Scientific Papers. Series B, Horticulture. Vol. LXIX, No. 2, 2025
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

STUDY ON THE BEHAVIOR AND DEGREE OF ADAPTABILITY OF THE MATILDE VARIETY IN THE CLIMATE CONDITIONS IN ROMANIA

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Abstract

The Romanian wine-growing area, through all the terroir conditions offered, ensures the cultivation of a varied range of table grape varieties, both from the international and domestic assortment, thanks to the generosity of the orographic, climatic, pedological factors and, last but not least, the applied technology, rich in innovative measures to ensure a good plant-productive balance. In the present work, the observations, measurements and analyzes focused on the evaluation of the agrobiological and technological parameters of the 'Matilde' variety, verified by calculating specific and representative indices that provide clues about the adaptation of this variety to the climatic conditions of southeastern Romania, different from of the place of origin of the variety. The results obtained, supported by the attributes and quality of the production, offer a positive perspective, which can include the variety in the planting list of economic agents who grow table grapes.

Key words*: adaptation, climate change, grape, quality, yield.*

INTRODUCTION

Of a world production of 80.1 Mt, 45.7% is destined for wine production, 47.4% for direct consumption as table grapes and only 6.9% for dried grapes, and the rest for the production of musts and juices (OIV, 2024). The increasingly high demands and preferences of consumers for table grapes are generally directed towards quality attributes, seen from a compositional perspective (Crespo et al., 2024; Seccia et al., 2019; Di Lorenzo et al., 2019), but also towards those related to aesthetics - the shape, size and shape of the berries, the shape, size and bunch density, uniformity of size, the firmness of flesh, taste and particular flavor (strong Muscat aromas), the uniformity of color, at full maturity (Rolle et al., 2011; 2013), the ripening period or any other qualitative attribute specific to grapes (Cichi et al., 2023; Benbouguerra et al., 2021; Dobrei et al., 2020; Tahereh et al., 2020). Therefore, producers must align their offers with consumer expectations and increase competitiveness and market dynamics. In order to meet this objective, the curators of ampelographic collections, upon the immediate appearance of news created varieties, take them into agronomic observation so that they can be evaluated from a quantitative and qualitative point of view. Most of the time, institutions holding viticultural germplasm are located in areas fundamentally different from the areas where the varieties were obtained, and then it is imperative to monitor the size of production in order to better quantify the notion of quality and competitive product. Therefore, ampelographic collections have the essential role of preserving and saving vine planting material and maintaining varietal biodiversity, and they also have a role in testing these varieties. The scientific results obtained here will be disseminated and transferred to economic agents who cultivate table grapes and will play a significant role in the decision-making process to enrich the varietal assortment of each country, shaping the dynamics of the consumer market (Cichi et al., 2019; Seccia et al., 2019). The study was approached starting from two considerations: determining and evaluating the agrobiological performances of the 'Matilde' variety (obtained in Italy) cultivated in an area different from its

origin, in the specific conditions of the South-East of Romania, and quantifying the productive balance in terms of defining quality parameters (Pârcălabu, 2010, cited by Stroe & Budescu, 2013). Basically, the idea was that, regardless of the origin of the varieties, their vigor, production capacity - their adaptability is also given by their genetics and how they are influenced by climatic and agrotechnical factors. Therefore, in studies that follow the behavior of grapevine varieties in areas different from their place of origin, more and more attention is paid to research that targets the mode of vegetative-productive manifestation, as a direct result of physiological processes and applied cultural practices.

MATERIALS AND METHODS

Plant Material and Growth Condition

The research was carried out in two years wine growers 2022-2023 and 2023-2024 at the located in the experimental field of the ampelography collection from University of Agronomic Sciences and Veterinary Medicine of Bucharest, with the code "ROM 06" in international platform the https://www.vivc.de/ (N Lat.: 44°47'07"; E Long.: 26°07'28"; alt. 87 m). The variety studied was the ‚Matilde' recognized for its precocity, productivity and special organoleptic qualities, which in our country we find only in ampelographic collections.https://www.vivairauscedo.com/en/product-sheet/matilde/. It was obtained in 1962 by Manzo P. at the Horticultural Research Institute of Roma. The genitors are ‚Italia' and ‚Cardinal'.The variety has a medium-large, ovoid and the color of skin is white. The flesh is crispy flesh with a discreet muscat flavor, and is used in its country of origin as a table variety, consumed fresh and in compotes. https://www.vivc.de/index.php?r=passport%2Fview&id=7512. The plantation planted in 2018 at a distance by 2.2 m (inter-row) and 1.2 m (intra-row), with a density of 3787 plant ha-1. The type of pruning applied is double Guyot on the stem 1.0 m, and the load distributed on the plant was 32 buds/vine. The variety was grafted on SO4-5 rootstock. During the vegetation period, a whole set of green special and operations specific to the table grape ensuring adequate management adapted to the growth vigor of this variety. The crop was managed with irrigation in critical phenophases (intense berry growth), fertilizer application and a standard disease control program was applied to control downy mildew (*Plasmopara viticola*), and gray rot (*Botrytis)*.

Sampling and Chemical Analysis

For the proposed objective - monitoring the behavior of this variety in the conditions of southeastern Romania, observations and determinations were made regarding the calendar course of the phenological spectrum and observations regarding the agrobiological and technological characterization. Each phenophase was considered for registration when the dates were recorded at which 50% of the buds, flowers, grapes reached the respective phenological stages (BBCH 08 - budburst; BBCH 65 - flowering; BBCH 81 - veraison and BBCH 89 - ripe berries for harvesting). Phenological information was expressed as "day of year" (DOY), as the number of days after January 1. During the vegetation period, determinations were made on the basis of which the fertility coefficients (absolute, relative) and productivity indices (absolute and relative) were calculated, as well as the number of grapes per bunch, the average weight of a grape, the berry weight (g), yield (kg/vine), sugars (g/l), acidity (g/l tartaric acid), pH. The content of solide solubile totale (TSS), were determined from 5 grape for each sample with refractive device Kruss DR301-95 (% Brix) (Mureşan, 2014; Oltenacu, 2015).The titratable acidity (TA) was determined by titration with 0.1N NaOH to pH 8.1, and the results were expressed in g tartaric acid/100 g. Titratable acidity calculation was done using the formula: Titratable acidity (%) = (V x N x C x 100)/m where V = volume of NaOH consumed; N = NaOH normality; C = tartaric acid equivalent; m = sample mass; C has values: 0.0075 to express acidity in tartaric acid (specificity for grapes, shoots, bananas). The maturation index, also known as the acidometric balance index, was calculated using the formula: TSS/TA. For all determinations were performed in triplicate. Statistical analyses were performed using Excel, including: average, standard deviation. To evaluate the quality of the production obtained, the notion of grape production quality was quantified (Pârcălabu, 2010, cited by Stroe

& Budescu, 2013) which was expressed by three components: yield/vine, (kg/vine); TSS, (g/l); TA, (g/l tartaric acid). Therefore, the quality denoted by Q would be a vector with three elements: Q = (Y, TSS, TA) and which offers a perspective on the balance between quantity and quality which in table varieties are not in antithesis, but because the study also addresses the adaptability of the variety, this approach was needed. For this, each quality component (Y, TSS, TA) is divided by the optimal values of each variety: Yopt, TSSopt, TAopt, considered to be the values obtained in Italy, as follows: TSS: 14-15 (% Brix), TA: 4.5 (g/l tartaric acid) and yield 13.20 (kg/vine). Therefore, the following are defined: The production quality coefficient: cY defined by the equation: cY=Y/Yopt; The quality coefficient in the content of the must in sugars: cTSS defined by the equation: cTSS = TSS/TSSopt; The quality coefficient in the content of the must in total acidity: cTA=TA/TAopt. The quality vector has the component Q = (cY, cTSS, cTA). The best quality is considered when for each component, the quality coefficients have a value close to 1. his being the ideal case, c= (1, 1, 1) or if expressed as a percentage then this value will become c=(100%, 100%, 100%). If the values of the quality coefficients are sub-unit or super-unit, the quality of the harvest is not within optimal parameters. In order to more easily estimate how qualitatively a variety performs within an area or following an applied technology, the relative quality coefficient (relative to optimal values) can be introduced, also defined by the three components:

Relative quality coefficient in production: cY defined by the equation: cYr=(Y-Yopt)/Yopt=cY-1; Relative quality coefficient in the sugar content of the must: cTSSr = (TSS-TSSopt)/TSSopt = cTSS-1; The relative quality coefficient in the must content in total acidity defined by the equation: cTAr = (TA-TAopt)/TAopt = cTA-1. The quality vector has in this case the component Qr = (cYr, cTSSr, cTAr). When assessing the quality potential of a variety according to the relative quality coefficient, it will be taken into account that the variety has better adaptability to the area as the values of the relative quality coefficients approach zero.

RESULTS AND DISCUSSIONS

Climatic conditions

The analysis of the climatic context in the analyzed period (2022-2024), assessed by comparison with the average of the 1991-2020 interval, shows that thermal resources are very high compared to the average, both in relation to the multiannual average and for each individual year, against the backdrop of drastically reduced water resources. Total precipitation in the growing season (IV-X), in 2023 it decreased by 213 compared to the average mm, and in 2024 it records a decrease of 91 mm.

Table 1. The main climatic parameters and bioclimatic indices during the experimentation period

Climatic parameters and bioclimatic indices	Average (1991-2020)	Years	
		2023	2024
Average annual temperature, ºC	10.98	14.61	14.70
Average temperature in the growing season, ºC (IV-X)	17.46	21.01	20.62
Average temperature in summer, ºC (VI-VIII)	22.15	27.22	26.30
Average annual minimum temperature, ºC	5.24	7.10	7.70
Average annual maximum temperature, ºC	17.6	21.20	21.10
Number of hot days (T_{max} > 30°C)	48	54	52
Number of very hot days (T_{max} > 35°C)	10	23	38
Annual total precipitation, mm	633	435	583
Total precipitation in the growing season (IV-X), mm	430	217	339
Total precipitation in summer (VI-VIII), mm	193	94	180
Hydrothermal coefficient (CH)	1.1	0.64	0.75
Huglin index (HI, Huglin, 1978)	3163	4054	4138
Winkler index (WI, Winkler)	1762	2356	2273
Cool night index (CI)	10.64	14.1	13.5

But even in these conditions, at such values, good results cannot be obtained, regardless of the variety or the set of green works and operations performed, irrigation being needed especially in critical phenophases. As for the climatic indicators (Huglin index, Winkler index, Cool night index), their values register a large amplitude, far exceeding the limits of a warm temperate climate with cool nights and passing into a warm climate with cold nights, (Bucur & Stroe, 2023). Practically, average temperature in summer, ºC (VI-VIII) (27.22 and 26.30) and especially those recorded in the last decade of ripening, accompanied by the temperatures recorded during the night (with differences from day to night) leave their mark on TSS (%), TA, gluco-acidometric index, pH

which are at the limit of potential according to the data in the genetic passport of the variety (Table 1).

Development of the main phenophases

The onset of the phenological stages and the interval between them are given by the genetics of the variety, first of all, then by the climatic and soil conditions and viticultural practices. For both years taken into study (Table 2) the average day of the year (DOY) values of the four phenological stages of the vine (budburst, flowering, veraison and harvest) show that, budbreak occurred on average 106 DOY (April 16 - 2023) and (April 102 - 2024). **Flowering** occurred on average at DOY 161 (June 10), exactly 55 days after budbreak (Stroe, 2020) suggesting precocity in this area of southern Romania as well. Regarding the other phenophases **veraison** was recorded on average at DOY 218, respectively 217 (August 6, 2023 and August 5, 2024), demonstrating a constancy of the variety. The average day of the year of ripening grape, for the 2 years studied, was DOY 246 and 248 (September 03 and September 5), with differences of only 2 days. Looking at the climatic conditions - average temperature in the growing season, ºC (IV-X) records higher values in 2023 (21.01), which shows that the onset of an earlier bud break in 2023 was followed by a close approximation of the data for the other 3 phenophases.

Fertility and productivity

The elements of fertility and productivity represent a complex determinant of the level of production that are influenced by the hereditary basis, the rootstock used, the applied agrotechnics, as well as the particularities of the climatic conditions specific to each harvest year. According to the data recorded in Tables 2 and 3, the variety was distinguished by an average fertility, falling into the variation class 1.1-2.0. The highest value was obtained in 2024 - (Fca = 1.21, Fcr = 0.75). These values influenced the productivity indices values, which due to the large size of the average weight of the grape (525.4 g), had values ranging between 635.73 g/shoot (Pia), respectively 394.05 g/ shoot (Pir); Finally, the number of grapes obtained per vine (Table 3), together with the average weight, gives us a perspective of the total production per vine - 11.02 kg/vine (2023) and 12.08 kg/vine (2024), quite high values for the specific conditions of the southeast of Romania. A positive side can be noted in the case of berry weight where the average value recorded of 5.35g although small compared to the potential of the variety (6-7 g) is large enough to ensure a special commercial appearance to the bunch. Regarding the organoleptic potential seen from the perspective of variation of: TSS (%), TA, gluco-acidometric index, pH during the 2022-2024, these fully meet the quality standards of table grape varieties, according to the commercial quality standards developed by the Working Party on Agricultural Quality Standards of the United Nations Economic Commission for Europe (UNECE, 2017) and OIV Resolution VITI 1/2008 (OIV, 2008, cited by Cichi et al., 2023; Stroe et al., 2021). Table grapes can be harvested at lower sugar concentrations compared to wine varieties, but not less than 16°Brix, with the exception of a few exceptions depending on the climate of each country. The data referring to these parameters indicate values that prove that the 'Matilde' variety has qualities that suggest that it can sometimes surpass its parental phenotype (especially the 'Cardinal' variety). The amounts of accumulated sugars are satisfactory, being in correlation with acidity, ensuring a balanced gluco-acidimetric index in accordance with standards required by the consumer (2.5÷4.5).

http://catalogoviti.politicheagricole.it/scheda.php?codice=547

Table 2. Mean day of year (DOY) of the phenological stages (budburst; flowering; veraison and harvest) and the synthesis of the main fertility elements of varieties study (2022-2024)

Main phenophases	Budburst date (DOY)	Flowering date (DOY)	Veraison date (DOY)	Harvest maturity date (DOY)
	Mean	Mean	Mean	Mean
2023	106 (April 16)	161 (June 10)	218 (August 6)	246 (September 3)
2024	102 (April 12)	161 (june 10)	217 (August5)	248 (September 5)

	Fertility coefficient (Fc)		Bunch weight (g)	Productivity indices (Pi)		Y/v[1] (kg/vine)	Y/ha (kg estimated)
	absolute	relative		Absolute (g/shoot)	Relative (g/shoot)		
2023	1.10	0.66	509.4	560.34	336.2	11.20	42.414
2024	1.21	0.75	525.4	635.73	394.05	12.08	45.747
					Mean	**11.64**	**44.080**

[1]Y/v = Yield/vine (kg)

Table 3.Synthesis regarding the characteristics of grapes and berries of the studied variety during the 2022-2024

Experimental year	No. bunch/vine		Bunch weight (g)		Berry weight (g)	
	Average	Std. dev.	Average	Std. dev.	Average	Std. dev.
2022-2023	22.0	±3.39	509.4	±12.92	5.3	±0.40
2023-2024	28.0	±3.74	525.4	±100.19	5.4	±0.25
Mean	25	±3.56	517.7	±11.67	5.35	±0.32

Table 4. Variation of: TSS (%), TA, gluco-acidometric index, pH during the 2022-2024

Experimental year	TSS[2](%)		TA[3] (g/L tartaric acid)		Gluco-acidometric index		pH	
	Average	Std. dev.	Average	Std. dev.	Average	Std. dev.	Average	Std. dev.
2022-2023	16.1	±0.60	4.00	±0.10	3.70	±0.35	3.51	±0.07
2023-2024	15.0	±0.12	3.9	±0.36	3.48	±0.24	3.63	±0.11
Mean	15.55	±0.36	3.95	±0.23	3.59	±0.29	3.57	±0.09

[2]TSS% = total soluble solids (Brix);[3]TA% Titrable acidity

Table 5. Variation of: TSS (%), TA, gluco-acidometric index, pH during the 2022-2023

Mean experimental years - (2022-2023); (2023-2024)				
'M A T I L D E'	c*Y* =Y/Y_{opt}[4] 0.88	Q = (cY, cTSS, cTA) (0.88; 1.07; 0.87) (88%, 107.24%, 87%)	*cYr =(Y-Yopt)/Yopt= cY -1* 0.12	Qr = (c*Yr*, c*TSSr*, c*TAr*) (0.12; 0.072; 0.13)
	c*TSS* =TSS/TSS_{opt}[4] 1.07		*cTSSr =(TSS-TSSopt)/TSSopt = cTSS -1* 0.072	
	c*TA* =TA/TA_{opt}[4] 0.87		*cTAr = (TA-TAopt)/TAopt = cTA -1* 0.13	

[4]The optimal values are: sugars 14.5[0] Brix (TSS), 4.5 (g/l tartaric acid) TA; 13.20 (kg/vine) Y/v[1]

The TSS(%), TA (g/L tartaric acid) values, which are a good substrate for the entire metabolism of the plant, emphasize the discrete muscat aroma of the variety (from the maternal parent 'Italia' variety). Regarding the evaluation of the productive balance in terms of defining quality parameters, this was expressed by three components: yield/vine, (kg/vine); TSS, (g/l); TA, (g/l tartaric acid) and the following were obtained: for the production parameter, respectively the acidity of the fresh product, the values obtained 0.88 or 88% and 0.87 (87%) indicate that from this point of view the variety was below the optimal threshold. The value of 1.07 is the closest to the value 1 (ideal), for the sugars accumulated in the berries, which indicates that the variety has reached a technological potential very close to the optimum (varietal potential) at the moment of full maturity. The assessment of the

qualitative potential of the variety according to the values of the relative quality coefficient emphasizes the same thing that, in terms of the accumulation of sugars reached, the variety registers values close to zero, 0.04, which indicates a good adaptation of the variety against the backdrop of very favorable ecopedoclimatic conditions, followed hierarchically by acidity and yied/vine, whose values are lower, but quite high for the specific conditions of the Southeast of Romania.

CONCLUSIONS

The behavior of the 'Matilde' variety in an area quite favorable for the cultivation of vines, (N Lat.: 44°47'07"; E Long.: 26°07'28"; alt. 87 m), related to the objectives of the study - demonstrates a good adaptability. The data indicating the agrobiological and technological potential prove that the 'Matilde' variety has qualities that suggest that it can sometimes surpass its parental phenotype (especially the 'Cardinal' variety). The special organoleptic potential of the variety, marked by the quantities of accumulated sugars in good balance with acidity, ensures a balanced gluco-acidimetric index, located within the preferential limits of consumers. The results obtained, verified by calculating specific and representative indices and supported by the attributes and quality of the production, offer a positive perspective, which can include the variety in the planting list of economic agents who grow table grapes.

ACKNOWLEDGEMENTS

This research work was carried out with the support and was financed from Project ADER 6.1.7/18.07.2023, partnership No. 7, University of Agronomic Sciences and Veterinary Medicine of Bucharest.

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