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YIELD OF TWO STRAWBERRY CULTIVARS DEPENDING ON THE CROPPING METHOD ON THE EXAMPLE OF A COMMERCIAL PLANTATION IN A SPECIALIZED HORTICULTURAL FARM

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Abstract. Poland belongs to leading producers of strawberries in Europe and strawberry production has played a significant role in Polish agribusiness for many years. The present study, conducted in a commercial plantation of a specialized horticultural farm during the period 2009–2011, evaluated the amount and quality of yield of two strawberry cultivars ('Elsanta' and 'Albion') grown under different cropping systems. The study determined the amount and structure of marketable yield. The different production systems included the cultivation of strawberries from fresh waiting-bed plants and frigo plants (class A and A+). Plants were grown in the ground and on black plastic under the row cropping system and the double-row strip cropping system. The average fresh marketable yield for cv. 'Elsanta' was 13.0 t·ha^{-1} and it was higher by 53.0% than the average strawberry yield for cv. 'Albion' (7.1 t·ha^{-1}). Treatment D, in which cv. 'Elsanta' class A+ frigo plants were grown on black plastic under the double-row strip cropping system, proved to be the best yielding system – the average fresh marketable yield was 14.4 t·ha^{-1}, while the total marketable yield 17.4 t·ha^{-1}. The lowest average fresh marketable yield was obtained from the cv. 'Albion' plantation established from class A frigo plants grown in the ground under the double-row strip cropping system – only 4.9 t·ha^{-1}. The percentage of fresh marketable fruits in the total marketable yield ranged from 66.6% for cv. 'Elsanta' to 89.6% for cv. 'Albion' plants.

Key words: *Fragaria* × *ananassa* Duch., yield, crop production system, fresh marketable fruits, frigo plants

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INTRODUCTION

Strawberries are fruits of high commercial value and economic importance in our country. In the world, it is commercially grown in many countries, among others, in Canada, USA, Japan, Spain, Germany, Korea, Italy, and Poland [Biswas et al. 2007]. Poland belongs to leading European strawberry producers, that is, after Spain it is the EU's second largest producer of this fruit. Over the last decade, Poland's average share in the EU's strawberry production has been about 20%. Unlike many countries in Western Europe, however, in Poland the statistical strawberry yield in commercial production is very low. Strawberry production in our country is still characterized by too low productivity and for many years average level of statistical yield has been 3.2–3.5 $t \cdot ha^{-1}$ [Paszko 2009, Kobuszyńska 2012]. One of the possibilities to increase the productivity of commercial plantations is to introduce new more productive cultivars or to use modern production technologies. These practices are necessary due to the growing interest of consumers in fruit quality and the need to extend the period of strawberry supply in the market.

In strawberry production, fruit quality and yield depend on many factors, e.g. the cultivar, weather conditions during the growing season and above all agronomic practices such as irrigation, fertilization or crop protection. Hence, it entails the need to continually conduct research on the suitability of cultivars for growing under specific conditions and on the effect of various production factors and technologies on strawberry yield, which can be seen both in Poland [Masny et al. 1996, Laszlovszky-Zmarlicka et al. 1997, Małodobry et al. 1997, Skupień and Oszmański 2004, Jarosz et al. 2011] and abroad [Khanizadeh et al. 1992, Lille et al. 2003, Bartual et al. 2004, de Matos Pires et al. 2006, Kahu et al. 2010, Shaw and Larson 2008, Gecer et al. 2013]. The aim of the present study was to evaluate the yield of two strawberry cultivars grown using different production systems in a specialized horticultural farm located in Lublin Voivodeship (province).

MATERIAL AND METHODS

The research was carried out over the period 2009–2011 in a commercial strawberry plantation at the specialized horticultural farm, Agronom Berries, in Lublin Voivodeship (N 51°24' E 22°57'). The study evaluated the productivity of two strawberry cultivars: 'Elsanta' and 'Albion', grown under different production systems over a period covering 3 regular strawberry fruiting seasons, i.e. the years 2009–2011. The field experiment was established as one-factorial trial with four replications. The studied factor was the crop production system. The analyzed cultivation technologies differed in planting time, types of plants (frigo A – crown diameter 10–15 mm, A+ – crown diameter above 15 mm, and waiting-bed plants – crown diameter above 18 mm and two or more side crowns), planting density, and tillage systems. In the case of cv. 'Elstanta', four cropping system treatments were applied:

– treatment A (raised bed cropping, on black plastic, from fresh waiting-bed plants, at a spacing of 80 + 60 × 30 cm and with a density of 47.600 $plants \cdot ha^{-1}$; plants were

planted in the 1st half of October 2008, fruiting in 2009–2011, the plantation area: 8 ha in four quarters of 2.0 ha each);

– treatment B (double-row strip cropping, spacing 80 + 60 × 30 cm, density 47.600 plants·ha^{-1}, class A+ frigo plants with a crown diameter of 15–18 mm, planted in the ground; plants were planted in the 2nd half of May 2009 for late harvest, fruiting in 2009–2011, the plantation area: 6,4 ha in four quarters of 1.6 ha each);

– treatment C (row cropping, spacing 100 × 25 cm, density 40.000 plants·ha^{-1}, class A frigo plants with a crown diameter of 10–15 mm, planted in the ground; plants were planted in the 1st half of April 2008, fruiting in 2009–2011, the plantation area: 22 ha in four quarters of 5.5 ha each);

– treatment D (double-row strip cropping, spacing 80 + 60 × 25 cm, density 57.100 plants·ha^{-1}, class A+ frigo plants with a crown diameter of 15–18 mm, planted on black plastic; plants were planted in the 2nd half of May 2009 for late harvest, fruiting in 2009–2011, the plantation area: 9.6 ha in four quarters of 2.4 ha each).

For cv. 'Albion', 2 treatments were designed:

– treatment A' (double-row strip cropping, spacing 80 + 60 × 25 cm, density 57.100 plants·ha^{-1}, class A+ frigo plants with a crown diameter of 15–18 mm, planted on black plastic; plants were planted at the beginning of April 2009, fruiting in 2009–2011, the plantation area: 7.2 ha in four quarters of 1.8 ha each);

– treatment B' (row cropping, spacing 100 × 25 cm, density 40.000 plants·ha^{-1}, class A frigo plants with a crown diameter of 10–15 mm, planted in the ground; plants were planted at the beginning of April 2009, fruiting in 2009–2011, the plantation area: 4.8 ha in four quarters of 1.2 ha).

In treatments A and C, the investment period included the year 2008 (the plants did not fruit), whereas in treatments B, D, A' and B' there was no investment period and the plants produced fruit already in the year of planting. All plantations were established on sandy soil, quality class V. Before the establishment of a plantation, each time the soil was analyzed for the content of macro- and micronutrients which were replenished based on the recommendations received. Moreover, before plantation establishment manure fertilization was applied at an amount of 40 t·ha^{-1} and mustard was sown three times for ploughing in. In the next years, plants were fertilized with granulated strawberry fertilizer. Thus, fertilization was as follows, expressed in kg of nutrient per hectare, in each of the above-mentioned treatments: 48 kg N·ha^{-1}, 19 kg P·ha^{-1}, 60 kg·K ha^{-1} and 7 kg Mg·ha^{-1}. To establish the plantations, frigo and raised bed plants were used from a licensed nursery run by the farm in question. All crop management operations were carried out in accordance with the recommendations for strawberry production plantations and plants were regularly irrigated using drip lines (plants grown on black plastic) or irrigation sprinklers (ground-grown plants). For winter, the plantations were covered with straw to protect the plants against frost, while in the spring the straw was raked away and left in the interrows. This was a purposeful operation which, apart from weed protection, was designed to delay fruiting of the plants beyond the main harvesting time for strawberry in our country, which is usually around the middle of June. In each growing season, the whole plantation, including the rows, strips and beds, was mulched with straw to protect fruits against pollution. Crop protection was done in accordance with the recommendations for strawberry production plantations and the GlobalGap system

applied at the farm in question. The production of fresh marketable strawberries, which were the main crop, was of major importance for strawberry cultivation at the farm studied. On the other hand, all strawberries that did not meet the requirements for fresh marketable fruits intended for direct consumption, but accepted by the fruit processing industry, thus without traces of mold and rot spots, were a secondary crop. Fruits were sorted during the picking of fresh marketable strawberries and sold to fruit processing. But fresh marketable strawberries were the main goal of production at this farm and therefore in this paper their yield is conventionally called the fresh marketable yield, while fruits intended for industrial processing are called the processing yield. Fruit harvest lasted from June to September, depending on the treatment. The amount of fruits harvested each day was recorded using an electronic harvest recording system that recorded the amount of fruits harvested (in kg), plantation and quarter number, harvest date and time as well as the data of the picker. Additionally, to verify the correctness of the operation of this computerized system, manual recording was also done in harvest records. The primary data were obtained from the electronic recording system[1]. The aim of the present study was to analyze and evaluate the marketable yield and its structure of two strawberry cultivars grown under different production systems. Apart from that, selected descriptive statistics were determined, such as: average daily fruit yield, Faedi index[2], harvest period duration or total harvest days. This allowed the differences in yield between particular cropping systems or cultivars to be evaluated more precisely. Commercial yield was weighted and calculated per hectare. The data were analyzed by a one-way analysis of variance. The results were statistically tested using Tukey's test to evaluate the significance of differences at the significance level = 0.05.

RESULTS AND DISCUSSION

The studies conducted by, among others, Moretti et al. [2010] and Li et al. [2010] show close correlations of temperature and rainfall with strawberry yield. In the period in question, the average temperatures in June, July, August and September were much higher than the long-term means. On the other hand, in the first year of observation (2009) the total rainfall in the months of May-September (without June) was lower than the mean rainfall for 1981–2010, but already the next two years (2010–2011) were characterized by much higher rainfall levels than the long-term means. The rainfall exceeded more than twice the long-term mean especially in June 2010 and May 2011 (tab. 1).

The studied strawberry cultivars showed variations in yield, depending on the cropping system used and year. The study demonstrates that during the period 2009–2011 the highest fresh marketable yield was obtained from cv. 'Elsanta' class A+ frigo plants grown on black plastic under the double-row strip cropping system (treatment D), in spite of quite low fruiting in the first year – 6 $t \cdot ha^{-1}$ (tab. 2). The difference between the

[1] Records were kept using Berrybase software (http://www.balticblue.pl/pomoc_w_gospodarstwie.pdf).
[2] Faedi index represents the fruit ripening time, i.e. the number of days from the beginning of the year until 50% of fruit yield has been obtained.

sum of fresh marketable yield of this cultivar obtained from treatment D and the yields from the other production systems ranged from 6.0 to 20.4 t·ha^{-1} [compare Mor et al. 2004, Lille et al. 2003, Masny and Żurawicz 2010b].

Table 1. Mean monthly air temperatures and rainfall during the growing season of strawberries (2009–2011) relative to the long-term mean (1985–2008) according to the Automatic Meteorological Station in Sosnowica

Month	Temperature (°C)				Precipitation (mm)			
	2009	2010	2011	mean 1985–2008	2009	2010	2011	mean 1985–2008
April	14.1	10.3	10.6	8.5	5.9	18.0	29.9	36.0
May	14.4	15.8	14.9	14.3	63.7	162.1	53.7	53.3
June	17.4	19.0	19.2	17.2	157.1	69.7	103.2	56.2
July	21.0	22.1	19.2	19.4	46.6	79.3	242.4	69.1
August	18.8	20.4	19.1	18.2	54.2	94.9	62.9	68.1
September	15.1	12.5	15.2	12.8	27.1	117.4	6.8	49.7

A significantly higher yield was obtained in treatment D compared to the other treatments. In the case of the total marketable fruit yield (fresh marketable fruits and fruits intended for processing), the difference for this cultivar was from 8.5 to 24.4 t·ha^{-1} . For cv. 'Albion', statistically significant differences were found between the fresh marketable yield in treatment A' (27.8 t·ha^{-1}) and treatment B (14.8 t·ha^{-1}). The average sum of yield of cv. 'Albion' processing fruits, regardless of the production technology, was 3.2 t·ha^{-1}. The cultivar 'Elsanta' was more productive throughout the cropping period, although in treatment A' cv. 'Albion' grown on plastic under the double-row strip cropping system was characterized by higher productivity of fresh marketable fruits (by 1.0 and 5.0 t·ha^{-1}) than 'Elsanta' in treatments A (waiting-bed plants) and B (ground-grown A+ class plants). During the period 2009–2011 only treatment B, consisting of 'Elsanta' class A+ frigo plants that fruited in the year of planting, had a lower total yield (27.7 t·ha^{-1}) than cv. 'Albion' (treatment A'). These conclusions are shared, among others, by Masny and Żurawicz [2010a] as well as by Masny et al. [2014] who included 'Elsanta' in the most productive cultivars and 'Albion' in the least productive cultivars in their research on the production value of foreign strawberry cultivars.

Evaluating the strawberry yield in individual years, it should be noted that in the first year of fruiting (2009) cv. 'Elsanta' plants, in the treatments with an investment period (A and C), always produced higher fresh marketable yields (respectively: 12.2 and 16.8 t·ha^{-1}) than in treatments B and D in which these plants fruited already in the year of planting – respectively 3.8 and 6.0 t·ha^{-1} (tab. 2). Moreover, these treatments were distinguished by an almost twice lower proportion of processing fruits in the total yield than class A+ plants that fruited directly after planting (tab. 3). This confirms the opinion of Bartczak et al. [2010] that it is difficult to obtain a high yield of good quality fresh marketable fruits from class A+ frigo plants in the year of planting. Another corre-

lation was found between the investigated cropping systems in growing cv. 'Albion' strawberries. Treatment B', consisting of class A plants grown directly in the ground, produced a nearly four times lower fresh marketable yield in the first year of fruiting (3.4 t·ha^{-1}) than the treatment composed of class A+ plants (14.0 t·ha^{-1}) but grown on black plastic (tab. 2).

Table 2. Fresh marketable and processing fruit yield of two strawberry cultivars in the years 2009–2011 in t·ha^{-1}

Cultivar	Treatments (year)	Yield (t · ha^{-1})									The sum of yield (t · ha^{-1}) (2009-2011)		
		2009			2010			2011					
		fresh marketable	processing	total	fresh marketable	processing	total	fresh marketable	processing	total	fresh marketable	processing	total
Elsanta	A	12.2c	2.0a	14.2c	14.3b	2.4b	16.7b	0.5a	1.3a	1.8a	26.9a	5.7b	32.6a
	B	3.8a	1.3a	5.1a	7.4a	0.3a	7.7a	11.6c	3.3b	14.9c	22.8a	4.9a	27.7a
	C	16.8d	2.3a	19.2b	14.1b	1.9b	16.0b	6.2b	2.1a	8.3b	37.2b	6.4b	43.6b
	D	6.0b	1.6a	7.6a	18.9c	2.6b	21.5c	18.3d	4.7c	23.0d	43.2c	8.9c	52.1c
Albion	A'	14.0a	0.2a	14.2a	9.8a	2.7a	12.5a	4.0a	0.4a	4.4a	27.8a	3.2a	31.0a
	B'	3.4b	0.4a	3.8b	4.6b	0.2b	4.8b	6.8b	2.6b	9.4b	14.8b	3.2a	18.0b

Note: Means in the column followed the same letter are not significant different at $\alpha = 0.05$

In the second year of fruiting, similar trends were observed in yields as in the previous year. The cv. 'Elsanta' crop from waiting-bed plants and the control treatment (C) produced a high yield again – slightly more than 14 t·ha^{-1}, but the highest fresh marketable yield (18.9 t·ha^{-1}) was obtained from the plantation of cv. 'Elsanta' plants grown under the double-row strip cropping system on black plastic using fertigation (treatment D) (tab. 2). Unfortunately, the lowest yield (7.4 t·ha^{-1}) was recorded in the cv. 'Elsanta' plantation established using ground-grown class A+ frigo plants compared to the other treatments for this cultivar. In the second year of fruiting, the lowest yield was obtained in the case of the cv. 'Albion' plantation established from class A frigo plants grown in the ground – only 4.6 t·ha^{-1}; this means that in the first two years of cropping treatment B' was characterized by the least yields of all the cropping systems studied. A reduction in plantation productivity for various strawberry cultivars has been observed in the third year of fruiting [Kopytkowski et al. 2006, Kahu et al. 2010, Małodobry and Bieniasz 2004, Masny and Żurawicz 2010a, b]. However, in the present study under commercial field production conditions, this was not confirmed for all cropping systems. In fact, in the third year of fruiting strawberry plants in treatments A, C and A' fruited much more poorly; the average total marketable yield was respectively 1.8, 8.3 and 4.4 t·ha^{-1}. Such

a low fresh marketable yield from waiting-bed plants in the third year of fruiting (0.5 t·ha^{-1}) justifies the limitation of the period of use only to two years under this cropping system. On the other hand, the crop in treatments B and D from class A+ frigo plants fruited exceptionally well, especially in treatment D where plants (18.3 t·ha^{-1}) also bore fruit in the year of planting (late harvest).

Table 3. Percentage of fresh marketable and processing fruit in total marketable yield of two strawberry cultivars in the years 2009–2011 in %

Cultivar	Treatments (year)	Yield structure (%)						Mean yield structure (2009–2011)	
		2009		2010		2011			
		fresh marketable	processing	fresh marketable	processing	fresh marketable	processing	fresh marketable	processing
Elsanta	A	86.1b	13.9b	85.4a	14.6a	28.2a	71.8a	66.6a	33.4a
	B	74.6a	25.4a	96.5b	3.5b	77.6c	22.4ab	82.9b	17.1b
	C	87.9b	12.1b	88.1a	11.9a	74.5b	25.5b	83.5b	16.5b
	D	78.6ab	21.4a	87.9a	12.1a	79.5c	20.5a	82.0b	18.0b
Albion	A’	98.9a	1.1a	78.4a	21.6a	91.6a	8.4a	89.6a	10.4a
	B’	88.5b	11.5b	95.4b	4.6b	72.7b	27.3b	85.5b	14.5b

Note: Means in the column followed the same letter are not significant different at $\alpha = 0.05$

In commercial plantations in fresh fruit production, the proportion of fresh marketable fruits in the total marketable yield is of key importance for the producer from the marketable point of view. In this research, depending on the cropping system and cultivar, the relations between the marketable yield of fresh marketable fruits and processing fruits varied significantly. The average percentage of fresh marketable fruits for cv. ‘Elsanta’ was at a level of about 78%, whereas for cv. ‘Albion’ it was as much as 87% (tab. 3). Treatment A was distinguished by the highest average percentage of processing fruits in the total yield (waiting-bed plants – 33.4%). Their very high percentage in the third year of fruiting, which was 71.8%, had a significant effect on this. Hence, due to the worsening fruit quality, plantations from waiting-bed plants should be maintained for two years of fruiting at the most. In the treatment C consisting of ground-grown class A frigo plants, the percentage of processing fruits in the total fruit was in agreement with the general trend and with the age of the plantation this percentage contribution systematically increased from 12.1% in 2009 to 25.5% in 2011. Besides, worth noting is the quite high percentage of processing fruits in the first year of fruiting (21.4 and 25.4%) in treatments D and B composed of class A+ frigo plants that fruited in the year of planting, planted both on black plastic and in the ground. This study confirms the opinion that in our country under field cultivation conditions it is difficult to obtain satisfactory yields of high quality fresh marketable strawberries from A+ plants in late cropping in the first year after planting. In the second and third year of fruiting, on the

other hand, the percentage of processing fruits was at a much lower level and in treatments B and D it was respectively 3.5 and 12.1% in 2010 and slightly more than 20% in 2011. Moreover, the study reveals that cv. 'Albion' was characterized by the highest average percentage of fresh marketable fruits, both in the treatment with plants grown in the ground (85.5%) and on black plastic (89.6%); this confirms its high commercial traits as a fresh marketable variety which is emphasized, among others, by Shaw [2004]. Special attention should also be drawn to the low percentage of processing fruits of this cultivar in the year of planting (2009) in the treatment on black plastic – it was only 1.1% of the total marketable yield. This means that almost all fruits were extra or 1st choice class. This was probably affected by the specific properties of the particular production system (lower weed infestation, more intensive protection against the European tarnished plant bug (*Lygus regulipennis*) due to cropping on black plastic, earlier harvest and a longer harvest period). In the next years, the yield structure (fresh marketable and processing fruits) varied more in this cultivar and ranged from 4.6% in 2010 to 27.3% in 2011.

Table 4. Some aspects of yield structure of two strawberry cultivars in the years 2009–2011

Cultivar	Treatments	Mean yield of fresh marketable fruits	Mean yield of processing fruits	Mean marketable total yield	Mean daily marketable yield	Faedi Index*	Length of harvest period	The sum of harvest days
		t·ha^{-1}	t·ha^{-1}	t ·ha^{-1}	t·ha^{-1}	days	days	number
Elsanta	A	9.0ab	1.9ab	10.9ab	0.7ab	178a	27a	14ab
	B	7.6a	1.6a	9.2a	1.2b	173a	29a	8a
	C	12.4ab	2.1ab	14.5ab	0.6a	182a	32a	25a
	D	14.4b	3.0b	17.4b	1.3b	177a	26a	13a
Albion	A'	9.3b	1.1a	10.4b	0.3a	210a	96a	29a
	B'	4.9a	1.1a	6.0a	0.4a	192a	66a	16a

* – the number of days from the beginning of the year until 50% of fruit yield has been obtained
Note: Means in the column followed the same letter are not significant different at $\alpha = 0.05$

Table 4 shows selected descriptive statistics concerning the yields of the studied cultivars depending on the cropping system used. The average fresh marketable yields of cv. 'Elsanta' ranged from 7.6 to 14.4 t·ha^{-1}, while in cv. 'Albion' they were respectively 4.9 and 9.3 t·ha^{-1} for treatments B' and A'. Over the three-year study period, the highest average total marketable yield (17.4 t·ha^{-1}) was obtained in treatment D consisting of cv. 'Elsanta' class A+ plants planted on black plastic and bearing fruit in the year of planting. A significantly higher yield was obtained in treatment D compared to treatment B. The treatment C in which class A 'Elsanta' plants were planted for harvest at conventional time, produced only a slightly lower yield (14.5 t·ha^{-1}). Treatment B', i.e. cv. 'Albion' planted directly in the ground, was characterized by the significantly lower average total marketable yield (6.0 t·ha^{-1}) than plants in treatment A'. The above results

show that in the farm investigated the average strawberry yields were much higher than the national average, which according to the Polish Central Statistical Office (GUS) has been at a level of 4.0 t·ha^{-1} for many years [Gołębiewska and Sobczak 2012].

In commercial fresh-market fruit production, an important aspect is the daily harvest per unit area, since this determines the possibility of preparing appropriate batches of produce for customers. The present study shows that the least average daily yield per 1 ha was obtained from the cv. 'Albion' plantation (respectively, 0.3 and 0.4 t·ha^{-1} for treatments A' and B'), which was largely associated with the relatively high total harvest days for these strawberry plants (29 and 16 days), but in the case of day-neutral cultivars a long period of fruiting is a trait that is appropriate for them (tab. 4.). Thus, to harvest 10–12 tones of cv. 'Albion' fruits within one day, a plantation of this strawberry cultivar should have an area of at least 20–30 ha. In cv. 'Elsanta', the average daily fruit harvest was much higher than for cv. 'Albion', but it varied significantly depending on the production technology. The average yield of fruits harvested in one day ranged from 0.6 to 1.3 t·ha^{-1}. The highest yield (1.3 and 1.2 t·ha^{-1}) was obtained in treatments B and D consisting of A+ plants grown for late harvest in the first year, which also correlated with the lowest total harvest days (respectively 8 and 13 days). The investigation of the harvest frequency and the duration of the fruit harvest period showed that the values of these traits were dependent not only on the production technology but also on the cultivar. The harvest period for cv. 'Elsanta' ranged between 26 and 32 days and fruits were picked almost every day (treatment C), every second day (treatments A and D), or every 3–4 days (treatment B). The fruit harvest period for cv. 'Albion' was much longer than in the case of cv. Elsanta, which is characteristic of repeat-fruiting cultivars (tab. 4). For cv. 'Albion' grown on black plastic, it was 96 days (treatment A') and 66 days for the plantation with ground-grown plants (treatment B'). In the present study, the average value of Faedi index for this cultivar was 173–182 days depending on the production technology and it was higher by about 10–20 days than the average value obtained in a study conducted in the Research Institute of Horticulture in Skierniewice [Masny and Żurawicz 2010a]. The value of this index for cv. 'Albion' was also much higher than in the above-mentioned research – it was as much as 210 (treatment A') and 192 days (treatment B'), whereas in the research of Masny and Żurawicz [2010a] its average value was 163.32 days.

CONCLUSIONS

The yields of the investigated cultivars varied depending on the cropping system, year and cultivar. Over the period 2009–2011, the average fresh marketable yield for cv. 'Elsanta' was 10.9 t·ha^{-1} and it was higher by 53.0% than the average strawberry yield for cv. 'Albion' (7.1 t·ha^{-1}). Treatment D, in which cv. 'Elsanta' class A+ frigo plants were grown on black plastic under the double-row strip cropping system, proved to be the best yielding treatment – the average fresh marketable yield was 14.4 t·ha^{-1}, while the total marketable yield 17.4 t·ha^{-1}. The lowest average fresh marketable yield was achieved from the cv. 'Albion' plantation established from class A frigo plants grown in the ground under the double-row strip cropping system – only 4.9 t·ha^{-1}. Fresh market-

able fruits were found to have a high percentage – 82.8% (‘Elsanta’) and 87.6% (‘Albion’) – in the total marketable yield in the case of both cultivars and all cropping systems, except for the treatment consisting of cv. ‘Elsanta’ waiting-bed plants (66.6%).

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PLONOWANIE DWÓCH ODMIAN TRUSKAWKI W ZALEŻNOŚCI OD SPOSOBU UPRAWY NA PRZYKŁADZIE PLANTACJI TOWAROWEJ SPECJALISTYCZNEGO GOSPODARSTWA OGRODNICZEGO

Streszczenie. W badaniach przeprowadzonych w latach 2009–2011 na plantacji towarowej w specjalistycznym gospodarstwie ogrodniczym oceniano wielkość i jakość plonu dwu odmian truskawki (Elsanta i Albion) prowadzonych w różnych systemach uprawy. Określono wielkość i strukturę plonu owoców deserowych i przeznaczonych do przetwórstwa. Różne systemy produkcji obejmowały uprawę truskawek z sadzonek wielokoronowych oraz sadzonek frigo klasy A+ i A, posadzonych zarówno w gruncie jak i na czarnej foli, w systemie rzędowym i pasowo-rzędowym oraz na zbiór w tradycyjnym terminie owocowania i zbiór opóźniony. Średni plon owoców deserowych odmiany Elsanta w latach 2009–2011 wyniósł 10,8 t·ha^{-1} i był o 53,0% większy od średniego plonu truskawek odmiany Albion (7,1 t·ha^{-1}). Najlepiej plonującym okazał się system uprawy z sadzonek frigo klasy A+ odmiany Elsanta uprawianej w systemie pasowo-rzędowym na czarnej folii (kombinacja D) – przeciętny plon owoców deserowych wyniósł 14,4 t·ha^{-1}, zaś ogólny plon handlowy – 17,4 t·ha^{-1}. Najmniejszy średni plon owoców deserowych osiągnięto z plantacji odmiany Albion prowadzonej w systemie pasowo-rzędowym z sadzonek frigo A w gruncie – tylko 4,9 t·ha^{-1}. Udział owoców deserowych w ogólnym plonie handlowym wahał się od 66,6% na odmianie Elsanta do 89,6% na roślinach odmiany Albion.

Słowa kluczowe: *Fragaria* × *ananassa* Duch., plon, technologia produkcji, owoce deserowe, sadzonki frigo

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