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CLIMATIC FACTOR INFLUENCE ON FETEASCĂ NEAGRA GRAPE VARIETY BEHAVIOR UNDER DEALU BUJORU VINEYARD CONDITIONS

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ABSTRACT

Fetească Neagră is a notable red grape variety indigenous to Romania. It is primarily grown in regions like Moldova and Muntenia. Fetească Neagră thrives in regions with a continental climate, benefiting from hot summers and cool winters. The current study aims at identifying climate factor modifications during 2019-2023, influencing the selected vine variety. Heat and temperature values, Rainfall regimes and specific vine index (Oenoclimate aptitude index, Huglin heliotermic index, night cooling index) were monitored. Current study results, show important changes of the main indices that define grape and wine quality due to possible global warming phenomena and Bujoru vineyard microclimate modifications. Overall, while global warming presents significant challenges, it also offers opportunities for innovation in viticulture. Fetească Neagră can be used as a bioclimatic indicator due to its sensitivity to climate factor variations. Viticulture strategies are being adapted whit the goal of finding new ways that maintain the regions characteristic Fetească Neagră wine organoleptic profile amidst current climate changes.

INTRODUCTION

Higher greenhouse gas concentrations have significantly modified Earth's energetic budget, with major weather and climate spatial pattern implications that also change their temporal regimes. These changes manifest not only by significant warming trends worldwide but also by changes in rainfall and other atmospheric variables, though with noteworthy spatial heterogeneities (Masson-Delmotte et al., 2021).Precipitation extremes will generally intensify in response to a warming climate. Acute modification of rainfall patterns is of particular concern, resulting in heavy rainfall and devastating floods. Often this intensification is explained as a consequence of the Clausius–Clapeyron law in a warmer world, under constant relative humidity (Tuel et al., 2022).Many viticultural areas around the world are faced whit maintaining know grapevine production that will require adaptation to climate change. Although adaptation strategies are providing insights, often these strategies overlook major constraints, ignore local adaptive capacity (Naulleau et al., 2021).It is essential that evaluation of adaptation regarding climate change impact needs to take in to account the complex relations between different indices (Gardner et al., 2021).

Vineyard water management has been a subject of interest for decades that manages wine quality.

Climate change and resulting water scarcity affect vine yields and wine quality (IPCC, 2015).Warming and drying trends, with an increased frequency and intensity of extreme weather events, particularly in summer months, are projected for Southern Europe (Tuel A. & Eltahir E. A., 2020).Grapevine cultivation practices for winemking, known as viticulture, is widely cited as a climate-sensitive system that has been used as an indicator of both historic and contemporary climate change. Potential climate change impact on viticulture, including climate variability or seasonal weather patterns, are rarely quantified (Mosedale et al., 2016). On an international scale Romania's viticulture practices through vineyards and viticultural centers, known not only for their fine wines, but also for the special quality of table grapes.

Statistical data analysis obtained from the Ministry of Agriculture and Rural Development, Data Source–National Institute of Statistics 2018, showed that Fetească Neagră variety is grown only on 2950 ha which represents a small amount when compared to Fetească Regală 14,010 ha and Fetească Albă cultivar is cultivated on an area of 9,298 ha (Bădulescu et al., 2020).

The current study aims at identifying climate factor modifications during 2019-2023 that influence the behavior of Fetească Neagră variety grown at Dealu Bujoru vineyard plantation.

MATERIAL AND METHODS

Experiments were carried out at Bujoru Research-Development Station, Galați County, Romania, on mature Fetească Neagră vines assessing variety yield and quality attributes via the following indices: actual production (kg/barrel), grape average mass(g), mass for 100 grape berries, volume for 100 grape berries, total sugar content and acidity.

Complex climate analysis was done by monitoring: Global heat balance, (Σt°g); Active thermal balance, (Σt°a); Useful heat balance, (Σt°u); Σ annual precipitation (mm);Σ rainfall during vegetation period (mm); Average annual temperature °C; Average temperature from the first and second decades/ June °C; Average temperatures during vegetation periods; average maximum temperatures during vegetation period; Mean maximum temperature values specific for August, °C; Insolation hours during vegetation period; Actual annual insolation. Climate data was compared to multiannual values from 2010-2019 except thermal regime behavior which was compared to specific temperate continental climate patterns.

CLIMATE DATA ANALYSIS

Climate factor variability have a deciding role in Fetească Neagră specific characteristics. Yield and variety specifics are heavily influenced by climate and dominant microclimate meteorological conditions (Smrkulj & Njavro, 2016)

Heat Balance parameters

Heat balance parameters showed a maximum values for 2022, whit low values for 2021 whit the exception of Active thermal balances, (Σt°a) which had a maximum specific for 2020 (3337). Global heat values varied from 3195 to 3483 (Σt°g) whit a SD values of 158.5695. Useful heat balance, (Σt°u) registered marginal increases, maximum values of 1698 (2022) compared to 2010-2019 (1697).

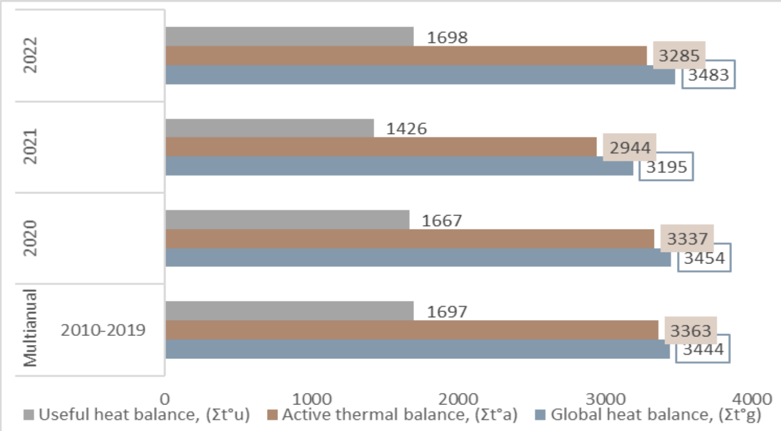

Figure.1 Heat balance parameters

Climate data recoded at Mutfatlar viticultural areal show a similar trend on heat balance parameters, whit maximum values superior to those recorded at „Dealu Bujoru vineyard” (Dina et al., 2020).

Temperature data for average temperatures during vegetation periods showd a decline for registered values in 2021 (24.1 ^{0}C) and a maximum value of 26.3 ^{0}C (2020), 0.4^0 higher than multi annual means and a value of 26 ^{0}C for 2022. Average temperatures during vegetation periods showed an increase and maximum value specific for 2022, as also seen in average maximum temperatures during vegetation period, 26 ^{0}C.June average temperatures for I and II/ decades (°C) and August average max temperatures (°C), also followed trends seen in heat balance parameters.

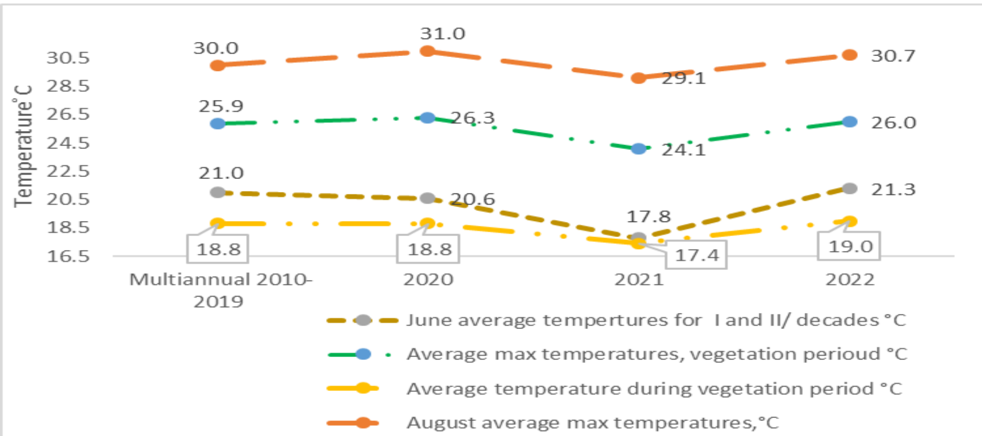

Figure 2. Temperature variations for specific periods

Average and maximum temperatures for vegetation periods as well as other temperature indices outline an ascending trend in temperature even though max values were recorded for 2020 by comparison to 2010-2019 annual values.

Temperature average variations are centralized in table no.1

Table no.1

Thermic regime 2020-2022

Month	Air temperature, ˚C			
	normal	2019-2020	2020-2021	2021-2022
XI	5,6	8,7	4,9	7,0
XII	0,3	2,8	3,5	1,6
I	-1,3	0,4	1,0	1,0
II	0,9	4,4	2,8	3,3
III	5,7	7,9	3,7	2,9
IV	11,9	10,5	8,4	11,1
V	17,9	15,2	15,5	16,7
VI	21,8	21,4	19,8	22,0
VII	24,4	23,3	23,5	23,9
VIII	23,5	23,4	21,9	23,8
IX	17,4	19,3	15,4	17,6
X	11,4	14,1	9,4	11,7

Thermic regime analysis has revealed higher than normal values during autumn and winter months for 2019-2020 and 2021-2022 averages. Temperature increases varied from 0.2^0 (2021-2022 IX) to 3.1^{0}C (2019-2020 XI). Temperature increases were seen for all intervals during January and February by 1.7 up to 2.3^{0}C. By comparison, 2020-2021 thermic regime was closes to normal temperate continental climate regime.

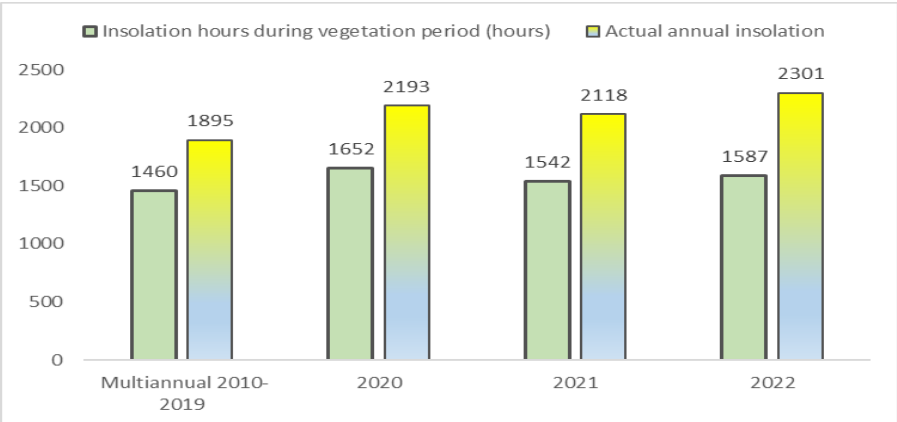

Figure 3. Insolation hours

Insolation parameters for 2010-2019, achivedspecifmultiannualvalues of: 1460 – Insolationhoursduringvegetation period and 1895 – Actual annual insolation. Parameter comparison for actual annual insolation regarding data from 2020-2022 revealed a maximum value of 2301 hours for 2022 representing a 17.64% increase. An actual annualinsolation standard deviation of 55.3022 was specific for 2020-2023 time interval. Insolation hours during vegetation period had similar tendyncies, whit an increase in total number of hours for 2022, but highestvalueswere specific for 2020. Previous studies regarding current influence of insolation hours done in Odobesti viticultural areal showed a similar indices path (Bosoi & Pușcalău, 2020).

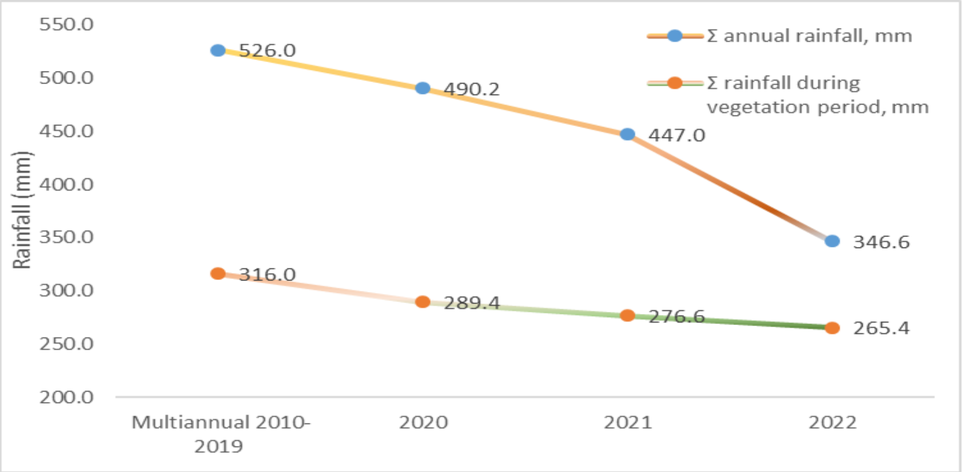

Figure 4.Rainfall variation

Annual rainfall was initially situated at a value of 526 mm (2010-2019), our data showing a gradual decrease of precipitation quantities starting whit 2020 (490 mm), ending whit an abrupt decline to a value of 346.6 mm for 2022 representing a 34.1% drop. During vegetation periods, declines in total rainfall quantities for 2020-2022 values varying from 289.4 mm to 265.4 mm compared to 316 mm multiannual values. Previous research showed higher values both for Σ annual precipitation (mm) and Σ rainfall during vegetation period (mm), but a start in soil water reserves declines since 2008 (Popescu et al. 2010).

FETEASCĂ NEAGRĂ VARIETY PRODUCTION ELEMENTS FOR 2020-2022 INTERVAL

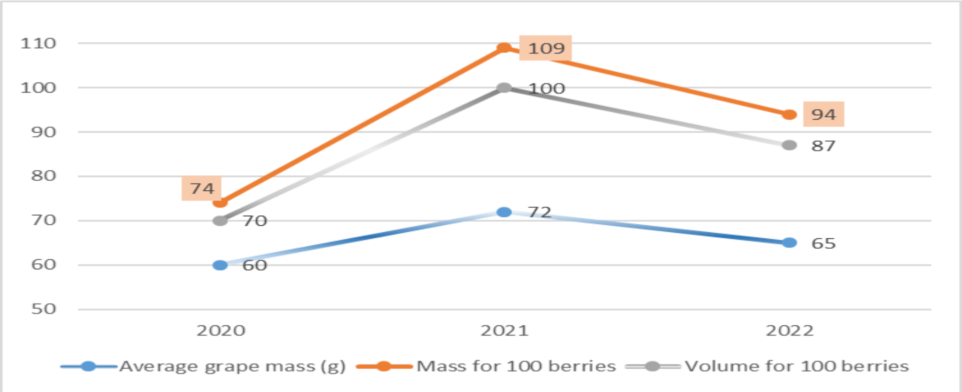

Figure. 5 Average grape mass, Mass for 100 berries and Volume for 100 berries

Fetească neagră grape mass and volume analysis between 2020-2022, has shown higher values for 2021 compared to 2020 average grape mass (60) and 2021 (94) and volume for 100 berries for 2020 (70) compared to 2021 (100) 30% lower and respectively 23% in 2022.

Total sugar content was directly influenced by complex relation and interactions between climatic factors, whit pronounced berry sugar accumulation seen recorded for 2020 and 2021. Whit lowest value recorded in 2021 of 244 g/L. Other results have shown that Fetească Neagră variety, grown in Stefănești-Argeș areal reached a total sugar value between 169-234 g/L and mean acidity levels of 4-4.7 g/L tartric acid (Vizitiu & Onache., 2014).

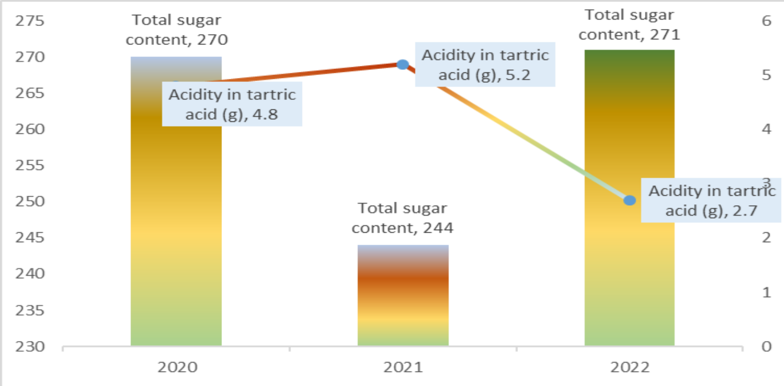

Fig.6 Fetească Neagră total sugar and acidity variation

Initial acidity levels remained at values of 4,8-5,2 g/L, an important drop in acidity values was recorded in 2021 as a probable concenquence of microclimate and factor changes. Climate change was previously implicated in red wine acidy alterations. Data colected by Colibaba et al. (2013) showed acidity value variation for white wines that support results obtained by our study.

CONCLUSIONS

Climate change is having a significant impact on wine acidity. As temperatures rise, grapes tend to ripen more quickly, which can lead to higher sugar levels and lower acidity in the resulting wine. This is because warmer conditions can accelerate the maturation process, causing grapes to lose their natural acidity before they reach optimal ripeness. Additionally, changes in precipitation patterns can affect water availability for vineyards, further influencing grape growth and acidity levels. Some regions may experience more extreme weather events, which can also impact the overall balance of acidity in wines. New climate conditions affect unique Fetească Neagră flavour profile, traditionally known for dark fruit flavors, such as black berries and plums, along with notes of spices, chocolate, and sometimes earthy under tones. Current climate factor evolution sugest that regions traditionally known for certain types of wine might become unsuitable, while new areas may become viable for viticulture. Climate change on viticulture is multifaceted, affecting every aspect from grape growing to wine production.

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