

## STUDIES ON THE YIELD AND QUALITY OF SOME RED-WINE GRAPE CULTIVARS GROWN ON THE SANDY SOILS OF SOUTHERN OLTENIA

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### Abstract

The present research aimed to evaluate the productive and qualitative potential of several red grapevine cultivars intended for red wine production, originating from the ampelographic collection of the Research and Development Station for Plant Cultivation on Sandy Soils, Dăbuleni. In 2024, among the red-wine grape cultivars, the highest yield was recorded for the cultivar 'Fetească neagră', reaching 24,868 kg/ha, which significantly exceeded the control cultivar 'Băbească neagră' by 13,839 kg/ha. These results confirm the high productive potential of 'Fetească neagră', emphasizing its adaptability to the specific pedoclimatic conditions of the sandy-soil region in southern Oltenia. Regarding the sugar content of grapes intended for winemaking, the measured values ranged from 182 g/L in the 'Cristina' cultivar to 240 g/L in 'Fetească neagră'. Sugar concentration is a key indicator of grape technological maturity, directly influencing the potential alcohol content of the resulting wine and the level of residual sugars remaining after fermentation. The findings recommend the 'Fetească neagră' cultivar as particularly well-suited to the pedoclimatic conditions of the Dăbuleni area, offering favorable prospects for producing high-quality red wines.

**Key words:** pedoclimatic conditions, phenology, technological maturity, *Vitis vinifera* L.

### INTRODUCTION

Viticulture is an applied science that studies the morphological and biological characteristics, as well as the technological cultivation practices of grapevines, to develop modern cultivation technologies that ensure high-quality yields. The term "viticulture" derives from the Latin words "vitis" (grapevine) and "cultura" (care, cultivation). Viticulture represents an intensive branch of agriculture, as the production obtained from one hectare of grapevines is equivalent to that of 10–15 hectares of

cereal crops. Red wines are generally more balanced and of higher quality than white wines. Red-wine cultivars are particularly appreciated for their higher acidity, which, unlike that of white-wine cultivars, is better preserved and results in more balanced, pleasant, and superior-quality wines (Vlădoianu, 1984). The impact of climate change over the past few decades on grapevines has been highlighted in numerous scientific studies. Among environmental factors, temperature is considered the most

influential parameter affecting the phenological development of grapevines. Grapes have always played an essential role in human nutrition. Their chemical composition makes them a valuable food source, alongside other fresh fruits. At present, Romania has approximately 190,000 hectares of vineyards, representing around 3% of the world's viticultural area and ranking fifth in Europe after Spain, France, Italy, and Portugal. The impact of climate change on grapevines has been documented in various scientific works. Rising temperatures primarily lead to earlier initiation and onset of phenological stages (Chuine et al., 2014; Van Leeuwen et al., 2016; Duchêne et al., 2005). Climate change also exposes grapevines to drought, either due to reduced precipitation or increased evapotranspiration caused by higher temperatures. This results in lower yields, mainly through reductions in berry size (Ojeda et al., 2002; Van Leeuwen et al., 2009) and shoot fertility. The pedoclimatic conditions of the sandy soils in Oltenia (high temperatures, low relative humidity) cause a marked decrease in acidity and even carbohydrate depletion in grape berries; consequently, the wines obtained may be flat and have lower alcohol content. For these reasons, the cultivation of red-wine cultivars characterized by a lower catabolic rate is recommended (Olteanu, 2000). Grape quality is directly influenced by the cultivar, ecoclimatic conditions, soil (its physico-chemical properties), winemaking process, transportation and storage conditions, the level of applied agrotechnical practices, and regional zoning (Coombe, 1987; Fernandez, 1988; Núñez et al., 2000; Marini et al., 2006; Voica et al., 2009; Rotaru et al., 2010; Bora et al., 2016). A favorable climate is essential for yield stability, whereas interannual variability

in weather conditions can strongly affect grape quality and, consequently, wine quality (Jones & Goodrich, 2008). Typically, grape maturity and harvest timing are determined by analyzing the sugar concentration, titratable acidity, and pH of the grape must (Ribéreau-Gayon et al., 2006). The sugar content depends on both the cultivar and the cultivation area (Nelson, 1985). Worldwide, established marketing standards exist for table-grape cultivars of *Vitis vinifera* L. Given the viticultural importance of the sandy soils in southern Oltenia and the increasing influence of climate variability on grapevine performance, this study aims to evaluate the yield and quality potential of several red-wine grapevine cultivars cultivated under these specific pedoclimatic conditions at the Dăbuleni Research and Development Station.

## MATERIALS AND METHODS

**Research area and biological material**  
The research was conducted in 2024, using grapevine cultivars from the ampelographic collection of the Research and Development Station for Plant Culture on Sands, Dăbuleni, where the performance of ten red-wine grape cultivars was evaluated: 'Băbească neagră', 'Codană', 'Mamaia', 'Cristina', 'Arcaș', 'Amurg', 'Fetească neagră', 'Pandur', 'Haiduc', and 'Novac'. The ampelographic collection was established in 2010. The vines are planted at a spacing of 1.2 × 2.5 m, trained on a trellis system, under non-irrigated conditions.

### *Analysed parameters*

Observations and measurements were conducted on grape phenology, yield, and quality. The experiment was arranged as a randomized complete block design (RCBD). Phenological stages, including budburst, flowering, veraison, and harvest, were recorded for all cultivars. Yield determinations

were performed by weighing harvested grapes in three replicates per cultivar. To assess grape quality, samples were collected and analyzed in the laboratory, including determination of berry weight, total sugar content, and titratable acidity. Berry weight was determined using a Kern PCB 2000-1 analytical balance, while soluble solids (Brix %) were measured with an Atago PAL-BX|ACID F5 digital refractometer (precision  $\pm 0.2\%$ ). The sugar content (g/L) was calculated from Brix (%) values using the STAS 6182/25-73 standard. Titratable acidity was determined by titrating grape must with 0.1 N NaOH, using phenolphthalein as an indicator, and the results were expressed as g/L H<sub>2</sub>SO<sub>4</sub>. Climatic data, including temperature and precipitation, were recorded using an  $\mu$ METOS CLIMA weather station installed in the experimental vineyard.

#### Statistical analysis

Statistical analyses were performed using one-way analysis of variance (ANOVA) in Microsoft Excel. Differences were considered statistically significant at  $p < 0.05$ , highly significant at  $p < 0.01$ , and very highly significant at  $p < 0.001$ . Data visualization was conducted in Python using pandas and matplotlib, resulting in a horizontal Gantt chart depicting the vegetation season and the principal phenological stages for each cultivar.

## RESULTS AND DISCUSSIONS

### Climatic Conditions During the Experimental Year

The total precipitation in May amounted to 114.0 mm, distributed over 15 days, providing an adequate water supply for shoot development, while simultaneously reducing the risk of fungal infections during the early stages of vegetation. The primary grapevine diseases, including downy mildew (*Plasmopara viticola*) and

powdery mildew (*Erysiphe necator*), typically reach their maximum severity before and after flowering; however, susceptibility decreases as berry formation and growth advance, a pattern also noted in the literature (Smart & Robinson, 1991; Pearson & Goheen, 1988). During the vegetation period, air temperatures exceeding 40°C limit shoot growth and may compromise the plant's reproductive processes. High temperatures of 40 $\pm$ 5°C, which are relatively common in vineyards established on sandy soils, are particularly harmful during flowering, as they inhibit pollination and fertilization. In the subsequent phenophase, such temperatures may cause sunburn or brown spotting on the berries. Precipitation during the dormancy period (October–March) was insufficient, totaling 267.2 mm. During the vegetation period (April–September), a total of 218.7 mm of rainfall was recorded, distributed over 55 days (Table 1).

Table 1. Main Climatic Data for the 2023–2024 Growing Season

Month	Temperature (°C)			Annual rainfall (mm)	Number of rainy days
	Average	Min	Max		
X	14.9	-0.8	33.2	8.2	3
XI	7.8	-3.9	23.1	156.2	20
XII	4.7	-4.7	20.0	16.0	11
I	0.5	-12.9	16.1	39.0	19
II	8.5	-7.1	22.0	11.2	8
III	9.25	-3.1	29.0	36.6	11
IV	15.2	2.7	34.1	36.0	7
V	16.7	7.4	28.6	114.0	15
VI	25.2	12.1	39.2	27.0	6
VII	26.5	10.2	40.9	22.6	5
VIII	25.8	10.5	40.3	1.4	2
IX	19.2	4.2	35.6	30.0	9
Average/Sum	14.52	-12.9	40.9	498.2	116

### Phenological Observations

For comparative purposes, the 'Băbească neagră' cultivar, an old native variety known to perform well on the sandy soils of southern Oltenia, was selected as a reference. Budburst of the red-wine grape cultivars began in the first decade of April, starting on

April 1 for 'Fetească neagră' and concluding on April 8 for 'Amurg'. Flowering of the studied red-wine cultivars commenced on May 14 for 'Fetească neagră' and ended on May 31 for 'Amurg'. The veraison phase began on July 16 for 'Mamaia' and was completed by July 31 for 'Novac'. Grape harvesting for red wine production took place from September 18 for 'Băbească neagră' to September 27 for 'Amurg'. Under the climatic conditions of 2024, leaf fall in the red-wine cultivars occurred between

October 30 and November 11 (Table 2). Băjenaru et al. (2024) reported for the cultivars 'Băbească neagră', 'Haiduc', 'Novac', and 'Arcaș', during the three years 2020–2022, budburst occurred later (16–18 April) than the dates recorded in the present study, while the harvest period was earlier (13–19 September) compared to that observed in 2025. These differences, when correlated with climatic data, confirm the influence of climate variability on the progression of vine phenophases.

Table 2. Phenological Observations on the studied Red-Wine Grape Cultivars in 2024

Cultivar	Budburst		Flowering		Berry growth onset	Veraison onset	Maturity of harvest	Leaf fall
	onset	end	onset	end				
'Băbească neagră'	04 Apr	09 Apr	19 May	27May	31May	29 Jul	18 Sept	30 Oct
'Haiduc'	04 Apr	09 Apr	22May	29May	02 Jun	22 Jul	23 Sept	08 Nov
'Codană'	06 Apr	13 Apr	18May	29May	02 Jun	15 Jul	23 Sept	06 Nov
'Mamaia'	04 Apr	11 Apr	20May	29May	02 Jun	16 Jul	20 Sept	04 Nov
'Novac'	02 Apr	07 Apr	16May	27May	31May	31 Jul	24 Sept	11 Nov
'Cristina'	06 Apr	13 Apr	17May	29May	02 Jun	19 Jul	25 Sept	06 Nov
'Pandur'	06 Apr	09 Apr	22May	31May	03 Jun	02 Aug	26 Sept	08 Nov
'Arcaș'	06 Apr	11 Apr	16May	24May	28May	22 Jul	19 Sept	04 Nov
'Amurg'	08 Apr	15 Apr	20May	31May	03 Jun	19 Jul	27 Sept	11 Nov
'Fetească neagră'	01Apr	05Apr	14May	24May	28May	29Jul	19Sept	04 Nov

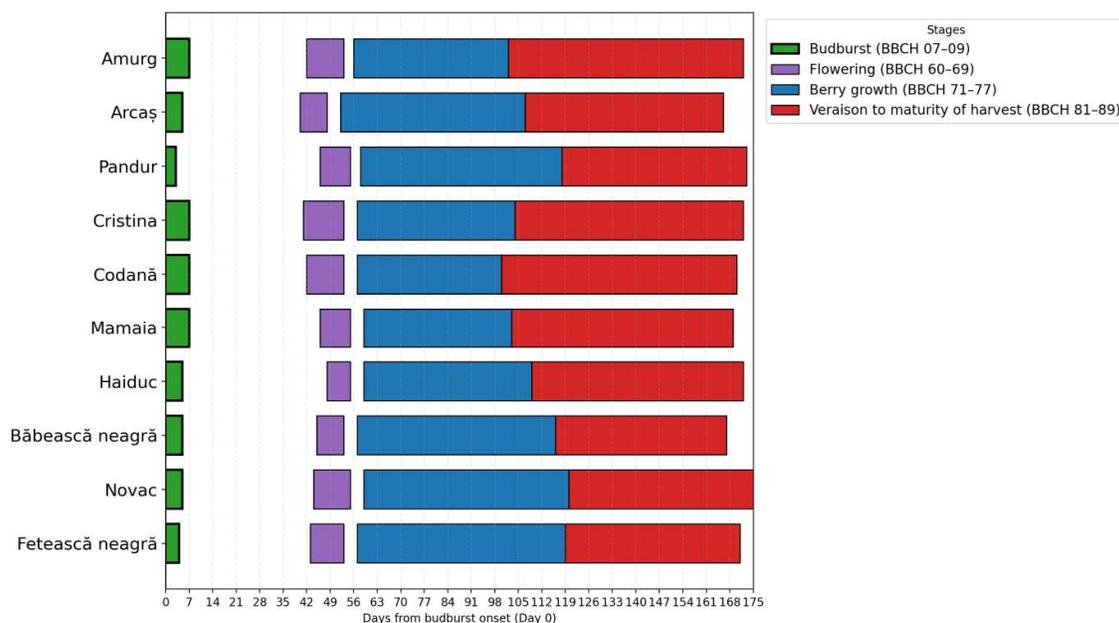


Fig. 1. Number of days from budburst to maturity of harvest, at the studied Red-Wine Grape Cultivars in 2024

A cultivar-specific phenological timeline (Figure 1) illustrates the vegetation period from budburst to maturity of harvest, with the number of days from budburst to flowering, berry growth (fruit set to veraison), and veraison to harvest, enabling comparative assessment of stage timing and duration across cultivars within a single growing season.

**Yield Components and Fertility Parameters**

The number of inflorescences per vine ranged from 7 to 34, with the highest number recorded in the 'Fetească neagră' cultivar. The relative fertility coefficient ranged from 0.68 in 'Amurg' to 1.39 in 'Arcaș'. The absolute fertility coefficient ranged from 1.16 in the

control cultivar 'Băbească neagră' to 1.70 in 'Cristina' (Table 3). For the cultivars 'Băbească neagră', 'Haiduc', 'Novac', and 'Arcaș', shoot fertility in 2024 was generally consistent with the data reported by Băjenaru et al. (2024) for 2020–2022 at the same site. Relative and absolute fertility coefficients showed minor inter-annual variations, confirming that soil and management practices provide a stable baseline. At the same time, year-to-year climatic variability can slightly influence reproductive potential. These results indicate that these cultivars maintain stable fertility in the sandy soils of southern Oltenia under varying climatic conditions.

Table 3. Shoot Fertility of Red-Wine Cultivars in 2024

Cultivar	Total number of shoots per vine	Number of fertile shoots per vine	Number of inflorescences per vine	Fertility Coefficient	
				relative	absolute
'Băbească neagră'	19	15	17	0.87	1.16
'Haiduc'	16	12	15	0.97	1.32
'Codană'	10	9	12	1.19	1.38
'Mamaia'	12	10	12	1.02	1.27
'Novac'	17	14	18	1.07	1.25
'Cristina'	12	10	16	1.39	1.70
'Pandur'	10	6	7	0.68	1.22
'Arcaș'	13	11	18	1.39	1.59
'Amurg'	12	10	13	1.09	1.35
'Fetească neagră'	29	26	34	1.17	1.31

Under the climatic conditions of 2024, the highest grape yield among the red-wine cultivars was recorded for 'Fetească neagră', reaching 24,868 kg/ha, which was 13,839 kg/ha higher than the control cultivar 'Băbească

neagră'. The lowest yield was observed in 'Mamaia', at 8,582 kg/ha, representing a difference of -2,447 kg/ha compared to the control (Table 4).

Table 4. Grape yield of different red-wine cultivars in 2024

Cultivar	Number of clusters per vine	Average cluster weight (g)	Grape yield (kg/ha)	Difference from 'Băbească neagră' (kg/ha)		Significance
				kg/ha	%	
'Băbească neagră'	13	319	11029	Mt.	100	-
'Haiduc'	14	259	13172	+2143	119	-
'Codană'	12	256	11428	+399	104	-
'Mamaia'	11	203	8582	-2447	78	-
'Novac'	16	257	15171	+4142	138	-
'Cristina'	16	254	15130	+4101	137	-
'Pandur'	7	262	6789	-4240	62	-
'Arcaș'	16	158	9617	-1412	87	-
'Amurg'	13	296	15022	+3993	136	-
'Fetească neagră'	35	183	24868	+13839	225	**
DL 5%= 79674    DL 1%= 10926    DL 0.1%= 14872						

The weight of 100 grape berries ranged from 151 g in 'Fetească neagră' to 250 g in 'Novac'. The higher sugar content observed in 2024, particularly in the cultivar 'Fetească neagră' (240 g/L), can be attributed to the elevated mean air temperatures and prolonged periods of sunshine recorded during the ripening period (July–September), as indicated by data from the  $\mu$ METOS CLIMA station. Average monthly temperatures frequently exceeded 30 °C, favoring accelerated sugar accumulation through enhanced photosynthetic activity and berry

dehydration. In contrast, the relatively low titratable acidity values (3.62–5.58 g/L  $H_2SO_4$ ) reflect increased respiratory consumption of organic acids under high thermal conditions and limited rainfall (218.7 mm during the vegetation period). These results confirm the strong influence of climatic variability on grape composition, consistent with reports highlighting the relationship between temperature, sugar, and acid in warm viticultural regions.

Table 5. Grape quality of red-wine cultivars under the climatic conditions of 2024

Cultivar	Weight of 100 berries (g)	Total sugar content (g/L)	Total titratable acidity (g/L $H_2SO_4$ )
'Băbească neagră'	237	236	3.92
'Haiduc'	186	236	3.82
'Codană'	194	204	3.92
'Mamaia'	210	197	4.21
'Novac'	250	229	4.90
'Cristina'	210	182	5.58
'Pandur'	247	222	3.62
'Arcaș'	154	197	4.91
'Amurg'	235	209	5.09
'Fetească neagră'	151	240	4.16

The number of grape clusters per vine was found to influence grape yield,

with the results represented by a polynomial correlation equation,

showing a significant correlation coefficient ( $r = 0.91$ ) (Fig. 2).

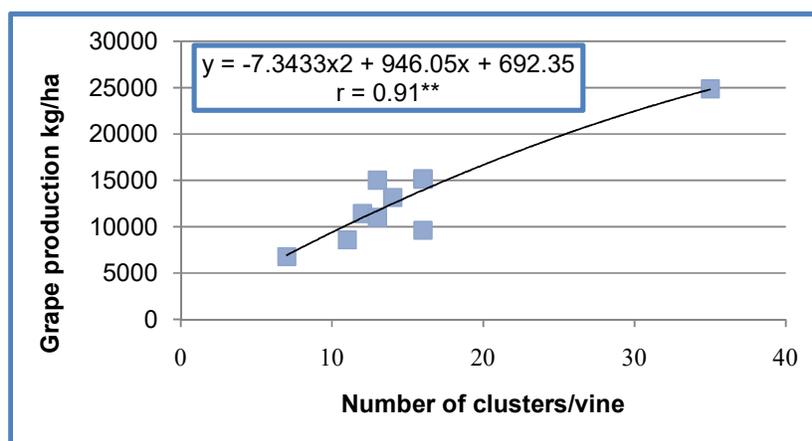


Fig. 2. Correlation between grape yield (kg/ha) and the number of clusters per vine

## CONCLUSIONS

The number of inflorescences per vine ranged from 7 to 34, with the highest number recorded in the 'Fetească neagră' cultivar. Under the climatic conditions of 2024, the highest grape yield among the red-wine cultivars was observed in 'Fetească neagră' (24,868 kg/ha), which was 13,839 kg/ha higher than the control cultivar 'Băbească neagră'. The lowest yield was recorded in 'Amurg' (6,789 kg/ha), representing a difference of -4,240 kg/ha compared to the control. The total sugar content at harvest varied among cultivars. Cultivars with total sugar content exceeding 200 g/L included 'Băbească neagră', 'Haiduc', 'Codană', 'Novac', 'Amurg', 'Pandur', and 'Fetească neagră'. These results highlight the superior adaptability and enological potential of 'Fetească neagră' under the pedoclimatic conditions of the sandy soils in southern Oltenia.

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