

## Phenological and Production Characteristics of Some Strawberry Varieties in the Region of Skopje

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### Abstract

Phenological and production characteristics have been observed on 17 strawberry varieties. The earliest flowering was observed in Honeoye and Eris (5 April). The latest flowering variety is Onda (13 April). Eris, Honeoye, Madlen and Onda are varieties with the earliest time of ripening period (12–14 May). The latest ripening period was registered in Evita, Tethis, Favette, Senga Sengana, Idea and Camarosa (17–18 May). Belrubi has the largest fruits (36.2 mm high, 32.6 mm wide and 39.1 mm thick). Senga Sengana has the smallest dimensions (27.8x25.7x22.8mm). The fruit mass ranged from 5.7g (Senga Sengana) to 11.1g (Madlen). The highest yield per plant was observed in Pocahontas (575.1g) and Evita (550.7g), while the lowest in Favette (297.9g). The yield per acreage ranges from 8,276 kg/ha (Chandler) to 17,770 kg/ha (Pocahontas).

*Key words:* strawberry, variety, blooming, ripening, productivity, weight, yield.

### Introduction

The recommendation of an assortment list is fairly dynamic and prone to changes and it requires continuous tracking, introduction and research, which necessitates the regular selection of the best commercial varieties (Mišić i Nikolić, 2003). In recommending the strawberry varieties, their phenological and productivity characteristics are well studied by various authors, who have made classifications by ripening group, starting from the early varieties to the late ones, classifications according to fruit mass, yield, quality of fruits and a different level of resistance to disease (Nenadović-Mratinić et al. (2006), Nikolić et al., (2007), Faedi et. al. (2000).

Annual strawberry production in the Republic of Macedonia is around 3-5000 t, mainly based on Senga Sengana and partially Pocahontas. Production is on the open

field, with no adequate and quality, but mixed planting material which produces low and unequal yields (6.15 t/ha).

The aim of this paper is to examine the phenological and production characteristics of 15 introduced high quality strawberry varieties and to improve the assortment in the R. Macedonia.

## Materials and methods

The analysis was performed in an experimental orchard of the Agricultural Institute in Skopje during 2002–2004. The experiment was established in the second half of September 2001, with a frigo virus-free planting material, in three repetitions in a line, consisting of 30 plants of each repetition (variety). The cultivation system was an open field, in two-row lines (long plots method), on black polyethylene foil at distance of 40x30 cm. The plants were irrigated with controlled quantities of water, through the drop-by-drop system. The soil was homogeneous, alluvial, possessing a good water-air regime, suitable for strawberry growing. The agrochemical composition of the soil consisted of 0.93-2.05% hummus, 9.32-10.38mg/100g N, 14.3-21.1mg/100g P<sub>2</sub>O<sub>5</sub>, 10.06-22.2 mg/100g K<sub>2</sub>O, 6.49-7.25% CaCO<sub>3</sub>, pH 7.93-8.19 in H<sub>2</sub>O and 7.4-7.63 in KCl. Based on the analyses, the soil has been ameliorative fertilised with mineral and organic fertiliser from California worms. Phenological and pomological characteristics were observed on 15 strawberry varieties introduced from Italy: Idea, Camarosa, Belrubi, Evita, Honeoye, Tethis, Onda, Chandler, Miranda, Paros, Elsanta, Eris, Madlen, Favette and Marmolada, and two standard varieties: Senga Sengana and Pocahontas. The following characteristics were studied: time and period of flowering and ripening, fruit weight (g), dimension of fruit (mm), yield per plant (g) and yield per acreage (kg/ha). Analyses of variance were performed with a significance level of 95% and 99%, followed by an LSD – test.

## Results and discussion

The studied varieties of strawberry started to blossom (Table 1). The average blossoming period is 27 days, while the full blossoming period amounts to 37 days. The Honeoye and Chandler have the shortest blossoming period (24 days), while Evita, Marmolada and Camarosa had the longest (30 days). The earliest blossoming was noted in 04 (March 30). The same year saw the longest blossoming period (44 days). In accordance with the beginning of blossoming, the examined varieties of strawberry have been divided into 3 groups: early- blossoming varieties (April 5-7 on average): Honeoye, Eris, Madlen, Evita, Chandler, Belerubi and Tethis; medium – blossoming (April 8-10): Marmolada, Elsanta, Pocahontas, Paros, Favette and Miranda and late-blossoming varieties (April 11-13): Camarosa, Senga Sengana, Idea and Onda. The Madlen variety did not blossom in 2002, due to the late planting which resulted in the inability of the fruits to produce a timely differentiation of floral buds.

Tab.1. Time of blooming  
*Vrijeme cvjetanja*

No	Cultivar	Year	Date		Number of days
			Beginning	End	
1	Honeoye	2002	5.04	29.04	25
		2003	11.04	30.04	20
		2004	30.03	25.04	27
		Average	5.04	28.04	24
2	Eris	2002	5.04	30.04	26
		2003	11.04	30.04	20
		2004	30.03	27.04	29
		Average	5.04	29.04	25
3	Madlen	2002	/	/	/
		2003	12.04	4.05	23
		2004	31.03	2.05	33
		Average	6.04	3.05	28
4	Evita	2002	6.04	7.05	32
		2003	12.04	5.05	24
		2004	31.03	4.05	35
		Average	6.04	5.05	30
5	Chandler	2002	6.04	28.04	23
		2003	12.04	1.05	20
		2004	2.04	29.04	28
		Average	6.04	29.04	24
6	Belrubi	2002	7.04	2.05	26
		2003	12.04	3.05	22
		2004	2.04	1.05	30
		Average	7.04	2.05	26
7	Tethis	2002	7.04	6.05	30
		2003	12.04	4.05	23
		2004	3.04	4.05	32
		Average	7.04	4.05	28
8	Marmolada	2002	8.04	7.05	30
		2003	12.04	7.05	26
		2004	3.04	5.05	33
		Average	8.04	6.05	30
9	Pocahontas	2002	7.04	8.05	32
		2003	13.04	4.05	22
		2004	5.04	4.05	30
		Average	8.04	5.05	28
10	Elsanta	2002	11.04	7.05	26
		2003	13.04	6.05	24
		2004	4.04	4.05	31
		Average	9.04	6.05	27
11	Paros	2002	11.04	7.05	27
		2003	14.04	5.05	22
		2004	5.04	6.05	32
		Average	10.04	6.05	27
12	Favette	2002	9.04	6.05	28
		2003	15.04	6.05	22
		2004	5.04	6.05	32
		Average	10.04	6.05	27
13	Miranda	2002	9.04	8.05	30
		2003	15.04	7.05	23
		2004	7.04	10.05	34
		Average	10.04	8.05	29
14	Camarosa	2002	11.04	9.05	29
		2003	15.04	9.05	25
		2004	7.04	12.05	36
		Average	11.04	10.05	30
15	Senga Sengana	2002	10.04	6.05	27
		2003	15.04	7.05	23
		2004	7.04	7.05	33
		Average	11.04	7.05	28
16	Idea	2002	12.04	7.05	26
		2003	15.04	6.05	22
		2004	8.04	8.05	31
		Average	12.04	7.05	26
17	Onda	2002	14.04	11.05	28
		2003	16.04	8.05	23
		2004	8.04	9.05	32
		Average	13.04	9.05	28
Average	2002	9.04	6.05	28	
	2003	13.04	5.05	23	
	2004	4.04	4.05	31	
	02/04	7.04	5.05	27	
Blooming interval	2002	4.04	11.05	37	
	2003	11.04	9.05	29	
	2004	30.03	12.05	44	
	02/04	5.04	11.05	37	

Tab.2. Time of ripening  
*Vrijeme zrenja*

No	Cultivar	Year	Date		Number of days
			Beginning	End	
1	Eris	2002	15.05	8.06	25
		2003	12.05	12.06	32
		2004	9.05	13.06	36
		Average	12.05	11.06	31
2	Madlen	2002	/	/	/
		2003	13.05	11.06	30
		2004	11.05	15.06	26
		Average	12.05	13.06	28
3	Honeoye	2002	21.05	7.06	18
		2003	12.05	11.06	31
		2004	9.05	15.06	38
		Average	14.05	11.06	29
4	Onda	2002	16.05	11.06	27
		2003	13.05	11.06	30
		2004	14.05	15.06	33
		Average	14.05	12.06	30
5	Elsanta	2002	23.05	5.06	14
		2003	12.05	11.06	31
		2004	10.05	12.06	34
		Average	15.05	9.06	26
6	Paros	2002	23.05	7.06	16
		2003	13.05	11.06	30
		2004	12.05	14.06	34
		Average	16.05	11.06	27
7	Marmolada	2002	21.05	11.06	22
		2003	13.05	12.06	31
		2004	12.05	12.06	32
		Average	15.05	12.06	28
8	Chandler	2002	16.05	9.06	25
		2003	13.05	6.06	25
		2004	15.05	12.06	29
		Average	15.05	9.06	26
9	Pocahontas	2002	16.05	7.06	23
		2003	15.05	14.06	31
		2004	15.05	17.06	34
		Average	15.05	13.06	29
10	Miranda	2002	22.05	4.06	14
		2003	13.05	11.06	30
		2004	13.05	15.06	34
		Average	16.05	10.06	26
11	Belrubi	2002	16.05	8.06	24
		2003	16.05	11.06	27
		2004	16.05	15.06	31
		Average	16.05	11.06	27
12	Evita	2002	18.05	9.06	23
		2003	16.05	11.06	27
		2004	17.05	16.06	31
		Average	17.05	12.06	27
13	Tethis	2002	19.05	10.06	23
		2003	16.05	8.06	24
		2004	17.05	13.06	28
		Average	17.05	10.06	25
14	Senga Sengana	2002	16.05	7.06	23
		2003	17.05	16.06	31
		2004	18.05	15.06	29
		Average	17.05	13.06	28
15	Favette	2002	19.05	9.06	22
		2003	17.05	11.06	26
		2004	17.05	12.06	27
		Average	18.05	11.06	25
16	Idea	2002	16.05	3.06	19
		2003	18.05	12.06	26
		2004	19.05	16.06	29
		Average	18.05	10.06	25
17	Camarosa	2002	1.06	9.06	9
		2003	18.05	14.06	28
		2004	20.05	20.06	32
		Average	26.05	14.06	20
Average	2002	19.05	8.06	21	
	2003	15.05	11.06	28	
	2004	14.05	15.06	33	
	02/04	16.05	11.06	27	
Ripening interval	2002	15.05	11.06	28	
	2003	12.05	16.06	36	
	2004	9.05	20.06	43	
	02/04	12.05	16.06	36	

Tab. 3. Dimension of fruit (mm)  
*Dimenzije ploda (mm)*

No.	Varieties	Average dimension of fruit 2002-2004, mm											
		2002			2003			2004			2002 / 2004		
		Hight	Widthe	Thickness	Hight	Widthe	Thickness	Hight	Widthe	Thickness	Hight	Widthe	Thickness
1	Idea	30,4	29,3	26,7	30,2	28,2	24,9	34,0	31,5	28,6	31,5	29,7	26,7
2	Camarosa	28,9	34,1	31,2	28,1	31,1	27,8	32,0	35,7	32,0	29,7	33,6	30,3
3	Belrubi	39,8	37,1	34,3	31,5	28,2	24,2	37,2	32,4	28,6	36,2	32,6	29,1
4	Evita	41,9	28,4	25,6	41,0	25,2	25,5	41,7	29,6	25,6	41,5	27,7	25,6
5	Honeoye	30,8	29,7	28,3	30,1	27,9	25,4	31,8	31,2	29,0	30,9	29,6	27,6
6	Tethis	34,9	29,8	27,5	32,1	29,3	26,2	35,0	31,7	28,7	34,0	30,3	27,5
7	Chandler	35,1	32,0	28,0	23,2	20,3	17,3	33,3	29,1	25,6	30,5	27,2	23,6
8	Onda	33,3	33,8	30,4	29,9	30,4	25,8	32,9	35,0	28,3	32,0	33,1	28,1
9	Pocahontas	26,3	28,3	26,0	28,3	27,1	24,2	32,0	31,8	28,7	28,9	29,1	26,3
10	Senga Sengana	26,6	24,1	21,7	28,8	26,5	22,7	28,1	26,4	23,9	27,8	25,7	22,8
11	Miranda	34,7	36,8	34,7	29,8	31,0	28,8	31,2	33,9	30,2	31,9	33,9	31,2
12	Paros	35,2	36,8	33,0	30,2	29,1	26,0	33,0	31,9	28,9	32,8	32,6	29,3
13	Elsanta	35,1	40,7	37,7	28,8	28,0	24,9	26,7	26,1	24,0	30,2	31,6	28,8
14	Eris	35,8	36,6	33,5	29,3	28,4	25,2	29,1	26,9	25,2	31,4	30,6	28,0
15	Madlen	/	/	/	33,0	31,3	27,5	35,8	33,1	30,5	34,4	32,2	29,0
16	Favette	32,0	32,2	29,8	32,3	29,5	26,1	27,4	26,6	24,3	30,6	29,4	26,7
17	Marmolada	34,6	34,6	32,3	33,1	30,7	26,9	29,8	28,2	25,6	32,5	31,2	28,3
	Average	33,5	32,8	30,0	30,6	28,4	25,3	32,4	30,7	27,5	32,1	30,6	27,6

LSD 0,05=2,21

LSD 0,01=3,15

Tab. 4. Fruit mass (g); yield g/plant and yield kg/ha  
*Masa ploda (g); prinos g/biljci i prinos kg/ha*

N°	Varieties	Fruit mass, g				Yield g/plant					Yield kg/ha				
		2002	2003	2004	2002 / 2004	2002	2003	2004	2002 / 2004	2003 / 2004	2002	2003	2004	2002 / 2004	2003 / 2004
1	Idea	11,8	6,2	9,5	8,6	59,0	209,7	641,5	272,8	417,5	2772	9888	28512	13724	19349
2	Camarosa	17,1	7,8	12,0	10,4	4,8	283,8	736,1	311,8	503,7	212	13293	32716	15407	23130
3	Belrubi	14,8	6,9	12,3	11,3	30,3	122,3	872,5	306,4	486,5	1446	5516	38775	15246	22192
4	Evita	14,0	5,7	8,9	7,7	33,5	320,6	789,4	366,7	550,7	1495	15733	35084	17438	25692
5	Honeoye	12,1	5,9	9,2	8,3	15,4	210,4	861,8	349,9	530,2	652	9625	38300	16192	24022
6	Tethis	17,2	5,3	12,3	10,7	70,4	155,4	684,4	209,1	407,3	3102	7951	30418	13823	19486
7	Chandler	15,3	3,0	9,2	9,5	91,4	217,0	429,4	140,6	323,2	4414	1329	19086	8276	10310
8	Onda	19,2	7,2	11,9	10,4	80,3	245,7	791,7	285,9	454,1	3615	11240	35186	16680	23275
9	Pocahontas	11,9	4,9	9,5	7,3	27,1	359,3	804,4	381,7	575,1	1300	16257	35752	17770	26061
10	Senga Sengana	7,6	4,8	6,6	5,7	20,6	400,6	471,4	262,6	434,1	993	18481	20952	13475	19848
11	Miranda	16,7	10,0	10,3	10,3	27,1	293,9	595,3	294,3	440,9	1156	13119	26457	13578	19775
12	Paros	15,3	7,9	10,8	9,7	10,0	239,9	590,2	229,5	401,3	431	10969	26230	12543	18689
13	Elsanta	18,7	6,6	9,0	7,4	10,6	302,7	382,3	188,6	326,7	453	13533	16989	10325	15278
14	Eris	13,7	7,0	8,2	7,6	21,4	432,1	613,3	279,0	501,8	980	19262	27486	15910	23329
15	Madlen	/	10,2	12,2	11,1	0,0	412,0	513,7	280,1	458,9	/	18701	22832	13844	20838
16	Favette	15,1	7,2	9,8	8,7	98,7	294,5	306,1	205,0	297,9	4526	13691	13662	10626	13787
17	Marmolada	18,3	7,8	10,6	9,4	92,5	352,2	400,7	248,0	367,5	4059	15691	18953	12901	16900
	Average	15,0	6,7	10,0	8,7	40,8	282,5	652,5	277,8	445,5	1859	12605	27494	13986	20116

LSD 0,05=1,29

LSD 0,01=1,74

LSD 0,05=21.82

LSD 0,01=29.34

LSD 0,05=1640,12

LSD 0,01=2250,17

This corresponds with the tests of Selamovska (2006) conducted at the same time and at the same location with the strawberry varieties, namely Senga Sengana and Pocahontas, concluding that the optimal planting period in the Skopje region is around 15 August. Kiprijanovski (2001) concludes that Pocahontas blossoms in the first decade of April in the Skopje region, with duration of 20 to 24 days. According to Veleva and Tešić (1973), Senga Sengana begins to blossom in the second decade of April, while according to Blagojević (1999) this happens in the first half of May, with a duration of around 20 days. Paunović et. al. (1974) state that Pocahontas has medium-length duration of blossoming. According to Milivojević (2003), in the region of Belgrade, Marmolada, Elsanta and Senga Sengana start blossoming in the third decade of March, while the blossoming comes to a close in the first decade of May. It reaches very high average values for the blossoming duration from 46 to 47 days. Regarding Honeoye, Stanisavljević et al. (1997) point out that it has a long blossoming period of 35 days, stretching from the middle of April to the second decade of May, while Senga Sengana begins to blossom several days later. Dénes (1997) determines the commencement of blossoming of the Elsanta and Senga Sengana varieties on the 24 and 25 April, respectively, with both varieties blossoming periods coming to a close on 30 May.

The varieties have a fruit ripening from 12 May to 16 June, in an interval of 36 days (Table 2). Early ripening varieties (beginning from 12 to 14 May) are: Eris, Honeoye, Madlen and Onda. Medium-ripening varieties (beginning from 15 to 16 May) are Elsanta, Paros, Marmolada, Miranda, Chandler, Pocahontas and Belrubi. Late ripening varieties (beginning from 17 to 18 May) are Evita, Tethis, Favette, Senga Sengana, Idea and Camarosa. According to Milivojević (2003), the average ripening of Marmolada, Elsanta and Senga Sengana lasts from 18 May to 6 June, with duration of 20 days. According to Selamovska (2006), Pocahontas ripens from 12 May to 5 June, while the Senga Sengana from 15 May to 8 June, with a ripening interval from 24 to 25 days. Blagojević (1999) places the ripening period between 23 May and 10 June, with an average duration of 17 days.

In 2002, the average fruit weight of the examined varieties was 15.0 g, twice as much as in 2003 (6.7 g) (Table 4). The average for 2002/2004 was 8.7 g. Most varieties have large fruits (9-14g), namely: Belrubi, Madlen, Tethis, Camarosa, Chandler, Onda, Miranda, Paros and Marmolada. Medium sized fruits (7-9 g) are found with Idea, Evita, Honeoye, Pocahontas, Elsanta, Eris and Favette. Only the standard variety Senga Sengana has small fruits (5-7 g).

According to Milivojević (2003), in the region of Belgrade, the fruit weight with the Marmolada reached 14.6 g, Elsanta had 14.10 g and Senga Sengana 8.01 g. Nenadović-Mratinić et. al. (2006), ascertained a fruit weight of 9.73g by Evita, 10.60g Favette, 11.04g Eris, 11.66g Madlen. Blagojević (1999) achieved a high average weight of the fruit amounting to 16.6g, with a variation of 13.5g Senga Sengana to 20.3g Red Gauntlet. Kiprijanovski (2001) ascertains average fruit weight values of 8.48g (from 8.11g Pocahontas to 8.86 g Red Gauntlet).

The average size of the fruit with the examined varieties amounts to: 32.1x30.6x27.6mm (Table 3). The largest fruits were measured in 2002. Belrubi is the variety with the largest fruit, while the smallest is the control Senga Sengana (Table 3).

Under unchanged growing conditions and technology, the genotype is a decisive factor in the ampleness and quality of the yield. The year 2002 saw the least amount of yield, amounting 40.8 g per plant (Table 4) as a result of late planting. In order to judge the yield and for the needs of further analysis of the varieties, we examined the average yield in the regular years of 2003 and 2004. The average yield amounted to 445.5 g. In the category of high-yield varieties (>500g/plant) are: Pocahontas, Evita, Honeoye, Camarosa and Eris. The Moderately high-yield varieties (400-500g) includes: Idea, Belrubi, Tethis, Onda, Senga Sengana, Miranda, Paros and Madlen. The medium yield category (300-400g) includes: Elsanta, Marmolada and Chandler, while Favette (297.9g) is the only low-yield variety (200-300g).

According to Kiprijanovski (2001), in Skopje, Pocahontas produces 414.0 g/plant. Kaska et al. (1993) determined a very high yield for Chandler of 739.19. This variety produced the least amount of yield in our research (140.6 g/plant). Chandler showed to be extremely sensitive to root diseases and a large number of plants wilted. Mišić i Nikolić (2003) (quote according to Nikolić, 2007) note that the Elsanta has an extremely high yield which varies between 500 to 1000 g/plant. According to Türemiş et.al. (1997) the average yield of the varieties planted with frigo materials amounted to 502.8 g/plant, while the ones with fresh materials yielded 361.1 g/plant. The lowest average yield was measured in 2002 (Table 4). The yield in 2003 amounted to 12,605kg/ha, while in 2004 it was at its highest at 27,494kg/ha. The category of very high-yield varieties (>30t/ha) was not reached by any of the varieties. The distribution was as follows: high yield (20-30t/ha): Pocahontas, Evita, Camarosa, Belrubi, Honeoye, Eris and Onda; medium yield (10-20t/ha): Idea, Onda, Favette, Tethis, Senga Sengana, Miranda, Paros, Elsanta, Madlen and Marmolada; low yield (5-10t/ha): Chandler and extremely low yield (<5t/ha) was also left empty. The highest average yield within the tested period was achieved by the following varieties: Pocahontas, Evita, Onda and Honeoye. The Chandler variety produced the lowest yield, followed by Elsanta and Favette.

Dénes (1997) determined yield of 2.0 kg/m<sup>2</sup> with Elsanta and 1.74 kg/m<sup>2</sup> with Senga Sengana. Stanisavljević et. al. (1997) determined the highest yield with Senga Sengana (36,286 kg/ha), Blagojević (1999) 22.55 t/ha and Milivojević (2003) 22.8 t/ha.

## Conclusion

1. Early- blossoming varieties are Honeoye, Eris, Madlen, Evita, Chandler, Belerubi and Tethis, medium – blossoming are Marmolada, Elsanta, Pocahontas, Paros. Favette and Miranda and late-blossoming varieties are Camarosa, Senga Sengana, Idea and Onda.

2. The varieties with early ripening time are Eris, Honeoye, Madlen and Onda. Medium-ripening varieties are Elsanta, Paros, Marmolada, Miranda, Chandler, Pocahontas and Belrubi. Late ripening varieties are Evita, Tethis, Favette, Senga Sengana, Idea and Camarosa.

3. The fruit weight varied from 5.7 (Senga Sengana) to 11.1g (Madlen).

4. Pocahontas and Evita had the highest yield per plant, while the lowest was observed in Favette.

5. The yield per acreage ranged from 8,276 kg/ha *Chandler* to 17,770 kg/ha *Pocahontas*.

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## Fenološke i produktivne karakteristike nekih sorti jagode u regiji Skoplja

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### Sažetak

Proučavane su fenološke i proizvodne karakteristike 17 sorti jagoda. Najranije vreme cvetanja utvrđeno je kod sorti Honej i Eris, 5-tog aprila. Najkasnije cveta Onda, 13-tog aprila. Sorte sa najranijim početkom sazrevanja su Eris, Honej, Madlen i Onda od 12-tog do 14-tog Maja. Sorte koje najkasnije sazrevaju su Evita, Tetis, Favet, Zenga zengana, Idea i Kamarosa, od 17-tog do 18-tog Maja. Belrubi ima najveće plodove 36,2x32,6x39,1mm. Zenga zengana ima najmanje plodove 27,8x25,7x22,8 mm. Prosečna masa plodova varira od 5,7 kod Zenga zengana do 11,1g kod Madlen. Najveći prinos po biljci imaju Pokahontas 575,1g i Evita 550,7g, a najmanji Favet 297,9g. Prosečan prinos po jedinici površine iznosi od 8276 kg/ha kod Čandler do 17770 kg/ha kod Pokahontas.

*Ključne reči:* jagoda, sorta, cvetanje, sazrevanje, produktivnost, masa, prinos.

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