

YIELDING OF NEW DESSERT STRAWBERRY CULTIVARS AND THEIR SUSCEPTIBILITY TO FUNGAL DISEASES IN POLAND

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A B S T R A C T

The paper presents the results of experiments aimed at assessing the fruit production value of five new dessert strawberry cultivars of the short-day type: 'Figaro', 'Sonata', 'Salsa', 'Flair' (Clone 03-08-01) and 'Palomar', in central Poland. The standard cultivars were 'Honeoye' (early) and 'Elsanta' (mid-early). The experiments were carried out in 2008-2009 in the experimental fields of the Research Institute of Pomology and Floriculture in Skierniewice (Central Poland). Under assessment were the following characteristics: the yielding of plants (marketable yield, fruit size, susceptibility of fruit to decay caused by grey mould, fruit firmness, soluble solids and vitamin C content in the fruit) and the susceptibility of the plants to leaf diseases and verticillium wilt. The late-bearing cultivar 'Salsa' was recognized as the most useful for cultivation in Poland. It is characterized by high yields and produces large, firm fruit with high vitamin C content, shows a high resistance to leaf diseases and verticillium wilt. The early-bearing cultivar 'Palomar' is also of interest – it yields very good crops, produces large and very firm fruit, but its susceptibility to verticillium wilt is not yet sufficiently known. The cultivars in this study need to undergo further evaluation in terms of their susceptibility to low temperatures.

Key words: *Fragaria x ananassa*, fruit weight, firmness, extract, ascorbic acid, *Verticillium* wilt

INTRODUCTION

In strawberry cultivation in Poland the dominant role is still played by the industrial variety 'Senga Sengana', but the share of this cultivar is

decreasing in favour of dessert cultivars. The growing interest of fruit growers and consumers in dessert varieties is due to the higher quality and attractiveness of this type of fruit, and better keeping quality in

retail trade in comparison with the fruit of the cultivar 'Senga Sengana'. In Europe, the most desired strawberry varieties are those that produce large, shapely fruit with a light red skin colour (Roudeillac and Trajkovski, 2004). High fruit firmness of dessert strawberries and low susceptibility to decay allow them to be transported over longer distances and stored for a while (e.g. on supermarket shelves) without the risk of reducing their quality or attractiveness. It is known from experience that the dessert varieties, especially those bred in countries with a climate warmer than that of Poland, are often unreliable when cultivated by traditional means in the field in Poland. During frosty winters, plants of these cultivars are often damaged by frost. Moreover, many foreign cultivars show a fairly high susceptibility to the diseases of the root system, verticillium wilt in particular, caused by the fungus *Verticillium dahliae*. Both of these factors weaken the growth of strawberry plants, reduce yield and fruit quality, and in the case of the most susceptible cultivars they can even lead to plants dying out. In order to introduce into fruit-growing practice new dessert cultivars of high productivity and fruit quality, and which are at the same time resistant to pathogens, two kinds of studies have been carried out at the Institute of Pomology and Floriculture in Skierniewice, Poland: (i) breeding of native cultivars well-adapted to the Polish natural environment, and (ii) evaluation of new, foreign-bred cul-

tivars in terms of their fruit production value in Poland.

The aim of the study was to assess the fruit production value of five new foreign strawberry cultivars, bred in recent years in three fruit plant breeding centres abroad, which had not yet been evaluated in Poland. The most valuable of these cultivars will be recommended for commercial cultivation in Poland. In the future they may be used as donors of important usability traits in further studies on strawberry breeding at the Research Institute of Pomology and Floriculture.

MATERIAL AND METHODS

The study was carried out in 2008-2009, at the Research Institute of Pomology and Floriculture in Skierniewice, Poland, based on two separate field experiments (Experiment 1 and Experiment 2). The same strawberry cultivars were evaluated in both experiments (Tab. 1). The standard cultivars were: 'Honeoye' (early-) and 'Elsanta' (mid-early-bearing). In Experiment 1, strawberry plant yields were assessed, as well as their susceptibility to leaf diseases, whereas their susceptibility to verticillium wilt was assessed in Experiment 2. Experiment 1 was set up in the Pomological Orchard of the Institute, on soil disinfected with the preparation Nemazin 97 XX before planting the strawberry plants. Experiment 2 was located in a field of the Division of Floriculture at Sabadiany, Poland, known for the high concentration of the *Verticillium*

Table 1. Origin of the cultivars under evaluation

Cultivar	Country of origin	Lineage
Honeoye - standard	USA	Vibrant x Holiday
Elsanta - standard	Holland	Gorella x Holiday
Figaro	Holland	Elsanta x Pajaro
Sonata	Holland	Elsanta x Polka
Salsa	Holland	*
Flair (Clone 03-08-01)	Holland	*
Palomar	USA	Camino Real & Ventana**

*no information in the specialist literature

**no information on the direction of crossing of the two parental forms

dahliae inoculum in the soil (the so-called “death field”). Both experiments were set up in the second half of April 2008, in a random block design with four replications. The experimental plot in Experiment 1 was comprised of 25 plants, whereas in Experiment 2 there were 20 plants, all growing in one row at a spacing of 0.25 x 1.1 m. The experiments were set up with frigo seedlings, category A+ (crown diameter 15-22 mm).

In March 2008, from the arable layer of the soil on which Experiment 2 was to be set up, 30 soil samples were randomly collected and combined to form a mixed sample. This sample was used to determine the population size of the fungus *V. dahliae* using the method developed by Harris and Yang (1990), and 12.6 propagules were found in 1 g of the soil. Before the plants were put into the ground, the soil in both experiments was fertilized with mineral fertilizers. The fertilizers were used at the following rates: 125 kg K₂O/ha as potassium sulphate (50% K₂O), 70 kg P₂O₅/ha as triple super-

phosphate (46% P₂O₅), with nitrogen fertilization during the growing season in two doses of 25 kg N as ammonium nitrate (34% NH₄NO₃). In Experiment 1, while the plants were flowering, protection was used against grey mould (in accordance with the recommendations of the protection programme for strawberry – the preparations Signum 33 WG, Switch 62,5 WG, and Thiram Granuflo 80 WG, applied at weekly intervals). No other form of protection against fungal diseases of leaves was used in the two experiments, nor any chemical means of weed control. A rototiller was systematically used on weeds and runner plants growing in between the rows, whereas those in the planted rows were pulled by hand (in Experiment 2, inflorescences were also removed). During the periods without rain, the plants were watered at least once a week with a “Polymat 130” automatic sprinkler. During the fruit ripening time and at harvest in 2008, the weather was hot and dry, whereas in the corresponding periods in 2009, the weather was rainy and cool.

Measurements and observations

Experiment 1

- Fruit ripening time (when 50% of the fruit had been collected – determined with Faedi's Index, developed as part of the project COST Action 836 (Navatel and Krüger, 2003).
- Marketable yield in g/plot (all fruit of quality class “extra” and ‘I’ – with diameter >1.8 cm).
- Weight of 100 fruit in g (ratio of crop weight and the number of healthy fruit collected).
- Infection of fruit with grey mould (percentage of fruit infected with grey mould in the total number of fruit).
- Fruit firmness in N (based on a sample of 20 fruit collected at three harvest times (harvests 3, 4 and 5), using INSTRON 5542 firmness gauge).
- Extract in Brix degrees (soluble solids content based on a sample of 20 fruit collected at three harvest times (harvests 3, 4 and 5), using Rudolph J-157 refractometer).
- Ascorbic acid content in mg/100 ml (based on a sample of 20 fruit collected at three harvest times (harvests 3, 4 and 5), using RQeasy reflectometer).
- Susceptibility of plants to leaf spot (*Mycosphaerella fragariae*), on a 0-4 ranking scale, where: 0 – no symptoms, 4 – plants dying out as a result of severe infection with the pathogen.
- Susceptibility of strawberry plants to leaf scorch (*Diplocarpon*

earliana), on a 0-4 ranking scale, where: 0 – no symptoms, 4 – plants dying out as a result of severe infection with the pathogen.

- Susceptibility of strawberry plants to powdery mildew of strawberry (*Sphaerotheca macularis*), on a 0-4 ranking scale, where: 0 – no symptoms, 4 – plants dying out as a result of severe infection with the pathogen.

Experiment 2

- Assessment of the degree of infection with *V. dahliae*, carried out at the end of August and the beginning of September 2008 and 2009, on a 5-point rating scale, where 0 – no symptoms of the disease, 4 – plants dying out or already dead.

The results were evaluated statistically with R.A. Fischer analysis of variance, with the assessment of the differences between mean values carried out using Duncan's t-test at a significance level of 5%.

RESULTS AND DISCUSSION

Experiment 1

In 2008, the first ripe fruit were picked around the middle of June, whereas in 2009 the fruit began to ripen more than two weeks earlier, already at the beginning of June. This was most likely caused by the warm, dry spring of 2009, which had created favourable conditions for the growing season to start early and the fruit to ripen early. This type of weather, however, was responsible for shortening the fruit ripening period

to the extent that even the fruit of the late cultivars ripened earlier. In both years of the study, the biggest first crop of strawberries was that of the cultivar 'Palomar' (Fig. 1 and 2). By making use of Faedi's Index, it was possible to determine precisely the harvest date when 50% of the crop of each of the cultivars under evaluation had been collected. The lowest Index value was obtained for the cultivar 'Flair' (by 0.6 lower in comparison with the cultivar 'Honeoye' in 2008, and by 2.4 lower in 2009), which means that the fruit of this cultivar normally began to ripen 1-2 days earlier than those of 'Honeoye'. 'Honeoye' is the cultivar so far regarded as one of the earliest ripening cultivars in Poland (Masny and Żurawicz, 2005). A cultivar that was similar to 'Honeoye' (in 2008), and even slightly earlier (by about 2 days in 2009), on the basis of the ripening time of 50% of the fruit, was 'Palomar'. The last to ripen were the fruit of the cultivar 'Salsa'. 'Salsa' strawberries ripened an average of 6-7 days later than the strawberries of the standard cultivar 'Elsanta', which is counted among the medium-early varieties (Neuweiler et al., 2000).

In the first year of the study (2008), the yield of all the cultivars was much worse than in the second year (2009). This was because the plants were still very young in 2008. In the first year of fruiting, three of the evaluated cultivars, 'Figaro', 'Sonata' and 'Palomar', had a better yield than the standard, early cultivar 'Honeoye', but at the same time significantly worse than the other stand-

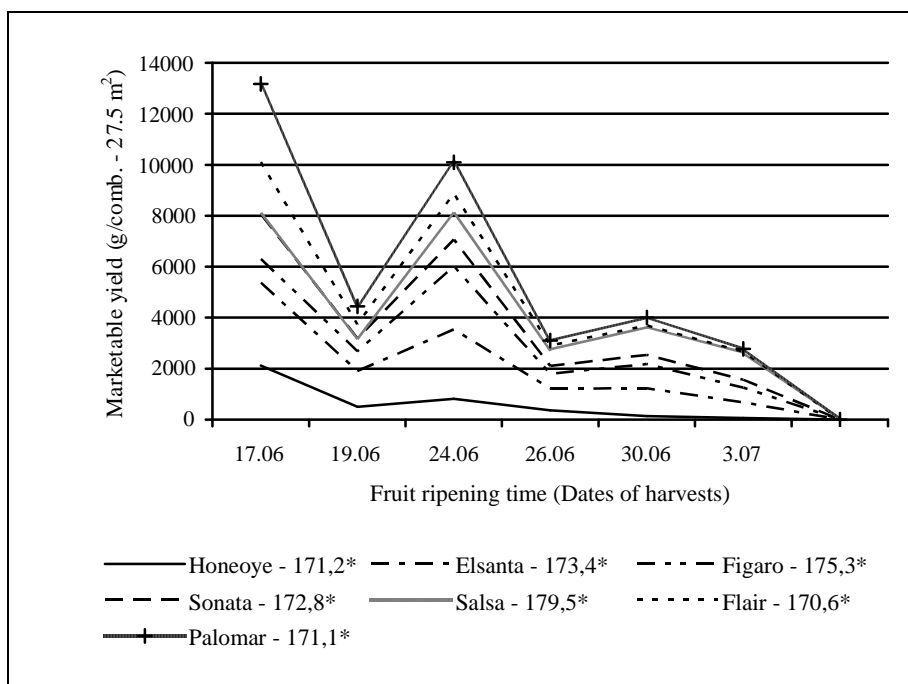
ard, mid-early cultivar 'Elsanta' (Tab. 2). The Dutch cultivars 'Salsa' and 'Flair' had a yield at the same level as the standard cultivar 'Honeoye'. In 2009, the highest marketable yield, significantly higher than the yields of the standard cultivars, was produced by the cultivar 'Salsa'. The cultivars 'Figaro', 'Sonata' and 'Palomar' had a yield which was much the same as the two standard cultivars. The least productive, as in 2008, turned out to be the cultivar 'Flair'. Considering the total yields, obtained in both years, it is clear that over the two years of the study the highest yield was obtained from the cultivar 'Salsa'. This cultivar had a significantly better yield than all the other cultivars under evaluation and of the two standard cultivars. On the other hand, the lowest total fruit yield was obtained from the cultivar 'Flair', which indicates that in Poland this cultivar has lower yield-producing potential than 'Salsa', 'Palomar', and 'Elsanta'. The obtained results, indicating high productivity of the cultivar 'Salsa' in Poland, are in agreement with the results of the studies conducted by Spornberger et al. (2008) on 13 strawberry cultivars in 2006-2007. According to the results obtained by these authors, the cultivar 'Salsa' produced considerably higher yields than the cultivars 'Elsanta' and 'Sonata'.

The results relating to fruit size are given in Table 2. As can be seen, in the first year all the cultivars produced smaller fruit than in the second year. This was undoubtedly caused

Table 2. The evaluated strawberry cultivar yields – Experiment 1 (Skierniewice, Poland, 2008-2009)

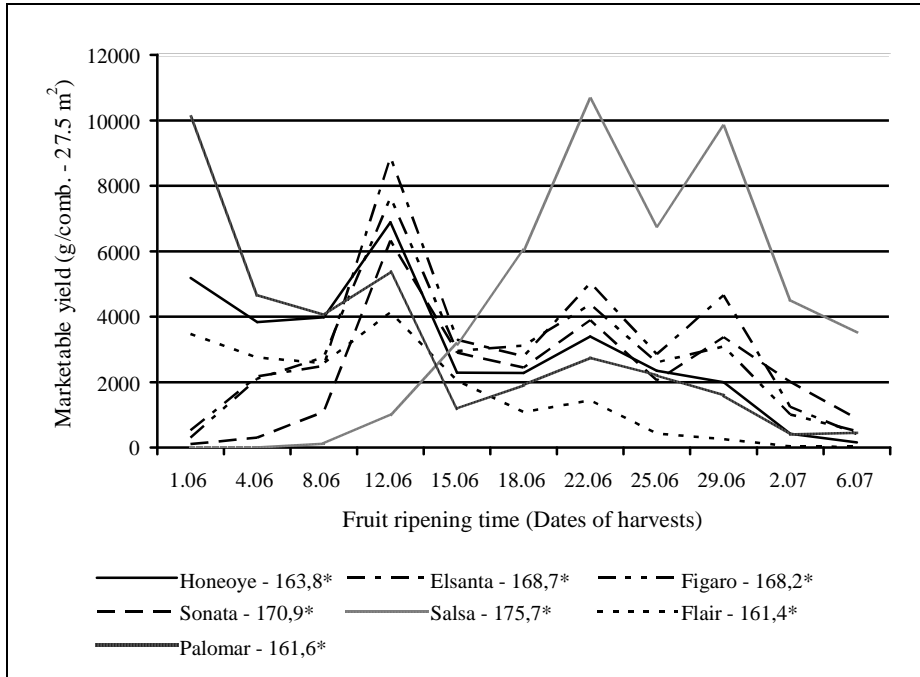
Cultivar	Marketable yield [g plot ⁻¹]			Mean weight of 100 fruit [g]		Share of decayed fruit in the total number of fruit [%]	
	2008	2009	Sum	2008	2009	2008	2009
Honeoye	997.8 a*	8009.1 b	9006.9 ab	769 a	1105 a	0.0 a	1.13 a
Elsanta	2486.6 d	9214.3 b	11500.1 b	927 bc	1086 a	0.1 a	1.38 a
Figaro	1822.5 c	7738.1 ab	9560.6 ab	964 c	1440 b	0.3 a	1.51 a
Sonata	1356.8 b	7738.0 ab	9094.8 ab	804 a	1125 a	1.5 b	3.62 b
Salsa	1159.5 ab	14704.8 c	15864.3 c	842 ab	1630 c	2.6 c	3.00 b
Flair	1013.4 a	5772.1 a	6785.5 a	756 a	1231 a	0.0 a	0.32 a
Palomar	1694.6 c	9068.4 b	10763.0 b	1224 d	1642 c	0.7 ab	0.88 a

*Values marked with the same letter are not significantly different at $\alpha = 0.05$



*Dates of harvest of 50% of fruit (number of days from 1 January), determined with Faedi's Index

Figure 1. Fruit ripening dynamics of strawberry cultivars of foreign origin (Skierniewice, Poland, 2008)



*Dates of harvest of 50% of fruit (number of days from January 1), determined with Faedi's Index

Figure 2. Fruit ripening dynamics of strawberry cultivars of foreign origin (Skierniewice, Poland, 2009)

by the cool and wet weather prevailing while the strawberries were ripening in 2009, which was more favourable to fruit development than the hot and dry weather the year before. The largest fruit were produced by the cultivar 'Palomar', in both years of the study the fruit of this cultivar were significantly larger than the fruit of the two standard cultivars. It must be mentioned, however, that in the second year of fruiting equally large fruit were produced by the cultivar 'Salsa'. Also, in the Austrian studies (Spornberger et al., 2008), the fruit of this cultivar weighed as much as 11 g and were slightly bigger than

the fruit of the cultivar 'Elsanta' and significantly bigger than those of the cultivar 'Sonata'. In our study, only the cultivar 'Figaro' produced slightly smaller fruit, but they were significantly smaller than the fruit of the cultivars 'Palomar' and 'Salsa'. The large size of the fruit of the three cultivars ('Palomar', 'Salsa' and 'Figaro'), as found in our experiments, confirms that these cultivars can be included in the group of large-fruited dessert cultivars. In favourable conditions 'Palomar', 'Salsa' and 'Figaro' can produce larger fruit than the standard cultivars 'Honeoye' and 'Elsanta'.

The experiments revealed an obvious variation in the susceptibility of the fruit of the evaluated cultivars to grey mould, which causes fruit decay. In the first year of the evaluation, despite the weather being not very favourable to the development of grey mould, most of the decayed fruit were those of the cultivars 'Salsa' and 'Sonata', and in relation to the standard cultivars the difference was significant. As might have been expected, in the following year of the study, thanks to the conditions favourable for the development of grey mould during fruit ripening, this tendency was maintained. Both 'Sonata' and 'Salsa' showed that their fruit can give way to grey mould, although the percentage of decayed fruit was relatively low (3.0% in 'Salsa', and 3.62% in 'Sonata'). In that respect, the results of our experiments differ slightly from those presented by Spornberger et al. (2008). They reported that the two cultivars were fairly resistant to grey mould. The susceptibility of strawberries to decay caused by grey mould is an important cultivar-related trait. It has long been known that strawberry cultivars differ greatly in terms of mould resistance. The varieties adopted by us as standard for the purpose of these experiments, grown in the field, are regarded as having a low-susceptibility to grey mould (Łabanowska et al., 2004).

The fruit of the evaluated cultivars differed in terms of firmness (Tab. 3), and in the two years of the study the fruit of the same cultivars

had a similar firmness. This means that this characteristic did not change with the age of the plants. In the first year of the study, the firmest fruit, significantly firmer than those of the standard cultivars, were produced by the cultivars 'Figaro' and 'Salsa'. Very firm fruit in that year were also produced by 'Sonata' and 'Salsa', which were significantly firmer than the fruit of the cultivar 'Honeye', but not those of 'Elsanta'. A similar trend in fruit firmness of the evaluated cultivars can also be seen in the second year. Again, the firmest fruit were produced by the cultivars 'Figaro' and 'Palomar' (fruit firmness was not assessed for the latter cultivar in the first year of the study). The high firmness (and excellent taste) of the fruit of the cultivar 'Palomar' has also been reported by Shaw (2007). The fruit of the other cultivars did not differ significantly in terms of fruit firmness from the two standard cultivars. This outcome of the fruit firmness assessment shows the fruit of the evaluated cultivars to be characterized by high firmness because 'Elsanta' is regarded in Poland as a cultivar with high, satisfactory fruit firmness (Masny et al., 2005).

The level of soluble solids, which mostly contain sugars (over 90%), varied in the fruit of the evaluated cultivars and depended on the cultivar and the year of the study (Tab. 3). In the first year of the study, the highest amounts of soluble solids were found in the fruit of the cultivars 'Flair', 'Palomar', 'Sonata' and 'Figaro' and in that respect they far surpassed both standard cultivars.

Table 3. Fruit firmness, total soluble solids and content of ascorbic acid in fruit of the evaluated strawberry cultivars – Experiment 1 (Skierniewice, Poland, 2008-2009)

Cultivar	Fruit firmness [N]		Soluble solids content [Brix]		Ascorbic acid content [mg 100 ml ⁻¹]	
	2008	2009	2008	2009	2008	2009
Honeoye	2.19 a*	2.24 a	9.74 ab	9.39 b	85.3 a	68.3 ab
Elsanta	2.42 ab	2.06 a	8.95 a	8.84 b	84.3 a	83.7 b
Figaro	3.48 c	3.19 bc	10.11 abc	8.93 b	70.3 a	65.0 ab
Sonata	2.84 bc	2.03 a	11.40 bc	8.97 b	68.7 a	62.7 a
Salsa	2.79 bc	2.50 ab	8.54 a	7.57 a	91.7 a	69.7 ab
Flair	3.28 c	2.72 ab	11.98 c	10.65 c	92.0 a	81.3 ab
Palomar	-	3.64 c	11.73 bc	8.78 b	78.0 a	84.3 b

*Explanation: see Table 2

A similar observation was made in the second year of the study, in which the highest soluble solids content was recorded, like the year before, for the fruit of the cultivar 'Flair', and the least amount, also like the year before, for the fruit of the cultivar 'Salsa'. The fruit of the other cultivars contained soluble solids at the level of the standard cultivars. High amount of soluble solids in strawberry fruit has a decisive influence on their pleasant, sweet taste (Alavoine and Crochon, 1989). It can thus be expected that strawberries cv. 'Flair' will be just as tasty as those of 'Honeoye' and 'Elsanta', or even tastier if the conditions during the growing season are favourable for the accumulation of sugars in the fruit.

Vitamin C belongs to a group of very important antioxidants, essential for the proper functioning of the human body. For this reason it is always desirable that dessert fruit,

including strawberry fruit, contain high amounts of vitamin C. The results in Table 3 show that the evaluated cultivars differ only slightly in respect of that parameter. In 2008, there were no significant differences. Such differences, however, were found in 2009 when the highest vitamin C content was measured in the fruit of the standard cultivar 'Elsanta' and the cultivar 'Palomar'. The lowest content of vitamin C was recorded for the fruit of 'Sonata'. The experiments carried out by Spornberger et al. (2008) also revealed a very low ascorbic acid content in the fruit of the cultivar 'Sonata' (334.67 mg/l) in comparison with the cultivar 'Elsanta' (607.26 mg/l).

The assessment of the degree of leaf diseases was carried out on strawberry plants only in 2009 (Tab. 4). The plants of the evaluated cultivars, including the standard cultivars, did not show any symptoms of infection with leaf spot, caused by the

Table 4. Extent of infection of the evaluated strawberry cultivars with leaf diseases – Experiment 1, and verticillium wilt – Experiment 2 (Skierniewice, Poland, 2008-2009)

Cultivar	Infection with leaf diseases in 2009			Infection with <i>Verticillium dahliae</i>	
	Leaf spot	Leaf scorch	Powdery mildew	2008	2009
Honeoye	0.0 a*	0.7 c	0.1 a	1.2 c	1.8 b
Elsanta	0.0 a	0.8 c	0.1 a	-	-
Figaro	0.0 a	0.2 a	0.0 a	0.4 bc	2.6 b
Sonata	0.0 a	0.2 a	0.0 a	0.3 b	0.4 a
Salsa	0.0 a	0.3 ab	0.1 a	0.0 a	0.1 a
Flair	0.0 a	0.6 ab	0.0 a	0.6 bc	2.2 b
Palomar	0.0 a	0.3 ab	0.0 a	-	-

*Explanation: see Table 2

fungus *Mycosphaerella fragariae*. Minor symptoms of powdery mildew, for which *Sphaerotheca macularis* is responsible, were found on the plants of the cultivar ‘Salsa’, and the standard cultivars ‘Honeoye’ and ‘Elsanta’, but the differences between the cultivars in that respect were very small and statistically insignificant. Slightly larger differences between the evaluated genotypes relate to the susceptibility of the plants to leaf scorch caused by *Diplocarpon earliana*. It needs to be mentioned, however, that although the symptoms were there, they were only minor and found only on the two standard cultivars, ‘Honeoye’ and ‘Elsanta’. A conclusion may thus be drawn that the cultivars evaluated in this study are not susceptible to the leaf diseases under consideration in the pedo-climatic conditions of Poland.

The susceptibility of strawberry plants to verticillium wilt is a very important agro-technical characteristic of strawberry, which to a large

extent determines the success of strawberry fruit production, particularly in the case of susceptible cultivars. In the experiment carried out in the “death field” (without the cultivars ‘Elsanta’ and ‘Palomar’), it was found that only the plants of the cultivars ‘Salsa’ and ‘Sonata’ were less susceptible to verticillium wilt than the plants of the cultivar ‘Honeoye’. ‘Honeoye’ is regarded in Poland as a variety highly susceptible to this disease of the root system (Meszka et al., 2005). Spornberger et al. (2008), having conducted two-year experiments on the susceptibility of 13 strawberry cultivars to *V. dahliae*, also classified the cultivar ‘Salsa’ among the cultivars highly resistant to this pathogen. A relatively resistant cultivar, in the studies of these authors as well as our own, proved to be the cultivar ‘Sonata’. This means that the other two cultivars, ‘Figaro’ and ‘Flair’, are susceptible to *V. dahliae* and should be grown on a soil free of this pathogen.

CONCLUSIONS

On the basis of the results obtained in this study, out of the five evaluated cultivars, the cultivar 'Salsa' can be regarded as valuable and the most useful for cultivation in Central Poland. This cultivar is a late bearing strawberry variety, characterized by abundant yielding, which produces large and very firm fruit. In terms of soluble solids and vitamin C content in the fruit, it is on a par with the standard cultivars 'Honeoye' and 'Elsanta'. It is also resistant to leaf diseases and shows field resistance to verticillium wilt. The cultivar 'Palomar', which is as early as the cultivar 'Honeoye', can also be considered as promising. It is productive, forms large and firm fruit, but its susceptibility to verticillium wilt has not yet been sufficiently established. It must be mentioned, however, that the years in which the cultivars were assessed were characterized by relatively mild winters, and therefore no opinion can be given as to the resistance of the evaluated cultivars to low, below-zero temperatures. These cultivars thus need to undergo further evaluation in the climatic conditions of Poland.

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A. Masny and E. Żurawicz

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PLONOWANIE I PODATNOŚĆ NA CHOROBY GRZYBOWE W POLSCE NOWYCH DESEROWYCH ODMIAN TRUSKAWKI

Agnieszka Masny i Edward Żurawicz

S T R E S Z C Z E N I E

Przedstawiono wyniki badań nad oceną wartości produkcyjnej w warunkach Polski centralnej kilku nowych, deserowych odmian truskawki typu krótkiego dnia: 'Figaro', 'Sonata', 'Salsa', 'Flair' (Klon 03-08-01) oraz 'Palomar'. Odmianami standardowymi były 'Honeoye' (wczesna) i 'Elsanta' (średnio wczesna). Badania prowadzono w latach 2008-2009 na polach doświadczalnych Instytutu Sadownictwa i Kwiaciarnictwa w Skierniewicach (Polska centralna). Oceniano plonowanie roślin (wielkość plonu handlowego, wielkość owoców, podatność owoców na gnicie powodowane przez szarą pleśń, jędrność owoców, zawartość substancji rozpuszczalnych i witaminy C w owocach) oraz podatność roślin na choroby liści i wertycyliozę. Za najbardziej przydatną do uprawy w Polsce uznano późną odmianę 'Salsa'. Odnacza się ona obfitym plonowaniem i wytwarza duże, jędrne owoce o wysokiej zawartości witaminy C, wykazuje wysoką odporność na choroby liści i wertycyliozę. Interesująca jest także wczesna odmiana 'Palomar' – plonuje bardzo obficie, wytwarza duże i bardzo jędrne owoce, ale jej podatność na wertycyliozę nie jest jeszcze dostatecznie poznana. Dalszej oceny wymaga także wrażliwość roślin badanych odmian na niskie ujemne temperatury.

Słowa kluczowe: *Fragaria x ananassa*, wielkość owoców, jędrność, ekstrakt, kwas askorbinowy, wertycylioza