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PRELIMINARY EVALUATION OF THE PERFORMANCE OF SOME LOCAL GRAPEVINE GENOTYPES UNDER THE PEDOCLIMATIC CONDITIONS OF DĂBULENI RDSPCSS

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Abstract

This study presents preliminary results on the evaluation of local grapevine genotypes cultivated under the pedoclimatic conditions of the Dăbuleni Research and Development Station for Plant Cultivation on Sandy Soils (southern Oltenia, Romania) during the 2025 growing season. The experiment was established in a young vineyard (third year after planting), trained on a trellis system with a 1.2 × 2.5 m spacing, and grown under drip irrigation. The biological material included three traditional cultivars ('Parmac', 'Berbecel', 'Roșioară') and one local genotype ('Gălbioară'). Phenological observations indicated a relatively uniform development of growth stages. Significant differences were recorded in yield components, especially cluster weight and productivity, with higher values in 'Parmac' and 'Roșioară'. Mechanical, morphometric, and physico-chemical analyses revealed genotype-specific patterns in berry structure, sugar accumulation, and acidity, reflecting adaptation to sandy soil conditions. These findings support the evaluation and conservation of regional grapevine genetic resources.

Key words*: agrobiological traits, genetic resources, phenology, sandy soils, Vitis vinifera, Romania.*

INTRODUCTION

The development of viticulture is closely linked to the evolution of human civilization, as the consumption of fresh grapes and their use for wine production have been documented since the Neolithic period, more than 8000 years ago (Estreicher, 2017). Archaeological evidence suggests that early wine production initially relied on collecting fruit from wild grapevines, followed by the cultivation of plants derived from the domestication of the Eurasian grapevine. Grapevine domestication is believed to have occurred at several geographic centers, ranging from ancient regions of Anatolia and the Caucasus to later areas in the western Mediterranean Basin and Central Europe (Muganu & Paolocci, 2013).

Grapevine (*Vitis vinifera* L.) is currently one of the most important cultivated species worldwide and is grown in most wine-producing regions. Its importance is reflected not only in the economic value of grape and wine production (Fraga et al., 2013; Fraga, 2019) but also in the cultural and nutritional role that this crop plays in many societies.

In recent decades, climate change has become a key factor influencing viticulture (Santos et al., 2020), with many wine-growing regions increasingly exposed to higher temperatures and water scarcity (Mărăcineanu et al., 2025). Under these conditions, identifying grapevine cultivars better adapted to drought represents an important strategy for maintaining production and adapting viticulture to emerging climatic scenarios (Gisbert et al., 2022). Consequently, the evaluation and characterization of existing cultivars are essential for adjusting cultivation strategies and ensuring the stability of grape production.

Climatic conditions strongly influence both grape yield and quality, with these outcomes resulting from complex interactions among temperature, water availability, plant material, and viticultural practices. In established wine-growing regions, growers have historically adapted cultivars and cultivation techniques to local environmental conditions to optimize productivity and fruit quality. However, ongoing climatic changes require further adjustments to both cultivation practices and varietal selection to maintain the balance between yield and quality (van Leeuwen et al., 2019).

The need for adaptation is particularly pronounced in viticulture because grape berry composition, an essential determinant of fruit quality, wine typicity, and market value, is strongly influenced by environmental conditions, annual climatic variability, and their interactions, commonly referred to as *terroir*. Consequently, climatic variability directly affects grape composition and wine characteristics, requiring continuous adaptation of both plant material and cultivation practices (Delrot et al., 2020).

The geographical distribution of grapevine varieties has traditionally been closely related to the climatic characteristics of wine-growing regions, with growers selecting cultivars that perform best under local conditions. Generally, there is strong agreement between current cultivation areas and the optimal climatic conditions for each cultivar, explaining the geographical distribution of grapevine cultivars across different viticultural regions (Fraga et al., 2016).

The traditional grapevine assortment cultivated on the sandy soils of southern Oltenia mainly consisted of the cultivars 'Roșioară', 'Berbecel', and 'Parmac', which are used primarily for the production of white and rosé wines and are well adapted to the pedoclimatic conditions of the region (Băjenaru et al., 2022). Grapevine genetic diversity allows cultivation under a wide range of environmental conditions and provides opportunities for producing grapes intended both for fresh consumption and industrial processing, particularly for winemaking. Morphological characteristics of clusters and berries, as well as the structure and proportion of their components, directly influence yield and grape quality. The determination of morphometric and physico-chemical parameters of grapes represents an important tool for varietal characterization, assessment of productive potential, and identification of technological suitability. In addition, the analysis of pulp, skin, and seed proportions provides relevant information regarding must yield and the quality of the raw material used in winemaking.

In this context, the present study aimed to analyse several local grapevine genotypes traditionally cultivated on sandy soils in southern Romania by determining cluster and berry morphological characteristics, evaluating the physical composition of grapes, and assessing the relationships among their main components in order to highlight the productive potential and particularities of these local viticultural resources.

MATERIALS AND METHODS

The research was conducted within the ampelographic collection of the Dăbuleni Research and Development Station for Plant Cultivation on Sandy Soils (RDSPCSS), located in Călărași, Dolj County, Romania, on the third terrace of the Danube River. The soil in the experimental area is a sandy eutric protosol with lamellar characteristics, with a pedological profile of Ap–Ac–C1–Cla.

The biological material (Figure 1) consisted of local grapevine genotypes 'Parmac' (prime name 'Dimyat' = 'Coarnă Albă' × 'Heunisch Weiss'; VIVC code 5716), 'Berbecel' (VIVC code 1148), 'Gălbioară', as well as the cultivar 'Roșioară' (prime name 'Pamid', VIVC code 8899), cultivated on their own roots. The vineyard was established at a planting distance of 1.2 m between vines and 2.5 m between rows, corresponding to a planting density of 3,333 vines ha^{-1}. The study was conducted in 2025, corresponding to the third year after planting, when training pruning was applied.

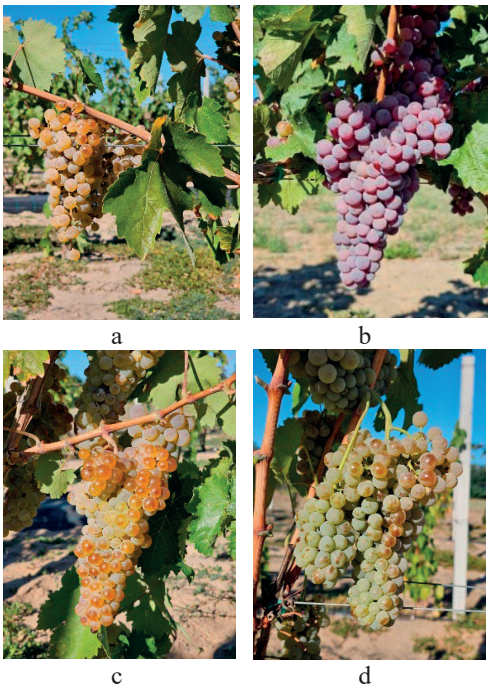

Figure 1. Clusters of the studied grapevine genotypes in the field: 'Gălbioară' (a), 'Roșioară' (b), 'Berbecel' (c), and 'Parmac' (d)

The experiment was arranged in a randomized complete block design (RCBD), with three replicates per genotype, each replicate consisting of three vines. The results represent the mean values of the three experimental replicates. Climatic data for the 2024-2025 agricultural year were recorded by an iMetos meteorological station located in the experimental field (Table 1).

Table 1. Main climate parameters for the agricultural year 2024-2025

Month	Air temperature (°C)			Total rainfall (mm)	No. of rainy days
	Mean	Max.	Min.		
XI	4.65	23.33	-6.99	40.00	13
XII	3.98	17.80	-2.96	128.00	17
I	2.56	17.91	-6.00	4.00	9
II	-0.47	15.27	-13.32	7.20	7
III	9.37	24.10	-5.99	29.20	10
IV	12.55	28.97	-3.97	21.00	9
V	16.07	29.87	1.53	55.40	12
VI	24.32	40.51	9.74	21.40	3
VII	25.75	41.21	10.69	11.60	4
VIII	23.99	40.95	7.53	26.40	5
IX	20.00	35.70	4.87	5.20	4
X	10.77	23.57	-1.96	169.40	11

During the growing season, standard vineyard management practices were applied in accordance with the cultivation technology specific to the region. Preventive phytosanitary treatments were carried out at the main phenological stages, while soil maintenance included mechanical operations, such as shredding plant residues, shallow soil cultivation, and weed control before budburst. The vineyard was managed under drip irrigation conditions.

Experimental observations focused on grapevine phenology, shoot fertility, yield, and grape quality. Phenological stages were monitored according to the BBCH scale, including budburst (BBCH 05-09), flowering (BBCH 61-69), berry growth (BBCH 71-79), veraison (BBCH 81), full ripeness (BBCH 89), and leaf fall (BBCH 93).

Fertility and yield assessments were performed by counting reproductive structures and weighing the harvested grapes for each replicate. For grape quality evaluation, berry samples were analyzed in the laboratory to determine the weight of 100 berries, soluble solids content (°Brix), total sugars, and titratable acidity. For each genotype, samples consisting of 100 berries were collected from each replicate. Berry weight was determined using an analytical balance (Kern PCB 2000-1), while soluble solids were measured using a digital refractometer (Atago PAL-BX|ACID F5; ±0.2%). Sugar content (g L^{-1}) was calculated from Brix values according to the STAS 6182/25-73 standard. Titratable acidity was determined by titration with 0.1 N NaOH using phenolphthalein as an indicator, and the results were expressed as g L^{-1} H_2SO_4.

Statistical analyses were performed using IBM SPSS Statistics 26. Data were subjected to one-way analysis of variance (ANOVA), and mean comparisons were performed using Duncan's multiple range test at $p \leq 0.05$. Pearson correlation coefficients were calculated to evaluate relationships among the studied parameters, with significance levels set at $p \leq 0.05$ and $p \leq 0.01$. Correlation matrices were graphically represented as lower-triangular heatmaps generated in Python using the Matplotlib library.

RESULTS AND DISCUSSIONS

Grapevine cultivars grown on the sandy soils of the Dăbuleni area have been investigated in several studies, particularly with regard to their adaptation to restrictive pedoclimatic conditions as well as their productive and qualitative potential (Gherman & Vlăduț, 1967; Baniță et al., 1967; Vlădoianu, 1985; Ploae & Baniță, 1994; Rățoi et al., 2010; Rățoi et al., 2021). However, climate changes observed in recent decades, together with the renewal of vineyards, require an update of this information and a reassessment of the performance of local genotypes under current cultivation conditions. In this context, the agrobiological and productive characterization of the local genotypes cultivated in the ampelographic collection of Dăbuleni RDSPCSS provides relevant insights into their adaptability to sandy soil conditions and contributes to the valorization and conservation of local grapevine genetic resources.

Phenological development of local grapevine genotypes

The monitoring of phenological stages revealed minor differences among the studied genotypes (Table 2).

Table 2. Main phenological stages of the studied grapevine genotypes during the 2025 growing season (BBCH scale)

Genotype	Budburst		Flowering		Berry growth (BBCH 71)	Start of veraison (BBCH 81)	Full ripeness (BBCH 89)	Leaf fall (BBCH 93)
	BBCH 05	BBCH 09	BBCH 61	BBCH 69				
'Gălbioară'	8 Apr	22 Apr	2 Jun	8 Jun	13 Jun	30 Jul	18 Sep	31 Oct
'Roșioară'	8 Apr	22 Apr	2 Jun	5 Jun	11 Jun	30 Jul	18 Sep	31 Oct
'Berbecel'	8 Apr	22 Apr	2 Jun	8 Jun	13 Jun	10 Aug	18 Sep	31 Oct
'Parmac'	10 Apr	22 Apr	2 Jun	9 Jun	13 Jun	30 Jul	18 Sep	31 Oct

The progression of these stages was influenced by the climatic conditions recorded during the 2024-2025 growing season (Table 1), which was characterized by elevated summer temperatures, with maximum values exceeding 40°C during June-August, and relatively low precipitation during the main vegetative period. Budburst (BBCH 05-09) occurred between 8 and 22 April, with the genotype 'Parmac' showing a slight delay compared with the other cultivars. Flowering (BBCH 61-69) took place between 2 and 9 June, with 'Roșioară' reaching full bloom slightly earlier than the other genotypes. Berry growth (BBCH 71) was recorded during the first half of June, while the onset of berry coloration (veraison, BBCH 81) occurred between 30 July and 10 August, with 'Berbecel' showing a slightly later entry into this stage. Full ripeness (BBCH 89) was reached on the same date (18 September) for all genotypes, whereas leaf fall (BBCH 93) occurred at the end of October. Overall, the relatively uniform phenological behavior suggests good adaptation of the local genotypes to the pedoclimatic conditions of the sandy soils of southern Romania. The elevated summer temperatures recorded during the growing season may also have contributed to the relatively synchronous ripening observed among the studied genotypes.

Shoot fertility and crop load

The productive potential of the studied genotypes was assessed through shoot fertility and crop load parameters (Table 3). The obtained data indicated that all four local genotypes exhibited balanced vegetative development during the first year of production. Crop load per vine ranged from 9.67 buds in 'Gălbioară' to 12.00 buds in 'Roșioară', indicating moderate differences in vine load intensity.

The number of burst buds and the total number of shoots per vine were similar, reflecting a good budburst capacity across all genotypes, likely favoured by drip irrigation conditions. The number of fertile shoots was relatively high in all cultivars, ranging from 7.67 in 'Gălbioară' to 9.67 in 'Berbecel', confirming a good fruiting potential even in the first year of production.

The number of inflorescences per vine was relatively uniform, averaging around nine, suggesting a stable reproductive capacity across genotypes. The relative fertility coefficient (Cfr) showed values close to unity, with the highest values recorded for 'Gălbioară' and 'Parmac', indicating an efficient conversion of fertile shoots into inflorescences.

Table 3. Shoot fertility, inflorescence number, and crop load per vine in the studied genotypes

Genotype	Crop load/vine	Burst buds	Number of shoots/vine	Number of fertile shoots/vine	Number of inflorescences/vine	Fertility coefficients	
						relative	absolute
'Gălbioară'	9.67±1.15	8.67±1.15	8.67±1.15	7.67±1.15	9.33±0.58	1.08±0.18	1.25±0.29
'Roșioară'	12.00±1.73	10.00±2.00	10.00±2.00	9.33±1.53	9.00±1.00	0.95±0.27	1.02±0.29
'Berbecel'	11.33±1.53	10.00±1.00	10.00±1.00	9.67±0.58	9.00±1.00	0.90±0.15	0.91±0.12
'Parmac'	10.33±1.53	9.00±1.00	9.00±1.00	9.00±1.00	9.33±0.58	1.06±0.12	1.06±0.12

Values are expressed as mean ± standard deviation (SD).

Similarly, the absolute fertility coefficient (Cfa) highlighted a slightly higher reproductive potential in 'Gălbioară', suggesting a greater capacity to support fruiting relative to the total number of shoots.

Overall, under the conditions of the first production year, all four local genotypes showed good vegetative and reproductive adaptation, with moderate differences among genotypes that may become more pronounced in subsequent years as the vines' productive potential stabilizes.

Correlation analysis (Figure 2) revealed strong relationships among the parameters describing crop load and vegetative development.

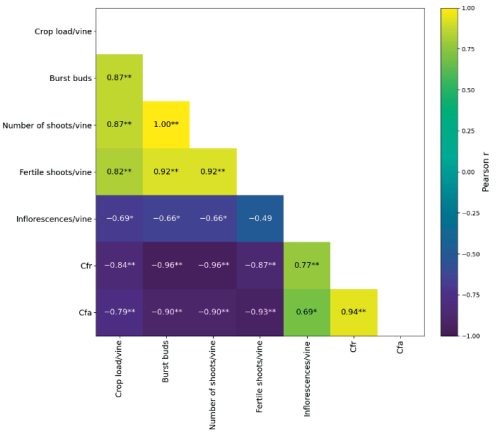

Figure 2. Pearson correlation heatmap of shoot fertility and crop load parameters

Crop load per vine was positively and significantly correlated with the number of burst buds, the total number of shoots, and the number of fertile shoots (r = 0.82-0.87; $p \leq 0.01$), indicating that vine load is mainly determined by budburst intensity and shoot development. The number of inflorescences per vine showed negative correlations with most vegetative parameters, suggesting a balance between vegetative growth and fertility expression. The relative (Cfr) and absolute (Cfa) fertility coefficients were negatively correlated with vigour-related parameters but showed a strong positive correlation between them (r = 0.94; $p \leq 0.01$), confirming the consistency of fertility assessment through the two calculation approaches.

Yield components and productivity

Yield performance of the studied genotypes was evaluated through the number of clusters per vine, mean cluster weight, and productivity expressed per vine and per hectare (Table 4). The analysis of grape yield in the first year of production revealed significant differences among the four local genotypes. The number of clusters per vine was relatively uniform, ranging between 8.33 and 9.33, indicating a comparable crop load among cultivars.

Differences in productivity were mainly determined by the mean cluster weight, which varied significantly among genotypes. The cultivars 'Roșioară' and 'Parmac' recorded the highest average cluster weights, reaching 270 g and 230 g, respectively, values significantly higher than those observed for 'Berbecel' and 'Gălbioară'. This differentiation was reflected directly in productivity per vine and per hectare. 'Roșioară' achieved the highest productivity per vine (2.41 kg vine^{-1}), closely followed by 'Parmac' (2.13 kg vine^{-1}), both were statistically superior to the other two genotypes. When expressed per hectare, productivity ranged from ~3 t ha^{-1} in 'Gălbioară' to ~8 t ha^{-1} in 'Roșioară', while 'Parmac' reached ~7 t ha^{-1}. 'Berbecel' showed an intermediate productivity level (~3.8 t ha^{-1}), but was significantly lower than 'Roșioară' and 'Parmac'.

Overall, the results indicate that under the conditions of the first production year and drip

irrigation, 'Roșioară' and 'Parmac' exhibit a superior productive potential, mainly determined by cluster size, whereas 'Berbecel' and 'Gălbioară' show a lower fruiting capacity typical of the juvenile phase of the plantation.

Băjenaru et al. (2025) reported that, for the period 1969-2000, yields ranged between 11.5 and 23.95 t ha^{-1} for 'Roșioară', between 16.07 and 22.35 t ha^{-1} for 'Parmac', and between 11.88 and 15.65 t ha^{-1} for 'Berbecel' under the pedoclimatic conditions of Dăbuleni RDSPCSS. The yields obtained in the present study were lower, which can be mainly explained by the young age of the plantation (third year after planting), when the vines' productive potential is not yet fully expressed, as well as by the climatic conditions specific to the studied year.

Table 4. Yield components and productivity of the studied genotypes

Genotype	Number of clusters/vine	Mean cluster weight (g)	Productivity (kg vine^{-1})	Productivity (kg ha^{-1})
'Gălbioară'	9.33±0.58	100±0.03^{b}	0.91±0.35^{b}	3036.67±1141.82^{b}
'Roșioară'	9.00±1.00	270±0.04^{a}	2.41±0.22^{a}	8036.33±739.50^{a}
'Berbecel'	8.33±0.58	140±0.01^{b}	1.13±0.15^{b}	3851.67±539.32^{b}
'Parmac'	9.33±0.58	230±0.01^{a}	2.13±0.21^{a}	7092.33±325.48^{a}

Values are expressed as mean ± standard deviation (SD). Different letters indicate statistically significant differences among genotypes ($p \leq 0.05$) according to ANOVA followed by Duncan's multiple range test.

Correlation analysis among yield components (Figure 3) revealed a very strong positive correlation between mean cluster weight and productivity expressed in kg ha^{-1} (r = 0.97; $p \leq 0.01$), indicating that yield variation was mainly determined by cluster mass rather than cluster number.

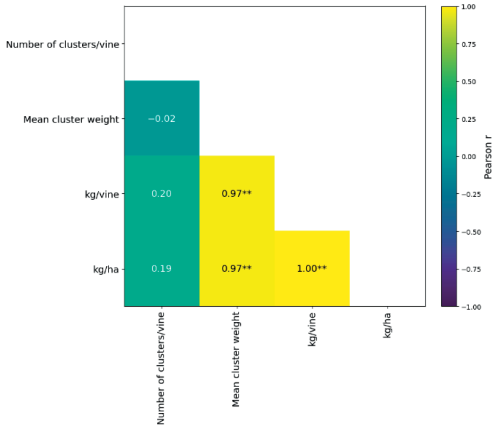

Figure 3. Pearson correlation heatmap of yield components in the studied genotypes

The number of clusters per vine did not show significant correlations with mean cluster weight (r = −0.02) or productivity (r = 0.19), suggesting that, under the conditions of this study, yield was influenced primarily by cluster size rather than by numerical crop load. The almost perfect correlation between productivity expressed in kg vine^{-1} and kg ha^{-1} (r = 0.999; $p \leq 0.01$) reflects the direct mathematical relationship between these two variables, determined by the constant planting density.

Physico-chemical characteristics of grapes at harvest

The technological maturity of the grapes was assessed by soluble solids content, total sugars, and titratable acidity (Table 5). The analysis of physico-chemical characteristics at harvest revealed differences among the studied genotypes in terms of sugar content, soluble solids, and total titratable acidity.

'Parmac' genotype recorded the highest values of total sugars (174 g L^{-1}) and soluble solids (15.77%), indicating a more advanced level of technological maturity compared with the other genotypes. The genotypes 'Gălbioară', 'Roșioară', and 'Berbecel' showed similar values of total sugars (153-156 g L^{-1}) and soluble solids (14.27-14.45%), suggesting a relatively uniform ripening process.

Regarding titratable acidity, 'Roșioară' presented the highest value (3.40 g L^{-1} H_2SO_4), while the other cultivars showed lower values (2.19-2.63 g L^{-1} H_2SO_4), indicating differences in the balance between sugar accumulation and acid degradation during the ripening period.

Table 5. Physico-chemical characteristics of grape must at technological maturity

Genotype	Total sugar (g L^{-1})	Soluble solids (%)	Total titratable acidity g L^{-1} H_2SO_4
'Gălbioară'	153.00±10.15^b	14.45±0.89^b	2.19±0.25^b
'Roșioară'	156.00±5.57^b	14.33±0.43^b	3.40±0.17^a
'Berbecel'	155.33±5.86^b	14.27±0.46^b	2.38±0.23^b
'Parmac'	174.00±5.57^a	15.77±0.43^a	2.63±0.38^b

Values are expressed as mean ± standard deviation (SD). Different letters indicate statistically significant differences among genotypes ($p \leq 0.05$) according to ANOVA followed by Duncan's multiple range test.

Compared with the data reported by Băjenaru et al. (2025) for the same viticultural area (1969-2000), the sugar content values determined in the present study fall within the ranges reported for 'Roșioară' (148-180 g L^{-1}) and 'Berbecel' (152-154 g L^{-1}), but exceed those previously reported for 'Parmac' (138-143 g L^{-1}). In contrast, titratable acidity values recorded in this study were lower than the ranges reported in the literature (2.6-4.5 g L^{-1} for 'Roșioară', 4.3-5.44 g L^{-1} for 'Parmac', and 3.9-4.98 g L^{-1} for 'Berbecel'). These differences may be associated with the climatic conditions of the study year and the ripening stage at harvest.

Mechanical composition of grape clusters (1 kg basis)

The mechanical composition of grapes expressed on a 1 kg basis (Table 6) revealed notable differences among the studied genotypes.

Rachis weight was highest in 'Gălbioară' (108.53 g kg^{-1}) and lowest in 'Parmac' (55.87 g kg^{-1}), indicating differences in the proportion of the structural woody part of the clusters.

Berry weight was similar in 'Berbecel' and 'Parmac' (~947-948 g kg^{-1}), although the number of berries differed considerably. 'Berbecel' showed the highest number of berries (1120 berries kg^{-1}), whereas 'Parmac' recorded the lowest value (685 berries kg^{-1}). These results suggest that 'Berbecel' produces smaller but more numerous berries, while 'Parmac' produces larger but fewer berries.

Must volume was higher in 'Berbecel' (600 cm^3 kg^{-1}) and 'Roșioară' (590 cm^3 kg^{-1}), while lower values were recorded in 'Parmac' (550 cm^3 kg^{-1}), indicating differences in winemaking potential among the genotypes. The proportion of skins and structural solids reached the highest values in 'Roșioară' (291.53 g kg^{-1}) and the lowest in 'Parmac' (251.78 g kg^{-1}), whereas seed weight was highest in 'Parmac' (93.06 g kg^{-1}) and lowest in 'Roșioară' (49.33 g kg^{-1}). The number of clusters per kilogram was higher in 'Gălbioară' (6–7 clusters kg^{-1}) and lower in 'Parmac' and 'Roșioară' (4–5 clusters kg^{-1}).

Overall, the significant differences among cultivars reflect varietal particularities in both morphological traits and the distribution of yield within 1 kg of grapes. These findings are relevant for cultivar selection depending on the intended use, either for fresh consumption or for winemaking, and for estimating must yield and the proportion of non-usable solid components.

Table 6. Mechanical components of grape clusters (1 kg basis) in the studied genotypes

Genotype	Rachis weight (g)	Berry weight (g)	No. of berries	Must (cm^3)	Skins and structural solids (g)	Seeds (g)	No. of clusters
'Gălbioară'	108.53±1.65^a	906.64±5.48^c	927.33±7.51^b	560.00±5.00^c	280.75±3.77^b	63.93±1.20^c	6.67±0.58^a
'Roșioară'	63.69±1.35^c	936.41±4.40^b	708.67±6.51^c	590.00±5.00^b	291.53±2.65^a	49.33±0.75^d	4.33±0.58^b
'Berbecel'	78.40±1.55^b	946.87±4.35^a	1120.33±10.02^a	600.00±5.00^a	263.42±2.87^c	82.93±1.30^b	5.33±0.58^b
'Parmac'	55.87±1.25^d	948.13±3.90^a	685.33±5.03^d	550.00±5.00^d	251.78±2.95^d	93.06±1.35^a	4.33±0.58^b

Values are expressed as mean ± standard deviation (SD). Different letters indicate statistically significant differences among genotypes ($p \leq 0.05$) according to ANOVA followed by Duncan's multiple range test.

Correlation analysis among the mechanical components of grape clusters (expressed per 1 kg of grapes) revealed several statistically significant relationships (Figure 4). Rachis weight showed a strong positive correlation with the number of clusters ($r = 0.88$; $p \leq 0.01$), suggesting that a greater structural mass is associated with a higher cluster load.

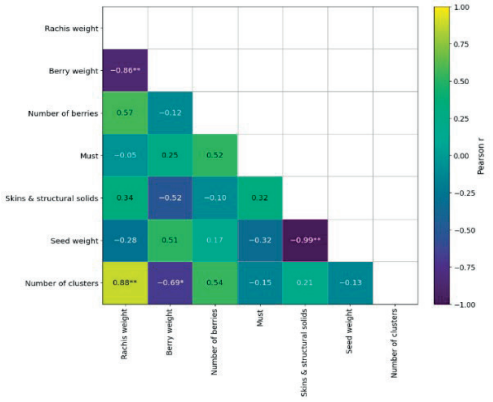

Figure 4. Pearson correlation heatmap of mechanical components of grape clusters (1 kg basis)

Conversely, rachis weight showed a strong negative correlation with berry weight ($r = -0.86$; $p \leq 0.01$), which may indicate a trade-off between cluster structural development and berry mass accumulation. Berry weight was also negatively correlated with the number of clusters ($r = -0.69$; $p \leq 0.05$), suggesting that a higher crop load per vine may reduce individual berry mass.

A very strong negative correlation was observed between skins and solid parts and seed weight ($r = -0.99$; $p \leq 0.01$), highlighting an inverse relationship between these structural components of the grape berry. The remaining correlations were low or not statistically significant.

Morphometric traits of clusters, berries, and seeds

The analysis of morphometric traits of clusters, berries, and seeds (Table 7) in the four studied genotypes ('Gălbioară', 'Roșioară', 'Berbecel', and 'Parmac') revealed significant differences among them. Regarding cluster dimensions, cluster length ranged from 14.10 cm in 'Gălbioară' to 17.57 cm in 'Roșioară', while cluster width varied between 6.93 cm in 'Berbecel' and 9.80 cm in 'Parmac'. The peduncles were longest in 'Roșioară' (2.60 mm) and shortest in 'Gălbioară' (1.20 mm). The number of cluster wings was relatively constant in most cultivars, with the exception of 'Parmac', which presented a slightly higher number (three wings).

Berry size also differed among genotypes. The greatest berry length and width were recorded in 'Parmac' (14.6 x 13.5 mm), while the longest seeds were observed in 'Berbecel' (6.1 mm). The weight of a single seed ranged from 0.05 g in 'Gălbioară' and 'Parmac' to 0.06 g in 'Roșioară' and 'Berbecel'.

Table 7. Morphometric descriptors of clusters, berries, and seeds in the studied genotypes

Genotype	Cluster length (cm)	Cluster width (cm)	Peduncle length (mm)	No. of cluster wings	Berry length (mm)	Berry width (mm)	Seed length (mm)	Seed weight (g)
'Gălbioară'	14.10±0.20^{c}	9.53±0.15^{a}	1.20±0.10^{c}	2.00±0.00	11.90±0.20^{c}	12.27±0.15^{c}	5.90±0.10^{b}	0.05±0.01
'Roșioară'	17.57±0.25^{a}	8.77±0.15^{b}	2.60±0.10^{a}	3.00±0.00	13.20±0.20^{b}	12.90±0.20^{b}	5.40±0.10^{c}	0.06±0.01
'Berbecel'	14.80±0.20^{b}	6.93±0.15^{c}	1.50±0.10^{b}	2.00±0.00	11.87±0.15^{c}	11.60±0.20^{d}	6.10±0.10^{a}	0.06±0.01
'Parmac'	14.90±0.20^{b}	9.80±0.20^{a}	1.40±0.10^{b}	3.00±0.00	14.60±0.20^{a}	13.50±0.20^{a}	5.80±0.10^{b}	0.05±0.01

Values are expressed as mean ± standard deviation (SD). Different letters indicate statistically significant differences among genotypes ($p \leq 0.05$) according to ANOVA followed by Duncan's multiple range test.

Correlation analysis among morphological descriptors (Figure 5) revealed strong structural relationships between cluster and berry parameters. Cluster length showed an almost perfect positive correlation with peduncle length ($r = 0.99$; $p \leq 0.01$), indicating a clear structural dependency between these two components. The number of cluster branches ("wings") showed strong positive correlations with berry length ($r = 0.89$; $p \leq 0.01$) and berry width ($r = 0.87$; $p \leq 0.01$), suggesting that a more complex cluster architecture is associated with larger berry size. Additional correlations highlighted significant relationships among berry dimensions. Berry length was strongly correlated with berry width ($r = 0.91$; $p \leq 0.01$), indicating a consistent proportional development of berry size across genotypes. In contrast, seed length showed negative correlations with several cluster and berry parameters, including cluster length ($r = -0.79$; $p \leq 0.01$) and peduncle length ($r = -0.75$; $p \leq 0.01$), suggesting an inverse relationship between seed size and certain structural characteristics of the cluster.

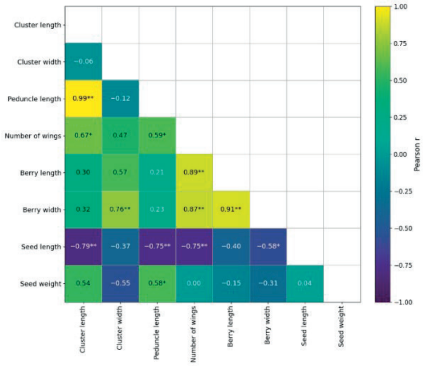

Figure 5. Pearson correlation heatmap of morphometric descriptors of clusters, berries, and seeds

Overall, these relationships highlight the interdependence between cluster architecture and berry morphology, reflecting varietal particularities that may influence both grape yield structure and technological potential.

Mechanical composition of 100 berries

The physical composition of berries, assessed on a sample of 100 berries for each genotype (Table 8), revealed significant differences among the studied cultivars in terms of total berry weight, distribution of berry components, and seed characteristics.

The total weight of 100 berries varied within a wide range, with the lowest values recorded for 'Gălbioară' (114.79 g) and 'Berbecel' (112.03 g), and significantly higher values for 'Roșioară' (154.72 g) and especially for 'Parmac' (179.69 g). These differences reflect substantial variation in berry size and mass among genotypes. Băjenaru et al. (2025) reported, for the period 1969-2000, values of 100-berry weight ranging between 184 and 255 g for 'Roșioară', approximately 302 g for 'Parmac', and 213 g for 'Berbecel', values higher than those obtained in the present study (154.72 g for 'Roșioară', 179.69 g for 'Parmac', and 112.03 g for 'Berbecel'). The observed differences may be mainly attributed to the young age of the plantation analysed and to the climatic conditions specific to the study year; these factors can limit dry matter accumulation and final berry size.

Table 8. Mechanical components of berries based on 100-berries

Genotype	Total weight (g)	Skin (g)	Pulp (g)	Seed weight (g)	No. of seeds	Weight of 100 seeds (g)
'Gălbioară'	114.79±2.94^{c}	25.54±1.35^{c}	78.12±1.38^{c}	7.85±0.27^{b}	192.33±3.51^{a}	3.84±0.11^{b}
'Roșioară'	154.72±6.39^{b}	39.73±1.41^{a}	89.27±0.97^{ab}	7.09±0.13^{b}	185.33±3.21^{ab}	3.87±0.03^{b}
'Berbecel'	112.03±3.67^{c}	23.21±0.99^{c}	85.93±1.55^{b}	8.65±0.41^{b}	162.67±4.51^{c}	3.91±0.06^{b}
'Parmac'	179.69±22.60^{a}	33.94±3.67^{b}	92.88±6.53^{a}	13.71±1.68^{a}	177.67±7.64^{b}	6.89±0.15^{a}

Values are expressed as mean ± standard deviation (SD). Different letters indicate statistically significant differences among genotypes ($p \leq 0.05$) according to ANOVA followed by Duncan's multiple range test.

Skin weight was highest in 'Roșioară' (39.73 g), followed by 'Parmac' (33.94 g), while 'Gălbioară' and 'Berbecel' showed significantly lower values (approximately 23-26 g). Pulp represented the largest fraction of the total berry mass, with values ranging from 78.12 g in 'Gălbioară' to 92.88 g in 'Parmac', the latter genotype standing out for its higher pulp content, which is favorable for must production.

The total seed weight of the 100-berry sample also showed significant differences among genotypes. 'Parmac' recorded the highest seed weight (13.71 g), while 'Gălbioară', 'Roșioară', and 'Berbecel' showed lower values ranging from 7.09 to 8.65 g. The number of seeds was highest in 'Gălbioară' (192.33 seeds per 100 berries) and lowest in 'Berbecel' (162.67 seeds per 100 berries), highlighting varietal differences in seed formation.

The weight of 100 seeds varied considerably among genotypes, with the lowest values recorded in 'Gălbioară', 'Roșioară', and 'Berbecel' (approximately 3.8–3.9 g), while the highest value was observed in 'Parmac' (6.89 g). This indicates that in 'Parmac', seeds are larger and heavier, contributing significantly to the increase in total berry mass.

Overall, the results demonstrate significant differences among genotypes in berry structure at the 100-berry level. The genotype 'Parmac' is characterized by larger berries with a higher proportion of pulp, but also heavier seeds, whereas 'Gălbioară' and 'Berbecel' show smaller berries with lower proportions of skins and

seeds. These characteristics are important for assessing grape quality and determining the technological suitability of each genotype.

Correlation analysis of the mechanical composition of 100 berries (Figure 6) revealed several significant relationships among the parameters.

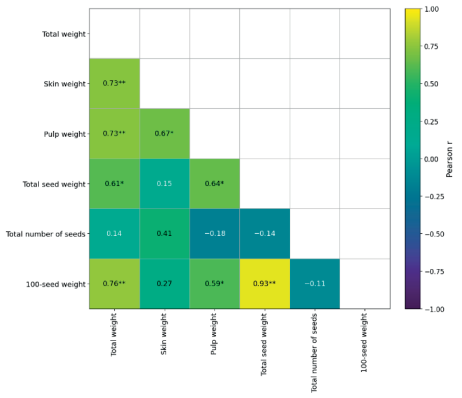

Figure 6. Pearson correlation heatmap of mechanical components based on 100-berry analysis

Total berry weight showed significant positive correlations with skin weight ($r = 0.73$; $p \leq 0.01$), pulp weight ($r = 0.73$; $p \leq 0.01$), and the weight of 100 seeds ($r = 0.76$; $p \leq 0.01$), indicating a proportional distribution of mass among the main berry components.

Pulp weight was positively correlated with total seed weight ($r = 0.64$; $p \leq 0.05$) and with the weight of 100 seeds ($r = 0.59$; $p \leq 0.05$), suggesting a coordinated development between fleshy tissues and reproductive structures. The strongest association was observed between total seed weight and 100-seed weight ($r = 0.93$; $p \leq 0.01$), confirming the internal consistency of the seed-related parameters.

The total number of seeds did not correlate significantly with the other analyzed variables, indicating that berry mass is more closely related to seed weight than to the number of seeds.

The results can also be interpreted in the context of the classical information reported by Alexei et al. (1970) for the cultivars 'Parmac', 'Berbecel', and 'Roșioară', grown in other viticultural regions of Romania.

For 'Parmac', the literature reports relatively high fertility indices (absolute fertility coefficient Cfa 1.8-2.6; relative fertility coefficient Cfr ≈ 2.1) and sugar contents ranging between 156 and 187 g L^{-1}, with total acidity between 3.4 and 7.7 g L^{-1}. In the present study, sugar accumulation (174 g L^{-1}) falls within the previously reported range, whereas the measured acidity (2.63 g L^{-1} H_2SO_4) was lower. In addition, both yield level and mean cluster weight were below the upper limits reported in the classical literature (108-411 g per cluster), which can be explained by the young age of the plantation and by the specific conditions of sandy soils.

For the cultivar 'Berbecel', Alexei et al. (1970) describe a highly fertile variety (Cfa 1.8; Cfr 1.7; approximately 97% fertile shoots), with sugar contents between 149 and 210 g L^{-1} and very high productivity (32-53 t ha^{-1}). The values obtained in the present study indicate a lower productive potential than in the literature, while the mean berry and cluster weights were within the lower limits of previously reported ranges (1.1-2.2 g per berry; 100-290 g per cluster). The sugar content recorded in this study (155 g L^{-1}) falls within the lower end of the reported interval, suggesting adequate technological maturity, although it does not reach the maximum potential described for other viticultural areas. Similarly, Gorjan and Botu (2013) mention 'Berbecel' as a cultivar characterized by moderate sugar accumulation and relatively low acidity under the conditions of the Drăgășani vineyard.

Regarding the cultivar 'Roșioară', the literature reports fertility indices of approximately Cfa 1.8 and Cfr 1.1, sugar contents ranging between 143 and 202 g L^{-1}, and high yields (32-41 t ha^{-1}), with cluster weights between 100 and 450 g. Under the conditions of the present study, sugar content (156 g L^{-1}) and acidity (3.40 g L^{-1}) fall within the previously reported ranges; however, the productivity recorded was considerably lower. These differences can be attributed to the plantation's young age, the climatic conditions of the 2025 growing season, and the specific pedological characteristics of the sandy soils of southern Oltenia.

Overall, the comparison with previous literature indicates that although the productivity values obtained in the present study are lower than the historical potential reported for these cultivars, the ripening parameters and morphological traits remain within the specific ranges characteristic of each genotype, confirming their adaptability to the ecological conditions of the studied area.

The obtained results also highlight the adaptation of the studied local genotypes to the pedoclimatic conditions specific to the sandy soils of southern Oltenia, as well as their particular morphological, productive, and technological characteristics. The characterization of these genotypes contributes not only to evaluating their agronomic and oenological potential but also to the valorization and conservation of the local viticultural heritage. In this context, the present study is part of the ongoing efforts to identify, preserve, and enrich the ampelographic collection of the Dăbuleni Research and Development Station for Plant Cultivation on Sandy Soils, with local genotypes considered valuable genetic resources for the adaptation of viticulture to current and future climatic conditions.

CONCLUSIONS

The present study enabled a comparative evaluation of local grapevine genotypes cultivated on the sandy soils of southern Romania, highlighting differences among them in phenology, fertility, yield level, morphological traits of clusters and berries, and the physicochemical composition of grapes.

Fertility parameters were closely correlated with vegetative development, confirming the interdependence between crop load and shoot dynamics, while productivity was mainly influenced by mean cluster weight.

Mechanical and morphometric analyses revealed structural relationships among cluster, berry, and seed components, suggesting possible associations between structural elements and the accumulation of usable berry mass.

From a technological perspective, the genotypes reached maturity parameters consistent with the climatic conditions of the study year, with variations observed in sugar accumulation and must acidity.

Overall, the results indicate that these local genotypes are adapted to the ecological conditions of the study area, highlighting their potential to maintain viticultural diversity and to be suitable for cultivation under restrictive pedoclimatic conditions.

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