Scientific Papers. Series B, Horticulture. Vol. LXIV, No. 2, 2020
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

STUDY ON THE MATURITY EVOLUTION OF SOME GRAPE VARIETIES FOR ESTABLISHING THE CORRECT HARVEST TIME IN THE CERNAVODA VINE CENTER

Grigore-Valentin BELENIUC[1], Nicolae GIUGEA[2], Georgeta BELENIUC[1]

[1]"OVIDIUS" University, 124 Mamaia Blvd., Faculty of Horticulture, Constanta, Romania
[2]University from Craiova, Faculty of Horticulture, 13 Al. I. Cuza Blvd, Craiova, Romania

Corresponding author email: georgetabelen@yahoo.com

Abstract

The paper's aim was to present the maturity evolution for three grapes varieties, for establishing the correct harvest time in 2019 in Cernavoda vine Center. These were: 'Victoria' - grapes for table, 'Riesling Italian' - grapes for white wine and 'Merlot' - grapes for red wine, for which there were determined the moments of commercial, full and technological maturity, settling the optimum time of the grapes harvest according to the degree of ripen, which is an important factor in the quality of future wine. The data obtained indicated that the grapes 'Victoria' had reached commercial maturity in August 24, with the caracteristics: sugars - 156.7 g/l and total acidity - 3.5 g/l H_2SO_4. The grapes, 'Riesling Italian' had reached full maturity in September 25, with the follow characteristics: sugars - 230 g/l and total acidity - 5.2 g/l H_2SO_4, and the black grapes 'Merlot' had reached in the same time full and phenolic maturity in October 3, with the characteristics: sugars - 235 g/l, total acidity - 6.02 g/l H_2SO_4 and anthocyanins 1680 mg/kg. The mechanical composition of the grapes was analyzed and the uvological indices were calculated, and the conclusion was that these are adequate to each variety.

Key words: *commercial maturity, full and phenolic maturity, total acidity, uvological indices.*

INTRODUCTION

Establishing the optimum harvesting time, consisted in knowing and choosing that data during the maturity (ripening) period in which the grapes correspond qualitative to their purpose and destination. The factor that determines the quality of the grapes is their maturity. This is influenced by: the geographical position of the vineyard, the forms of relief, climate, soil, agrotechnical works applied to the soil and the plants. The maturity of the grapes is also appreciated according to their destination, that they are for direct consumption or processing. Those destined for processing, are evaluated according to the category and the type of wine expected to be obtained. As an evolutionary phase, maturation is a genetically coordinated physiological process characterized by complex morpho-anatomical and chemical changes (Pomohaci, 2000). During maturation, the processes of accumulation in sugars, organic acids, nitrogenous substances, vitamins, aromatic substances, a.s.on, are considerably increased (Târdea et al., 2010).

The epicarp changes its green color, becomes translucent and softens due to pectin hydrolysis.

In this stage the grapes increase their volume due to the cells elongation and accumulations of assimilated, especially sugars (Antoce, 2007).

The grape varieties for wine have a greater capacity for sugars accumulation compared to those for the table. Other important processes that occur in grapes during this period are: reduction of acidity, hydrolysis of pectic substances, accumulation of color (anthocyanins) and aromatic compounds (Cotea et al., 2009). The grapes maturation process is influenced by the vine variety and the climatic conditions and therefore it is very important to follow the dynamics of grape maturity in order to determine the optimal moment of grape harvest (Beleniuc and Beleniuc, 2015).

The grapes maturity is divided in: - physiological maturity; full maturity; technological maturity, over maturity (over ripening), commercial maturity (Cotea, 1985).

MATERIALS AND METHODS

The working material was represented by three vine varieties: 'Victoria'-grapes for table, 'Riesling Italian'-grapes for white wine and 'Merlot'- grapes for red wine, to which were determined the moments of commercial maturity, full and technological maturity, settling the optimum time of the grapes harvest according to the degree of ripping, which is an important factor in the quality of future wine. (Figure 1)

Figure 1. Grapes variety: 'Victoria', 'Riesling Italian', 'Merlot'

These three varieties are grafted on the rootstock of the Berlandieri x Riparia Oppenheim Selection 4 and planted at 2.2 m distances between rows and 1.1 m between plants in a row; the area of a vine nutrition is 2.42 m^2; the vine number/ha - 4132; rows orientation N-S; support system: concrete pillars; number of wires: 6 (two load-bearing wires and two double rows for off shoots directing); trunk highness: semi-tall with 70 cm; driving form: double Guyot. The paper's aim was to present the maturity evolution of these three grapes varieties, for establishing the correct harvest time in 2019 year in Cernavoda vine Center.

METHODS OF STUDY

The study included observations in the vine plantations and laboratory analyzes to determine the characteristics of the grapes according to the time of ripening. Observations and determinations made in plantations are referring to: - the ecological relations between the vine and the local conditions; - the effective heliothermic resources; - the dynamics of the grape's maturity, starting from the beginning of maturity to the full or technological maturity of the grapes and then to the harvest.

In 2019, from the beginning of the maturation, grapes samples were taken from 5 to 5 days, and as the maturation process advanced, from 3 to 3 days. The sample consists of grapes from 20 vines, located at different points in the plot. With a scissors, small portions of bunches of 3-5 grape berries were harvested from the grapes located in the center of the vine and from those on the sunny or shaded side. Very ripped grapes or those with a large number of grape berries affected by mold were avoided. Grapes of all sizes have been harvested, because large grapes are high in sugar and have low acidity while small grapes are poorer in sugar and have high acidity. Samples were put in plastic bags labeled with variety, date of harvest and plot number. The sample taken weighed 1kg/variety. The samples were worked on the same day, but until the analysis started, they were kept in the refrigerator at 40ºC.
In laboratory were analyzed in dynamic:
- the weight of 100 grapes berry (g) starting from the beginning of maturity and to harvesting, was determined gravimetrically using a technical balance (Figure 2);

Figure 2. The separation of 100 grapes from clusters and weighing them, from the varieties: 'Victoria', 'Merlot'

- sugar content (g/l), by refractometric method;
- total acidity (g/l H_2SO_4), by titrimetric method using a NaOH solution of a certain normality; These have been determined from the musts. 'Victoria', 'Riesling Italian' and 'Merlot' grapes varieties, have been crushed well and the resulting musts have been placed in tubes that were stored in the refrigerator for a few hours to clear them. Sugar and total acidity have been determined from the clear musts (Figure 3).

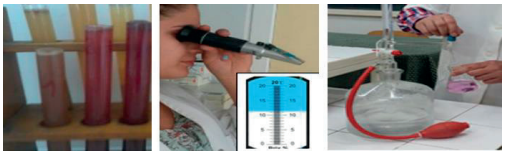

Figure 3. Musts in the tubes for clearing; sugars evaluation; total acidity evaluation

The data obtained have been recorded and helped us to realize the maturation graphs of the varieties;

- anthocyans content (for black grapes only for determining the phenolic maturity), by spectrophotometric method. After weighing 100 Merlot grape berries, they were crushed and treated with strongly acidic HCl solution (pH = 1) and macerated for 4 hours. Then the colored extract was filtered and using the spectrophotometer the optical density (DO280) of the extracts was measured and the content in anthocyanins (A) was determined. In addition, the mechanical composition of the grapes was analyzed and the uvological indices have been calculated. All of these have been made in the wine technology and chemistry laboratory of the Cernavoda vine center.

RESULTS AND DISCUSSIONS

The climatic factors evolution in the ecosystem of Cernavoda viticol centre was monitored using the WS-GP1 performance meteorological station (air temperature value, precipitation, hygroscopicity and sun shine time). In the Figure 4 and Table 1, it can be observed that during the nonvegetative vine period (November - February) 2018-2019 was slightly warmer than normal, the average temperatures of January and February were higher than the multiannual averages (5.9°C compared to 0.5°C normal value for January, and 7.9°C in February compared to 1.3°C).

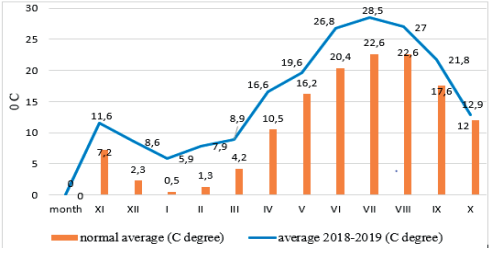

Figure 4. The evolution of the average monthly temperatures in the viticol year 2018-2019

The absolute minimum temperatures recorded at the beginning of January of - 14.0°C (02.01.2019) did not affect the vines winter buds. This is because the minimum temperatures were recorded in one day only. In the spring months, the temperatures were higher than normal (March 8.9°C versus 4.2°C multi-year average, and in April with 6.1°C higher than normal values). Air temperatures in the summer months were higher than normal (in August the absolute maximum was 38.7°C.

Table 1. Average monthly temperatures in the vine year 2018-2019 compared to the multiannual (normal)

Month	Average temperature ^{0}C		Absolute maximum temp ^{0}C
	Normal	2018-2019	2018-2019
XI	7.2	11.6	23.9
XII	2.3	8.6	17.9
I	0.5	5.9	18.0
II	1.3	7.9	24.9
III	4.2	8.9	27.1
IV	10.5	16.6	36.0
V	16.2	19.6	34.1
VI	20.4	26.8	36.3
VII	22.6	28.5	38.1
VIII	22.6	27.0	38.7
IX	17.6	21.8	36.3
X	12.0	12.9	26.4
average	11.45	16.34	

During the vegetation period, the amounts of global temperature levels, (Σ^0C global), active (Σ^0C active) and useful (Σ^0C useful), have been much higher than the multiannual values (Table 2). Thus, the global thermal balance was 4,234.4^{0}C compared to 3422,0^{0}C multiannual value, the active thermal balance was 4,234.4^{0}C with 903,8^{0}C compared to the normal, and the useful thermal balance of 2,435.4^{0}C compared to 1,615.6^{0}C multi-year average by almost 820^{0}C more.

Table 2. Rainfall in the viticol year 2018-2019

Month	Global (Σ°C)		Active (Σ°C)		Useful (Σ°C)	
	Normal	2019	Normal	2019	Normal	2019
IV	369.7	477.5	219.8	477.5	53.8	187.4
V	513.7	608.1	513.6	608.1	203.7	297.0
VI	620.1	810.0	620.1	810.0	328.1	504.0
VII	726.3	863.9	726.3	863.9	416.3	564.9
VIII	671.0	825.3	671.0	825.3	361.0	523.4
IX	521.2	649.6	552.7	649.6	252.7	358.7
Σ°C	3422	4,234.4	3,303.6	4,234.4	1,615.6	2,435.4

In the viticol year 2018-2019 the rainfall recorded 47.9 mm higher than normal, and for this reason the year was considered to be a normal one. During the vegetation period (April - September), the amount of rainfall recorded was 26.0 mm less than the multiannual average (245.7 mm). In May, there was a precipitation surplus, 99.9 mm, and in the

other months a deficit between 1.5-32.4 mm. In July the deficit was a big one of 32.4 mm (Table 3). At that moment the grapes were between the growing and compacting grapes phenophase -and the beginning of the ripening process.

Referring to the air relative humidity, its value, during the vegetation period was close to the multiannual averages, between 60 and 77% (Table 3). The lowest amount of insolation was in May, when it totaled 163.4 hours compared to the normal of 261.8 hours. Total hours of sunshine exceeded the normal value (Table 3).

Table 3. Rainfall in the viticol year 2018-2019

Month	Rainfall (mm)		Higroscopicity %		Sunshine (hour)	
	Nor-mal	2018-2019	Normal	2018-2019	Normal	2018-2019
XI	40.4	70.0	82	83	87.2	135
XII	34.0	3.5	85.0	89	66.1	120
I	31.0	63.4	83.0	91	63.5	120.2
II	33.0	31.5	81.0	88	84.8	137
III	21.7	34.3	75.0	87	111.7	122
IV	33.5	22.5	72.0	73	160.7	197.1
V	50.2	99.9	68.0	77	261.8	163.4
VI	53.2	41.6	65.0	67	314.5	222
VII	35.6	3.2	61.0	60	323.7	356.9
VIII	31.6	19.9	60.0	62	305.5	309
IX	41.6	32.6	68.0	67	221.0	286.7
X	30.2	61.5	70.0	81	176,0	170.7
Ave-rage	436	483.9			2,176.5	2,340.0

- The evolution of the grapes maturity

The evolution of the maturation process for ‚Victoria' variety was carried out starting with 10.07.2019 (Table 4 and Figure 5) when the grapes characteristics were: weight of 100 grapes, 180.3 g; sugars, 52.2 g/l, total acidity, 10.5 g/l H_2SO_4. At harvest the grapes weight and acidity slightly decreased and sugars slightly increased.

Table 4. The evolution of the table grapes maturity in the Cernavoda vine center in 2019

Grapes variety	Date of sample harvest and analysis	Analised element		
		Weigh of 100 grapes berries (g)	Sugars (g)	Total acidity (g/l H2SO4)
'Victoria'	10.07. 2019	180.3	52.2	10.5
	15.07. 2019	199.0	58.1	9.4
	20.07. 2019	215.7	65.1	8.5
	25.07. 2019	240.0	79.6	7.4
	30.07. 2019	290.3	92.5	6.9
	04.08.2019	312.5	110.9	6.1
	09. 08.2019	337.4	129.6	5.6
	14. 08.2019	350.1	140.8	4.8
	21.08.2019	380.1	154.9	3.8
	24.08.2019	405.5	156.7 Commercial maturity	3.5
	26. 08.2019	395.2	157.1 Harvest	3.1

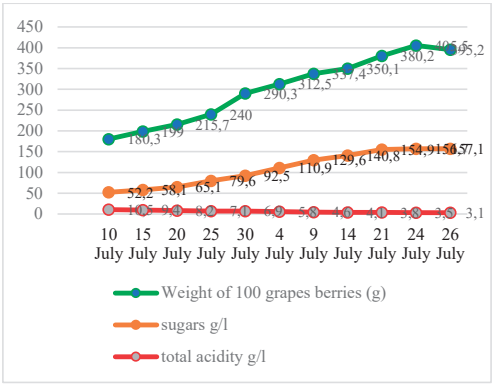

Figure 5. The evolution of the table grapes maturity in the Cernavoda vine center in 2019

From the Table 4 and Figure 5, it can be seen that the commercial maturity of the Victoria variety was reached on 24.08.2019, and the harvest started on 26.08.2019, the grapes having the characteristics: weight of 100 grapes, 405.5 g; sugars, 157.1 g/l, total acidity, 3.1 g/l H_2SO_4.

For the others variety, respectivly 'Riesling Italian' and 'Merlot' (both grapes for wine) the evolution of the full maturity of the grapes, started with 15.08. 2019. The data obtained are presented in the Tables 5 and 6.

Table 5. The evolution of the grapes full maturity for 'Riesling Italian' variety

Grapes variety	Date of sample harvest and analysis	Analised element		
		Weigh of 100 grapes berries (g)	Sugars (g)	Total acidity (g/l H_2SO_4)
'Riesling Italian'	15. 08.2019	94.5	168.5	9.4
	20. 08.2019	99.9	174.9	8.9
	25. 08.2019	106.3	180.7	8.2
	30. 08.2019	111.5	188.6	7.8
	05.09.2019	115.1	202.3	7.0
	10.09.2019	120.7	210.7	6.5
	15.09.2019	128.5	217.0	6.1
	20.09.2019	134.8	224.5	5.7
	25.09.2019	141.5	230.8 Full maturity	5.2
	28.09.2019	137.6	232.8 Harvest	4.7

From the Table 5, it can be seen that the grapes of 'Riesling Italian' variety reached full maturity in 25.09.2019, when the grapes had 230.8 g/l sugars and the weight of 100 grapes berries had 141.5 g, and a balanced acidity, than the last two parameters start to decrease. From the Table 6, the grapes of 'Merlot' variety reached full maturity in 03.10.2019,

when the grapes had 235 g/l sugars, the weight of 100 grapes berries had 148 g and acidity 6.02 g/l H_2SO_4.

Table 6. The evolution of the grapes full and phenolic maturity for 'Merlot' variety

Grapes variety	Date of sample harvest and analysis	Analised element			
		Weigh of 100 grapes berries (g)	Sugars (g)	Total acidity (g/l H_2SO_4	Antho-cians mg/kg
'Merlot'	15. 08.2019	72	129.0	12.9	72
	20. 08.2019	78	137.5	12.1	190
	25. 08.2019	85	147.1	11.5	310
	30. 08.2019	98	161.9	10.6	420
	05.09.2019	105	169.7	9.7	580
	10.09.2019	112	182.6	9.1	750
	15.09.2019	120	194.7	8.5	890
	20.09.2019	128	207.8	7.9	1,070
	25.09.2019	136	217.1	7.0	1,360
	30.09.2019	140	228.7	6.5	1,560
	03.10.2019	148	235.0	6.02	1,680
		Full & phenolic maturity			
	06.10	143	236.1 Harvest	6	1,610

In this case the full maturity was reached in the same time with phenolic maturity (specific to black varieties) when the anthocyanins accumulated in the grape skin reached the maximum value of 1680 mg/kg (Figure 6), then these values started to decrease also.

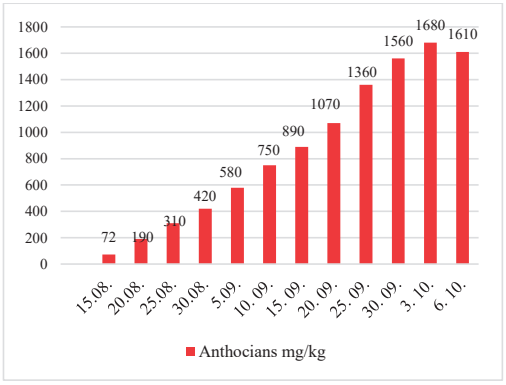

Figure 6. 'Merlot' - the quantity of anthocyanins in the grape skin (2019)

The data from Figure 6 show that the 'Merlot' grapes contain sufficient amounts of anthocyans, that according to the wine technology will ensure a specific color of the future 'Merlot' red wine.

At the beginning of the grapes maturity period (15.08.2019), the weight of 100 grapes was different according to variety, having values between 72-94.5 g. In the interval 15.08 - 31.08 2019, the increase of weight of the grapes was ascending, growing relatively little and differently depending on the variety (Figure 7).

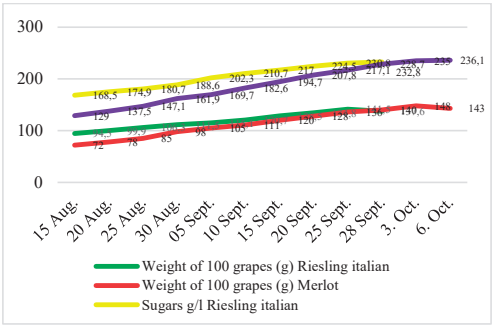

Figure 7. Evolution of grape weight and sugar content in 'Riesling Italian' and 'Melot' varieties

In the first decade of September due to precipitation, there was a slight stagnation of grapes growth. After this period due to the increased influx of leaf sugars and moderate amounts of water absorbed by plants from the soil, in order to achieve osmotic balance, the weight of the grapes increased, so that at harvest date they reached values of: 137.6 g - 'Riesling Italian' and 143 g - 'Merlot'. Referring to the sugars evolution (Figure 7), at the first determination they had values between 129 ('Merlot') and 168.5 g/l ('Riesling Italian') and than increased to 232.8 g/l ('Riesling Italian') and 236.1 g/l ('Merlot') at harvest.

The total acidity parameter at the beginning of the grape maturity, was 9.4 g/l H_2SO_4 ('Riesling Italian') and 12.9 g/l H_2SO_4 ('Merlot'). The total acidity decreased in both grapes varieties and at the end of the analyzed period (at harvest), its values registered between 4.7 g/l H_2SO_4 ('Riesling Italian') and 6.0 g/l H_2SO_4 ('Merlot') (Figure 8).

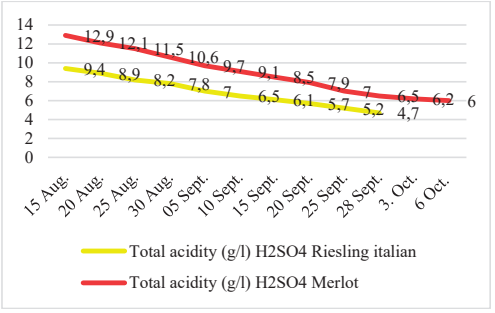

Figure 8. Total acidity evolution of 'Riesling Italian' and 'Merlot'

From the obtained data it appears that the evolution of the grapes weight and the concentration in sugars are the main indicators which help us to establishe the moment of full maturity. The study of the evolution of total acidity is important because, together with the concentration in sugars, provide us data on the grapes quality side.

The mechanical composition was determined for each grapes variety. This consist in the analysis of 1 kg of grapes, the analysis of 100 grapes berries and the calculation of the uvological indices (Table 7).

Table 7. Mechanical composition of the three grapes variety in 2019 year (average data)

Variety / Analized elements	'Victoria'	'Resling Italian'	'Merlot'
1 kg of grapes contains:			
Bunches, g	23.5	36.0	53.0
Grape berries, g	930.5	952.0	921.0
Grape berries, no.	180.0	943.0	943.0
Must, ml	670.0	699.0	680.0
Must, g	770.0	763.0	755.0
Skin and hard parts of the pulp, g	175.0	155.9	150.0
Seeds, g	48,1	40.0	46.0
Total husks of grapes, g	241.6	231.9	249.0
100 grapes berries have:			
Total weight, g	580.0	147.0	138.2
Skin, g	29.0	23.0	22.2
Pulp, g	570.4	125.6	130.0
Seeds, g	9.0	6.0	6.0
Number of seeds	220.0	180.0	179.0
Seeds weight of 100 g	4.0	3.9	3.6
Uvological indices:			
Grape structure index	39.6	26.4	17.37
Grape berrie index	29.0	96.0	94.0
Grape berrie composition index	15.01	4.33	4.60
Efficiency index	3.18	3.29	3.03

From the table 7, it can observed that the values of the analyzed parameters are specific to the studied varieties. The values of the efficienty index are close to the three varieties (3.03-3.29). In the specialized literature this index is not considered as a criterion in distinguishing the wine varieties, those for the table (Cotea, 1985). In the case of wines grapes varieties, the uvological characterization allows the varieties association in technological assortments and the establishment the best technologies for obtaining different categories and types of wines.

CONCLUSIONS

Grapes maturity from Cernavoda vine centre is a complex process, dependent of many factors.

The complexity process was different from one variety to another, depending of the grapes destination and the quality of the products obtained from them.

The climatic factors (heat, light and humidity), influenced the ripening process in 2019.

The studied varieties reached the corresponding maturity at different dates, the ripening time being a criterion in their classification.

All the results presented in the paper (grapes weight, sugars, acidity) correspond to the studied varieties.

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