8.35	108.72	0.67	*
	Average	7.68	100.00	-	-

LSD P 5%- 0.39; LSD P 1% -0.85; LSD P 0.01%- 1.16

Depending on the cultivar used (Table 3), total production was between 5.78 kg/m<sup>2</sup> and 10.27 kg/m<sup>2</sup>. Largest production was recorded at Estiva F1 hybrid and the smallest at Blue Fog variety. Total production of Estiva F1 hybrid was 2.59 kg/m<sup>2</sup> higher than experience average, where total production was 7.68 kg/m<sup>2</sup>. Lowest total production was recorded in at Muscat variety, where total production was 5.78 kg/m<sup>2</sup> followed by Blue Fog variety with a total production of 6.26 kg/m<sup>2</sup>.

Total productions ranging from 5.78 to 7 kg/m<sup>2</sup> were recorded at Muscat (5.78 kg/m<sup>2</sup>), Osu Blue (6.56 kg/m<sup>2</sup>), Blue Fog (6.26 kg/m<sup>2</sup>) and Rosse de Berne (6.74 kg/m<sup>2</sup>) varieties. Total production ranging from 7

to 8 kg/m<sup>2</sup> was recorded for Giant Belgium (7.13 kg/m<sup>2</sup>), Blue Beauty (7.79 kg/m<sup>2</sup>), Ananas (7.37 kg/m<sup>2</sup>), JL Midnight Select (7.66 kg/m<sup>2</sup>), Caroten de Plovdiv (7.90 kg/m<sup>2</sup>) and total yields ranging from 8 to 9 kg/m<sup>2</sup> were recorded on Brandywine Pink varieties (8.66 kg/m<sup>2</sup>), Merveille des Marchés (8.23 kg/m<sup>2</sup>), and Potiron Ecarlate (8.35 kg/m<sup>2</sup>) and Double Rich (8.92 kg/m<sup>2</sup>). Largest yield was recorded at Estiva F1 hybrid (10.27 kg/m<sup>2</sup>).

Compared with experience average, Estiva F1 and Double Rich cultivars recorded higher yields with 16.14 and 33.72%, with production differences being very significant (Table 3).

Table 4

**Commercial quality of tomatoes (Husasau de Tinca, 2015-2016)**

No	Cultivar	Production (kg/m <sup>2</sup> )					% Extra + QualityI	
		Total	Extra	QualityI	QualityII	Extra+I	From total	Compared to average
1	Rose de Berne	6.74	3.45	2.23	1.06	5.68	84.27	91.31
2	Merveille de Marchés	8.23	4.49	3.21	0.53	7.70	93.56	123.79
3	Double Rich	8.92	5.24	2.53	1.15	7.77	87.10	124.92
4	Muscat	5.78	2.66	1.40	1.72	4.06	70.24	65.27
5	Brandywine Pink	8.66	4.32	2.23	2.11	6.55	75.63	105.30
6	Giant Belgium	7.13	2.25	2.48	2.40	4.73	66.33	76.04
7	Osu Blue	6.56	3.43	2.01	1.12	5.44	82.92	82.92
8	Blue Fog	6.26	2.92	2.33	1.01	5.25	83.86	84.40
9	Caroten de Plovdiv	7.90	5.32	1.92	0.66	7.24	91.64	116.39
10	Blue Beauty	7.79	4.31	2.15	1.33	6.46	82.92	103.85
11	Ananas	7.37	4.08	2.31	0.98	6.39	86.70	102.73
12	JL Midnight Select	7.66	3.89	2.34	1.43	6.23	81.33	100.16
13	Estiva F1	10.27	7.50	2.18	0.59	9.86	96.01	158.52
14	Potiron Ecarlate	8.35	4.37	2.30	1.68	6.67	79.88	107.23
15	Average	7.68	4.14	2.08	1.46	6.22	80.98	100.00

Commercial quality of tomato fruit was influenced by the cultivar used, so that the production volume of Extra + Quality I was between 4.73 kg/m<sup>2</sup> for Giant Belgium variety and 9.86 kg/m<sup>2</sup> for Estiva F1 hybrid. High quality produce (Extra + Quality I) of over 7 kg/m<sup>2</sup> was also recorded in Merveille de Marchés, Double Rich and Caroten de Plovdiv and Estiva (Table 4). High quality production ranged between 66.33% (Giant Belgium) and 96.01% (Estiva F1) from total production. A high percentage of high-quality production (over 85%) was recorded in Merveille varieties of Marchés, Double Rich, Caroten de Plovdiv, Ananas and Estiva F1. Compared with experience average, the following cultivars Merveille by Marchés, Double Rich, Brandywine Pink, Caroten of Plovdiv, Blue Beauty, Ananas, Estiva F1 and Potiron Ecarlate, the Extra + Quality I was higher with 2.73% up to 58.52 %.

## Conclusions

Based on the results obtained from the research on organic grown tomatoes in polyethylene tunnel, under the specific conditions of the Western area of Romania, the following conclusions were drawn:

- production harvested in June represented a relatively low percentage from total production achieved, being between 1.01% (Caroten de Plovdiv) and 11.36% (Giant Belgium). In July the harvest volume ranged between 32.32% for Estiva hybrid and 60.53% for Roze de Berne variety.
- early production, considered until end of July, ranged between 2.96 kg/m<sup>2</sup> (Blue Fog) and 4.85 kg/m<sup>2</sup> (Blue Beauty). The largest production was obtained at Blue Beauty variety 4.79 kg/m<sup>2</sup>, 22.82% above average, the production difference being very significant.
- depending on the cultivar used, total production was between 5.78 kg/m<sup>2</sup> and 10.27 kg/m<sup>2</sup>. Largest production was recorded at Estiva F1 hybrid and the smallest at Blue Fog variety. Total production for Estiva F1 hybrid was 2.59 kg/m<sup>2</sup> higher than experience average, where total production was 7.68 kg/m<sup>2</sup>.
- production volume of Extra + Quality I was between 4.73 kg/m<sup>2</sup> for Giant Belgium variety and 9.86 kg/m<sup>2</sup> for Estiva F1 hybrid. High quality (Extra + quality I), over 7 kg/m<sup>2</sup>, was also recorded in Merveille de Marchés, Double Rich and Caroten de Plovdiv and Estiva.
- top quality production was between 66.33% (Giant Belgium) and 96.01% (Estiva F1) from total production. A high percentage of high-quality production (over 85%) was recorded at Merveille of

Marchés, Double Rich, Caroten de Plovdiv, Ananas and Estiva F1 varieties.

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