Influence of canopy management on yield, grape and wine quality. Relationship between the potassium content and pH in must and wine of the cultivar "Tempranillo".

Influence de la gestion de la haie foliaire sur le rendement, la qualité des raisins et des vins. Rapport entre la teneur en potassium et le pH des moûts et des vins pour le cépage "Tempranillo".

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Summary

In recent years red wines are being produced in Andalusia from indigenous and foreign grape varieties, one of which is the Spanish variety Tempranillo.

In young vineyards the vegetation/production ratio tends to be unbalanced, whereby the must obtained is not of high quality. To achieve a better vegetation/grape production ratio different ways of managing the canopy have been tested. The study has been carried out on *Vitis Vinífera* L. Cvs. Tempranillo in a vineyard in the province of Cadiz in southern Spain, a zone considered to have a warm climate.

Canopy management techniques used are as follows: pruning later, removal of bunch, training higher and more buds. Pruning later causes less vegetation, yield and a reduction in berry size. Removing the bunch induces more vegetation and increases berry size increasing the potassium content and pH. Higher training improves yield. The higher number of buds increases production and vegetative development.

These techniques improve aeration and photosynthetic activity. In the area in which the bunches are located, the temperature is higher and the percentage humidity is lower relative to the control.

Despite having succeeded in increasing total acidity of the must in some cases, the pH of same was not lowered as the high concentrations of potassium salify the acids and raise the pH.

Keywords: Canopy management; Yield; Potassium; pH; Tempranillo.

Introduction

The grape variety, soil and climate together with the growing techniques and oenological practices form the basis for the production of quality wines. Growing techniques such as pruning, training, green pruning, etc., affect the development and physiology of the plant and thus the quality of the grape produced. Obtaining a quality wine requires that the relationship between yield and vegetative development of the vine be defined.

The Tempranillo variety is one of the red wine varieties introduced into Andalusia for the production of red wines. It is the Spanish autochthonous variety more widely extended, original from La Rioja. Large bunches and medium-large sized berries are its characteristic features. Grapes are produced in great quantity in regions with a warm climate and the must obtained is of low acidity and high pH (Puertas et al., 2005)

Studies have shown that it is possible to balance plant production and obtain lower pH through proper vineyard management. Vine training, aimed at decreasing the vigour of the plant and obtaining an effective area of foliage, that is, better distribution of foliar area exposed to the sun (type of pruning) translates into lower production and lower pH wine (less shade), as well as greater accumulation of

biosynthesis compounds in the bunches (acids, sugars, anthocyanins). This is the consequence of increasing the nº of leaves/bunch ratio (Kliewer, 1970).

This study has looked at how different growing techniques used for the Tempranillo variety in 2006 and 2007 have affected grape production, berry size, total acidity and pH. The techniques studied are: pruning later, removal bunch, increasing exposed vegetation and increasing the number of buds.

Material and methods

Data used in this study come from a vineyard in Gibalbín in the municipality of Jerez de la Frontera. Annual rainfall is approximately 560 L/m^2 and the average annual temperature is 17.6º C.

Characteristics of the trial and plant material

The soil is a characteristic white, porous chalky soil typical of the area that is limy, clayey and with a high water retention capacity. The land was planted in 2002 and grafted from 2003 onwards using rootstock 161-49 C. The plantation area is 2.40 x 1.10 m. The trellis system used is vertical espalier at a height of 1.10 m. The plant material used is Tempranillo clon SL

Trials

- Control (CT)
- Pruning later (PL): pruning was done when plant buds began to break (mid March).
- Removal of bunch (RB): carried out at the veraison, whereby approximately half of the bunches were removed (one per shoot was left).
- Trellis at highest (TH): the height of the espalier supporting the vine trellis for some 30 cm was increased; we changed from 1.10 m vertical espalier to 1.40 m.
- Increase of bud (IB): the number of buds was increased by 15 % relative to the control.

Microclimatic controls

The solar radiation received by bunches and vegetation has been controlled using a PAR light sensor, which measures the photosynthetically active light from flowering until the grape is harvested.

A data logger with four-channel USB recorder (Mod, Hobo) was used to control the temperature and humidity of the micro-climate of the vine. It was programmed to take measurements from flowering until grape harvest. It was placed inside the foliage near the bunch area.

Vegetative and agronomic controls

Controls relating to vine geometry, leaf area index (LAI), external leaf surface area (SA) and leaf and vegetation density index (LAI/SA) and the relationship between SA and yield were carried out taking the vine as the elemental plot, using a total of ten repetitions.
When the grapes were harvested, the grape produced was weighed and the following controls were conducted: number of bunches per vine, weight of vine, bunch size, number of berries per bunch, berry weight and stem weight.

Oenological controls

From the veraison, the development of a series of parameters was followed weekly. The vines for the sample were marked in advance, taking 2 Kg per technique, selecting bunches situated at all angles on the vine and on the different parts of the bunch.

To monitor technological maturity, the following parameters were studied: average berry weight, degree Baumé, total acidity, pH, potassium and maturity index (official community methods, 1990).

Once the grapes were harvested they were weighed to establish the yield, their condition was checked and they were destemmed and crushed. The following parameters were determined in the musts obtained after spinning: degree Baumé, total acidity, pH, tartaric and malic acid, potassium and Folin-Ciocalteu Index (official community methods, 1990).

Results and Discussion

Microclimatic methods

When the PAR radiation was measured to assess the radiation received in the trials -both in leaves and in fruits- it was observed that all trials in both harvests increased the radiation captured in the cited zone relative to the control (Fig. 1), thus improving the aeration and photosynthetic activity.

Furthermore, it was established that the temperatures were greater in the bunch area (Fig. 2) and the percentages of humidity relative to the control crop were lower. The control crop was a shadier area with lower temperatures and greater relative humidity content (Fig. 3).

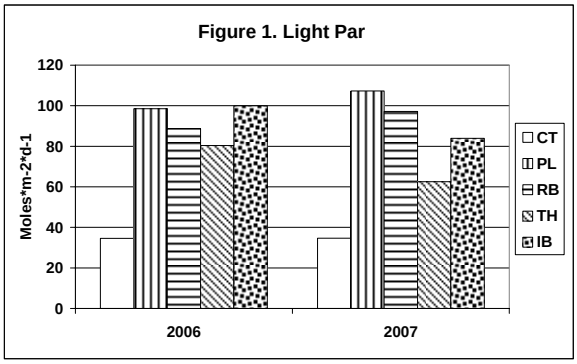

Figure 1 Light Par

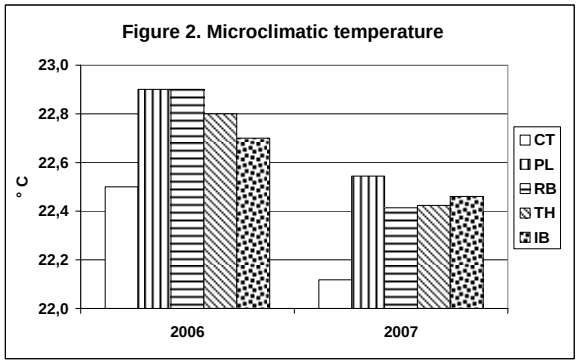

Figure 2 Microclimatic temperatur

Vegetative and agronomic controls

Grape production in RB and IB was lower during the two harvests, in the latter some of the bunches were removed during ripening. Both TH and CT behaved similarly and only PL trial did not show a similar tendency during the two harvests studied (Fig. 4).

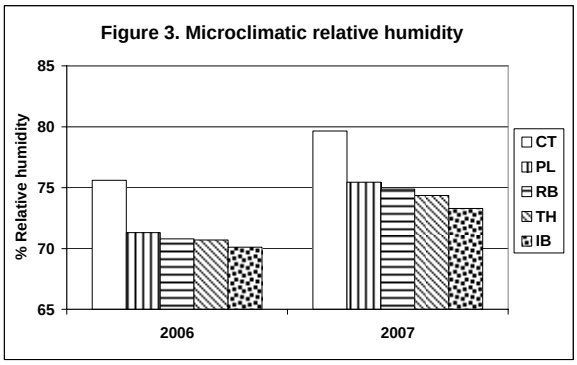

Figure 3 Microclimatic relative humidity

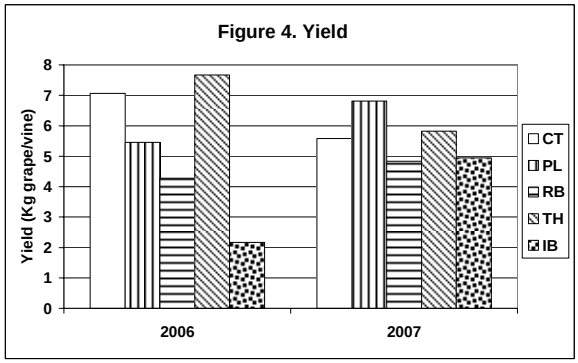

Figure 4 Yield

In Table 1 the result relative to vine geometry, nº of bunch per vine, vigour and Ravaz index are shown for each harvest.

Technique	YEAR	LAI	SA	LAI/SA	Nº bunch/vine	SA/Kg m^2	Vigour	Ind. Ravaz
CT	2006	34.6	1.68	1.77	19.6	0.66	1.00	7.22
	2007	34.7	1.71	2.65	12.9	0.79	1.04	5.57
PL	2006	98.5	1.52	1.86	18.2	0.77	0.86	6.35
	2007	107.3	1.64	2.35	15.2	0.66	1.04	6.55
RB	2006	88.6	1.58	2.22	11.4	1.08	0.91	4.77
	2007	97.2	1.89	2.82	10.8	1.10	1.26	3.82
TH	2006	80.3	1.78	1.87	19.8	0.63	1.06	7.22
	2007	62.5	2.03	2.72	14.9	0.93	1.37	4.26
IB	2006	99.9	1.69	2.17	12.1	1.44	0.93	3.62
	2007	83.9	1.88	2.33	12.9	1.06	1.26	3.92

Table 1Agronomic controls

As it would be expected, raising the espalier increases the exposed leaf surface area (SA), which is beneficial to the functioning of the plant, in that the vegetative mass is better able to capture radiation and foliage aeration is improved. Meanwhile pruning later is reduced, a due to the plant cycle is cut the development of its vegetation is affected, which is corroborated by the lower leaf area index (Serrano et al, 2004).

For the leaf area index (LAI) parameters calculated and the LAI/SA ratio in both harvests, all trials and the control exceed the optimum values indicated by Smart for a vertical espalier, with higher values in general being recorded in 2007.

The optimum values for the SA/ production ratio should be within the range 0.7 – 1.7 for a balanced plant (Smart et al., 1991). The plant balance has been improved in the RB, TH, IB trials relative to CT for the 2007 harvest.

All the trials, during the two harvests, exceed the optimum range according to as regards acceptable vigour for a variety (Hidalgo, 1993). A vine is balanced with Ravaz indexes between 4 and 8. The unbalance observed in the IB and RB trials is caused by excess vegetation translated into wood weight as opposed to production. Removal of bunches carried out in these trials is considered excessive according to this parameter, as production is not compensated with vegetative development.

Oenological controls

Development of the different parameters analysed during ripening (data not shown) was as expected, whereby not many differences were found between the different trials. The harvest date was established when it was deemed that this was the optimum time for the control. The PL trials were harvested in both seasons, two weeks later than the others.

Except with PL, with the other techniques a higher Baumé level was obtained in both crops than in the CT (Fig. 5). With RB, the sugars that are synthesised are concentrated in bunches not removed and thus we have a higher saccharimetrical level. With the TH technique, a greater exposed leaf surface area implies greater biosynthesis of some compounds such as the sugars. With IB we are weakening the vigour of the plant increasing the effective leaf area whereby the effect of the Baumé level will be similar to that of the TH technique (Crippen et al., 1986). However, having pruned later (PL), the vine is weakened, will have less reserves as part of these have already been mobilised by the plant and the Baumé level will be less than in the control.

Relative to the total acidity (Fig. 6), if we compare each technique in the two harvests, we can appreciate that the differences are very small, even if it is true that in 2006 in the case of all techniques, lower total acidity values were obtained than with the CT and vice versa in 2007.

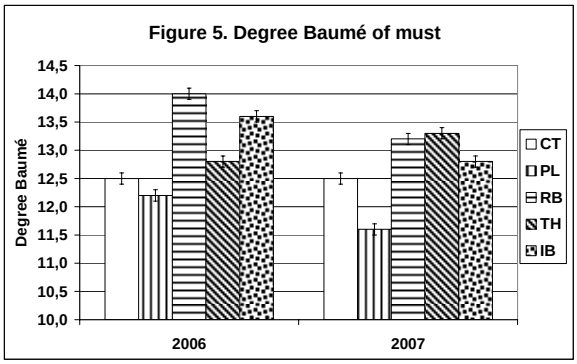

Figure 5 Degree Baumé of must

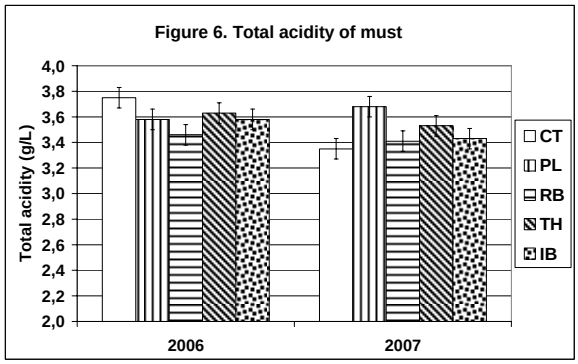

Figure 6 Total acidity of must

The total acidity parameter is strongly related to the tartaric acid concentration (Fig.7) and in 2006 higher values were found than in 2007. The dilution and respiratory combustion phenomena of this acid are strongly linked to the climatology (temperatures, rainfall, etc.) during the ripening period (Blouin et al., 2000). The year has had greater influence on this parameter than the growing technique used, as the differences between techniques are not significant, nevertheless there were great differences, they enter harvests, in the temperature and the relative humidity of the microclimate (Fig. 2 and 3).

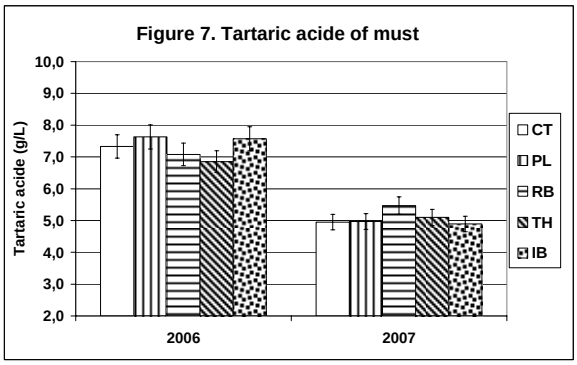

Figure 7 Tartaric acid of must

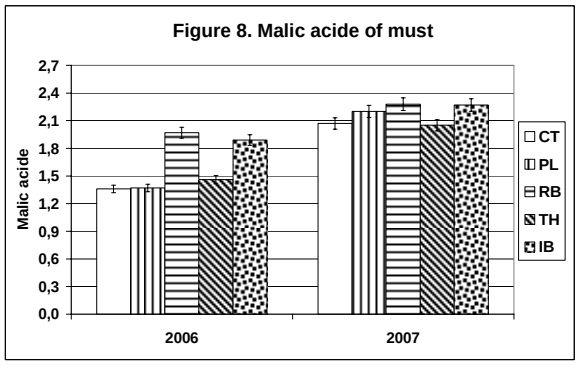

Figure 8 Malic acid of must

With respect to the malic acid (Fig. 8), the combustion phenomenon is the most significant. The concentration of this acid in the must depends both on the temperature during ripening and the degree to which the bunch is shaded (Ribereau-Gayon et al., 1998). In general, concentrations were lower in 2006 than in 2007. In both harvests a higher malic content was obtained with the RB and IB techniques. The PL and TH techniques did not have a significant effect.

The majority of techniques used were not effective in obtaining a lower pH in the must (Fig. 9). The pH in 2006 was greater than in 2007 despite the fact that tartaric concentrations in 2006 were higher. This is explained by the high potassium concentrations (Fig.10) that salify the tartaric acid and increase the pH; this was observed to a significant degree in 2006. The pH could only be decreased with the PL technique and only significantly in 2007.

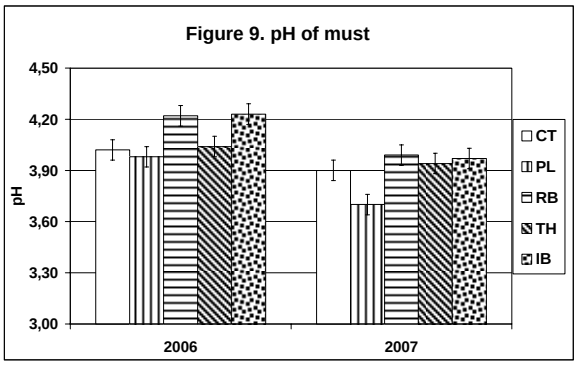

Figure 9 pH of must

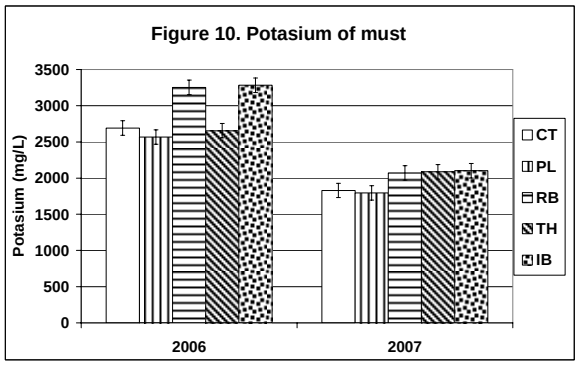

Figure 10 Potassium of must

Conclusion

Although the canopy management can improve some parameters of Tempranillo´s wine such as degree Baumé, the pH of the must obtained from this variety is not lowered with the techniques studied (Pruning later, removal of bunch, trellis at highest and increase of buds). Obtaining a lower pH must is very important in yielding quality wines with an intense colour and stability over time, for this reason further studies should be carry on.

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