

Research concerning the behavior of table grape cultivars grown on the sandy soils of Southern Oltenia

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ABSTRACT

The current study aimed to describe the performance of five table grape cvs. recently introduced in the agro-environmental conditions of southern Oltenia. These cultivars were: 'Napoca', 'Otilia', 'Prima Cl. 1022', 'Perla de Zala' and 'Moldova', belonging to the ampelographic collection of the Dabuleni Research-Development Station for Plant Culture on Sands. 'Victoria' cv., was taken as a control because it is the most widespread table grape cultivar in the area where the study was carried out. The phenological stages, the resistance to spring frost, the fruit quality and the productivity of these cultivars were studied during the period 2018-2021. Phenological observations were made regarding the beginning of bud burst (07 BBCH), the beginning of ripening (81 BBCH) and berries ripe for harvest (89 BBCH). In the studied area, the complete bud burst phenophase (07 BBCH) occurred 2 days before 'Victoria' cv. in the case of 'Napoca' and 'Otilia' cvs. (on April 9) and two days after 'Victoria' cv. in the case of 'Moldova' cv. (on April 18). 'Prima Cl. 1022' cv., although it was not the first cultivar in which the beginning of bud burst phenophase was noted, it was the first in which the beginning of ripening phenophase was noted, respectively in the period 2-10 July. 'Moldova' cv. registered the latest beginning of ripening, between July 23-29. The berries ripe for harvest occurred, the earliest, in the case of 'Prima Cl. 1022' cv., between July 25-28 and the latest in case of 'Moldova' cv., between September 22 and October 19.

Keywords: table grape cultivars, phenological stages, fruit productivity, climatic conditions.

INTRODUCTION

The seasonal morphological development of bunches and eventually the chemical composition of the berry result from the interaction between soil and climatic characteristics and the consequences of long-term practices (e.g. establishment techniques, row orientation, vine spacing and trellising, training and pruning systems), short term practices (e.g. seasonal irrigation, fertilization and canopy management) and harvest criteria applied by the grower (Jackson and Lombard, 1993; Hunter and Archer, 2001a,b; Deloire *et al.*, 2002; Hunter *et al.*, 2004).

The main climatic factors which determine the conditions for the development of vines are heat, light, and humidity. At the same time, during the year, climatic phenomena with increased risk on the life cycle of the culture may occur, such as frosts, droughts, and lack of heat or humidity, which may have a limited character, but can cause a state of stress in the unfolding of the plant's physiological processes (Șîrbu, 2014). The cultivated vines, although they originated from wild vines, are sensitive to climatic adversities, being subject to risks of any kind during the year. During the dormancy period, it is under the influence of minimum

negative temperatures and glazed frost, and during the growing season, it withstands possible late spring frosts or hoard-frosts, hail, drought, and heat during the summer and possibly early autumn frosts. Also, the abundance of precipitation is harmful when it occurs during or immediately after flowering or during the ripening period of the grapes (Martin, 1968; Oprean, 1975; Oşlobeanu, 1980). The achievement of phenological stages, based on a long-term data set, is important to determine the adaptation of grapevine cultivars to a certain climatic regime. Among the main environmental factors, the climate has the greatest impact on vine phenology and grape quality. The cultivars less sensitive to climate change offer an option for farmers (Ivanišević *et al.*, 2019). The vegetation period represents the sequence of the annual biological cycle in which physiological processes are manifested with increased intensity and produce visible anatomical and morphological changes. The leaves, flowers, and fruits, however, go through the development phases during a year, and the changes these organs undergo are benchmarks for the evolution of the phenological stages of the vine. The onset of vegetation and the rate of development of the phenophases are influenced by environmental factors, especially by temperature, the optimal limits for the development of the main phenophases of the vine being between 20-30 °C (Olteanu, 2000, Paraschiv *et al.*, 2021). The warmer the climate is, the more intense the biological processes are and the duration of the phenophases is shorter (Irimia, 2012).

The calendar of each phenological phase differs based on each grapevine cultivar and is generally linked with local thermic conditions (Parker *et al.*, 2011). Indeed, phenological models based on temperature accumulations higher than the reference temperature have been widely reported in different studies (Kliewer 1977; Rădulescu *et al.*, 2010; Parker *et al.*, 2011). Complex models have also been developed by using different threshold values (Parker *et al.*, 2011). A number of studies have shown that high temperatures are associated with the early phenological development of plants (Cola *et al.*, 2017; Rădulescu *et al.*, 2010, Fraga *et al.*, 2013). Based on the phenological phase, the highest consumption of water is recorded during the maximum sprout and grapevine growth stages, while the lowest consumption recorded occurs between the beginning of weeping and flowering (Olteanu 2000; Rădulescu *et al.*, 2010).

Accurate monitoring of vine phenophases is essential to ensure successful technical management. This provides the means to establish the relative maturity levels of grapes, characterize the current crop, and carry out precise technical operations such as phytosanitary treatments (Agnes Destrac Irvine *et al.*, 2019).

MATERIALS AND METHODS

The study was carried out on 5 table grapes cultivars from the ampelographic collection of Dabuleni Research-Development Station for Plant Culture on Sands, newly introduced in the southern area of Oltenia ('Napoca', 'Otilia', 'Victoria', 'Prima Cl. 1022', 'Perla de Zala', 'Moldova'). The control was 'Victoria' cv., because it is the most widespread table grape in the area of sandy soils in southwestern Romania. The ampelographic collection was established in 2010. The form of driving the vines was the classic (low), the planting density was 3787 vines/ha and the planting distances were 2.2/1.2 m.

Observations and determinations were made regarding the phenological stages: the beginning of bud burst (07 BBCH), the beginning of ripening (81 BBCH), and berries ripe for harvest (89 BBCH), the production and quality of grapes.

The phenological determinations consisted of the visual observation and notation every day at the beginning of each phenophase, for each cultivar.

Production determinations were conducted by weighing grapes from 3 plants at 4 repetitions, for each cultivar. For quality determinations, samples are taken from the harvested plants and analyzed in the laboratory: the weight of 100 berries was determined

gravimetrically; the content in sugars was determined with the refractometer; the titratable acidity at harvest was determined by the titrimetric method.

The results obtained were statistically analyzed using the analysis of variance (ANOVA). Means were compared using the Duncan test at 0.05 probability levels. The different letters from the figures are significantly different according to the Duncan test ($P \leq 0.05$).

RESULTS AND DISCUSSIONS

In the period 2018-2021, relatively favorable conditions for grapevine culture were manifested, during this period the winters were warmer and without frost danger. The average temperature in the period 2018-2021 was between 12.5-14.1°C, the lowest average temperature was recorded in 2021, and the highest in 2020 (Table 1).

High temperatures occurred frequently in the vineyards in the south of Oltenia region. During the 2018-2021 period the maximum temperature fluctuated between 35.7 °C, on August 18, 2018, reaching a maximum of 41.2°C in this period on 01-02 August 2021. Both low and high temperatures can affect fruit set in grapevines. Pre-flowering low temperatures can disrupt both the formation and function of ovules and pollen during flowering. Likewise, exposure to temperatures of 15 or 40 °C can significantly lower the fruit set (Kliwer, 1977). Temperatures below 15 °C and above 32 °C are considered detrimental. Berry number per bunch is the product of flowers per inflorescence and the percentage of flowers that set fruit. Cool temperatures shortly before the budburst can increase the total number of flowers per shoot (Eltom *et al.*, 2017). However, cold weather after the budburst may prevent the formation of individual flowers (Buttrose and Hale, 1973). Fruit set (or the proportion of flowers that are retained as berries) represents a change-over from the static condition of the fully developed flower to the rapidly growing condition of the young fruit (Coombe, 1962).

Table 1. The main climate data in the period 2018-2021

Year	Average temperature (°C)	Maximum temperature (°C)		Minimum temperature (°C)	Amount of annual precipitation (mm)	Amount of precipitation during the growing season (mm)
		Value	Date			
2018	13.4	35.7	August 18	-17.6	1055.5	510.1
2019	12.8	38.4	August 08	-14.9	482.3	272.8
2020	14.1	37.3	Sept. 01	-9.4	550.4	290.6
2021	12.5	41.2	August 01-02	-10.6	544.6	173.6
Average	13.2	38.2	-	-13.1	658.2	311.7

In terms of annual precipitation, 1055.5 mm were recorded in 2018, and 482.3 mm in 2019. During the vegetation period, the highest amount of precipitation was recorded in 2018 at 510.1 mm, and the lowest amount of precipitation was recorded in 2021, at 173.6 mm.

In 2018, grape production was affected by the main diseases of the vine, *Plasmopara viticola* and *Uncinula necator*, due to the abundance of precipitation (1055.5 mm annually and 510.1 mm during the growing season).

In 2019, although the amount of recorded precipitation was reduced, the large number of days with rain and high atmospheric humidity (8 days in May and 12 days both in June and July) determined favorable conditions for the emergence and establishment of the main pathogens for a vine, *Plasmopara viticola* and *Uncinula necator*. In this context, it was necessary to apply a large number of phytosanitary treatments since May. The beginning of bud burst (07 BBCH) in the period 2018-2021 started during April, the earliest between

April 9-24 at 'Napoca' and 'Otilia' cvs. and the latest between April 18-27, at the 'Moldova' cultivar (Table 2).

In the specialized literature, it is highlighted that the moment of bud burst does not correlate with the moment of ripening of the grapes. Knowing the moment of bud bursting is important for zoning the cultivars, avoiding the placement of cultivars with early bud bursting in areas with a high frequency of spring frosts (Martin, 1972).

Table 2. The main phenological observations of studied table grape vine cultivars in the period 2018-2021

Cultivars	The beginning of bud burst	Beginning of ripening	Berries ripe for harvest
'Victoria'	April 12 -26	July 14-22	July 2-August 16
'Napoca'	April 09-24	July 06-16	July 27-August 14
'Otilia'	April 09-24	July 09-20	July27-August 12
'Prima Cl. 1022'	April 12-26	July 02-10	July 25-28
'Perla de Zala'	April 16-24	July 12-27	August 14-September 08
'Moldova'	April 18-27	July 23-29	September 22-October 19

'Prima Cl. 1022' cv., although it was not the first cultivar in which the beginning of bud burst phenophase was noted, it was the first in which the beginning of ripening phenophase was noted, in the period July 2-10. 'Moldova' cv. registered the latest beginning of ripening, between July 23-29. In the period 2018-2021, the complete ripening of the grapes occurred, the earliest, for 'Prima Cl.1022' cv., between July 25-28, and the latest for 'Moldova' cv., between September 22 and October 19.

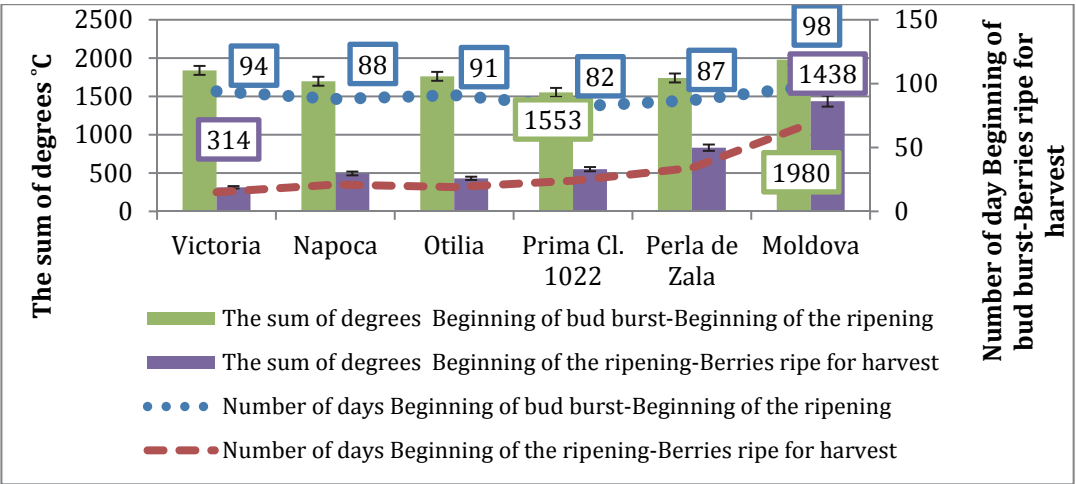


Figure 1. The course of the phenological stages of table grape cultivars

The specialized literature emphasizes that the ripening of grapes evolves differently, to the earliness of the cultivars, the vigor of growth, the size of the production, and the favorability of the climatic conditions. For this reason, to determine the optimal time of harvesting, it is necessary to know the dynamic of the ripening process, marked by the evolution of the weight of the grapes, the accumulation of sugars and the decrease of the acidity (Irimia, 2012).

'Prima Cl. 1022' cv., which is the earliest of the analyzed cultivars, required 82 days from bud bursting to the beginning of ripening and 24 days from the beginning of ripening to maturity of the grapes. The sum of temperature degrees required from bud bursting to begin of ripening was 1553 °C and from the beginning of ripening to maturity of the grapes was 551 °C (Fig. 1). The latest cultivar, 'Moldova', recorded 98 days from bud bursting to the beginning of ripening and 69 days from the beginning of ripening to ripening. The sum of the temperature degrees required to go through the phenophases was 1980°C from bud bursting to the beginning of ripening and 1438 °C from the beginning of ripening to harvesting grapes.

The average production of grapes from 2018-2021 ranged between 8663-13822 kg/ha (Table 3). Most of the researched cultivars yielded more than 10 tons of grapes per hectare, which proves that table grape cultivars can be grown on sandy soils due to their high economic efficiency.

Table 3. Grape production (t/ha) of the studied table grape vine cultivars in the period 2018-2021

Cultivars	Grape production (t/ha)				Average
	2018	2019	2020	2021	
'Victoria'	14.8±1.1 a*	6.8±0.4 c	10.2±0.8 b	16.5±2.9 a	12.05±4.4 ab
'Napoca'	7.6±0.4 b	5.3±0.3 b	11.0±3.0 a	10.8±2.4 a	8.6±2.7 c
'Otilia'	9.5±0.4 c	10.6±0.2 c	17.4±1.9 a	14.9±1.6 b	13.6±3.7 ab
'Prima Cl. 1022'	12.9±0.3 b	6.4±0.5 c	17.0±2.4 a	16.1±2.5 a	13.1±4.8 ab
'Perla de Zala'	20.1±0.3 a	6.8±0.2 c	14.4±1.0 b	14.0±3.5 b	13.8±5.4 a
'Moldova'	17.0±0.1 a	10.2±0.3 c	13.3±1.4 b	12.8±0.8 b	13.3±2.8 a

*Values are expressed as mean ±SD. Means within each column followed by different letters are significantly different according to the Duncan test ($P \leq 0.05$).

The analysis of the studied fruit production shows that 'Victoria' cv. (Figure 2) recorded the highest values in 2021 (16.5 t/ha) and 2018 (14.8 t/ha), values that differ statistically from the values obtained in 2020 and 2019 respectively, in which the lowest productions were recorded (10.2 t/ha and 6.8 t/ha respectively). In the case of 'Napoca' cv., we note that the highest value was recorded in 2020 (11.0 t/ha), a value that differs statistically from the values recorded in 2019 (5.3 t/ha) and the year 2018 (7.6 t/ha).

The productions recorded by 'Otilia' cv. during the studied period are divided into three statistical classes, the highest value being registered in 2020 (17.4 t/ha).

The data from table 3 show that the cultivars 'Perla de Zala' cv. and 'Moldova' cv. recorded higher productions in 2018 (20.1 t/ha and 17.0 t/ha, respectively), which differ from the other years of the study with differences, insured from a statistical point of view, between 33.9-71.7%.

On average, over the four years of study, 'Perla de Zala' cv. recorded the highest production (13.8 t/ha), differentiating from the statistical point of view compared to the other studied cultivars.

Quality analyses consisted of determinations of 100 berries' weight, total sugar content, and total titratable acidity at harvest (Table 4). The weight of 100 berries recorded the highest value in the control cultivar ('Victoria' - 736 g), with the other cultivars being very significantly lower.

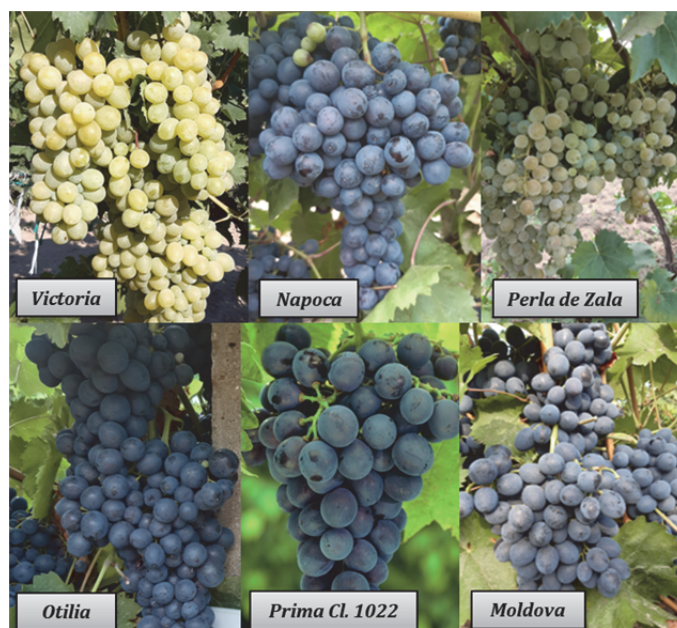


Figure 2. Original images of the studied cultivars

The content in total sugars recorded the highest value in the case of the cultivars 'Perla de Zala' (202 g/L) and 'Moldova' (195 g/L), being statistically assured as very significantly positive. Most of the studied cultivars have accumulated the amount of sugar specific to quality table grapes. The total titratable acidity at harvest had values between 4.1-5.3 g/L H_2SO_4 .

Table 4. Grape quality in the studied vine cultivars with table grapes in the period 2018-2021

Cultivars	Weight of 100 berries (g)	The difference compared to the control (g)	Total sugar content (g/L)	The difference compared to the control (g/L)	Total titratable acidity (g/L H_2SO_4)	The difference compared to the control (g/L)
'Victoria'	763	Mt.	147	Mt.	4,1	Mt.
'Napoca'	394	-369.3	142	-4.8	4,6	0.5
'Otilia'	284	-478.8	162	14.8	5,1	1.0
'Prima Cl. 1022'	424	-338.8	140	-7.0	5,1	1.0
'Perla de Zala'	282	-481.3	202**	54.8	5,3	1.2
'Moldova'	407	-356.0	195**	48.0	4,6	0.5
	<i>DL 5%</i>	<i>84.0</i>	<i>DL 5%</i>	<i>29.8</i>	<i>DL 5%</i>	<i>1.3</i>
	<i>DL 1%</i>	<i>116.3</i>	<i>DL 1%</i>	<i>41.3</i>	<i>DL 1%</i>	<i>1.9</i>
	<i>DL 0.1%</i>	<i>160.5</i>	<i>DL 0.1%</i>	<i>57.0</i>	<i>DL 0.1%</i>	<i>2.6</i>

CONCLUSIONS

In the period 2018-2021, the studied table grape cultivars behaved differently depending on the climatic conditions of the crop year.

During the four years of study, bud bursting started during April. 'Napoca' and 'Otilia' cvs. recorded the earliest beginning of bud burst between April 9-24, and 'Moldova' cv. recorded the latest beginning of bud burst between April 18-27.

The first cultivar in which the beginning of ripening phenophase was recorded was the 'Prima Cl. 1022' cv., during the period 02-10 July, needing 1553 °C to reach this phenophase. The latest beginning of ripening was noted between July 23-29 for the 'Moldova' cv., requiring 1980 °C.

During the 4 years of study, in the area of sandy soils in the south of Oltenia, the earliest table grapes were harvested between July 25-28, 'Prima Cl. 1022' cv. standing out for its earliness. The latest was the 'Moldova' cv., which ripened between September 22 and October 19.

On average over the four years of study, 'Perla de Zala' cv. recorded the highest production (13.8 t/ha), differentiating from the statistical point of view compared to the other studied cultivars.

The weight of 100 berries recorded the highest value in the case of the control cultivar ('Victoria' 736 g), with the other cultivars being very significantly negative. The content in total sugars recorded the highest value in the case of the cultivars 'Perla de Zala' (202 g/l) and 'Moldova' (195 g/l), being statistically assured as very significantly positive.

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