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COMPARATIVE CHARACTERIZATION OF *VITIS VINIFERA* L. GENOTYPES BASED ON MORPHOLOGICAL, AGROBIOLOGICAL, AND PHENOLOGICAL TRAITS

Manolescu Andreea Elena[1], Dumitru Anamaria Mirabela[1*], Dinu Daniel Grigorie[1], Sumedrea Dorin Ioan[1]

[1*]National Research and Development Institute for Biotechnology in Horticulture – Stefanesti (INCDBH), Stefanesti, Argeş, Romania

** Correspondence author. E-mail*: *anamaria.ilina@yahoo.com*

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ABSTRACT

The phenological and morphological diversity of grapevine in Romania provides opportunities for conservation and breeding. This study characterized five Vitis vinifera L. accessions ('Radames', 'Leana', 'Rodi', 'Triumf', and 'Syrah') from the germplasm collection of INCDBH Ștefănești–Argeș. Characterization followed OIV (2023) descriptors, focusing on varietal traits and accessions' phenology. The main stages (budburst, flowering, veraison, ripening) were recorded, and earliness was analyzed. Morphological and phenological data allowed cultivar differentiation and highlighted adaptation patterns. Cluster analysis (UPGMA), based on Euclidean distances, identified three distinct groups, demonstrating morphological and phenological diversity. The results support documentation and conservation of grapevine genetic resources and sustainable viticulture and breeding programs.

INTRODUCTION

Viticulture is a significant agricultural sector for the Romanian economy, contributing substantially to national income, while also providing nutritional value and health benefits through grape-derived products (Bounab & Laiadi, 2019). Grapevine is one of the oldest cultivated plant species in the world, and the interest in its study has remained constant over time (Galet, 1956; Galet, 1998; Khouni, 2023). The geographical position of Romania, along with its climat, soil, and relief conditions, has favored the development of viticulture since ancient times. Written records and archaeological evidence indicate that grapevines were cultivated in these territories as early as the 7th century BC (Constantinescu et al., 1970). Over the centuries, Romanian viticulture has undergone numerous challenges, the most significant being the period following the phylloxera invasion (first reported in 1884 in Chițorani–Prahova). After the destruction of the affected vineyards, until the grafting technique was improved, local cultivars were largely replaced with foreign cultivars or direct producer hybrids, considered more efficient at the time. These changes led to increased attention toward the knowledge, conservation, and valorization of Romanian grapevine cultivars, which in turn resulted in the establishment of the first germplasm collections beginning in 1925. Currently, important grapevine collections are maintained in various research institutes and

universities to ensure the integrity of the biological material and to support breeding and varietal characterization activities. In Romania, the management of germplasm collections is carried out in accordance with standards established by the International Organisation of Vine and Wine (OIV), the European Cooperative Programme for Plant Genetic Resources (ECPGR), and the Food and Agriculture Organization (FAO).

Initially, grapevine characterization was performed using morphological and botanical methods, reflected in a series of ampelographic publications between 1959 and 1970, later supplemented by the works of Indreaș and Vișan (2001), Rotaru (2009), Dobrei et al. (2017), Popescu et al. (2018), Cichi (2022), and Ilina et al. (2023). Currently, morphological characterization is standardized through the OIV Descriptor List for Grape Varieties and *Vitis* Species (OIV, 2019), widely used internationally to ensure a precise description of cultivars and comparability across studies. Ampelographic and phenological studies remains essential for differentiating grapevine genotypes and constitute a critical step in the identification and classification of cultivars. Recent research in Romania has demonstrated the relevance of these analyses for evaluating the performance of cultivars under different environmental conditions, as well as for supporting conservation and clonal selection activities (Ilina et al., 2023). Although molecular methods provide additional precision in genotype authentication (Maul et al., 2015; Popescu et al., 2017), morphological and phenological characterization provide fundamental information regarding varietal adaptability to local conditions, agronomic performance, and technological potential. In this context, the present study aimed to characterize the morphology and phenology of five common grapevine cultivars (‘Radames’, ‘Leana’, ‘Rodi’, ‘Triumf’, and ‘Syrah’) from the germplasm collection of the ˈNational Research and Development Institute for Biotechnology in Horticulture (INCDBH) Ștefănești–Argeșˈ. The characterization was performed according to the methodology and descriptors outlined by the OIV (2023), with a focus on identifying varietal traits and the phenological behavior of each cultivar under the experimental site's pedoclimatic conditions.

This study aims to supplement existing knowledge regarding commonly cultivated grapevine cultivars in Romania and to support the conservation, identification, and valorization of viticultural resources preserved in the national germplasm.

MATERIAL AND METHODS

The study was carried out in 2025 on five *Vitis vinifera* L. cultivars (‘Leana’, ‘Radames’, ‘Syrah’, ‘Rodi’, and ‘Triumf’) maintained in the germplasm collection of INCDBH Ștefănești–Argeș.

The main phenological stages, budburst, flowering, veraison, and ripening, were visually assessed according to the BBCH scale (Lorenz et al., 1995). For each cultivar, the calendar dates of each stage were recorded, and the intervals between stages, as well as the total duration from budburst to ripening, were calculated. The data were analyzed descriptively to compare cultivar earliness.

Morphological and phenological characterization was performed based on 44 OIV (2023) descriptors. Euclidean distances between cultivars were calculated, and cluster analysis was performed using the UPGMA method. The dendrogram obtained reflects the level of similarity and differentiation among the studied cultivars.

RESULTS AND DISCUSSIONS

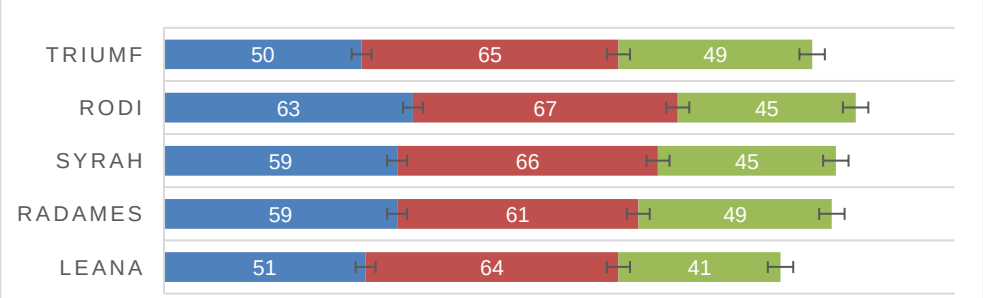
Phenological evolution of the studied grapevine accessions

The analysis of the phenological evolution of the five *Vitis vinifera* L. accessions revealed significant differences in the dynamics of growth stages (Figure 1). The average duration between budburst and flowering ranged from 50 to 63 days, indicating a difference of approximately two weeks between early and late-developing cultivars. The shortest intervals were recorded for 'Triumf' (50 days) and 'Leana' (51 days), while 'Rodi' showed a delayed development, requiring 63 days to reach flowering.

The period between flowering and veraison was relatively constant among cultivars (61–67 days), suggesting a higher degree of phenological synchronization likely influenced by similar summer climatic conditions. The veraison–ripening interval showed moderate variation (41–49 days), with the fastest ripening observed in 'Leana' and the slowest in 'Radames' and 'Triumf'.

The total phenological cycle, from budburst to ripening, ranged from 156 to 175 days. 'Leana' was the earliest cultivar, reaching full maturity after 156 days, while 'Rodi' had the longest growing period (175 days). These results indicate clear genotypic differences in earliness, an important criterion for cultivar selection in areas with shorter growing seasons.

Statistically, the intercultivar variability was more pronounced for the budburst–flowering interval (estimated coefficient of variation ≈1 0 %) compared to later stages (<5 %), confirming that the early vegetative phases are more sensitive to genetic factors and local microclimatic conditions.



	Leana	Radames	Syrah	Rodi	Triumf
Budburst→Flowering Duration	51	59	59	63	50
Flowering→Fruit Set Duration	64	61	66	67	65
Fruit Set→Ripening Duration	41	49	45	45	49

Figure 1. Phenological calendar of five *Vitis vinifera* L. accessions recorded in 2025 (Ștefănești–Argeș)

Dendrogram analysis of grapevine cultivars

The analysis of grapevine accessions was performed based on 44 morphological and phenological traits, according to OIV descriptors (2023) (Figure 2). Pairwise distances between cultivars were calculated using Euclidean distance, and the dendrogram was generated using the UPGMA method (Unweighted Pair Group Method with Arithmetic Mean). Based on this analysis and Ward's method,

the final dendrogram reveals three distinct clusters, reflecting the degree of similarity and differentiation among the studied genotypes (Figure 3).

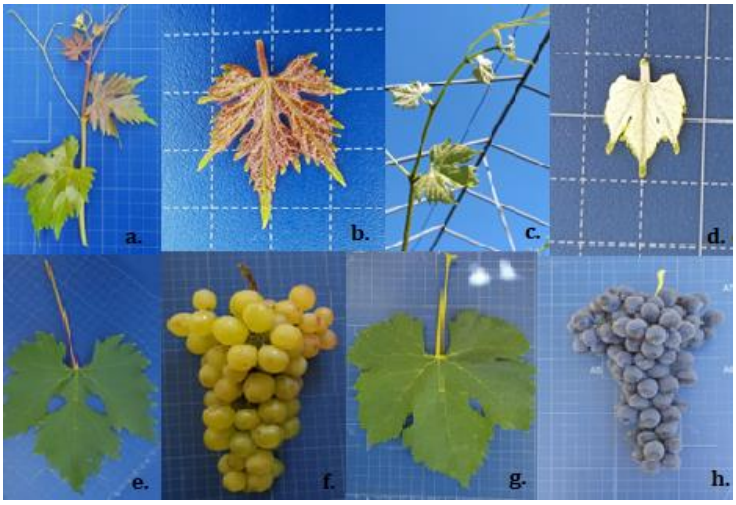


Figure 2. Variability in the grapevine accessions' ampelographic characteristics: shoot tip (a–c), young leaf (b–d), mature leaf (e–g), and bunch (f–h).

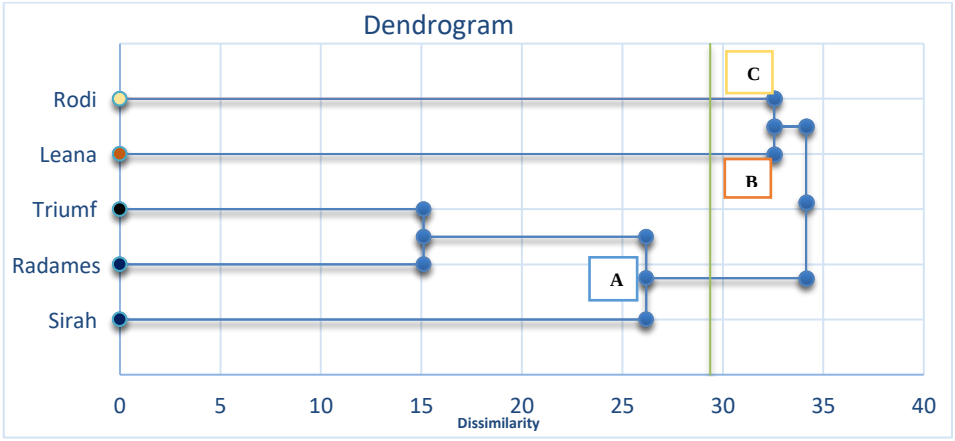


Figure 3. Dendrogram of grapevine genotypes based on morphological traits with OIV descriptors.

- *Cluster A*: 'Radames', 'Syrah', and 'Triumf'. These genotypes form a relatively close group, indicating moderate to high similarity. 'Radames' and 'Triumf' show very similar morphological and phenological traits, while 'Syrah' differs slightly, but remains closer to these two genotypes than to others.
- *Cluster B*: 'Leana'. This genotype is positioned at a greater distance from the others, particularly from 'Syrah', highlighting distinct morphological and phenological characteristics that make it unique within the studied group.
- *Cluster C*: 'Rodi'. This genotype is clearly differentiated from the others, showing distinctive traits such as cluster shape and structure, leaf size, and

ripening timing. Being a seedless cultivar, ‘Rodi’ is clearly distinct from the other genotypes.

The dendrogram analysis aimed to reveal the degree of similarity and differentiation among the grapevine genotypes, providing complementary insight to the phenological results described earlier.

The grouping of cultivars into three main clusters indicates close genetic and morphological relationships among ‘Radames’, ‘Triumf’, and ‘Syrah’, while ‘Leana’ and ‘Rodi’ stand out through their specific traits. This clustering pattern likely reflects distinct genetic origins and adaptive responses to environmental conditions.

When correlated with phenological observations, early-ripening cultivars (‘Leana’, ‘Triumf’) tend to share convergent morphological traits, whereas the late-ripening ‘Rodi’ appears clearly separated, confirming its genetic independence. The diversity revealed by the dendrogram highlights the value of these genotypes for breeding, selection, and germplasm conservation purposes.

CONCLUSIONS

The phenological analysis highlighted clear genotypic differences among the studied *Vitis vinifera* L. accessions, with the greatest variability observed during the budburst–flowering phase and higher synchronization in later developmental stages. Understanding these temporal dynamics is crucial for selecting cultivars best suited to local climatic conditions and for optimizing vineyard management practices. The contrasting precocity of ‘Leana’ and the lateness of ‘Rodi’ provide valuable insight into the adaptability of grapevine genotypes to diverse environmental conditions and potential shifts under future climate scenarios.

The cluster analysis based on morphological and phenological traits revealed three distinct groups among the studied genotypes, reflecting both their genetic diversity and adaptive differentiation. The close association among ‘Radames’, ‘Triumf’, and ‘Syrah’ indicates shared morphological patterns, while ‘Leana’ and ‘Rodi’ exhibit unique characteristics that underline their potential for breeding and conservation purposes.

Overall, integrating phenological and morphological information provides a comprehensive understanding of grapevine diversity and adaptation. Such knowledge is essential for identifying promising parental lines, guiding breeding strategies, and ensuring the long-term conservation of genetic resources in accordance with OIV descriptors. Ultimately, recognizing the relationships among cultivars and their phenological behavior supports the development of resilient viticultural systems capable of withstanding environmental variability and climate change.

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