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## YIELD STRUCTURE AND CONTENT OF SOME COMPONENTS IN FRUIT OF SIX STRAWBERRY CULTIVARS

### STRUKTURA PŁONU I ZAWARTOŚĆ NIEKTÓRYCH SKŁADNIKÓW W OWOCACH SZEŚCIU ODMIAN TRUSKAWKI

**Abstract:** Studies were conducted in the years 2002–2004 at Experimental Station of Faculty of Horticulture in Garlica Murowana near Krakow. The experiment was set up in November 2000. Six strawberry cultivars were investigated.

Strawberry plants started yielding in year 2002. In the first year of cropping 'Elkat', 'Kent' yielded at the highest level. In year 2003 every cultivars gave the smallest yield. In the third year of cropping 'Kent' and 'Selva' cultivars showed the highest yields. For 'Elkat' and 'Senga Sengana' the highest unmarketable fruit crop was recorded. The differences in one fruit mass from the first and late crops were the biggest for 'Elkat', 'Gerida' and 'Kent' in years 2002 and 2003. For 'Gerida', 'Elsanta' and 'Kent' the highest percentage of fruit of diameter 25 mm was recorded.

**Keywords:** yield structure, vitamin C, anthocyanins

In Poland recently production of strawberry is the subject of some changes, in respect of number of grown cultivars. The studies on strawberry plants are conducted both in Poland and abroad [1–9]. New cultivars listed in index of cultivars every year are evaluated not only in the respect of morphological and usable features but the ability for fruit cropping as well.

### Material and methods

The experiment was set up in November 2000 at the Experimental Station of Faculty of Horticulture in Garlica Murowana near Kraków. The following strawberry cultivars were the subject of experiment: 'Elkat', 'Elsanta', 'Gerida', 'Kent', 'Selva' and 'Senga

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Sengana'. Young fresh strawberry plants were supplied by the Fruit Research Experimental Station in Brzezna. The experiment was carried out using the method of randomized blocks in an independent design in four replications, one replication consisted of 15 plants. The field was cover with black non-woven mulch, the plants were spaced 25 × 40 cm apart (area of one plot was 1.5 m<sup>2</sup>). During the draught the plants were irrigated. The studies were carried out in the years 2002–2004.

The following measurements were completed: marketable yield (for 'Selva' sum of early and late crop), the yield of unmarketable fruit (ie fruit with disease symptoms, little and misshapen fruit), the mass of 100 fruits, percentage of fruit of equatorial diameter 22 and 25 mm (on the base of 100 fruits from each harvest). Following chemical analysis of fruit were performed within the fullness of time of harvesting with following methods: L-ascorbic acid content – acc. to PN-A-04019:1998, total soluble solids by refractometric measurement – acc. to PN-EN 12143:2000, pH of fruit juice by potentiometry – acc. to PN-90/A-75101/06, titratable acidity – acc. to PN-EN 12147:2000), anthocyanins – differentiated pH method calculated onto pelargonidyn-3-glucoside [10].

Results were statistically verified at using analysis of variance, the significant differences were evaluated using the Duncan test at p = 0.05.

## Results and discussion

In the discussed years both total precipitation and precipitation in April, May and July was lower than ten years' value (Table 1).

Table 1

Total precipitation, mean year temperature in the years 2002–2004 and ten years' values

Year	2002	2003	2004	Ten years' values
Total precipitation [mm]	588	479	568	602
Precipitation distribution [mm]				
April	42	40	23	60
May	57	98	56	80
July	93	39	51	101
Mean year temperature [°C]	8.7	8.2	7.8	8.1

The lowest precipitation was noted in the 2003. Mean year temperature was at the similar level as many years' value.

Due to the late time of strawberry planting in October 2000 the plants did not fruit in year 2001 and the simple inflorescences were removed. The first crop of strawberry fruit was recorded in year 2002 (Table 2).

In the first year the highest crop was noted for 'Elkat' and 'Kent', while the lowest yield was recorded in Selva cultivar. The highest unmarketable fruit was obtained in 'Elkat', the other cultivars showed the similar amount of those fruit. In 2003 all the investigated cultivars gave the low crops, yet, 'Elkat' produced the most fruit. Low precipitation in that year was the reason of that fact probably (Table 1). 'Elkat' and

‘Senga Sengana’ gave the highest unmarketable fruit yield. In the third year of fruiting the highest crops were recorded for Kent and ‘Selva’. Other cultivars yielded on the same level. Similarly as in 2003, ‘Elkat’ and ‘Senga Sengana’ produced the most unmarketable fruit.

Table 2

Marketable yield and yield of unmarketable fruit of six strawberry cultivars in the years 2002–2004 (calculated per plot = 15 plants)

Cultivar/ year/ yield	2002		2003		2004		Total yield	
	market- able	unmarket- able fruit	market- able	unmarket- able fruit	market- able	unmarket- able fruit	market- able	unmarket- able fruit
	[kg]							
Elkat	6.85 b*	2.62 b	3.64 b	0.93 b	3.50 a	1.95 b	13.99 b	5.5 b
Elsanta	5.53 ab	0.47 a	1.42 a	0.18 a	3.70 a	0.60 a	10.65 a	1.25 a
Gerida	4.38 ab	0.45 a	2.59 ab	0.18 a	3.59 a	0.55 a	10.56 a	1.18 a
Kent	6.08 b	0.50 a	2.80 ab	0.23 a	5.35 b	0.76 a	14.23 b	1.49 a
Selva	3.83 a	0.55 a	1.87 a	0.23 a	4.12 ab	0.60 a	9.82 a	1.38 a
Senga Sengana	4.53 ab	1.05 a	2.64 ab	0.69 b	3.48 a	1.55 b	10.65 a	2.34 b

\* Means in the columns followed by the same letters do not differ significantly at  $\alpha = 0.05$ .

In the discussed study the total highest crops were obtained for ‘Kent’ and ‘Elkat’ what is in agreement with the studies of other authors [3–5, 11, 12]. Cultivars ‘Senga Sengana’, ‘Selva’, ‘Elsanta’ and ‘Gerida’ yielded on lower level, what is confirmed by others authors [5, 6, 9, 11, 12]. The yield of unmarketable fruit was highest in 2002, when the precipitation raised up to 93.2 mm in June. In two others years of studies ‘Elkat’ and ‘Senga Sengana’ produced the most unmarketable fruit. Many authors inform of high percentage of ‘Senga Sengana’ rotten fruit [6, 13, 14].

Cultivars differed in respect of fruit mass (Table 3).

Table 3

Mass of 100 fruit of six strawberry fruit

Cultivar	2002	2003	2004
	[kg]		
Elkat	1.25 ab	1.13 ab	1.27 ab
Elsanta	1.39 b	1.37 b	1.40 b
Gerida	1.48 b	1.35 b	1.41 b
Kent	1.30 ab	1.19 ab	1.29 ab
Selva	1.11 a	0.92 a	1.05 a
Senga Sengana	0.92 a	0.83 a	0.90 a

Explanation see Table 1.

In every year of experiment the greatest mass of fruit was noted for ‘Gerida’ and ‘Elsanta’, and the lowest one for ‘Selva’ and ‘Senga Sengana’. Also in other experiment

[6] cultivars ‘Gerida’ and ‘Elsanta’ exhibited the greatest fruit mass. Other authors [11, 12, 14] obtained slightly less fruit mass for ‘Elsanta’ and Elkat. Kopytowski et al [11] recorded greater mass for Kent fruit and similar fruit mass for ‘Senga Sengana’ comparing with the presented study. ‘Gerida’, ‘Elsanta’ and ‘Kent’ produced the most fruit of equatorial diameter 25 mm (Fig. 1).

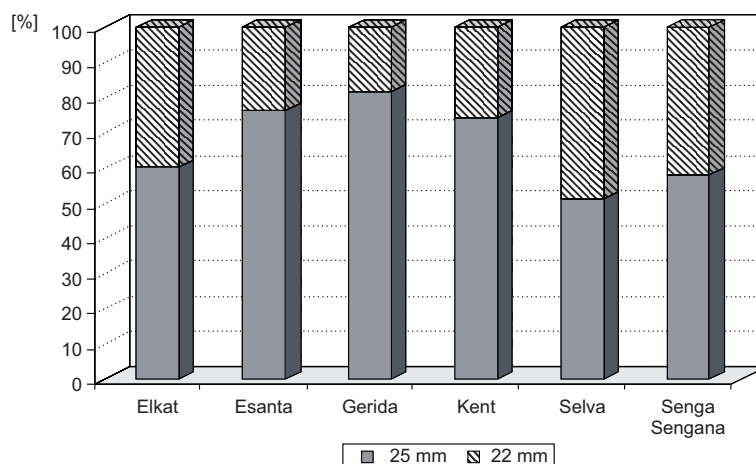


Fig. 1. Percentage of fruit recorded in two groups (22 and 25 mm fruit diameter) in marketable yield for six strawberry cultivars (mean for three years)

The results concerning L-ascorbic acid and anthocyanins content in fruit of investigated strawberry cultivars were presented in Table 4.

Table 4

L-ascorbic acid and anthocyanins content in fruit of six strawberry cultivars [ $\text{mg} \cdot 100 \text{g}^{-1}$ ]

Cultivar	2002		2003		2004	
	L-ascorbic acid	anthocyanins	L-ascorbic acid	anthocyanins	L-ascorbic acid	anthocyanins
Elkat	47.6 b	39.1 d	45.1 c	42.1 d	38.0 bc	40.5 d
Elsanta	73.5 c	13.4 a	76.1 e	13.0 a	66.1 d	14.0 a
Gerida	47.6 b	17.3 b	62.7 d	16.9 b	38.9 bc	18.4 b
Kent	44.1 a	30.1 c	41.0 b	25.5 c	25.9 a	29.7 c
Selva	48.1 b	17.5 b	29.9 a	16.9 b	41.1 c	17.9 b
Senga Sengana	48.7 b	35.3 d	51.0 c	33.7 cd	34.6 b	38.8 d

Explanation see Table 1.

In each year of study the highest content of L-ascorbic acid was recorded for fruit of ‘Elsanta’ cv., and in the fruit of other cultivars the content of that vitamin was lower. Zmuda et al [15] and Skupien [16] stated the high content of L-ascorbic acid in ‘Senga

Sengana' cv. Masny et al [17] obtained much lower content of vitamin C in 'Senga Sengana' and 'Elkat' fruit.

In the discussed study 'Senga Sengana' and 'Elkat' fruit contained the most anthocyanins. Masny et al [17] and Zmuda et al [15] obtained similar results. However, Bojarska et al [18] got the different results for 'Elsanta'.

In Table 5 the results concerning total soluble solids, pH of fruit juice and titratable acidity are presented.

Table 5

Total soluble solids, pH of fruit juice and titratable acidity

Cultivar	2002			2003			2004		
	Total soluble solids [%]	pH	Titratable acidity [g · 100 g <sup>-1</sup> ]	Total soluble solids [%]	pH	Titratable acidity [g · 100 g <sup>-1</sup> ]	Total soluble solids [%]	pH	Titratable acidity [g · 100 g <sup>-1</sup> ]
Elkat	5.90 a	3.53 b	0.90 b	7.89 a	3.53 a	0.88 bc	9.31 b	3.47 bc	0.94 b
Elsanta	7.63 e	3.48 b	0.85 ab	10.13 d	3.81 c	0.77 abc	9.25 b	3.51 bc	0.89 ab
Gerida	7.95 f	3.50 a	0.80 a	10.18 d	3.77 c	0.76 ab	8.91 b	3.50 bc	0.82 a
Kent	7.55 d	3.40 a	0.85 ab	11.03 e	3.82 c	0.76 ab	8.50 b	3.54 c	0.89 ab
Selva	7.43 c	3.38 a	0.90 b	9.42 c	3,62 b	0.72 a	8.47 b	3.45 ab	1.05 c
Senga Sengana	6.43 b	3.50 b	0.85 ab	8.74 b	3.64 b	0.91 c	7.40 a	3.39 a	0.82 a

Explanation see Table 1.

Total soluble solids content, value of pH and titratable acidity varied depending on the strawberry cultivar and year of study (Table 5). Masny et al [19] obtained similar results.

## Conclusions

1. Strawberry 'Elkat' and 'Kent' cultivars showed the highest marketable yield.
2. The high yield of unmarketable fruit was obtained for 'Elkat' and 'Senga Sengana'.
3. Gerida and 'Elsanta' produced the fruit of the greatest mass.
4. The highest content of L-ascorbic acid was noted for 'Elsanta' fruit.
5. 'Elkat' and 'Senga Sengana' fruit contained the most anthocyanins.
6. Total soluble solids, pH of juice and titratable acidity changed depending the year of study.

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**Abstrakt:** Badania prowadzono w latach 2002–2004 w Stacji Doświadczalnej Wydziału Ogrodniczego w Garlicy Murowanej koło Krakowa. Doświadczenie zostało założone w listopadzie 2000 r. Badaniami objęto sześć odmian truskawek: ‘Elkat’, ‘Elsanta’, ‘Gerida’, ‘Kent’, ‘Selva’ oraz ‘Senga Sengana’.

Rośliny rozpoczęły owocowanie w 2002 r. W pierwszym roku plonowania uzyskano najwyższe plony owoców truskawek odmiany ‘Elkat’ oraz ‘Kent’. W roku 2003 wszystkie odmiany cechowały się najmniejszym plonem w porównaniu z uzyskanymi z pozostałych dwóch lat badań. W trzecim roku owocowania największy plon owoców dały odmiany ‘Kent’ oraz ‘Selva’. Dla odmian ‘Elkat’ oraz ‘Senga Sengana’ odnotowano najwyższy plon owoców niehandlowych zarówno w poszczególnych latach, jak i łącznie po trzech sezonach. Największe różnice w masie jednego owocu z pierwszych i ostatnich zbiorów stwierdzono w przypadku odmian ‘Elkat’, ‘Gerida’ oraz ‘Kent’ w latach 2002 i 2003. W przypadku odmian ‘Gerida’, ‘Elsanta’ oraz ‘Kent’ odnotowano największy procentowy owoców o średnicy 25 mm.

**Słowa kluczowe:** struktura plonu, witamina C, antocyjany