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PRELIMINARY STUDIES ON THE INFLUENCE OF THE CLIMATE ON THE PHENOLOGY OF THE VARIETIES FOR BLACK GRAPEVINES GROWN IN THE BANU MĂRĂCINE VITICULTURAL CENTER

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ABSTRACT

Each wine-growing area is characterized by the presence of a complex of climatic, edaphic and anthropogenic factors, which can influence the moment of the onset of the phenophases, the duration of the phenophases, the quality and quantity of grape production, depending on the genetic characteristics of the varieties, the specific climatic conditions of the crop year and by the applied technology. Starting from these considerations, the present work represents a preliminary stage of a case study regarding the observation of how 3 grape varieties: Cabernet Sauvignon, Merlot and Fetească neagra go through the main phenophases in the climatic conditions specific to the Banu Maracine wine center in the year 2023, as well as the evaluation of the productive results obtained. The study proves to be important in the context of the changes found in the course of the phenophases as a result of the climate changes that have occurred in recent years.

INTRODUCTION

The effect of the variable climatic conditions in each crop year on the vines in different crop areas is the subject of studies by numerous researchers (Cichi et al. 2009, Costea et al. 2015, Mărăcineanu et al. 2019, Xenophon et al. 2020). The grapevine is a plant with great adaptability to variable environmental conditions (Pastore et al. 2022), but climate change studies predict scenarios for the coming years that could affect grapevine culture over large areas (Costea D. 2006, Leeuwen et al. 2019, Mărăcineanu et al. 2021). The ecological characteristics specific to the area and the climatic conditions specific to each crop year influence the intensity of the physiological and biochemical processes (Costea et al 2023, Giugea et al 2015, Mărăcineanu et al 2021), accumulation of substances that determine the quality of the grape harvest and give specific results to the wines obtained in year and respective area (Căpruciu et al. 2022, Costea et al. 2015, Dobrei et al. 2023). Temperature variation influences the chemical composition of grapes, sugar accumulation, acidity, anthocyanin content and flavor precursors (Bucur & Dejeu 2017, Căpruciu et al 2023, Mărăcineanu et al 2019).

The period of active vegetation includes several phenophases, each representing a certain manifestation of the plant, externally visible through

morphological changes. Knowing all these phenophases helps the technologist to establish and correctly apply agrophytotechnical measures (Giugea et al 2011). The temporal rhythmicity of plant phenology is mainly attributed to climatic rhythmicity, photoperiod, and response properties of phenological phenomena to weather and climate (Chen 2017). The studies showed that the insignificant correlation coefficients between the dates of occurrence of the phenophase in the current year and the next year; therefore, the occurrence date of the phenophase in the current year does not influence the occurrence date of the same phenophase in the following year (Jiang Mengdi et al. 2020).

Phenological data have recently been used to suggest that the length of the growing season in Europe has increased over the past 30 years by one week in both spring and autumn. Budding is an indicator of the beginning of spring. To break dormancy, buds must accumulate a certain amount of heat, in degree-days, above a certain temperature threshold (John Worrall, 1999).

Daily average temperature data were used to simulate the timing of grape phenological stages using different phenological models Phenological models are important tools with a wide range of applications in viticulture. The models can be applied in the short-term planning of viticultural practices, to establish technological works for different stages of grape growth and development (Galvan et al. 2009). Phenological models have proven to be useful tools for projecting the impact of climate change on viticulture (Duchêne et al. 2010). Obvious phenological changes have been observed in different regions and in different grape varieties (Duchêne and Schneider 2005; García de Cortázar-Atauri et al. 2017). Increasing temperature, combined with advancing phenological phases, will profoundly affect many different processes during plant growth, altering both the quality and quantity of production obtained. Sugar content is considered to be a good indicator of maturity, but it can be influenced by many other factors besides climate (Jackson and Lombard, 1993).

Through the research carried out, the scientific community tries to offer technological solutions to the growers to counteract the negative effect of the variability of the climatic conditions by trying to identify the reaction mechanisms of the vine (Costea et al. 2010) one of the methods used with being the study of phenology.

MATERIAL AND METHODS

Observations and determinations were made at the wine farm at the Banu Mărăcine Didactic Station, located in the demarcated area for the production of wines with Controlled Designation of Origin (DOC) "Banu Mărăcine" (44.3550N, 23.6810E), on a terrain with slopes of 10º-30º and the maximum altitude of 500 m.

To characterize the wine-climate specific to the 2023 wine year, meteorological data were obtained from the Oltenia Regional Weather Center. These were interpreted by using some climatic indicators used by viticultural ecology (numerical method) but also by making the climagram of the year 2023, as a graphic method of characterization.

The effect of varied climatic resources on the studied varieties was evalua. The identification of vegetation phases (phenophases) was made using the BBCH phenological scale for grapevines. The working method involved making observations starting in March and ending in September. At each moment, several plants of the same variety were observed, and the vegetation phases identified were noted. In the content of the work, reference will be made to the following

phenophases BBCH: 00-Dormancy, 01-Beginning of bud swelling, 10-the appearance of leaves, 13-3rd leaves unfolded, 14-4 leaves unfolded, 53-Inflorescences clearly visible, 55-Inflorescences swelling, flowers closely pressed together, 73- Groat-sized berries, 75- Pea-sized berries, 89- Berries ripe for harvest. For each vegetation phase, the heat balance accumulated up to the time of its initiation was calculated, then the number of the day of the year (DOY) on which they were initiated was determined.

Qualitative evaluation of grape production was carried out at full maturity, at the last determination in the field when grapes were harvested from the observed plants.

RESULTS AND DISCUSSIONS

Oenoclimatic evaluation of the Banu Mărăcine wine-growing center.

The main climatic characteristics recorded in Banu Mărăcine, in 2023, are presented in figure 1. From figure 1 it can be seen that the number of hours of sunshine during the vegetation period (real insolation) recorded a value of 1429.7 hours.

This value allowed a first oenoclimatic characterization of the wine-growing center. According to it, the area is favorable for obtaining white and aromatic wines, sparkling wines and distillates from wine.

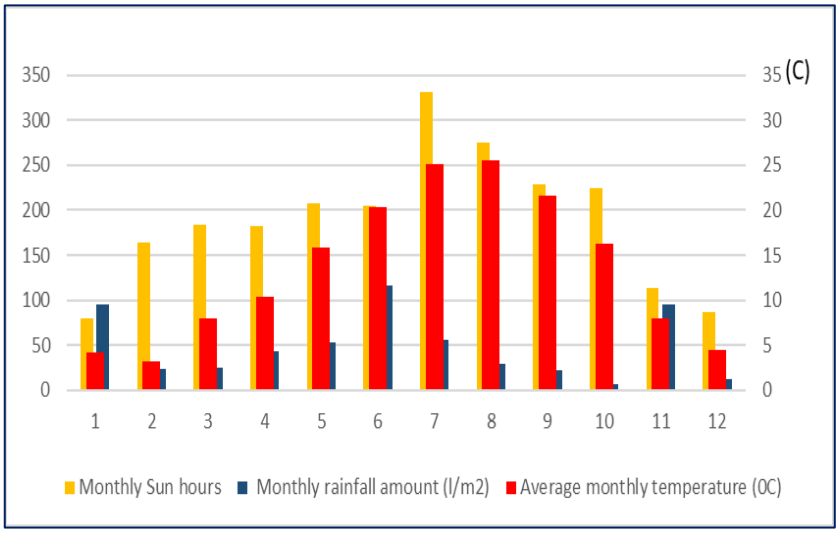

Figure 1. Evolution of some climate parameters recorded at Banu Mărăcine, 2023

In the same interval, the amount of precipitation was 318.1 l/m^2 and the annual amount of precipitation was 575.4 l/m^2 and the global heat balance recorded an amount of 3627.5 ^{o}C and the useful heat balance of 1797.5 ^{o}C .

The calculated value of the heliothermic index was 2.6 and that of the hydrothermal coefficient was 0.8. These values show the possibility of accumulation of carbohydrates in the grapes, so that the possibility of obtaining sweet wines is ensured.

The calculation of the ternary indicators, in the form of the oenoclimatic aptitude index (4989.1) and the bioclimatic index of the vine (8.9), allow us to conclude that the oenoclimate of Banu Mărăcine ensures the ripening of grapes from the middle ripening group and the obtaining of wines white, aromatic and top quality red wines.

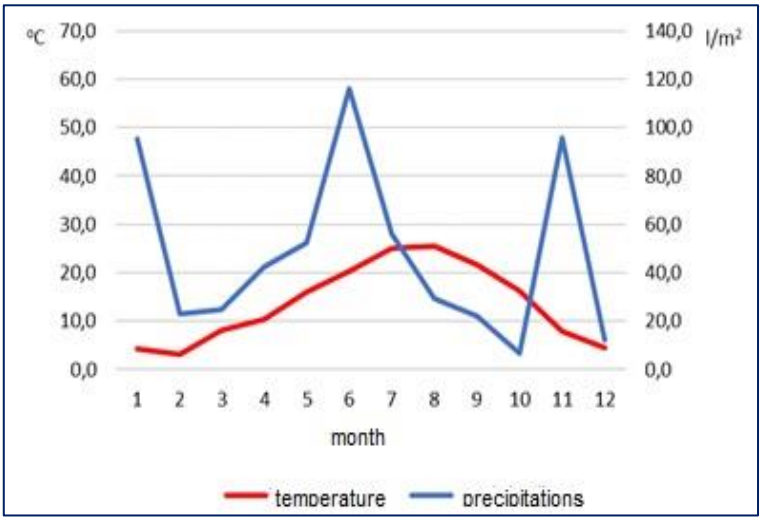

Figure 2. The climagram of the year 2023

The climagram of the year 2023 (figure 2) shows that in the period between the end of summer and autumn, there was a water deficit at Banu Mărăcine that overlaps with the period of grape ripening; this can be beneficial for quality.

Identification of phenophases and correlation with climate characteristics

In order to identify the vegetation phases, observations were made in the field on the following calendar dates: 30.03.2023, 13.04.2023, 24.04.2023. 16.05.2023, 30.06.2023 and 7.09.2023. The observations made showed that the vegetation phases of the 3 varieties were not identical, but there were close moments. In this context, Merlot is the most delayed variety in terms of the time of the beginning of the phenophases, while the Fetească neagra and Cabernet-Sauvignon varieties have a similar evolution.

Thus, at the first moment of observation, the Merlot variety was at the BBCH 00 stage and the other two varieties at the BBCH 01 stage; at the 2nd observation time, the Merlot variety was at the BBCH 01 stage and the other two varieties at the BBCH 05 stage; in the 3rd time of observation, the Merlot variety was at BBCH 10, Fetească neagră at BBCH 13 and Cabernet-Sauvignon at BBCH 14; at the 4th observation time, the Merlot variety was at the BBCH 53 stage and Fetească neagră and Cabernet-Sauvignon, at BBCH 55; at observation no. 5, the Merlot variety was at the BBCH 73 stage and Fetească neagră and Cabernet-Sauvignon, at BBCH 75; at the time of observation with no. 6, all varieties were at the BBCH 89 stage.

The observed differences are also highlighted by calculating the days required until the onset of the observed vegetation phases (DOY – number of the day of the year). The existing differences in this case were recorded in table no. 1

Table 1

The number of days required for the beginning of the phenophases

Merlot						
Phenophase	00	01	10	53	73	89
Date	30.03	13.04	24.04	16.05	30.06	7.09
DOY	89	103	114	136	181	264
Fetească neagră						
Phenophase	01	05	13	55	75	89
Date	30.03	13.04	24.04	16.05	30.06	7.09
DOY	89	103	114	136	181	264
Cabernet - Sauvignon						
Phenophase	01	05	14	55	75	89
Date	30.03	13.04	24.04	16.05	30.06	7.09
DOY	89	103	114	136	181	264

The data in table 1 show a certain earliness of the Fetească neagră and Cabernet – Sauvignon varieties compared to the Merlot variety. Basically, on the same date, on the same DOY, the vegetation stage was more advanced. This allowed the graphical transposition, in the form of a phenogram, of the calculated data, with the graphical highlighting of these differences (figure 3).

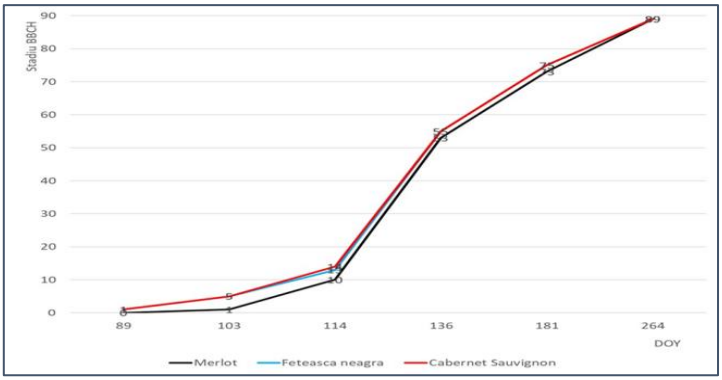

Figure 3. Phenogram of the studied varieties

The phenogram (fig 3) shows the differences between the varieties regarding the beginning of the phenophases in the conditions of 2023. On the occasion of the first observation in the field, 2 of the varieties (Fetească neagră and Cabernet) were in the bud swelling phase (BBCH01) and Merlot in the previous stage winter bud (BBCH00). The differences are still maintained, so that the 2 varieties are slightly more advanced in vegetation and in the following observations in the field. On the occasion of the last determination carried out on 7.09.2023, all varieties could be assessed as having reached maturity.

To complete the interpretation, the sum of the temperature degrees that accumulated until the beginning of the vegetation phases (thermal balance) was also calculated.

Table 2

The thermal balance accumulated up to the date of the beginning of the phenophases

Observation number	1	2	3	4	5	6
Date	30.03	13.04	24.04	16.05	30.06	7.09
Accumulated global heat balance (ºC)	459,8	601,7	715	1031,2	1878,7	3598,5
Accumulated global heat balance (% of total)	6	7	9	12	23	43

From the data presented in table 2, it can be observed that in the Cabernet Sauvignon and Fetească neagră varieties, the same temperature level ensured a different phenological expression, compared to the Merlot variety, in the sense of a more advanced vegetation. The differences were maintained until the full maturation phase.

Qualitative evaluation of grape production at full maturity

At full maturity, the determination of the sugars content indicated a potential alcoholic degree of the future wine of: 15 vol % alcohol for Merlot; 16 vol% alcohol for Cabernet-Sauvignon; 16 vol % alcohol for Fetească neagră. The correspondence with the accumulated sugars content is presented in figure 4

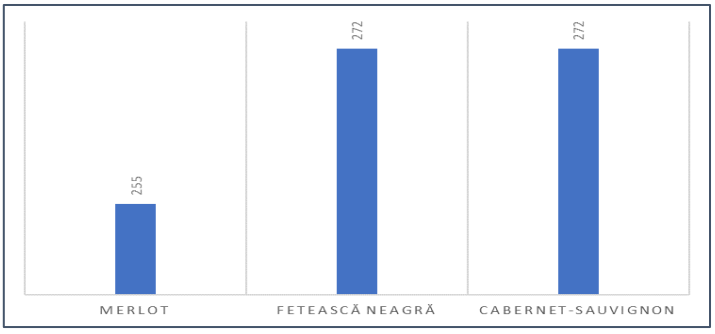

Figure 4. Sugar content of grapes at full ripeness (g/l)

The high amounts of accumulated sugar can be explained by the oenological aptitude of this wine-growing area, by the aptitude of the variety but also by the calendar moment in which the determination was made. The longer the time of picking is delayed, in the conditions of a favorable wine year, the higher the sugar content.

CONCLUSIONS

The oenoclimatic assessment of a wine-growing area is more accurate if both the wine-growing climate indicators and graphical methods are used, such as the climagram; from this point of view, the evaluation demonstrated that from an oenoclimatic point of view, the Banu Mărăcine wine center presents favorable conditions for viticulture, both wine grapes and table grapes, with early, middle and late ripening.

The beginning and duration of the vegetation phenophases depends on the variety and the climatic conditions in the crop area; in the climatic conditions of 2023, the observations made demonstrated that the phenophases of vegetation started earlier in the Cabernet-Sauvignon and Fetească neagră varieties, compared to the Merlot variety.

The work can be continued in the following years in order to obtain a relevant amount of information that will allow the phenology characterization of red wine varieties grown at Banu Mărăcine

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