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AGROPRODUCTIVE EVALUATION OF SOME SWEET CHERRY CULTIVARS IN THE PEDOCLIMATIC CONDITIONS OF N-E ROMANIA

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Abstract

The sweet cherry (Prunus avium L.*) can be one of the most profitable fruit crops grown in temperate climates, highly appreciated worldwide due to the taste, color and nutritional value of the fruits. This study was carried out in the 2021-2023 years using some foreign ('Regina', 'New Star' and 'Kordia') and autochthonous cultivars ('Bucium' and 'Maria') from the Research Station for Fruit Growing (RSFG) Iasi. The aim of this research was to evaluate the productivity in the context of current climate change by determining the main physical and biochemical characteristics of the fruits (weight, diameter, color, sugar composition, titratable acidity and vitamin C), the total fruit production as well as the productivity index related to the trunk section area. The obtained results were interpreted statistically and although there was a variability between the experimental variants, the local cultivars present characteristics that allow agrobiodiversity and a better planning of future improvement programs.*

***Key words**: fruit quality, growth, production, Prunus avium* L.

INTRODUCTION

Sweet cherry is an important fruit species that is cultivated and distributed globally (Palasciano et al., 2022). In addition to the traditional and modern known cultivars in Europe, there are also a multitude of cultivars obtained as a result of the genetic improvement of the growing countries, representing a way of completing and improving the current assortment (Iurea et al., 2019). In Romania, the area of sweet cherry orchards being on average on the last 5 years approximately 4 thousand hectares annually, and the fruit production approximately 45 thousand tons (FAO, 2021). Sweet cherries, are among the first fresh fruits of the year and the most appreciated due to its organoleptic characteristics (color, aroma), but also due to recognized benefits for human health (biochemical composition) (Blando & Oomah, 2019). Although the sweet cherry is an economically profitable crop, it also has several characteristics that subject it to multiple risks in the context of current climate change (Lang, 2019; Păltineanu & Chitu, 2020).

In order to limit climatic stress factors (high temperatures, drought) and improve production and its quality, genetically (rootstock) and horticulturally (training systems) research is needed (Whiting et al., 2005).

Regarding the rootstock, the adaptability of *Prunus mahaleb* to the continental climate, tolerance to drought, hot summers due to the root system, expand its importance for sweet cherry culture in the future (Martins et al., 2021; Hrotkó et al., 2023) becoming increasingly used in European countries, in Central Asia and Northwest China (Ercisli et al., 2006; Hrotkó, 2016). These traits gain greater importance due to accelerated climate change and replanting conditions. Although researchers agree that rootstocks affect fruit quality, growth control on mahaleb rootstocks can be managed by applying frequent pruning and maintaining an optimal canopy for an optimal production (Tabakov et al., 2020; Martins et al., 2021).

The recent increase in sweet cherry production worldwide has given new importance to the quality of the fruits. Thus, recent studies emphasize the value of balancing the crop load but also of increasing the dimension and quality of the fruits. For sweet cherries, fruit size and color remain the most important attributes, and the development of strategies to improve fruit quality through research on rootstocks, cultivars, crop loading, environmental factors and final production is of great interest (Whiting & Ophardt, 2005; Zhang & Whiting, 2011; Malchev et al., 2022).

The objective of this study was to compare the growth, the production yield as well as some physical and biochemical qualities of the fruits of some foreign with autochthonous sweet cherry cultivars, in the context of current climate changes.

MATERIALS AND METHODS

The study was carried out during the years 2021-2023 using five cultivars of sweet cherry with the same decade of fruit ripening, of which three are foreign: 'Regina', 'Kordia', 'New Star' and two Romanian cultivars: 'Bucium' and 'Maria'. The biological material is part of a competitive crop within the Research Station for Fruit Growing (RSFG) Iasi, geographically located in the North-East of Romania (47°20′N and 27°60′E). The cultivars were grafted on rootstock of medium to high vigor *Prunus mahaleb* L., and trained in an improved Spanish vase form. During the study, the orchard was not irrigated and the fertilization and maintenance management was carried out in accordance with the agronomic specifics of the sweet cherry (Quero-García et al., 2017).

The weather conditions monitored in the experimental field during the research years (2021-2023) are shown in Table 1. The average annual temperature of the last three years was 11.3°C, and the total precipitation was 430.3 mm with a deviation of 87.5 mm from the multiannual values.

All determinations were performed on three replicates, from three trees, annually and statistically interpreted by the method of multiple comparisons with the Duncan test. Differences were considered significant at $p < 0.05$ and are indicated by different letters.

The weight was carried out by weighing with the electronical scale 0.01G Radwag type sensitivity and the diameter is the average of two diameters, made by means of a precision digital caliper.

Epidermal color was evaluated using a Minolta colorimeter (CR400 C. Minolta Japan) to determine chromaticity values using the indices: *L** (for lightness), *a** (shades from green to red), and *b** (shades from blue to yellow) (Ibraheem et al., 2012).

The soluble dry solids (SDS) content was measured with a digital refractometer (Hanna Instruments HI96804) and the results expressed in °Brix. Titratable acidity (TA) was determined by acid-base titration with 0.1 N NaOH to the end point of pH 8.1. The results were expressed as mg of malic acid content×100g^{-1} fruit (Hayaloglu & Demir, 2016). For vitamin C content, the 2,6-dichloroindophenol titrimetric method of juice analysis (AOAC Method 967.21) was used and the results were expressed in mg ascorbic acid×100 g^{-1} fruit (Nielsen, 2017).

The cross-sectional area of the trunk, TCSA expressed in cm^2 was calculated by ½ the diameter of the trunk^2 × π and the projection volume of the canopy expressed in m^3, CV by [(sum of two diameters of the crown)^2/2]+crown height ×0.416 . Cumulative production efficiency index was calculated by relating annual production (kg per tree) to average TCSA (cm^2) and CV (m^3).

Table 1. Climate condition at Iaşi county
(RSFG Iași-Romania, 2021-2023)

Month	Air temperature (°C)			Precipitation (mm)		
	*Av.	M.a	Dev.	Sum	M.a	Dev.
I	1.1	-3.3	+4.4	14.2	28.9	-14.7
II	1.6	-1.5	+3.1	19.1	27.4	-8.3
III	4.5	3.1	+1.4	38.3	28.1	+10.2
IV	9.3	10.3	-1.0	46.5	40.3	+6.2
V	16.0	16.1	-0.1	30.9	52.5	-21.6
VI	20.7	19.4	+1.3	44.7	75.1	-30.4
VII	23.2	21.3	+1.9	58.2	69.2	-11.0
VIII	23.0	20.5	+2.5	68.1	57.6	+10.5
IX	16.7	16.3	+0.4	30.7	40.8	-10.1
X	12.1	10.1	+2.0	14.3	34.4	-20.1
XI	6.6	4.0	+2.6	39.9	34.6	+5.3
XII	1.3	-0.9	+2.2	25.1	28.9	-3.8
Av./Sum	**11.3**	**9.6**	**+1.7**	**430.3**	**517.8**	**-87.5**

* Av.-average; M.a.- Multiannual (1969-2019); Dev.-Deviation

RESULTS AND DISCUSSIONS

The results of the characterization of the morpho-physiological traits are reported in Table 2. The fruit weight of the sweet cherry cultivars during the study period ranged from 7.02 g ('Maria') to 10.52 g ('Regina'), and the largest diameter was highlighted at the 'New

Star' cultivar (23.63 mm). Although the fruit ripening stage occurs in the same decade, it is influenced by the load of the crop of the year, but also by the genetic character of the cultivars (Kurlus, 2008; Magri et al., 2023).

Table 2. Physical characteristics of fruits (n = 3, RSFG Iași-Romania, 2021-2023)

Cultivar	Weight[1]	Diameter[1]	Colour[1]		
	(g)	(mm)	$\mathscr{L}$	a*	b*
Regina	10.52 [a]	23.62 [a]	20.94 [a]	19.04 [a]	2.29 [a]
Kordia	9.28 [b]	21.58 [b]	20.15 [b]	15.91 [b]	0.94 [b]
New Star	8.48 [c]	23.63 [a]	19.42 [b]	15.56 [b]	1.14 [b]
Bucium	8.40 [c]	22.57 [ab]	21.23 [a]	19.17 [a]	2.27 [a]
Maria	7.02 [d]	21.8 [b]	21.23 [a]	15.30 [b]	2.63 [a]

[1]Different letters after the number correspond with statistically significant differences for *p* 5% - Duncan test.

Fruit weight and fruit dimensions in diameter (width, thickness and length) are very important properties being the parameters that give the appropriate commercial appearance to the fruits. Sweet cherry cultivars with large fruits (both in size and weight) are increasingly valuable, but these parameters are strongly influenced by the climatic conditions and the applied culture system (Sirbu et al., 2018), being able to vary from year to year even by 4 g fruit weight (Hayaloglu & Demir, 2016).
Besides size, another key criterion used to evaluate the attractiveness of sweet cherries is fruit color (Romano et al., 2006). The color of the epidermis is considered to be the most significant indicator of the quality and maturity of cherries (Magri et al., 2023). The fruit color parameters of the evaluated cultivars are reported in Table 2. Luminance values (*L**) ranged from 19.42 at 'New Star' to 21.23 at local cultivars 'Bucium' and 'Maria'. The shades of intense red (*a**) with the highest values were found on average in the cultivar 'Bucium' (19.17).
Important biochemical components such as dry soluble solids (SDS), acidity as well as vitamin C influence consumer preference for the nutritional quality of fruits (Serradilla, 2012) and are presented in the Table 3.
Although the chemical composition varied annually, on average over the course of the study, the lowest SDS content was recorded at 'Kordia' cultivar (19.8°Brix), while the highest was at 'Bucium' (22.5°Brix), followed by 'Maria' (21.4°Brix) and 'Regina' (20.93°Brix). Depending on the cultivar of sweet cherry, the SDS content of fruits during maturity, according to numerous researches (Girard & Kopp, 1998; Guarino at al., 2010), can have minimum values of 13.2°Brix and can reach maximum values of 25.5°Brix. Similar findings to our results were also found in Wen et al. (2014), which showed SDS values between 17.77 and 19.97°Brix, in medium ripening cultivars.
TA estimates for different cultivars of sweet cherry is usually by malic acid content (Ricardo-Rodrigues et al., 2022), ranging from 0.62 mg malic acid/100 g for 'Kordia' to 1.03 mg malic acid/100 g for 'Bucium' cultivar. Significant differences were observed between all the variants examined (Table 3).
In our study, the highest level of vitamin C was found in the cultivar Bucium (23.7 mg×100 g^{-1} F.W.), followed by 'Kordia (20.17 mg×100 g^{-1} F.W.) and 'New Star' (20.0 mg×100 g^{-1} F.W.). The rate of formation of the vitamin C background in medium-ripening sweet cherry fruits exceeds the average parameters of the cultivars (Ivanova et al., 2022), a fact also confirmed in this study, where the vitamin C content was maximum.

Table 3. Chemical characteristics of fruits (n = 3, RSFG Iași-Romania, 2021-2023)

Cultivar	SDS[2]	TA[3]	Vitamin C
	(°Brix)[1]	(mg /100 g^{-1})[1]	(mg·100 g^{-1})[1]
Regina	20.93 [bc]	0.68 [cd]	18.00 [b]
Kordia	19.80 [c]	0.62 [d]	20.17 [ab]
New Star	19.83 [c]	0.71 [c]	20.00 [ab]
Bucium	22.53 [a]	1.03 [a]	23.67 [a]
Maria	21.40 [a]	0.88 [b]	18.33 [b]

[1]Different letters after the number correspond with statistically significant differences for *p* 5% - Duncan test.
[2]SDS- Soluble Dry Solids
[3]TA- Total Acidity

Vitamin C depends on weather conditions the growing season as well as the orchard area (Hayaloglu & Demir, 2016) thus, the same cultivar, analyzed in different surveys can have very significant variations. Previous data of the 'Regina' cultivar showed a minimum vitamin C content of even 7.29 mg×100 g^{-1} F.W. and in the conditions of N-E Romania, in the 3 years it recorded a value of 18.0 mg×100 g^{-1} F.W. Other research (Średnicka-Tober et al., 2019), indicates that sweet cherry fruits can reach a significantly higher content of vitamin C, up to 42.89 mg×100 g^{-1} F.W.

An analysis of tree productivity, both on average per tree (kg) and per surface unit (t/ha) was presented in Table 4. Thus, among the analyzed cultivars, production with values greater than 30 kg per tree was registered at 'Bucium' (34.4 kg) and 'Kordia' (31.2 kg).
The drought conditions during the years of the study influenced the growth and productivity of the studied cultivars differently. Thus, depending on the TCSA and CV of the trees, the productivity index of the sweet cherry trees was also calculated.

The obtained results confirmed that 'Bucium' produced a significantly higher production yield compared to the other cultivars, although TCSA and CV had medium values.
The greatest vigor of trunk growth was recorded in the 'Regina' cultivar (148.3 cm²) and in crown volume, 'New Star' (8.93 m³). The 'Maria' cultivar stood out with the lowest growth vigor, but with satisfactory results in terms of the productivity index (0.29 kg/cm² and 3.46 kg/m³).

Table 4. Productivity and vigor of the studied sweet cherry trees (n = 3, RSFG Iași-Romania, 2021-2023)

Cultivar	Production		TCSA[2]	CV[3]	Productivity index	
	(kg/tree)[1]	(t/ha)[1]	(cm²)[1]	(m³)[1]	(kg/cm²)[1]	(kg/m³)[1]
Regina	22.53 [b]	11.27 [b]	148.33 [a]	8.05 [b]	0.15 [c]	2.80 [b]
Kordia	31.20 [a]	15.60 [a]	125.82 [c]	7.22 [d]	0.25 [b]	4.32 [a]
New Star	24.67 [b]	12.33 [b]	135.94 [b]	8.93 [a]	0.18 [c]	2.76 [b]
Bucium	34.43 [a]	17.22 [a]	100.28 [d]	7.55 [c]	0.34 [a]	4.56 [a]
Maria	25.83 [b]	12.92 [b]	88.33 [e]	7.47 [c]	0.29 [b]	3.46 [b]

[1] Different letters after the number correspond with statistically significant differences for *p* 5% - Duncan test;
[2] TCSA - Trunk cross-sectional area;
[3] CV – Crown volume;

To determine the relationship between two variables, the correlation coefficient between average fruit weight and production, TCSA, CV and productivity index (kg/cm²) was calculated (Table 5).

Table 5. Pearson correlation coefficient (r) between mean fruit weight and productivity and vigor indices (RSFG Iași-Romania, 2021-2023)

Correlation coefficient	Weight[1] (g)
Production (kg/tree)	-0.219
TCSA[1] (cm²)	0.863
CV[2] (m³)	0.139
Productivity index (kg/cm²)	-0.650

[1] TCSA - Trunk cross-sectional area;
[2] CV – Crown volume;

Thus, in the relation fruit weight-production (r=-0.219) and weight-crown volume (r=0.139), the correlation coefficient was weak, having values ≤0.35.
In the relationship weight-TCSA (r=0.863) and weight-productivity index (r=-0650), the correlation was significantly high.
The statistical interpretation of the correlation coefficient was in agreement with Taylor, 1990.

CONCLUSIONS

The studied cultivars are of high productivity, and o superior fruit quality, finding favorable growth and productivity conditions in the North-Eastern part of Romania.
Although there were conditions of water and heat stress, the vigorous rootstock *Prunus mahaleb* imposed great resistance on both local and foreign cultivars.
The autochthonous cultivars created and approved within the Research Station for Fruit Growing (RSFG) Iasi, 'Bucium' and 'Maria' can be successfully introduced into the international assortment of mid-ripening sweet cherry cultivars, possessing physical and chemical qualities similar to or even superior to internationally relevant cultivars as well as a very good productivity.

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