

Testing of strawberry cultivars - indicators defining the yield

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Abstract

In this research paper are presented the results from the analysis of the following strawberry cultivars - Ostara, Korona, Pineberry, Maxim, Dora with standard for Cambridge favourite. The experiment began in mid-May, 2015 on experimental fields in Kostinbrod of four sets with 20 plants each, with a planting distance of 1.00 m / 0.25 m. A variety of indicators has been studied for the experiment: number of inflorescences and flowers per plant, count of flowers per inflorescence, average fruit mass and yield. Number of inflorescences and flowers per plant, count of flowers per inflorescence, average fruit mass and yield are the studied indicators for the experiment. It is established that the average number of inflorescences per plant of strawberry cultivars is 5.4. The lowest number has Pineberry (2.5) while the biggest one has Korona – 10.0. The higher number of flowers per inflorescence increase the fertility of the cultivars. The average number of flowers per plant for the tested period is 49.5. The lowest numbers has Pineberry (20.9) and with the biggest is Korona (97.6). The fruit of the white-fruited cultivar Pineberry are very small, the products from Dora are not sufficiently large. However, their high fertility allows for a good yield. The Cambridge favorite, Korona and Maxim are distinguished by their large fruit. It has been established that Ostara and Pineberry have mid yield. The standard Cambridge favorite has very good yield. Excellent yield was found at Korona, Dora and Maxim.

Key words: strawberry cultivars, number of inflorescences, number of flowers, average mass of fruit, yield.

Introduction

The garden strawberry (*Fragaria x ananassa* Duch.) is a plant with a high ecological adaptability and its fertility potential can reach 4-5 t/da or more. For a good and stable yield, the unification of all important economic qualities of one phenotype is required: the industrial variety has to be an intensive type with high fertility, resistant to extreme environmental conditions, diseases and pests. A variety which can be harvested mechanically, is suitable for direct consumption, freezing and processing (Tulinova et al., 2009). The formation of inflorescences and flowers is one of the most important factors for obtaining high and stable yields. The plants have to be upright, to have long strong inflorescences with compact flowers (Boycheva & Milanov, 1994; Tulinova et al., 2009). Yield is a very complex value, which is driven by all factors affecting plants during their growth period and their development (Tulinova et al., 2009). The yield rate is always a ratio between fertility of the cultivar and resistance to abiotic stress factors. In favorable conditions such as sufficient water supply, suitable temperature, rich soil, etc., the advantage goes to the cultivar with high fertility potential. In unfavorable conditions the advantage will have the cultivar with a sensitivity to abiotic stress factors. When the conditions are unfavorable, the ecological plasticity of the grown cultivars is the most important trait for the expression of the genetically-based fertility. The climatic conditions in Bulgaria determine different dry periods during the vegetative development of the plants and therefore irrigation is necessary to obtain high yields. (Subkova & Zafirova, 2005, Zafirova, 2008.)

The aim of the study is to test the introduced strawberry cultivars choosing the ones which are of interest for the selection process and for cultivation, and which distinguish themselves with high fertility and large fruit.

Material and methods

The experiment began in mid-May, 2015 in testing grounds in Kostinbrod in field conditions

of four sets with 20 plants each, with a planting distance of 1.00 m / 0.25 m (Barov & Shanin, 1965; Boycheva & Lazarov, 2003). Drip irrigation is used. Distance between individual emitters is 23 cm. The soil type is leached vertisol chernozem with good water absorption and water holding capacity; it has low acid reaction (pH 5.5-6.5). The altitude of the experimental field is 543 m. Included are the following varieties of origin – Dutch (Ostara, Korona, Pineberry); Belgian (Maxim); Italian (Dora) and the English standard (Cambridge favourite).

Observation and survey indicators: number of inflorescences and flowers, average mass of fruit (g), yield (kg/plant, kg/da). The readings were based on four well-developed plants from each replication of all strawberry cultivars.

The study was conducted following the Methodology for studying plant resources in fruit plants (Nedev et al., 1979) and Methodology for conducting competitive variety experiments with strawberry cultivars for biological and economic qualities (Boycheva & Lazarov, 2003). The collected data of the surveyed indicators is processed via the dispersion analysis method (Maneva, 2007).

Results and discussion

• Number of inflorescences and flowers

One of the main factors characterizing the yield of strawberry cultivars is the number of inflorescences and flowers. It has been found that the varieties that form a larger number of inflorescences are more prolific and have a greater economic importance (Popovski & Popovska, 2011). In the first year, the Korona variety forms the largest number of inflorescences, which are around 10.3 inflorescences per plant, followed by Ostara with 7.0 (Table 1). The small plants of Pineberry have the fewest number – 1.8 inflorescences per plant. With the exception of this variety, the remaining ones form a larger number of inflorescences than the standard one, which has 3.5 inflorescences per plant. The number of flowers is in the range of 17.8 (Pineberry) up to 95.0 per plant for Korona, while the standard one takes an intermediate position – it has 45.0 numbers. In the predominant

part of the varieties the number of flowers on the inflorescence is in the range of 5.8 – 10.9. Ostara and Korona have similar values.

During the second year, Korona and Ostara again formed more inflorescences, but fewer compared to the previous year. Maxim also formed fewer inflorescences. In contrast, Dora and Cambridge favorite have increased the number of inflorescences, and especially Pineberry, which formed two times more inflorescences (1.8-3.3). The variety that forms the largest number of inflorescences, also forms the most flowers – this is the Dutch Korona (95.0-100.2). During the second vegetation only in some of the varieties, an increase in flower numbers is found. The variation is between 23.9 and 100.2 numbers per plant. Again, Pineberry and Korona are the varieties with the smallest and largest number of flowers, respectively. For the Italian Dora there is a sharp decrease in numbers in the second year.

On average for the two years of study, the standard has the highest number of inflorescences (10.5), followed immediately by Dora (10.2). The data from the statistical analysis of the number of inflorescences show that for the varieties Ostara and Korona, this indicator has proved stable over the years. Relatively strong variation was observed in Pineberry (Table 2). The same is seen for number of flowers per plant – while with Pineberry the variation is less compared to the number of inflorescences.

- Average mass of the fruit

Data on the weight of strawberry fruit in individual varieties is present in table 3. In 2016 the average mass of fruit varies between 6.4 g and 20.2 g. Maxim (19.2 g) and Korona (20.2 g) both have larger fruit than the control variety, but in Maxim individual fruits of the order of 55.0 g can be found, and with Korona – 28.3 g.

During the second vegetation the average mass of strawberry fruits ranges from 6.8 g to 20.1 g. Maxim is once again the leader, with individual fruits reaching 37.0 g, values which are much lower compared to last year. The fruits of Korona grow up to 24.0 g. Prichko et al., (2005) obtained fruits of the same variety with an average mass of 11.1 g, which is lower than our results. The prob-

able reason for that are the lower temperatures in Southern Russia. The standard is surpassed only by Maxim which has a fruit mass of 20.1 g. In a study conducted by Antipenko and Popova (2008) it was found that the average mass of the controlled variety (Cambridge favorite) is 13.2 g with a maximum fruit mass of 34.0 g.

For the test period, the average weight of the strawberries was 14.4 g, ranging from 6.6 g (Pineberry) to 19.7 g (Maxim). This data places the fruits of individual varieties in the group of very small to large fruits. Compared to the other varieties tested, the fruits of the Pineberry were small during the entire period with an average value of 6.6 g. The fruits of Dora are not large enough, but the high fertility allows for a good harvest. Korona is also large-fruited, slightly exceeding the control, whose fruit mass is 17.2 g. The variety Maxim has the largest fruits.

The statistical analysis showed that the average fruit mass of the tested strawberry cultivars was characterized by stability. The only exception was Maxim, in which this indicator was partially unproven (Table 4).

- Average yield

According to Gorelikova (2017), the yield of the strawberry cultivars is primarily determined by the genotype of the respective variety and depends on the level of adaptation towards a number of unfavorable abiotic and biotic factors. During the first year of cultivation, lower yield than the standard variety was recorded with Ostara and Pineberry, 1488.0 g/da and 1404 kg/da, respectively (Table 3, Fig. 1). For Maxim (3978.0 kg/da), Dora (3300.0 kg/da) and Korona (3096.0 kg/da) the yield is higher.

The following year the standard once again had a higher yield than Ostara (1452.0 kg/da) and Pineberry (1320.0 kg/da) and a lower yield compared to Korona (2682.0 kg/da), Dora (2886.0 kg/da) and Maxim (3516.0 kg/da).

Depending on the expressed fertility, on average, during the years of testing, the cultivars are divided into three groups according to Boytcheva & Lazarov, (2003):

- average yield (1001 - 1500 kg/da) - Ostara, Pineberry;

Table 1. Number of inflorescences and flowers

Variety	Inflorescences / pl.			Flowers / pl.			Flowers / inflorescence		
	2016	2017	x*	2016	2017	x*	2016	2017	x*
Ostara	7.0	5.7	6.4	66.3	60.2	63.3	9.5	10.6	10.1
Korona	10.3	9.6	10.0	95.0	100.2	97.6	9.3	10.4	9.9
Pineberry	1.8	3.3	2.6	17.8	23.9	20.9	10.9	7.2	9.1
Maxim	4.8	4.5	4.7	27.8	28.3	28.1	5.8	6.3	6.1
Dora	4.5	5.0	4.8	60.3	31.8	46.1	14.0	6.4	10.2
C. favourite	3.5	4.6	4.1	45.0	37.0	41.0	13.0	8.0	10.5
x*	5.3	5.5	5.4	52.0	46.9	49.5	10.4	8.2	9.3

x* - average value for the period

Table 2. Comparative analysis of indices number inflorescences and flowers/plant

Variety	Ostara	Korona	Pineberry	Maxim	Dora	Cambridge favourite-standard	LSD		
							0.05	0.01	0.001
Index									
	2016								
inflorescences	7+++	10.3+++	1.8++	4.8+	4.5+	3.5	0.9358	1.296	1.788
flowers	66.3++	95+++	17.8++	27.8+	60.3+	45	15.02	20.8	28.7
	2017								
inflorescences	5.7ns	9.7+++	3.3ns	4.5ns	5ns	4.55	2.285	3.165	4.367
flowers	60.2ns	100.1+++	23.9ns	28.3ns	31.8ns	36.9	23.6	32.69	45.1
	2016 – 2017								
inflorescences	6.4++	10.2+++	2.3+	4.6ns	4.8ns	4.05	1.443	1.999	2.759
flowers	63.3++	97.6+++	20.8++	28ns	46ns	41	13.53	18.74	25.85

ns – no significance; + (P<0.05); ++ (P<0.01); +++ (P<0.001)

Table 3. Yield (kg/plant, kg/da) and average mass of fruit (g)

Variety	Mass of fruit (g)			Yield					
				kg/plant			kg/da		
	2016	2017	x*	2016	2017	x*	2016	2017	x*
Ostara	11.9	11.5	11.7	0.248	0.242	0.245	1488.0	1452.0	1470.0
Korona	20.2	15.4	17.8	0.516	0.447	0.482	3096.0	2682.0	2892.0
Pineberry	6.4	6.8	6.6	0.234	0.220	0.227	1404.0	1302.0	1362.0
Maxim	19.2	20.1	19.7	0.663	0.586	0.625	3978.00	3516.0	3750.0
Dora	12.2	14.8	13.5	0.550	0.481	0.516	3300.0	2886.0	3096.0
C. favourite	16.1	18.2	17.2	0.391	0.295	0.343	2346.0	1770.0	2058.0
x*	14.3	14.5	14.4	0.434	0.379	0.406	2602.0	2271.0	2438.0

x* - average value for period

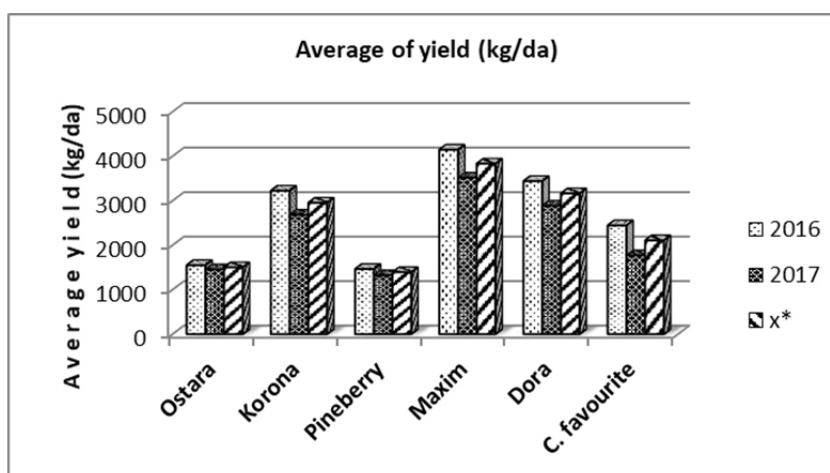


Fig. 1. Average yield (kg/da)
x* - average value for period

- very good yield (2001 - 2500 kg/da) - Cambridge favourite;
- excellent yield (over 2500 kg/da) - Korona, Maxim, Dora.

In 2015-2016, an experiment of the Ostara variety yielded about 1831 kg/da (Petruk et al., 2016), which even in the extreme conditions of

Western Siberia, is higher than that obtained in our study (1470.0 kg/da). Although Ostara is a variety of the neutral day, meaning it can have flower buds regardless of the length of the day. It fails to fully manifest its valuable economic qualities in our soil and climatic conditions. In 2000, it was included in the varietal list of fruit

Table 4. Comparative analysis of the average mass of fruit (g) and yield of plant (kg)

Variety Index	Ostara	Korona	Pineberry	Maxim	Dora	Cambridge favourite standard	LSD		
							0.05	0.01	0.001
2016									
mass of fruit	11.87++	20.22++	6.425+++	19.17+	12.17+	16.1	2.916	4.039	5.573
yield/plant	0.248+	0.516+	0.239+	0.663+++	0.550+	0.391	0.1181	0.1636	0.2257
2017									
mass of fruit	11.47+++	15.4ns	6.775+++	20.07ns	14.8+	18.2	2.953	4.09	5.644
yield/plant	0.2472ns	0.447+	0.220ns	0.586+++	0.481++	0.295	0.1278	0.177	0.2442
2016-2017									
mass of fruit	11.7+++	17.85ns	6.625+++	19.65ns	13.47++	17.15	2.523	3.495	4.822
yield/plant	0.245ns	0.482+	0.230+	0.625+++	0.516++	0.343	0.1095	0.1517	0.2093

crops in Estonia, with the main goal of extending the period of consumption of fresh strawberries (Libek, 2002).

According to Gorelikova (2017), there is a correlation between the fertility of strawberry varieties and the average fruit mass ($r = 0.561$). Höfer et al., (2012) found a correlation between the number of inflorescences and higher yield ($r = 0.66$). The yield is negatively correlated with the appearance of the plant ($r = -0.56$), meaning the varieties that have upright plants have a lower yield per plant. In addition, plant yield was positively correlated with fruit size ($r = 0.47$) and harvest length ($r = 0.43$).

During the second vegetation in all varieties, there is a decrease in yield, but it is relatively small. For a study conducted for Cambridge favourite, the first growing season yielded 0.189 kg per plant, and in the following year, it doubled more than twice its size, increasing to 0.528 kg (Antipenko & Popova, 2008). In our study in the second year, there is a decrease - from 0.391 to 0.295 kg / plant.

The average yield per decare for the period is 2438.0 kg, and the variation is in the range - from 1470.0 to 3750 k / da. The fertility of the varieties is presented in ascending order - Pineberry, Os-

tara, Cambridge favourite, Korona, Dora, Maxim. The standard is in third place in terms of fertility, surpassing only the white-fruited Pineberry and the variety of the neutral day (Ostara). According to the data from the statistical processing, stable yield is observed in Maxim and Dora, while in Pineberry and the standard it is more variable

Conclusions

The varieties that form a larger number of inflorescences are more fertile and of greater economic importance. Depending on the year of testing, the number is the lowest in 2016 - 5.3 inflorescences per plant;

The average number of inflorescences of strawberry varieties is 5.4. The lowest number forms Pineberry (2.6), the highest number per plant forms Korona (10.0).

The larger number of flowers on the inflorescence allows for higher fertility of the varieties. The average number of flowers per inflorescences is 9.3. Maxim (6.1) has the smallest number, while Cambridge favourite (10.5) and Dora (10.2) form the largest number.

The number of flowers per plant gives a clearer idea of the genetic potential of the varieties in terms

of fertility. The average number for the period is 49.5. The smallest number forms Pineberry (20.9), with the largest number being Korona (97.6).

The fruits of the white-fruited Pineberry are very small. With medium-weight fruits are Ostara and Dora. The fruits of the standard Cambridge favourite variety, Korona and Maxim are large.

The Ostara and Pineberry varieties have an average yield; with a very good one is Cambridge favourite; excellent yield is observed in Korona, Dora, Maxim.

Strawberry varieties Dora, Korona and Maxim are recommended for industrial cultivation. Pineberry is suitable for small areas and especially for amateur gardeners, because of the interesting colour of the fruit (white to pinkish-white), low fertility and relatively soft and small fruits.

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