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FIRST RESULTS OF SOME DAY-NEUTRAL STRAWBERRY CULTIVARS BEHAVIOR IN THE BUCHAREST AREA CONDITIONS

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Abstract

The main objective of the experiment consist in testing three cultivars of strawberries: two day-neutral ('Albion' and 'San Andreas') and one with one year harvest ('Benicia'). The goal was to monitor and evaluate their behaviour in the first year of vegetation in a plasticulture system considering the pedo-climatic conditions of Bucharest. We focused mainly on the following characteristics and traits: flowering and fruit maturation, the amounts of the accumulated temperatures during the bearing period, fruit weight, fruit shape, solid dry matter content, ascorbic acid content and total sugar content (glucose, fructose and sucrose). The earliest ripening date ranged between 18th and 25th of June and the amounts of temperatures accumulated up to this phenophase ranged between 1380 and 1515.5 ^{o}C. The strawberries reached the harvest maturity between June, 27th and July 1st for a period of 6-9 days. The day-neutral strawberry cultivars develop fruits who have been ripening during the entire summer and autumn season, the last significant harvest was remarked toward the end of October, when they accumulated 2317 ^{o}C each. The plants had continued to produce even in November and December, till the first frost. In the first months after planting, fruit weight was lower (8.33 g - 11.52 g) than achievable weight of each cultivar. All the studied cultivars have excellent organoleptic characteristics, a good shelf life potential and a high efficiency of fructification, taking into account the cultivation system and the overall technological measures. A high sugar content of 6.49% (glucose, fructose and sucrose) and solid dry matter content of 6.8% has been recorded by 'San Andreas' and the ascorbic acid content was of 71.92 mg/100g. A lower content in sugar was registered by 'Albion' with 4.81% and 4.28% by 'Benicia'. Regarding ascorbic acid content, 'Albion' accumulate the highest content in fruits (84.89 mg/100g) next by 'Benicia' with 74.6 mg/100g. The day-neutral cultivars remarked also by a notable number of runners at the end of the year.

Key words*: day-neutral, strawberry, traits, cultivar, 'Albion', 'San Andreas', 'Benicia'*

INTRODUCTION

The strawberries (*Fragaria* x *ananassa* Duch.) are along with cherries, early fruits which are ripening in May or June (Asanica A. and Hoza D., 2013).

Cultivating day-neutral strawberry cultivars (produce flowers regardless of the photoperiod and allow multiple harvests within one year) it is possible therefore to have fresh strawberries from spring until the end of the fall.

With a small stature (15 to 40 cm), as more or less compact/rare plants, strawberries could be grown successfully in pots, small kitchen garden, green houses or in large outdoors areas (Chira, 2000). Strawberries, also could be cultivated interleaved in plantations or between different other cultures (Hoza, 2000). Success depends on the location of culture, quality of soil, cultivar potential, plant age and moment of harvest (Montero et al.,1996).

The sugar, acid and vitamin C content of the strawberries is considered a quality factor both by consumers and food industry (Kim et al., 2013). The relationship between these components and sensory traits such as flavour or colour have been studied (Wrolstad et al.,1970) also in the postharvest technologies. Anyway, correlated with the time on the market, the strawberry fruit appearance including size, colour, shape as well as the flesh sensorial properties represent many times the consumer criteria for choosing one or another strawberry cultivar.

MATERIALS AND METHODS

The experimental field of the Fruit Growing Department is located in the geomorphological unit Romanian Plain, subdivision Vlasiei to 44^{o}29′50″N and 26^{o}15′26″E. The climate is temperate - continental with warm, sometimes hot and frequent droughts and cold winters, with large amounts of snow. The springs are short, with big jumps in temperature from

month to month and with significant variations between day and night amplitude. Autumns are distinguished by moderate thermal and slow transition to winter.
The annual rainfall volume is between 500 and 600 mm, the maximum occurring in the period from May to July.
In April 2013, within the Department of Fruit Growing field, it was established a demonstration plot where it were planted three new strawberry cultivars: two day-neutral ('Albion' and 'San Andreas') and one with a single major crop/year ('Benicia') in plasticulture system.
The soil was covered with Agrotextile mulch, three strips of strawberry rows have been performed for each cultivar (Figure 1). The planting distances were of 35 cm between strips and 20 cm between plants in the row. Each of the strawberry row benefits of irrigation through a 16 mm drip irrigation pipe with pre settled drip nozzles.

Figure 1. Experimental plot of strawberry cultivars in the Faculty of Horticulture field

For studying these strawberry cultivars, specific methods were applied for the following traits and plant/fruit characteristics: flowering period and fruit maturation, the amounts of temperatures accumulated during the fruiting period, fruit weight, fruit shape, dry soluble content, ascorbic acid content and total sugar content (glucose, fructose and sucrose).

The flowering period and fruit maturation were determined by distinct stages of each phenophase.
The temperatures accumulated during the fruiting period were calculated by summing, for each cultivar, based on daily temperature, corresponding trigger data and fruiting performance of each phase separately.
The average fresh weight of the fruit (g) was determined by weighing 25 fruits from each type of composite sample using an electronic balance.
The shape index (SI) of the fruit was carried out by measuring with callipers the height (cm) and the diameter (cm) of 10 sample fruits. Thus, shape index was calculated as the ratio between these two dimensions.
The content of soluble dry matter (SDM%) was determined by a Zeiss refractometer using a sample juice resulting from 10 fresh fruits. The content of ascorbic acid (mg/100g) and the total glucidic content (%) (glucose, fructose and sucrose) was measured by means of a modular assembly HPLC detector with tuneable optical absorption in the spectral range of 190- 900 nm. For the ascorbic acid determination, the juice was diluted with 1% oxalic acid, filtered and then 2 ml analysed by HPLC. To determine the total sugar content, it was used a 2 ml filtered juice, obtained by boiling 50 g of pulp in distilled water until disintegration, afterward analysed with HLPC device.

RESULTS AND DISCUSSIONS

The April - October 2013 period was characterized by average monthly temperatures slightly higher than the climatologically average (1960-2004) (Figure 2), providing sufficient thermal resources for the strawberry crop growth and development of fruits.
In terms of water supply, however, rainfall was deficient in the first months after planting, compared to the multiannual average (1960-1990) (Figure 3), which is common in the South part of the country so that's why the irrigation system we consider it indispensable for the strawberry culture.

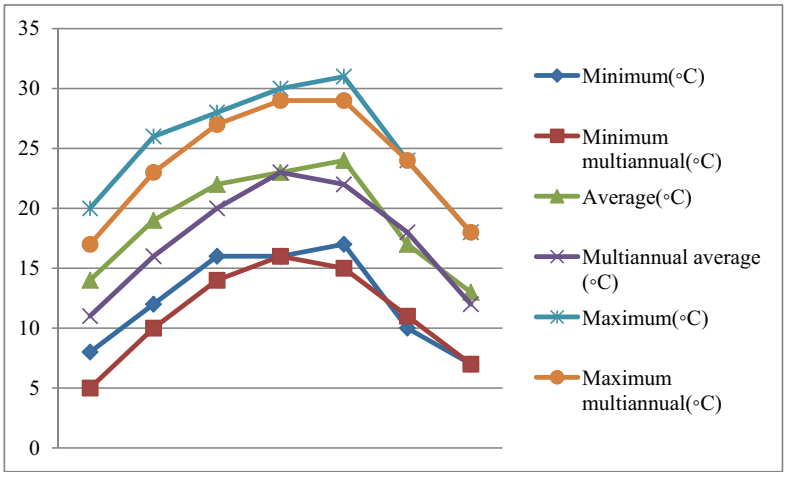

Figure 2. Variation of minimum, maximum and average temperatures compared to the multiannual averages (1960-2004), the first year of vegetation conditions of strawberry cultivars, 2013

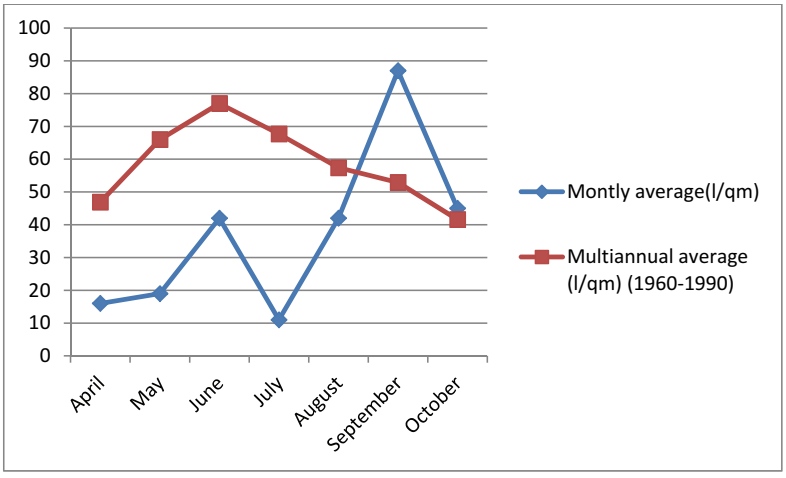

Figure 3.Variation in rainfall compared to multiannual averages (1960-1990), the first year of vegetation conditions of strawberry cultivars, 2013

In the newly established strawberry experimental crop, the day-neutral cultivars had ripening very early as follows: on 18.06.2013 'San Andreas' respectively 20.06.2013 for 'Albion'. From planting to the first ripened fruits were accumulated 1380^{0}C in the San Andreas case and 1407.5^{0}C at 'Albion' (Table 1). They had the ripening period over 6 and 9 days, around the date of June, 27th when the temperature accumulated was of 181.5^{0}C ('Albion') and 205^{0}C ('San Andreas'). 'Benicia' had a quick development of foliage after planting and the first red fruits have been picked up around the 25th of June, when it were accumulated 1515.5^{0}C. The fruits ripening in around six days and pass in the first days of July accumulating other 158.5^{0}C. The fructification continue during entire month and slows down in late of July.

The day-neutral cultivars have been blossom and fruiting continuously over the summer and autumn, the last harvest was towards the end of October (Table 1), when they accumulated 2317^{0}C each. Both cultivars continuing to produce some fruits even in late November, but more of them remains smaller, green or white with pale pink blush on the sunny part (Figure 4).

Table 1. Phenological data on the first year fruiting strawberries cultivars, 2013

Cultivar	Early ripening (date)	Temperatures until early ripening (^{0}C)	First fruit riped (date)	Fruit maturation period (days)	Temperatures from early ripening to first ripening fruits (^{0}C)	Last harvest (date)	Temperatures of the entire fruiting period (end of July to October) (◦C)
'Albion'	20.06	1407.5	27.06	6	181.5	20.10	2317
'San Andreas'	18.06	1380	27.06	9	205	20.10	2317
'Benicia'	25.06	1515.5	01.07	6	158.5	-	-

Figure 4. Day-neutral cultivars: 'Albion' (left) and 'San Andreas' (right), 28.11.2013

In terms of the fruits size, it seems that first fruits obtained had encounter modest weight. 'Albion' realised for the first picked fruits only 8.33 g/fruit as an average value, 'Benicia' 9.50 g/fruit and 'San Andreas' 11.52 g/fruit (Table 2).

But the biological potential of the cultivars former is far better. At UC Davis (University of California), fruit weight performance reported was of 32,1 g for 'Albion', 32,4 g for 'San Andreas' and 33,5 g for 'Benicia' (Watsonville Research Facility). In West Central Research and Outreach Center of University of Minnesota, 'Albion' in the same cultural conditions as we experimented, the day-neutral cultivars reach the average weight of the fruit of 14,32 g and 'San Andreas' 16,52 g/fruit.

In this regard, our results must be interpreted as the field potential of the strawberry cultivars, taking into account the fact that the land and culture was not fertilised at all and the fruits harvested comes from the runners planted few months ago.

In our technological and land conditions, the cultivars description have been made in order to compare them also by commercial aspect.

'Albion' cultivar develop long conical fruits with a shape index of 1.26. The colour of fruit is bright red (Figure 5) with red-whitey flesh.

'San Andreas's fruit is conical, with a shape index of 1.21, bright red, shiny (Figure 6), sweet and with a great fragrance.

'Benicia' cultivar has long shaped fruit conical with shape index of 1.32 (Figure 7), medium consistency, bright red outside colour, with a nice and attractive red pulp inside.

The three studied cultivars have an excellent taste (all organoleptic characteristics are superior), good shelf life potential and high fructification efficiency.

'San Andreas' had accumulated the highest content of sugars (glucose, fructose and sucrose) respectively 6.49%, with about 35% more than the next cultivar in range ('Albion'). Also, the dry soluble matter content of the 'San Andreas' fruits (6.8%) was higher, but the values between the studied cultivars were very closed to each other (Table 2).

Lower sugar content was recorded by 'Benicia' (4.28%) and 'Albion' (4.81), but this decreased content of total sugar in fruits, did not

disqualified the organoleptic feature of the cultivars.
Regarding the ascorbic acid content, 'Albion' recorded the highest value of 84.89 mg/100g next by 'Benicia' cultivar with 74.6 mg/100g and 'San Andreas' (71.92 mg/100g).

Table 2. The main characteristics of strawberry cultivars fruits harvested in the first year of culture, 2013

Cultivar	Weight (g)	Length/ width (cm)	Shape index (SI)	DSM %	Ascorbic acid (mg/100g)	Sugar content (%)			
						Fructose	Glucose	Sucrose	Total
'Albion'	8.33	2.94/2.32	1.26	6.7	84.89	1.97	1.86	0.98	4.81
'San Andreas'	11.52	3.39/2.78	1.21	6.8	71.92	2.7	2.47	1.32	6.49
'Benicia'	9.50	3.35/2.52	1.32	6.6	74.6	2.06	1.82	0.4	4.28

Figure 5. Albion

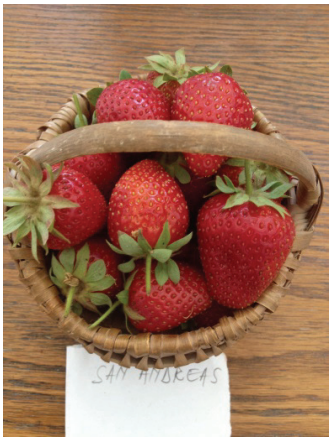

Figure 6. San Andreas

Figure 7. Benicia

Plants of each cultivar had shown different genetic finger print vigour. 'San Andreas' behave as a low vigorous cultivar and develop a dark green foliage. 'Albion' presented a medium vigour and 'Benicia' the highest height with big leaflets and thick petioles.
The data presented in the Table 3, reflect the average number of runners/plant at the end of the vegetation period. In comparison with 'Benicia', the day-neutral strawberry cultivars spread more runners/plant. 'Albion' has develop the highest number of runners/plant (4) and 'San Andreas' 3 runners/plant.
This trait is technologically important both for producers and traders, the total number of runners/plant as a genetic feature could also be used as a providing biological material capacity.

Table 3. Number of runners/plant after the first year of vegetation

Cultivar	'Albion'	'San Andreas'	'Benicia'
Average number of runners/plant	4	3	1

CONCLUSIONS

After the first year of plasticulture system in the Bucharest area conditions, the studied three strawberry cultivars proved a good agrobiologic potential.
Plants presented a good resistance to the main diseases and start fruiting in 57-60 days after planting. First fruits picked in these conditions recorded a moderate weight but with good organoleptic features, close to the cultivar potential.

The last fruits of both day-neutral cultivars ('Albion' and 'San Andreas') were harvested from the snow when the first frost occurred proving to be a very good cultivars especially for home garden use.
Day-neutral cultivars 'San Andreas' and 'Albion' develop more runners than 'Benicia'.
Research will continue in the next year for a better evaluation of these cultivars.

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