Scientific Papers. Series B, Horticulture. Vol. LXV, No. 2, 2021
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

EVALUATION OF THE VITICULTURAL POTENTIAL FROM THE PIETROASA WINE-GROWING REGION IN THE CONTEXT OF CURRENT CLIMATIC CHANGES

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Abstract

Pietroasa wine-growing region is characterised by their particular natural environment, such as climate, soil properties, and a human factor, deciding on the use of grapevine cultivars and viticulture practices. The database underlying this study includes climatic factors and indicators that are considered to be defining for the climatic suitability of a geographic area. They are: solar insolation (hours/1.04-30.09), annual average temperature (°C), the hottest month average temperature (°C), the sum of fractions of average daily temperatures above 10°C for the period from 1st April to 30 September (Σtu°C), average rainfall for the period from 1st April to 30 September (mm), the length of bioactive period (mm), the heliothermal index (IHr), the bioclimatic index (Ibcv) and the index of oenoclimatic aptitude (IAOe). Significant changes were noticed when comparing recent climatologic period (2010-2020) to the reference climatological period (1958-2009).

Key words*: viticulture; climate change, bioclimatic indices.*

INTRODUCTION

Climate change is a global phenomenon, triggered at the beginning sec. XX, against the background of the increase of the industrial activity. It manifests through increasing the air temperature, changing the precipitation regime, the increase of insolation and solar radiation, as well as the intensification of the phenomena extreme weather conditions (IPCC, 2013).

Climate is the critical component of *terroir* limiting grape and wine production, which also determine suitability of particular grapevine (*Vitis vinifera* L.) varieties for wine production in the particular winegrowing region (Gladstones, 1992). Impact of change climate on viticulture is major; the change in phenology vines; the growth alcoholic potential and decrease in the total acidity of the must; lower predictability of output size and quality wine; earlier maturation of grapes, with altered colour and their aromatic profile; profile change well-known organoleptic of wines.

Several bioclimatic indices are commonly used in vineyard zoning and in aim to describe suitability of climate of different winegrowing regions (Jones et al., 2009). Bioclimatic indices are also useful metrics to provide the information about climate changes impact on viticulture (Malheiro et al., 2010). One of the most widely used indices is temperature - based Winkler index (WI), using a growing degree base of 10°C (growing degree-days; GDD), to place viticulture in the context of climate suitability (Winkler, 1944).

The Cool Night Index (CI), which accounts for minimum temperatures during grapevine maturation period, is also one of the strictly thermal indices (Tonietto, 1999; Tonietto & Carbonneau, 2004). Using a degree-day approach, with the inclusion of a day-length factor as a proxy for radiation, the Huglin Heliothermal Index (HI; Huglin, 1978) allows assessing the thermal potential of a given region. HI can help in determination of the thermal demands for the ripening of each grape variety, also reflecting the potential grape sugar content.

MATERIALS AND METHODS

For this study, there were used weather date recorded for a period of 10 years (2010-2020) and use the database for period 1961-2020. Bioclimatic indices were calculated: the average temperature of the growing season

(AvGST), Growing degree-days (GDD or WI) according to Winkler et al. (1974), Huglin index according to Huglin (1978), Cool night index (CI) according to Tonietto (1999) and Tonietto and Carbonneau (2004) and maximum/minimum temperature and the amount of precipitation in growing season.

Average growing season temperature according to Jones (2006) (AvGST):

$$1/N \sum ((Tmax + Tmin)/2)$$

Growing degree-days (GDD or WI) according to Winkle et al. (1974):

$$WI=\sum(Tmax+Tmin)/2-10^0C ;$$

Tmax – maximum daily temperature

Tmin – minimum daily temperature

Huglin Index (HI) according to Huglin (1978):

$$\sum((Tavg-10^0C)+(Tmax-10^0C))/2*k ;$$

Tavg - average daily temperature

k – Latitude, daylight adjustment factor

Cool night index (CI) according to Tonietto (1999) and Tonietto and Carbonneau (2004):

$$CI= 1/N \sum Tmin;$$

N – number of days in the period

To calculate the agro-climatic indices, the database of the Pietroasa Research Station was used.

Bioclimatic indices were evaluated based on the listed class levels:

Index	Period/classes definition April-October
Average growing season temperature (TGS) Jones (2006)	Too cool < 13°C Cool 13 - 15°C Intermediate 15-17°C Warm 17-19°C Hot 19-21°C Very hot 21-24°C Too hot > 24°C
Growing degree - days (GDD or WI) Winkler et al. (1974)	Region I < 1390 Region II 1391 - 1670 Region III 1671 - 1940 Region IV 1941 - 2220 Region V > 2220
Index	Periode/classes defination April-September
Huglin index (HI) Huglin (1978)	Very cool (HI-3) < 1500 Cool (HI-2) 1500 - 1800 Temperate (HI-1) 1800 - 2100 Temperate warm (HI+1) 2100 - 2400 Warm (HI+2) 2400 - 2700 Very warm (HI+3) > 2700
Index	Periode/classes defination September
Cool night index (CI) Tonietto (1999)	Very cool nights(CI+2)<12°C Cool nights (CI+1) 12 - 14°C Temperate nights (CI-1) 14 - 18°C Warm nights (CI-2) > 18°C

In addition to bioclimatic indices, it was take into account:

Maximum temperature in growing season T^0C April-October period;

Precipitation in growing season (mm) April-September period.

RESULTS AND DISCUSSIONS

Temperature is a primary environmental factor that plays a key role in affecting several plant physiological processes including phenology, vegetative growth, flowering and fruit set, crop development, yield and quality.

The wine-growing Pietroasa region belonged to intermediate climate based on AvGST for reference period 1961-1990, ranging from 16°C to 16.69°C. Regarding the period from 1990-2010 values ranged from 16.69°C to 17.63°C meaning that region moved to another variety favourability class fall into warm climate according to AvGST. The growing season temperature increased by 0.72°C from 16.69°C between 1961-1990 to 17.42°C between 1990-2020

Recent climatological period 2010-2020, AvGST values ranged from 17.07°C (2010) to 18.71°C (2012), thus maintaining region in warm climate (Figure 1).

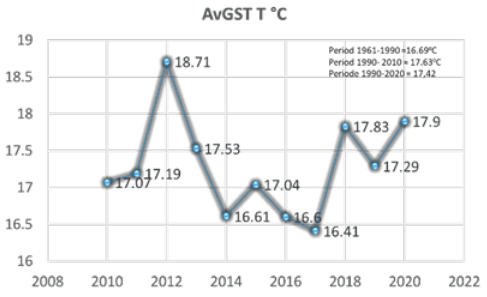

Figure 1. AvGST in period 2010-2020

The Winkler Index, sometimes known as the Winkler Scale or Winkler Regions, is a technique for classifying the climate of wine growing regions based on heat summation or growing degree-days. Regarding climatological period 2010-2020, values ranged from 1662 to 1825 GDD, which means that Pietroasa belongs to Winkler region III. These results show that the region is favourable for high production of

standard to good quality table wines (Figure 2). Along with local varieties in Pietroasa wine-growing region are found favourable conditions for international varieties 'Chardonnay', 'Pinot noir', 'Sauvignon Blanc', 'Riesling', 'Cabernet Sauvignon', 'Merlot', 'Semillion', 'Syrah', 'Chardonnay', 'Tempranillo', 'Grenache', 'Barbera'.

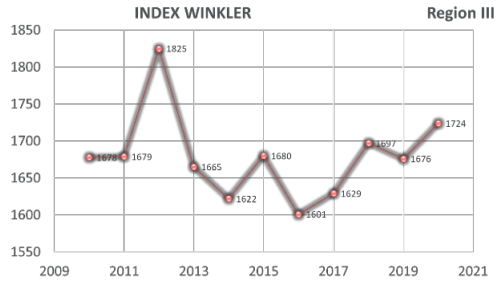

Figure 2. Index Winkler
in period 2010-2020

The Huglin heat sum index (or after Huglin respectively is warmth index or short Huglin index,) in which the temperature sum over the temperature threshold of 10°C is calculated and then summed for all days from beginning of April to end of September. The calculation uses both the daily average temperatures and the maximum temperatures and slightly modifies the calculated total according to latitude. Each grape variety needs a certain amount of heat in order to be cultivated successfully in the long term in a given area. According to the Huglin index for the period 2010-2020, Pietroasa belongs the area temperate warm (HI+1). In ranging from 2243 (2016) and 2345 (2020). In the year 2012 the index Huglin was 2640 which indicates the change of region in warm (HI+2) (2400 - 2700) (Figure 3). Considering HI, there are certain limits regarding growing of different grape varieties. Varieties such as 'Cinsault', 'Syrah', 'Grenache', 'Carignan', 'Mourverdre' needs to be grown in temperate warm (HI+1) climate to reach maturity.
Regarding this, such varieties are suitable for growing in Pietroasa wine region, important aspect for zoning and other varieties in this wine area.

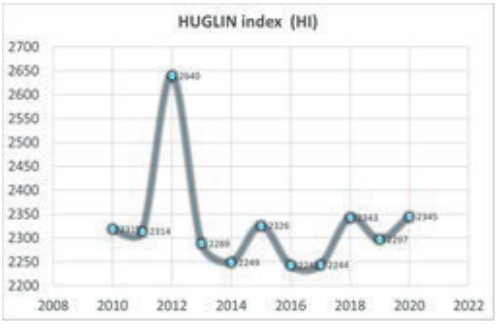

Figure 3 Index Huglin in period 2010-2020

Cool night index ranged from 15.8°C to 20.0°C in period 2010-2020 which shows us that they are temperate nights CI-1 there is an intermediate condition between viticulture climates cool nights and warm nights. The cool night index has an upward trend (Figure 4).
It is important monitoring this index for the next years for evaluation the qualitative potentials of wine-growing Pietroasa region, especially in relation to the secondary metabolites of grapes (polyphenols, aromas), responsible for the colour and aromas of grapes and wine.

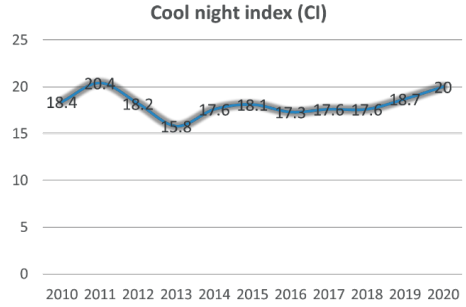

Figure 4. CI in period 2010-2020

In wine-growing Pietroasa region, the maximum temperatures in the summer often reach 33-39 °C for growing season (Figure 5). This high level causes the photosynthesis process to be blocked and the respiration and evapotranspiration processes to intensify. The heat also hastens ripening, producing grapes with bolder flavours, more sugar, and wine with more alcohol and short on taste and aroma.

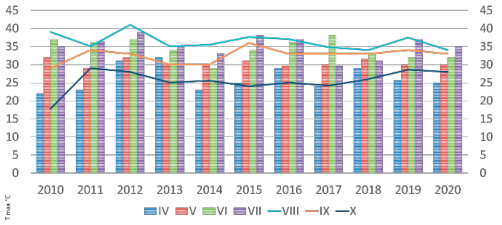

Figure 5. Maximum temperatures in period 2010-2020

While climate and humidity play important roles as well as the soil, a typical grape vine needs 635 to 890 mm of water a year, occurring during the spring and summer months of the growing season, to avoid stress. If much of the vines water needs are met by rainfall, the distribution rather than the total amount of rainfall is important. In wine-growing Pietroasa region, the precipitation has been increasing since 1961. In period 1961-1990 multiannual average of precipitation in growing season was 373 mm, in period 1991-2010 multiannual average of precipitation in growing season was 377 mm and in period 2010-2020 multiannual average of precipitation in growing season was 394 mm.

The precipitation within a wide range, uring the growing season (April 1st- September 30th) slightly increased between 1961-2020, with an average of about +21 mm.

The results obtained in the period 2021-2020 (Figure 6) show that there is a tendency to increase precipitation during flowering (late May to early June) and the installation of excessive drought starting with August during the ripening of the grapes.

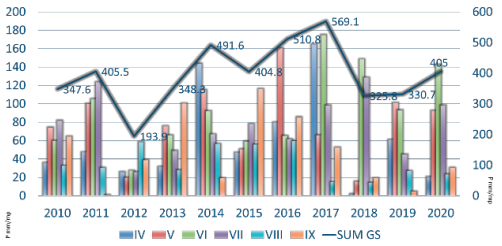

Figure 6. Amount of precipitation (mm) in period 2010-2020

Although the amount of annual precipitation is optimal, their uneven distribution during in growing season period causes them to lead to a physiological stress of the vine.

CONCLUSIONS

This study provides detailed analysis of bioclimatic indices in Pietroasa winegrowing regions. The growing season temperature increased by 0.72°C from 16.69°C between 1961-1990 to 17.42°C between 1990-2020. In period 2010-2020 values ranged from 1662 to 1825 GDD, which means that Pietroasa region belongs to Winkler region III.

According to the Huglin index for the period 2010-2020, Pietroasa belongs the area temperate warm (HI+1). In ranging from 2243 (2016) and 2345 (2020). In the year 2012 the index Huglin was 2640 which indicates the change of region in warm (HI+2) (2400 - 2700)

The precipitation in growing season, increased by +21 mm between 1961-2020

Regardless of the geographical region and the type of climate specific to it, climate change is expected to alter the specificity of vineyards and will change the boundaries of DOC wine production areas

REFERENCES

Gladstones J. (1992). Viticulture and environment. *WineTitles, Adelaide*. 310 pp;

Huglin P. (1978). Nouveau Mode d'Evaluation des Possibilites Heliothermiques d'un Milieu Viticole. C. R. Acad. Agr. France, 1117-1126;

Jones G.V., Moriondo M., Bois B., Hall A., Duff A. (2009). Analysis of the Spatial Climate Structure in Viticulture Regions Worldwide. *Proceedings of the 32nd World Congress of the Vine and Wine and 7th General Assembly of the International Organisation of Vine and Wine, June 28 - July 3, 2009. Zagreb, Croatia ;*

Malheiro A.C., Santos J.A., Fraga H., Pinto J.G. (2010). Climate change scenarios for viticultural zoning in Europe. *Clim. Res*., 43, 163–177;

Tonietto J., Carbonneau A. (2004). A multicriteria climatic classification system for grape-growing regions worldwide. *Agric. Forest Meteorol*., 124, 81–97.

Winkler A. J.and all (1974). *General Viticulture* (4th ed.), University of California Press, Berkeley, 740 p.