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MORPHOLOGICAL AND BIOCHEMICAL CHARACTERISTICS OF SEVENT CHERRY FRUITS CULTIVARS

Pește anu Ananie[1]*, Manziuc Valeriu[1], Cumpanici Andrei[1], Cușmenco Tatiana[1], Borsai Orsolya[2], Bantaș Lora[1]
[1*]Technical University of Moldova
[2]University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca
** Correspondence author. E-mail*: ananie.pesteanu@h.utm.md

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ABSTRACT

The research was carried out in the plantation of the S.R.L. 'Agroparc Management' company in 2025. The orchard was planted in the spring of 2015. As the object of research were the trees of 'Sweet Early', 'Rocket', Frisco', 'Grace Star', 'Big Star', 'Kordia' (C), 'Regina' grafted on MaxMa rootstock. Planting distance 5.0 x 3.0 m. The fruit height, big and small diameters, and shape index ranged from 20.8 to 27.1 mm, 23.4 to 26.6 mm, 19.0 to 22.8 mm and 0.97 to 1.08, respectively. The average weight of a fruits, the percentage of flesh, stone and stem, ranged from 6.57 to 10.35 g, 90.0 to 93.9 %, 4.8 to 8.6 % and 1.1 to 1.9 %, respectively. The yield of the cultivars ranged from 3.52 to 7.84 t/ha. Flesh firmness ranged from 0.52 to 0.61 kg/cm², with SSC ranging from 14.7 to 18.6 %, AT from 0.40 to 0.83 % and vitamin C content ranged from 10.75 to 13.82 mg/100 g.

INTRODUCTION

The sweet cherry (Prunus avium L.) is a valuable fruit species for the Republic of Moldova, owing to the nutritional, technological, and commercial qualities of its fruit. Total sweet cherry production in the country amounted to 11,600 tonnes in 2025. That year, 8.000 tonnes of cherries were exported, generating revenue USD 20 million, that significantly exceeded figures from previous years. While the majority of cherry exports in 2024 were destined for CSI countries (84%), the European Union became the primary destination in 2025, with export volumes nearly doubling compared to the 2024 year (www. statistica. gov.md).

In recent years, the Republic of Moldova has lacked a breeding program for new sweet cherry cultivars; consequently, the introduction of foreign cultivars remains the only method to improve the species' varietal assortment (Balan et al. 2023, Long et al. 2014). Introduced cultivars must possess superior characteristics compared to existing ones, such as self-fertility, consumer-preferred fruit size, appealing organoleptic qualities, firmness, flavor, and extended shelf life. They should also offer a staggered ripening season with a prolonged harvest period, as well as resistance to abiotic and biotic stresses (Balan et al. 2021, Long et al. 2014). Currently, numerous new cultivars adapted to specific growing conditions have been developed at breeding centers worldwide (Sansavini & Lugli 2008). Global climate change necessitates the adoption of modern cherry cultivation technologies capable

of withstanding associated hazards, requiring the testing of various scion-rootstock combinations under actual production conditions (Balan et al. 2021, Ungureanu et al. 2022, Saraginovski et al. 2026). High productivity and competitive fruit quality are the primary criteria for cultivar selection (Hulujan et al. 2025, Pește anu et al. 2023).

The aim of our research was to examine the morphological, biochemical characteristics, the productivity and quality of the 'Sweet Early', 'Rocket', 'Frisco', 'Grace Star', 'Big Star', 'Kordia', and 'Regina' cultivars grafted onto the semi-vigorous MaxMa 14 rootstock in the southern region of the country.

MATERIAL AND METHODS

The research was conducted during the during the growing season of the year 2025 in a sweet cherry orchard established in the spring of 2015, using one-year-old trees within the SRL 'Agroparc Management' near the city of Vulcanesti, Gagauzian ATU, in the southern part of the country. The trees of cherry cultivars served as biological research material, which considered promising for the southern area of the Republic of Moldova: 'Sweet Early', 'Rocket', 'Frisco', Grace Star', 'Big Star', 'Regina'. As a control was the Kordia cultivar. The trees were grafted onto MaxMa 14 rootstock, planting distance 5.0 x 3.0 m, with trees trained as spindle. The orchard is not irrigated.

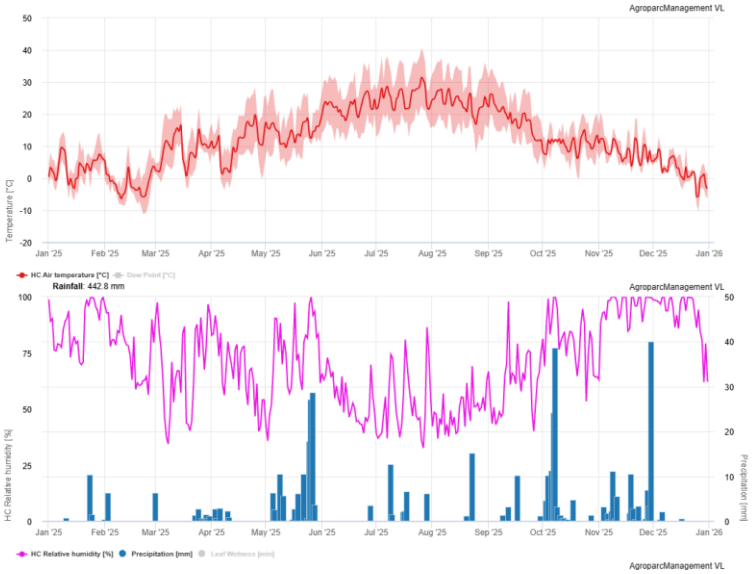


Figure 1. Climatic conditions in the experimental plot at the SRL "Agroparc Management' during 2025 (iMetos weather station).

The average temperature in 2025 was 12.3 °C, with a maximum of 25.5 °C and a minimum of 0.5 °C; total rainfall was 442.8 mm, and relative humidity was 71.5 %. In May and June, the values mentioned above differed and were 14.5 °C, 27.8 °C, 3.4 °C, 124 mm, 73.7 % and, 22.4 °C, 36.1 °C, 11.6 °C, 3.6 mm, 54.9 %, respectively. The rainfall in May had a positive influence on growth and fruiting processes, but the weather conditions in June had an impact on the activities mentioned above (Figure 1).

The studied cultivars ripened in 2025 in the following order: ‘Sweet Early’ – 3 June, ‘Rocket’ – 5 June, 'Frisco' – 10 June, ‘Grace Star’ – 13 June, ‘Big Star’ – 18 June, ‘Kordia’ – 23 June and ‘Regina’ – 28 June.

The ripening stage at harvest, determined by color of fruits. The ‘Sweet Early’ and ‘Rocket’ cultivars were harvested when they were mahogany red, the ‘Frisco’, ‘Grace Star’, and ‘Big Star’ cultivars were mahogany color; and the Kordia and Regina cultivars were dark mahogany.

For each cultivar (variant), there were three replicates, each comprised of eight plants. One model tree was selected from each replicate, ensuring that they exhibited uniform vigour and a similar fruit load, to serve as a reference for the research. From each model tree in the replicate, at the optimum harvest time, 150 fruits per cultivar were systematically collected from the eye-level zone on the eastern and western parts of the crown (Balan et al. 2023).

In the field, the yield for each replicate and variant was determined using the weighing method, by calculating the average yield per tree and per unit area.

The other indicators were determined in the biochemistry laboratory at the Faculty of Agricultural, Forestry and Environmental Sciences, TUM. The distribution of fruit by diameter according to the biological characteristics of the cultivar was determined for all cherries in the replicate (150 pieces) using the weighing method. These cherries were sorted using a standard template with orifices with diameters of 22, 24, 26, 28, 30 and 32 mm, which were subsequently weighed to determine the proportion of cherries of different sizes (Balan et al. 2023).

From each replicate of 150 fruits, 25 fruits were randomly selected, and their morphological parameters, productivity and biochemical indicators were determined. The morphological parameters included the average weight of the fruit, the proportion of the pulp, pit, and the stem, using a RABWAG PS 4500/c/2 (g) scale, as well as the fruit’s dimensions (length, width and thickness) using a calliper; fruit firmness (kg cm^2; using a Delta Trak Model 12226 with a 3.5-mm-diameter probe); soluble solids content (SSC) (°Brix) using a portable PAL-1 digital refractometer at a constant temperature of 20 °C; titratable acidity (TA) was determined by titration with 0.1 N NaOH to pH 8.2, using a TitroLine 5000 automatic titrator system, and the results were expressed as a percentage (%) of malic acid; the SSC/TA ratio was calculated and used as an indicator of taste quality; vitamin C content was determined by titration with a standardized 2,6-dichlorophenolindophenol (DCPIP) and expressed as mg/100^{-1}g of fresh weight (FW).

Statistical analyses of the results were performed using SPSS Statistics 18.0 (SPSS Inc., Chicago, IL, USA). Analysis of variance (ANOVA) was used to assess the effects of the experimental factors, and mean comparisons were performed using Duncan’s multiple range test when significant differences were detected, Statistical significance was considered at $p<0.05$. Results were expressed in comparison to the control.

RESULTS AND DISCUSSIONS

Morphological parameters provide quantitative criteria for the distribution of cultivars across various markets, since in international trade, cherry cultivars with a diameter greater than 28 mm, an elongated shape, organoleptic attractiveness, and a long stem are preferred (Balan et al. 2023, Long et al. 2014).

Sweet cherry fruit morphological parameters are indicators that differ significantly among the studied cultivars. Higher fruit height values were recorded for

the 'Regina' (26.6 mm) and 'Rocket' (26.1 mm) cultivars, while lower values were observed for 'Sweet Early' (20.8 mm). The 'Kordia' cultivar used as the control as well as the 'Grace Star' and 'Big Star' cultivars, showed intermediate heights of 25.5 mm, 24.7 mm, and 25.5 mm, respectively (Table 1).

The major diameter correlates directly with the biological characteristics of the studied cultivars. Higher major fruit diameter values were recorded for 'Rocket' (27.1 mm), 'Big Star' (26.6 mm), and 'Regina' (26.3 mm), while lower values were found for 'Sweet Early' (23.4 mm). The 'Kordia', 'Frisco', and 'Grace Star' cultivars were characterized by intermediate values for this parameter: 24.0 mm, 24.8 mm, and 25.7 mm, respectively.

The pattern observed for the major fruit diameter also applies to the minor diameter, with values ranging from 19.0 mm for 'Sweet Early' to 22.8 mm for 'Regina'. The differences between the studied cultivars are statistically significant ($p < 0.05$). In terms of the shape index, the ‘Sweet Early’ and ‘Frisco’ cultivars recorded values of 0.98 and 0.97 respectively close to 1.0 and corresponding to a spherical fruit shape whereas cultivars such as ‘Rocket’, ‘Grace Star’, ‘Big Star’, ‘Kordia’, and ‘Regina’ exhibited a slightly elongated shape (with the index ranging from 1.06 to 1.15) and are perceived differently by consumers.

Table 1

Morphological parameters of sweet cherry fruits according to the biological characteristics of the cultivar, 2025

Cultivar	Hight, mm	Large diameter, mm	Small diameter, mm	Shape index	Stem length, mm
Sweet Early	20.8c	23.4c	19.0c	0.98c	36.0c
Rocket	26.1a	27.1a	22.0a	1.07b	44.0b
Frisco	21.8c	24.8b	20.0b	0.97c	54.0a
Grace Star	24.7b	25.7b	20.2b	1.07b	42.0b
Big Star	25.5b	26.6a	21.3b	1.06b	41.0b
Kordia (C)	25.5b	24.0b	20.1b	1.15a	59.0a
Regina	26.6a	26.3a	22.8a	1.08b	57.0a

Note: Lowercase letters indicate significant differences between the means of different cultivars within the same evaluation period at $p<0.05$ according to Duncan’s multiple range test.

An important morphological indicator is the length of the fruit stem, which influences ease of harvesting and resistance to fruit detachment. Longer stem was observed in the ‘Frisco’ (54 mm), ‘Regina’ (57 mm), and ‘Kordia’ (59 mm) cultivars, while the shortest was found in the ‘Sweet Early’ cultivar (36.0 mm). The other cultivars studied are characterized by an intermediate stem length (41.0-44.0 mm).

Structural parameters of the cherry fruit specifically the weight of the fruit, the stone, and the stem serve as fundamental quality indicators with direct implications for handling and transport capabilities.

The ‘Kordia’ cultivar, used as the control (8.08 g), exhibits an average weight typical of mid-to-late ripening cultivars, yet it is surpassed by several of the other evaluated cultivars. A higher average fruit weight was recorded for the ‘Regina’ cultivar (10.35 g), exceeding the control by 28.1 %. The ‘Rocket’ (9.65 g) and ‘Big Star’ (9.23 g) cultivars produce significantly larger fruit than the control, whereas ‘Sweet Early’ (6.57 g) and ‘Frisco’ (7.25 g) recorded lower values. For the ‘Grace Star’ cultivar, the measured value was slightly though not significantly higher than that of the control, at

8.33 g (Table 2). A higher proportion of fruit flesh was recorded for the 'Rocket', 'Grace Star', 'Big Star', and 'Regina' cultivars, with values ranging from 93.2 % to 93.9 % figures comparable to that of the 'Kordia' (control) cultivar (93.6 %). A lower flesh proportion was observed in the 'Frisco' (90.0 %) and 'Sweet Early' (90.8 %) cultivars.

The study regarding the proportion of the stone within the fruit reveals a pattern inversely proportional to the flesh content. A higher stone proportion was recorded for the 'Sweet Early' (7.3 %) and 'Frisco' (8.6 %) cultivars, whereas lower values ranging from 4.8 % to 5.6 % were observed for the other cultivars. Similar results were reported in research conducted by Milatovic T. D. et al. (2013) in Serbia.

Table 2

Structural parameters of sweet cherry fruits according to the biological characteristics of the cultivar, 2025

Cultivar	Average weight, g	Proportion, %		
		Pulp	Pit	Stem
Sweet Early	6.57c	90.8b	7.3a	1.9a
Rocket	9.65a	93.2a	5.6b	1.2c
Frisco	7.25b	90.0b	8.6a	1.4c
Grace Star	8.33b	93.5a	4.8b	1.7b
Big Star	9.23a	93.4a	5.0b	1.6b
Kordia (C)	8.08b	93.6a	5.1b	1.3c
Regina	10.35a	93.9a	5.0b	1.1c

Note: Lowercase letters indicate significant differences between the means of different cultivars within the same evaluation period at $p<0.05$ according to Duncan's multiple range test.

A higher stem proportion was recorded for the 'Big Star' (1.6 %), 'Grace Star' (1.7 %), and 'Sweet Early' (1.9 %) cultivars, while the other cultivars remained at the level of the control variant, ranging from 1.1 % to 1.4 %.

Fruit production is a final indicator that reflects the climatic conditions during the reference year, the effectiveness of the agrotechnical measures taken, and how a particular cultivar will be promoted in a specific fruit-growing region (Figure 2).

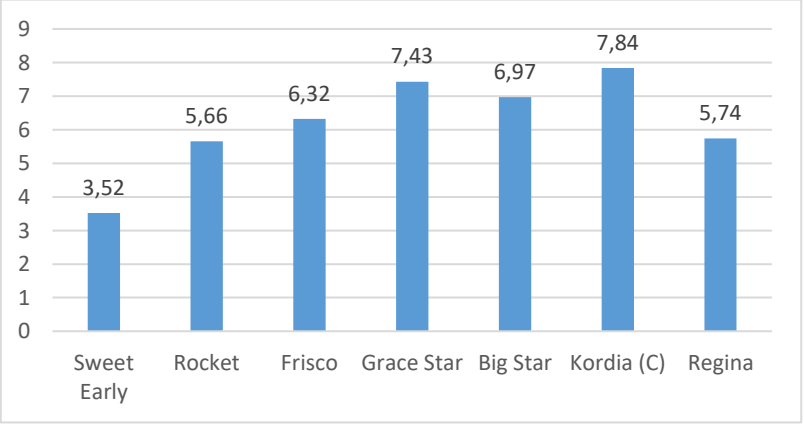


Figure 2. Cherry orchard productivity based on biological characteristics in the southern part of the country, t/ha, 2025-year, $p < 0,05$.

The studies conducted showed that in 2025, the lowest fruit yield was recorded for the ‘Sweet Early’ cultivar - 3.52 t/ha, followed by the cultivars ‘Rocket’ - 5.66 t/ha, ‘Regina’ cultivar - 5.74 t/ha, ‘Frisco’ - 6.32 t/ha, ‘Big Star’ - 6.97 t/ha, ‘Grace Star’ - 7.43 t/ha, and ‘Kordia’ - 7.84 t/ha. Based on the yields obtained, the cultivars studied can be divided into three groups. The first group includes the ‘Sweet Early’ cultivar, the second group includes the ‘Rocket’, ‘Regina’, and ‘Frisco’ cultivars and the third group includes ‘Grace Star’ and ‘Kordia’. Practically, all the studied cultivars recorded lower yields than the control cultivar.

Cherry quality is evaluated based on indicators characterizing the product's organoleptic appearance, physicochemical properties, and recorded economic metrics. Higher fruit firmness values were recorded for the ‘Grace Star’ (0.57 kg/cm²), ‘Big Star’ (0.58 kg/cm²), ‘Regina’ (0.58 kg/cm²), ‘Rocket’ (0.59 kg/cm²), and ‘Kordia’ (control) (0.61 kg/cm²) cultivars, while lower values were observed for ‘Sweet Early’ (0.52 kg/cm²) and ‘Frisco’ (0.55 kg/cm²) (Table 3).

Table 3

Fruit quality based on firmness and chemical composition of sweet cherries across different cultivars, 2025 year

Cultivar	Firmness, kg/cm^2	SSC, %	TA, %	SSC/TA	Vitamin C, mg/100gr
Sweet Early	0.52b	14.7c	0.40c	36.7a	10.75c
Rocket	0.59a	17.0b	0.60b	28.3b	13.00a
Frisco	0.55b	18.5a	0.54b	34.2a	13.06a
Grace Star	0.57a	16.8b	0.78a	21.5c	11.57b
Big Star	0.58a	17.4b	0.82a	21.2c	12.12b
Kordia (C)	0.61a	18.6a	0.83a	22.4c	13.82a
Regina	0.58a	18.1a	0.80a	22.6c	13.02a

Note: Lowercase letters indicate significant differences between the means of different cultivars within the same evaluation period at $p<0.05$ according to Duncan’s multiple range test.

Soluble solids content reflects the sugar concentration in the flesh and is associated with the fruit's sweetness. In the conducted research, values for this parameter ranged from 14.7 % for the ‘Sweet Early’ cultivar to 18.6 % for the ‘Kordia’ cultivar (the control). Higher soluble solids content was recorded for the ‘Regina’ (18.1 %), ‘Frisco’ (18.5 %), and ‘Kordia’ (control) (18.6 %) cultivars; these were followed in descending order by ‘Grace Star’ (16.8 %), ‘Rocket’ (17.0 %), and ‘Big Star’ (17.4 %), while the lowest value was recorded for the ‘Sweet Early’ cultivar (14.7 %). Titrable acidity contributes to the flavor balance of the fruit and the sensation of freshness. Research indicates that the titrable acidity of the cherry fruit ranged from 0.40 % in the 'Sweet Early' cultivar to 0.83 % in the 'Kordia' cultivar. The 'Grace Star', 'Regina', 'Big Star', and 'Kordia' cultivars exhibited mean values for the studied parameter of 0.78 %, 0.80 %, 0.82 %, and 0.83 %, respectively. The 'Rocket' and 'Frisco' cultivars are characterized by low titrable acidity (0.54–0.60 %), while the early-ripening 'Sweet Early' cultivar showed a titrable acidity of 0.40 %, which is considered very low.

By comparison, the 'Big Star' and 'Kordia' cultivars display higher acidity, resulting in a more intense flavor, whereas the 'Sweet Early' cultivar, with its very low titrable acidity, exhibits a less balanced flavor profile.

The soluble solids-to-titrable acidity ratio serves as a composite indicator of overall flavor balance. High values suggest a predominantly sweet taste, while low

values reflect pronounced acidity. Among the studied cultivars, this ratio ranged from 21.2 ('Big Star') to 36.7 ('Sweet Early'). The other cherry cultivars recorded intermediate values for this ratio.

Vitamin C is a valuable indicator of fruit quality, contributing to antioxidant properties. A value of approximately 7-12 mg of vitamin C per 100 g of fresh fruit is typical for many cherry cultivars; however, the content can vary significantly depending on the cultivar, stage of maturity, climatic conditions, tree nutrition, and time of harvest. Recorded vitamin C values ranged from 10.75 mg/100 g ('Sweet Early') to 13.82 mg/100 g ('Kordia'). The other cultivars studied showed an intermediate content (11.57-13.02 mg/100 g), confirming a balanced relationship between nutritional and commercial fruit quality.

Fruit diameter is a key morphological indicator for assessing the commercial quality of cherries. In the context of exports and European market demands, fruits with a diameter exceeding 28 mm are in higher demand and are preferred for fresh consumption (Balan et al., 2023) (Table 4).

Table 4

Redistribution of fruit by diameter according to the biological characteristics of the cultivar, 2025

Cultivar	<22.0	22.1-24.0	24.1-26.0	26.1-28.0	>28.0
Sweet Early	24.7	35.1	30.4	9.8	-
Rocket	-	-	24.3	50.2	25.5
Frisco	-	29.6	50.3	20.1	-
Grace Star	-	-	58.9	41.1	-
Big Star	-	-	29.6	60.3	10.1
Kordia (C)	-	7.5	56.3	36.2	-
Regina	-	-	34.4	65.8	-

Analysis of fruit distribution across diameter classes reveals clear differences between cultivars, driven by genetic potential and specific biological growth characteristics. Based on diameter distribution, the ‘Rocket’, ‘Grace Star’, ‘Big Star’, and ‘Regina’ cultivars stand out for their superior quality and high commercial potential, as their fruit starts at a diameter of 24.1 mm; meanwhile, the ‘Kordia’ and ‘Frisco’ cultivars fall into the medium category, with fruit starting at a diameter of 22.1 mm. Fruit with a diameter exceeding 28.1 mm was recorded only for the ‘Rocket’ (25.5 %) and ‘Big Star’ (10.1%) cultivars. The ‘Sweet Early’ cultivar is characterized by small-sized fruit typical of early-ripening cultivars and is recommended for sale solely on the local market.

Thus, under 2025 conditions, the fruit distribution confirms that the ‘Kordia’, ‘Rocket’, ‘Big Star’, ‘Grace Star’, and ‘Regina’ cultivars are suitable for commercial cherry production.

CONCLUSIONS

Morphological and structural parameters of sweet cherries are indicators that vary significantly depending on the biological characteristics of the cultivars under study. The fruit height from 20.8 to 27.1 mm, big and small diameters were from 23.4 to 26.6 mm and 19.0 to 22.8 m, respectively and shape index ranged was from 0.97 to 1.08, respectively.

The flesh firmness of the cherry cultivars studied ranged from 0.52 to 0.61

kg/cm^2, the soluble sugar content from 14.7 to 18.6 %, the titratable acidity from 0.40 to 0.83 %, and the vitamin C content between 10.75 to 13.82 mg/100 g.

The most constant fruit yields were registered for the 'Big Star', 'Grace Star', and 'Kordia' cultivars (6.97–7.84 t/ha), average yields for 'Rocket', 'Regina', and 'Frisco' cultivars (5.66–6.32 t/ha), and the lowest value of the studied index for the 'Sweet Early' cultivar (3.52 t/ha).

The results obtained indicate that the studied 'Sweet Early', 'Rocket', 'Frisco', 'Grace Star', 'Big Star', 'Kordia', 'Regina' cultivars, can be utilized in cherry cultivation practices in the southern part of the country, producing fresh fruit over a 25-day period.

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