VITICULTURAL PARAMETERS AND ENOLOGICAL PERFORMANCE OF SIX MERLOT CLONES IN TWO CONTRASTING VINTAGES

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Abstract:

Context and purpose of the study

Vitis vinifera L. and other *Vitis* have high genetic variations for cultivars or varieties. Many countries carried out strong efforts creating new clones of varieties, mainly focusing on plants free of viruses and other grapevine diseases, but also on different agronomical and enological characteristics of the plants. The aim of this study was to evaluate six clones of Merlot in the traditional viticulture of southeastern Brazil, focusing on distinct characteristics of yield, enological potential of grapes and wine typicality, in order to improve wine quality.

Material and methods

Six Merlot clones grafted onto Paulsen 1103 rootstock were planted in 2018, and evaluated in two consecutive vegetative cycles (2021 and 2022), analyzing viticultural and enological parameters. The 2021 vintage was characterized as wet in the beginning and dry close to the harvest date; the 2022 vintage was dry in the beginning and very dry at the end. Vines were trained on vertical shoot positioning (VSP), trellised in bilateral cordons, with 1 m spacing between plants and 2.5 m between rows. The experimental design was a randomized block, with four replicates of twelve plants each per clone per treatment. French and Italian breeding programs developed the evaluated clones: INRA-ENTAV 181 (standard, already used in the region by many wineries), R12, VCR 1, VCR 101, ENTAV 348 and ENTAV 519. Viticultural parameters evaluated were days until budburst, days until flowering, days until maturation, days until harvest, total cycle, yield per vine, and yield per hectare, in both vintages, taking as reference the solstice day (June 21st). From each experimental unit, two hundred berries were collected at harvest, to determine enological parameters and 20 kg of grapes per treatment were gathered for winemaking. Wines were elaborated in an experimental scale, according to classical protocols. After bottling, wines were analyzed to determine classical parameters and phenolic compounds. Results are shown as the mean of two vintages.

Results

Significant differences were observed for all clones, in all phenological stages, except for days of flowering, yield per vine and yield per hectare. The climatic condition was different and influenced all parameters, except in days for maturation. Clone Merlot R12 was the earliest to be harvested, at 167.6 days, followed by VCR1, ENTAV 519 and VCR101, ENTAV 348, and the last was clone ENTAV 181, at 176.0 days. Yield was not significantly different between clones, but vintage has a significant effect, with higher values observed in 2021. Grape composition varied in total soluble sugars, higher in clones ENTAV 181 and ENTAV 348, followed by other four clones. No differences were observed in pH and titratable acidity. Wines had significant differences in alcohol degree, total titratable acidity, color intensity, and total phenol index (TPI), while no differences were observed to the other parameters. Clones VCR1 and ENTAV 181 had the highest alcohol degree, while ENTAV 348, VCR1, and R12 had greater TPI. These results bring new alternatives for producers and wineries, showing the importance to choose between clones with

different agronomical and enological characteristics, mainly increasing the harvest period, as well as the possibility to elaborate young or aging wines.

Keywords: *Vitis vinifera* L., terroir; grape, wine, phenolic compounds, typicality.

1. Introduction

Traditional wine producing countries have invested in research to obtain better adapted materials to different terroirs, searching for positive characteristics such as moderate to high yield, less bunch compactness, canopy thickness and fruit color (Wolpert, Kasimatis and Verdegaal, 1995; Bouquet, 2000; Fidelibus et al., 2007; Zombardo et al., 2022). The aim of this study was to evaluate agronomical an enological potential of six clones of Merlot in the traditional viticultural region in Brazil. The use of grape cultivars *Vitis vinifera* L. started fifty years ago, mainly in the south, where 90% of Brazilian wines are produced (Pereira, 2020).

In Brazil, three kinds of commercial wines are produced, according to climate conditions (geography) and vine management (Pereira, 2020). There are traditional wines, elaborated in temperate and subtropical climates for over a hundred years in the south and southeast, where grapevines are pruned and harvested once a year, similar to all traditional countries worldwide, in both hemispheres. There are tropical wines, in northeastern Brazil, produced in a tropical semi-arid climate, where vines are pruned and harvested twice a year, since 1985. By scheduling plots and vineyards, viticulturists are able to prune and harvest every single day of the year. Finally, a new third winegrowing zone started in 2002 in the southeastern and northeastern regions of Brazil, between 600 and 1300 m of elevation, where vines are pruned twice and harvested just once per year, producing winter wines. Under this management, vines are pruned after winter and green bunches are removed in the summer. Vines are pruned again 60-70 days later, during the summer, with grapes being harvested in the winter (Regina et al., 2011).

In southern Brazil, under traditional viticulture, *Vitis vinifera* L. was introduced in the 1970's. Currently, around 2000 hectares of different grape varieties are being commercially used for winemaking. The most important winegrowing region in Brazil is the Serra Gaúcha, where there is a Geographical Indication recognized since 2012: a Denomination of Origin (DO) called "Vale dos Vinhedos". The three varieties allowed for sparkling wines are Chardonnay, Pinot Noir and Riesling, whereas the only variety allowed for red wines is Merlot (Tonietto et al., 2014). Only one Merlot clone is currently being used (INRA-ENTAV 181). Other Merlot clones could produce different yields, grape characteristics and wine typicality, in this typical climate condition, in order to improve wine quality. The objectives of this two-year study were to evaluate six different clones of Merlot at Serra Gaúcha, to determine agronomical responses of grapevines and enological potential of grapes and wines, in physical, chemical and sensorial characteristics, over two successive vintages (2021 and 2022).

2. Material and methods

Characterization of the vineyard and enological parameters

Plant materials – The experiment was carried out in a reputed commercial winery installed in Bento Gonçalves, state of Rio Grande do Sul (southern Brazil; 29°10 S, 51°31 W), in the middle of the DO Vale dos Vinhedos. Two consecutive vegetative cycles were evaluated (2021 and 2022), and results are showed as means of both years. Six Merlot clones grafted onto Paulsen 1103 rootstock were planted in 2018, with vines trained using vertical shoot positioning (VSP), trellised in bilateral cordons, with 1 m spacing between plants and 2.5 m between rows. The experimental design was a randomized block, with four replicates of twelve plants per clone per treatment. French and Italian breeding programs developed the evaluated clones: INRA-ENTAV 181 (standard, already used in the region by many wineries), R12, VCR 1, VCR 101, ENTAV 348 and ENTAV 519. Evaluated viticultural parameters were days for budburst, days for flowering, days for maturation, days for harvest, total cycle, yield per vine, and yield per hectare, in both vintages, taking as reference the solstice day (June 21st). From each treatment, two hundred berries were collected at harvest time, to determine pH, total soluble solids, and total acidity (OIV, 1990; Pereira et al., 2021).

Winemaking – Wines were elaborated in an experimental scale. For each treatment, 20 kg of grapes were collected (5 Kg from each replicate). The protocol followed traditional winemaking for reds. After harvest, grapes were

destemmed and put in glass tanks (20 L each), with 50 mg L^{-1} of sulfur dioxide and 20 g hL^{-1} of yeast (*Saccharomyces cerevisiae*). Alcoholic fermentation (AF) was carried out at 25±2 °C, with one pumping over per day, for six days, when AF finished. After pressing and separation of wine and solids, malolactic fermentation (MF) was carried out with native bacteria, for 30 days at 18±2 °C. At the end of MF, wines were placed in a cold room for stabilization (0±2°C) for 30 days, and 30 mg L^{-1} free sulfur dioxide was added. In the end, wines were bottled and stored at 16±2 °C until analyses, thirty days after bottling. Clone ENTAV 181 wine was lost in the 2021 vintage.

Wine analyses – Wines were analyzed for classical parameters, such as density, pH, alcoholic degree, total acidity (mEq L^{-1}), volatile acidity (mEq L^{-1}), and dry extract (g L^{-1}). Colorimetric methods were used to determine total anthocyanins, total phenol index (TPI), color intensity and tonality (OIV, 1990).

Statistical analysis – All results acquired from viticultural, physicochemical, and chromatographic data were tested using analysis of variance (ANOVA) and similar means were grouped using the Scott-Knott test. Analyses were performed using Action Stat 3.7 software, Genes (Cruz, 2013) and R (R Core Team, 2023).

3. Results and discussion

3.1. *VIticultural parameters of the clones*

Phenological stages days until budburst, maturation and harvest, as well as total cycle, differed significantly between clones (**Table 1**). Days until flowering and yield did not vary among clones. Of all parameters, only days until maturation was not significantly different for vintage. Phenology evaluation started on the solstice date (June 21st), because pruning date was different in both vintages. The climatic condition in 2021 was characterized as initially wet, then dry near harvest, whereas in 2022 it started out dry and became very dry in the end. According to the total cycle duration, Merlot clone R12 was the first to be harvested, at 167.6 days from pruning to harvest, followed by VCR1 and ENTAV 519 (171.5 and 171.8 days), VCR101 and ENTAV 348 (172.8 and 172.9 days), and ENTAV 181 (176.0 days), with a total spread of 8.4 days on harvest date. It is important to have clones with different cycle durations, in order to help viticulturists and enologists schedule grape harvests. Yield was not significantly different among clones, but varied between vintages, with higher values in 2021 (**Table 1**). A previous study showed a strong effect of Merlot clones on yield and fruit composition in California, USA (Fidelibus et al., 2007). Agronomic differences were also found in Cabernet Sauvignon clones in California (Wolpert et al., 1995). Even in data presented no differences, there was a trend to higher yields for clone ENTAV 181, the most used in the region, compared to others.

3.2. *Enological characteristics of grapes and wines*

Grapes harvested from the six clones differed significantly in total soluble sugars, but not in pH and titratable acidity (**Table 2**). ENTAV 181 (23.64 °Brix) and ENTAV 348 (23.35 °Brix) had higher values than the others. Vintage effect was significant all three variables, with higher pH and total soluble sugars and lower total acidity in 2022 than in 2021 (**Table 2**). Another work found variation in total soluble sugars of Cabernet Sauvignon clones in the US, but not in pH and titratable acidity (Wolpert et al., 1995).
Clone effect on wine characteristics was significant for alcohol degree, total titratable acidity, color intensity, and total phenol index (TPI), while no differences were observed in the other parameters. Clones VCR1 and ENTAV 181 had more alcohol than the others. Total acidity was higher amounts in wines from grapes of ENTAV 181 and ENTAV 348, although no significant difference was observed in pH. Color intensity was higher in ENTAV 516 wines, while TPI was higher in wines from ENTAV 348, VCR1 and R12 (**Table 2**). The main clone of Merlot currently used in DO Vale dos Vinhedos is ENTAV 181. These results show that the choice of clone can contribute to change the enological characteristic of Merlot grapes, resulting in different quality and typicality of wines. The best choice depends on the kind of wine enologists intend to make, whether they aim for young or aging wines.

4. Conclusions

This research brings useful results for viticulturists and winery enologists, as well as for the scientific community, explaining part of the agronomic variability of plants in the field. Differences of cycle duration of six clones of Merlot at Serra Gaúcha, could be an interesting information for helping producers to schedule grape harvests and winemaking. R12 was the earliest harvested, while ENTAV 181, the most used in the region, the latest. Yield was not significant according to the clones, but vintage presented a strong influence, with higher values in 2021. The study shows that the choice of the clone is very important to obtain grapes and wines presenting distinct enological potential. Wineries can decide on which material to use for different kinds of products, among young or aging wines.

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Table 1. Viticultural parameters* of six clones of Merlot evaluated at Serra Gaúcha, Bento Gonçalves, state of Rio Grande do Sul (southern Brazil; 29°10S, 51°31W), in two consecutive vintages (2021 and 2022).

Viticultural parameter	ENTAV 181[1]	ENTAV 348	ENTAV 519	R12	VCR1	VCR101	2021	2022
[1]Days until budburst	81.0b	80.6b	81.8a	80.4b	82.0a	80.8b	81.6A	80.6B
[2]Days until flowering	41.6	41.5	42.0	42.4	41.1	42.3	40.3B	43.4A
[3]Days until maturation	68.9a	67.8b	67.9b	69.4a	69.1a	68.6a	68.7	68.5
[4]Days until harvest	65.5a	63.6b	61.9c	55.9d	61.3c	61.9c	57.7B	65.7A
[5]Total cycle	176.0a	172.9b	171.8c	167.6d	171.5c	172.8b	166.6B	177.6A
Yield per vine (Kg)	3.28	2.99	2.88	2.75	2.96	2.35	3.98A	1.75B
Yield per hectare (ton)	13.18	11.94	11.50	10.88	11.78	9.35	15.88A	7.00B

[1]Days from the solstice (June 21st) to budburst.
[2]Days from budburst to flowering.
[3]Days from flowering to maturation.
[4]Days from maturation to harvest.
[5]Days from the solstice (June 21st) to harvest.
*Clone means in the same line followed by the same lowercase letter or no letters do not differ, according to the Scott-Knott test ($p>0.05$); Vintage means in the same line followed by different uppercase letters differ, according to the F-test ($p<0.05$).

Table 2. Enological parameters* of grapes and wines from six clones of Merlot evaluated at Serra Gaúcha, Bento Gonçalves, state Rio Grande do Sul (southern Brazil; 29°10S, 51°31W), in two consecutive vintages (2021 and 2022).

Enological parameter	ENTAV 181[1]	ENTAV 348	ENTAV 519	R12	VCR1	VCR101	2021	2022
			Grapes					
pH	3.57	3.53	3.59	3.59	3.61	3.58	3.41B	3.75A
Total soluble sugar (°Brix)	23.64a	23.35a	22.98b	22.78b	22.76b	22.59b	21.71B	24.32A
Total acidity (mEq L^{-1})	71.0	74.6	73.4	72.5	72.9	73.1	84.0A	61.8B
			Wines					
Density	0.9937	0.9928	0.9932	0.9935	0.9928	0.9944	0.9932	0.9936
Alcoholic degree (%v/v)	13.59a	13.42b	13.21b	13.15b	13.82a	13.23b	12.22B	14.58A
pH	3.83	3.63	3.74	3.71	3.77	3.81	3.68B	3.82A
Total acidity (mEq L^{-1})	84.6a	81.4a	78.9b	73.7b	76.2b	76.8b	79.0	78.2
Dry extract (g L^{-1})	29.4	26.9	27.1	27.8	28.1	30.3	22.6B	34.0A
Total anthocyanins (mg L^{-1})	319	275	262	374	299	266	265B	334A
Color intensity	11.54b	11.71b	13.12a	10.78b	11.12b	10.26b	10.37B	12.47A
Total phenol index - TPI	44.7b	55.2a	44.3b	49.9a	51.6a	45.7b	42.3B	54.8A
Tonality	0.77	0.74	0.71	0.77	0.75	0.78	0.72B	0.78A

[1]Wine from the ENTAV 181 was lost in 2021 vintage; means were estimated based on main effects of clone and vintage.

*Clone means in the same line followed by the same lowercase letter or no letters do not differ, according to the Scott-Knott test ($p>0.05$); Vintage means in the same line followed by different uppercase letters differ, according to the F-test ($p<0.05$).