CLIMATE EFFECT ON RIPENING PROCESS IN Vitis vinifera, L. Cv. CENCIBEL

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ABSTRACT

A seven years survey (2003 to 2009) has been carried out over old traditional vineyards cv. Cencibel in La Mancha region (Spain). Seven plots with more than 35 years old were sampled from veraison to harvest, measuring soluble solids (ºBaumé) and acid concentration (g/l in tartaric acid). The ripening process was different each year depending on season climate character (vintage). The monthly mean temperatures (April to September) and the rainfalls accumulated (April to September) have been studied and these factors have been related with the date of vintage and the colour intensity (very important parameter for wine quality). The growing-degree day (GDD) for the variety Cencibel (1551,1ºC) has been calculated.

The temperature of May is critical for the development of photosynthetic apparatus of the vineyard and thus, conditions all the ripening process. It has been found two different models of vintage: mild-fresh year (2004, 2007 and 2008) and warm year (2003, 2005, 2006 and 2009). In the warm conditions of La Mancha it is very desirable a delay in the ripening process. As the later will be the process, the cooler will be the nights at the end of ripening. This will improve the quality of the vintage, as it happened in the fresh years.

KEYWORDS

Vintage – ripeness –growing degree day - harvest.

INTRODUCTION

The concept of "vintage" is widely spread in the majority of wine-growing regions in the world. The mentioned concept, used since long time ago, reveals that the annual climate has a direct influence on the quality of the wines when the rest of the factors (soil, plant and cultural practices) are equal. These factors constitute the wine agricultural ecosystem ("Terroir") (Van Leewen *et al*., 2004).

The temperature and the rainfall have been the main climatic factors studied traditionally to define vintage (Mesoclimate). Other factors like the sun irradiation, winds, relative humidity and cultural practices have importance as well, but only for microclimatic level and they do not concern to extensive areas (Jackson, Lombard, 1993; Bergquist, *et al*., 2001; Spayd, *et al*., 2002).

There are many climatic parameters used in viticulture (Winkler, 1965; Hidalgo, 2002) that characterize the suitability of the climate for the quality grapes production and, therefore, for a good ripeness.

In some regions, with hot climate, the supposition that the vintage has little importance has been accepted because, except in serious accidents or catastrophes, grapes complete its ripeness without problems year after year.

The aim of this work is to verify the effect of climate on the vintage in hot regions (Western of La Mancha, Spain) in an early variety as Cencibel (red variety for quality wines called Tempranillo in La Rioja). In addition, simple parameters, that could predict the future vintage date and quality, will be determined.

MATERIALS AND METHODS

The present study was carried out on traditional vineyards of Cencibel from 2003 to 2009. They were all dry farming plantations, more than 35 years old, planted 2,5m x 2,5m (between rows and plants) and head-pruned (from 4 to 7 spurs with 2 buds). Their productions were relatively low, from 1.5 to 3 kg/vine. All the vineyards bring the production to Bodegas Naranjo S.A. (Carrión de Calatrava) and constituted the base to elaborate the higher quality red wines, very estimated by the customs of the cellar.

The ripening process was followed in 6 to 10 plots (depending on the year) distant less than 10 km from the cellar, over different soils. Since the veraison, chunks of clusters of every control vine, picked from different parts and from different orientations of the vine and the cluster were collected to complete approximately 200 grape grains. Every sample from every plot was kept in an independent bag and labeled with the date and the plot weekly.

In every sample the following analytical determinations were carried out:

Content in soluble solids (sugars) from the musts obtained from the samples of grapes was measured using a refractometer with compensation of temperature (model Zuzi-50-305000). The expression of the result was in "ºBe", by direct reading in the scale of the device.

Total Acidity was measured by acid - base valuation and it was expressed in g/l equivalent in tartaric acid.

Colour Intensity: Addition of optical density (O.D.) at 420 nm in tray with 1cm of thickness, O. D. at 520 nm and O.D. at 620 nm in the final wines elaborated every year.

Meteorological data were obtained from the SIAR (the Irrigation Advisory Service for Farmers) and later they were confirmed by those of the National Institute of Meteorology in Spain (Meteorological Station of Ciudad Real: Altitude 627m; Latitude 38 º 59 ' 22 "N; Length 03 º 55 ' 11 "W).

RESULTS AND DISCUSSION

CLIMATIC CHARACTERIZATION

Tab. 1 shows the mean temperatures for every month from April to September (2003-2009) and the rainfall accumulated from April to September.

It can be inferred that the studied area presents a climate with hot summer because ripeness temperatures are, in all cases, over 20ºC, zone B (Jackson, Lombard, 1993). The temperature of May is critical for the development of photosynthetic apparatus of the vineyard, conditioning all the ripening process.

Watching the information of rainfall exposed in the Tab.1 a low and irregular rainfall can be noted from year to year. The rainfall during the vegetative period is, in average, 150 mm per year and mainly occurs in spring (April to June).

The rainfall during the growing season presents important differences between 2007-2008, and 2003, 2005, 2006 and 2009. 2004 presented a low rainfall with low mean temperature. The rainfall in the most humid years (2007, 2008) had influence on the development of the mildiu (*Plasmopara vitícola* Berl. *et* De Toni) reducing the harvest.

Tab.1. Mean temperatures (ºC) for every month from April to September (2003-2009) and the rainfall (R) accumulated (mm) from April to September each year.

	April	May	June	July	August	September	R (mm)
2003	11,79	17,66	24,91	25,53	25,17	20,58	125,60
2004	10,61	13,46	23,13	24,97	23,69	20,69	74,20
2005	12,77	18,03	23,90	25,75	24,71	19,23	93,00
2006	13,56	18,94	22,70	26,78	24,60	20,55	125,80
2007	10,70	15,00	20,02	24,46	23,81	20,06	252,20
2008	11,90	14,38	21,01	24,02	24,40	18,23	240,00
2009	10,72	17,75	22,91	25,21	25,44	15.30	140,80
MEAN	11,72	16,46	22,65	25,25	24,55	23,48	150,23

Growing Degree Day over 10ºC (GDD, Winkler, 1965) from April to August and from April until September have been calculated and the results appear in the Tab. 2.

Tab.2. Growing Degree Day over 10ºC (ºC) from April to August and from April to September, date of harvest and Colour Intensity (C.I.).

	GDD(IV-VIII)	GDD(IV-IX)	Date of harvest	C.I.
2003	1685,2	2000,2	22/08/2003	15,4
2004	1403,0	1724,0	02/09/2004	24,7
2005	1688,4	1964,4	24/08/2005	19,2
2006	1735,3	2050,3	24/08/2006	14,5
2007	1350,2	1650,2	05/09/2007	19,4
2008	1400,3	1646,3	09/09/2008	19,1
2009	1595,3	1754,3	27/08/2009	14,4

The mean GDD (April - September) of seven studied years is 1826.8ºC, zone III or IV Winkler (Hidalgo, 2002). The GDD is higher than the one needed for ripeness in Merlot variety (1693 º), similar in cycle to Cencibel. It can be seen in the Tab.2 that the vintage has been carried out at the end of August. So, the GDD of the Cencibel (April- August) in the studied area is 1551,1ºC. This is consistent with data obtained for the years 1987 to 1991 in nearby locations as Tomelloso (Jiménez, 1993).
In the years 2003, 2005, 2006 and 2008 the GDD (April- August) overcome 1551,1ºC (warm years). However, the years 2004, 2007 and 2008 do not reach this amount and the ripeness delays on the first days of September (mild-fresh years). The warm years are correlated with dry springs and the mild-fresh years with the rainy springs (except in 2004). The spring rains, in the studied zone, produce a significant fall of the temperatures associated with overcast skies, less sunlight and more air humidity.
Water stress in 2005 was so hard because a very dry spring was preceded for a dry winter (water deficit marked). In 2005 the growth was already being affected from the budbreak, leading to a very early veraison (on the 15th of July) and a long ripeness period with high temperatures. This deficit can explain that 2005 is the warm year with the highest Colour Intensity (Tab. 2). An over-ripening has been produced with a stress water situation, giving high content in polyphenols and in C.I., although the quality of the wine in 2005 is not considered excellent by the cellar.
To sum up, the years 2004, 2007 and 2008 have been characterized as mild-fresh years, especially in spring, with moderate temperatures. They can be qualified as not hot and humid years, with late and uniform ripeness, very suitable for red quality wines. On the opposite, the years 2003, 2005, 2006 and 2009 can be noted as hot and dry year model. The whole vegetative cycle of the grapevine was accelerated due to the high temperatures: budbreak, leaf development, veraison and ripeness. Moreover, the ripeness took place during the hottest days of August, so the harvest was delayed respect to the ripeness. It is expected lower contents in coloured compounds (Bergquist, *et al.*, 2001; Spayd, *et al.*, 2002).

CONSEQUENCES ON THE RIPENESS
Traditionally, the ripening process begins with the veraison and ends with the harvest. Technological Ripeness is defined as the moment in which the quantity of sugars and organic acids accumulated allows to make the optimum wine. It changes according to the climatic characteristics of the year (Jackson, Lombard, 1993) and to the type of wine. In this case, for traditional vineyards of Cencibel, the grapes might be harvested when overcomes 12.5 º Baumé.
To determine the technological ripeness two parameters are used: Solid Soluble (º Baume) and Total Acidity (g/l equivalent in tartaric acid). In the Fig. 1 appears the evolution of the above mentioned parameters in the years 2008 and 2009 respectively. The information of all the plots in the years of the

study there has been collected and an average of the ripeness of the variety Cencibel in the studied area has been calculated. 2009 represents the model of ripeness in warm year and 2008 is the model of ripeness in mild-fresh year (only these years have been represented in order to clarify the graph).
It is interesting for the quality of the vintage the evolution of total polyphenols. Direct information of the above mentioned compounds is not available for every year, but the indirect information is reported by Colour Intensity (C.I.) measured in final wines in Tab.2.

It can be observed in the Fig.1, that in 2009 (model of warm year) the veraison was early (on the 28th of July) and the whole process of ripening was produced in the first fortnight of August (high mean temperatures and, therefore, very warm nights). The harvest (very early) took place later than it was recommended, for what over-ripeness and a fall of the acidity was produced. Nevertheless, in 2008 (model of mild-fresh year) the veraison was late (on the 8th of August) and the process of ripeness took place in the second fortnight of August with lower mean temperatures and night temperatures below 20ºC. The harvest was carried out coinciding with the technological ripeness, obtaining more balanced musts. This allowed better phenolic ripeness, giving wines with more intensity in colour and better quality.

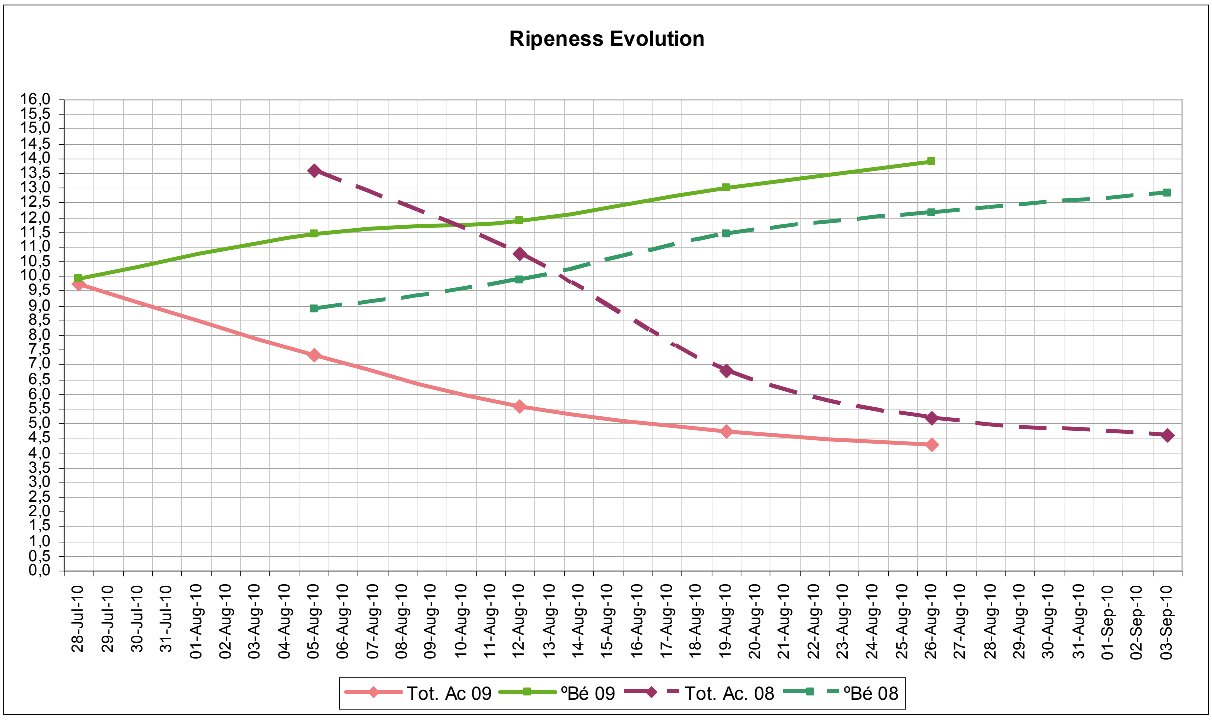

Fig. 1.Evolution of the Total Acidity (g/l equivalent in tartaric acid) and Solid Soluble (ºBaume) for the year 2008 (discontinuous line) and 2009 (continues line) in vineyards of Cencibel in Carrión de Calatrava (Ciudad Real, Spain).

CONCLUSIONS

In the studied years, two models of ripeness have been observed:

- Early technological ripeness. In these years (2003, 2005, 2006 and 2009), the veraison has been early and the process of ripeness has developed in the first fortnight of August. The harvest has been early too, the colour intensity of the wines has been low (except in 2005) and the quality of the wines has been medium. They correspond with a warm year model (high mean temperatures, high Growing Degree Day and low spring rainfalls).
- Late technological ripeness. In these years (2004, 2007 and 2008), the process of ripeness has been carried out in the second fortnight of August and the first days of September. The harvest has been coinciding with the technological ripeness, obtaining more balanced musts. The colour intensity of the wines has been high and the quality of the wines has been very good. They correspond with a model mild-fresh year (moderate mean temperatures, low Growing Degree Day and high spring rainfalls).

The study of the environmental parameters (mean temperature and rainfalls from April to September) can be useful in the prediction of the vintage model. May monthly mean temperature seems to be the key for the development of the photosynthetic apparatus of the grapevine and, therefore, it determines the whole vegetative cycle in the studied years: A fresh May (Tm <15ºC, indicated in grey in the Tab. 1) delays the growth of the buds and the whole cycle. On the other hand, a hot May (Tm> 15ºC) supposes a rapid growth during this month, developing the photosynthetic apparatus that is not stopped in the following months that are always hot and leads to an early ripeness with high temperatures.

ACKNOWLEDGMENTS

The present work has been elaborated in collaboration with Bodegas Naranjo S.L. that has provided the facilities and the staff of the cellar. Special gratefulness for Mrs Pilar Almansa and Mr Ramon Muñoz de Cuerva.

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