



Pruning management of 'Marselan' grapevines in the Serra do Sudeste region, in Southern Brazil

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Abstract

The agronomical behavior of the 'Marselan' grapevine, indicated for the production of high-quality fine wines, is related to the management of the vineyard and the edaphoclimatic conditions of the cultivation region. This work aimed to evaluate the vegetative, productive, and qualitative behavior of 'Marselan' grapevines subjected to the Spur Pruning and Double Guyot pruning systems, cultivated in a municipality belonging to the Serra do Sudeste region, RS state, Brazil. The 'Marselan' grapevines were conducted in a vertical shoot positioning training system over a 'Paulsen 1103' rootstock, in a commercial vineyard located in Encruzilhada do Sul, RS, Brazil. During the 2016/2017 and 2017/2018 cropping seasons the vegetative vigor, the mass of pruned shoots, Ravaz Index, production, and chemical-physical composition of the must were evaluated. The double Guyot pruning system in the 'Marselan' grapevines induced a lower plant vigor, promoted an increase in the number of bunches per plant, bunch mass, production, and yield. The pruning type interferes with the vigor and yield of the 'Marselan' grapes without altering must quality. In the management of the cv. 'Marselan' in the Serra do Sudeste region, Brazil, the double Guyot pruning system is the most indicated.

Keywords: *Vitis vinifera*, spur pruning, double Guyot, Ravaz index, yield

Introduction

Serra do Sudeste is one of the newest viticultural areas of the Rio Grande do Sul state, with its aptitude discovered in the '70s. However, it was only in the early 2000s that important wineries implanted their vineyards (Copello, 2015). Viticulture related to the elaboration of fine wines has been consolidated as an important and promising economic activity in the Serra do Sudeste region, especially in the municipality of Encruzilhada do Sul, Rio Grande do Sul state, Brazil.

In this region, both soil and climate conditions are favorable for the cultivation of several cultivars, such as the red cultivar 'Marselan', belonging to the genus *Vitis vinifera* and presenting French origin, obtained through the genetic crossing between cultivars 'Grenache Noir' and 'Cabernet Sauvignon', performed in 1961 at the Institut National de La Recherche Agronomique – INRA, France, in Domaine de Vassal, near the city of Marseillan

(INRA, 2016). The cultivar 'Marselan' is characterized for presenting big bunches and small berries (average of 1.3g), average must yield, production of excellent quality wines, intense coloring, and good tannic structure (INRA, 2016).

The vegetative, productive, and qualitative behavior of the grapes are affected by the edaphoclimatic conditions of the vineyard, by the characteristics of the cultivars, the training system, as well as the pruning management adopted (Mendonça et al., 2016). On the other hand, the choice of the pruning system depends mainly on the cultivar, soil type, climatic conditions, and sanitary aspects.

The varieties that present greater fertility in the buds closer to the base of the shoot normally undergo a short pruning, whereas varieties with more fertile latent buds in the median position of the vine shoots are subjected to a longer or mixed pruning (Mendonça et

al., 2016).

Among the existing and most used pruning methods by winegrowers, there is the Spur Pruning system, when a short pruning is desirable, in which only the spurs containing one or two buds remain on the plant, and the simple or double Guyot system, when the aim is to perform a long pruning, keeping spurs and cordons on both sides (double) or in only one side of the plant (simple) (Aliquó et al., 2010). It must be considered that the canopy management, as a function of the type and intensity of the pruning, interferes with the production of the subsequent cycle, given its impact on the content of accumulated reserves and bud fertility (Pellegrino et al., 2014).

However, the available information is still scarce on which is the most adequate system for grapevines destined to fine wine production in the Serra do Sudeste region, RS state, especially regarding the cultivar 'Marselan'. This work aimed to evaluate the vegetative, productive, and qualitative behavior of 'Marselan' grapevines subjected to the Spur Pruning and double Guyot pruning systems, cultivated in the municipality of Encruzilhada do Sul, Serra do Sudeste region, RS.

Material and Methods

The experiment was conducted in the productive cycles of 2016/2017 and 2017/2018, in a commercial vineyard belonging to the Vinícola Casa Valduga winery, which has a 120-hectare vineyard, located in the municipality of Encruzilhada do Sul, Rio Grande do Sul state, Brazil. The municipality is located at latitude 30° 32' 35" South and longitude 52° 31' 20" West, with

an elevation of 420m above sea level, in the Serra do Sudeste physiographic region (Randin et al., 2017). The municipality presents a subtropical climate, with humid mesothermal classification. In the place, the mean annual temperature is 17° C, and the mean annual rainfall ranges from 1500 to 1600 mm (SEPLAG, 2019). The average accumulation of temperatures below 7.2°C in Encruzilhada do Sul is 252 hours (Wrege et al., 2016).

The 'Marselan' grapevine used in this experiment had as a rootstock the cv. Palsen 1103, which is currently the most indicated rootstock for the Rio Grande do Sul and Santa Catarina states, due to its good adaptation to the edaphoclimatic conditions.

The vineyard had eight years of implantation, with an average planting density and spacing of 1.2 m between plants and 2.7 m between rows, totaling 3000 plants ha⁻¹. The plants presented a trellis training system. The cultural practices performed were the same used in other vineyards of the company, under the regional cultivation recommendations during the cropping season: fertilization based on soil analysis, application of phytosanitary treatments when necessary, and weed control.

The experimental design was completely randomized, with two treatments that consisted in two pruning systems: Spur Pruning (Figure 1A) and double Guyot (Figure 1B), with four replications, each composed of four plants. The dry pruning was performed in the Spur Pruning system, allowing from 8 to 10 spurs in the plant with 02 buds each, and in the double Guyot system it allowed 02 canes per plant, with 4 or 5 buds each.



Figure 1. 'Marselan' grapevine under different pruning methods. A – Spur Pruning; B – double Guyot.

The prunings were performed on August 28, when the vegetative vigor evaluations were performed. The evaluations proceeded as follows: number of bunches per plant: counting of all bunches per plant at harvest; bunch mass: determined through the sampling of 5 bunches per plant, totaling 20 bunches per plot; mean production: obtained through bunch weighing, using plastic boxes and a portable electronic balance, with the results expressed in kg plant⁻¹; estimated yield: obtained by multiplying the production per plant by the number of plants per hectare, according to the adopted spacing; number of shoots: counting of the shoots resulting from the pruning of each plant; shoot mass: after the counting of shoots in each plant, these were weighed in a portable electronic balance; Ravaz index: determined by the ratio between the weight of the fruits produced and the weighed of the pruned material (Cus, 2004). The evaluations of the production parameters occurred at harvest, which occurred on March 20, 2017.

Furthermore, samples were collected from five bunches per replication for the analyses of qualitative characteristics of the grape at the Laboratory of Physical-Chemical Analyses of the Federal Institute Sul-Rio-Grandense (IFSul), Campus Pelotas Visconde da Graça.

The berries were detached from the stems, randomly sampling 10 berries per bunch, which were crushed. The must was extracted and had its solid residues removed with the aid of a plastic sieve with a 2 mm mesh. The must was destined for the analytical determinations, with three replications, of the following quality attributes: soluble solids content: (SS), expressed in °Brix; pH, and titratable acidity (AT), expressed in g of tartaric acid in 100 ml of must, according to the analytical rules of the Adolfo Lutz Institute (Zenebon et al., 2008). The soluble solids (SS) – were measured in a refractometer; pH – determined with the aid of a pH meter, model PHS-3B, using one sample of pure must from each replication; titratable acidity (AT) – determined through neutralization titration, with the dilution of 10 ml of pure must in 90 ml of distilled water, and titration with a solution of NaOH 0.1N until the must reached pH 8.1, following the methodology of Manzano et al. (1987). Furthermore, the SS/AT ratio was determined through the quotient of the total soluble solids and the titratable acidity.

For the anthocyanin variable, the method described by Lees & Francis (1972) was employed, through which the samples were homogenized with an extractive solution based on ethanol (pH 1) acidified with hydrochloric acid for one hour. After this homogenization period, the reading was performed in

a spectrophotometer (PG Instruments Ltd®, T90+UV/VIS) in the wavelength of 520 nm, with the equipment being previously zeroed with ethanol pH 1. The content of total anthocyanins was expressed in mg 100 g⁻¹ of must.

The total polyphenols index was determined according to the methodology described by De Ávila (2002), through the maceration of the fruit samples, aiming at must formation. Afterward, the must obtained from each sample was subjected to reading in the spectrophotometer (PG Instruments Ltd®, T90+UV/VIS) in the wavelength of 280 nm, using distilled water as a blank. The obtained values were applied in the formula: IPT = Absorbance reading x 100 (dilution factor).

The obtained data were subjected to analysis of variance (ANOVA) and the means were compared by the T-test at a 5% level of probability, using the Assisat software, version 7.7 beta.

Results and Discussion

In both productive cycles evaluated, the double Guyot pruning system provided higher means regarding the number of bunches per plant, bunch mass, production, and yield, when compared to the Spur Pruning system (Table 1). Accordingly, Panceri et al. (2018), when studying the influence of pruning intensity in Chardonnay grapevines, verified that the Spur Pruning system provided a reduction in the number of bunches per plant, compared to the Guyot system. According to Zapata et al. (2004), it is expected that the Spur Pruning system should provide a reduction in the number of bunches, since the increase in the vigor of the shoots provided by the short pruning may lead to an unbalance between the vegetative and productive parts of the plant, thus resulting in abundant vegetation and low production. This increase in vigor occurs due to the greater accumulation of the reserves stored in the previous cycle, in the permanent organs of the plants pruned in this system, which may also be observed in the present study.

It is worth mentioning that the short pruning in the Spur Pruning system aims at maintaining a larger number of buds in the plant, compared to the Guyot system (Panceri et al., 2018). Therefore, the results obtained in this study are similar to those found by Brighenti et al. (2017) in studies with different pruning methods in three cultivars of Italian grapevines, in which the authors obtained a higher bunch mass when using the Guyot pruning system, in spite of the smaller number of buds kept in the plant.

Likewise, Panceri et al. (2018), when studying the influence of pruning intensity in the grapevine cv. Chardonnay obtained no significant increase in

plant productivity under the Spur Pruning system. In this manner, it is possible to verify that not always a higher number of buds kept at pruning leads to a linear increase in productivity. According to Würz et al. (2019), the

increase in the load of plant buds causes a reduction in the photosynthetically active radiation in the vegetative canopy, thus influencing bud fertility, an event that may have occurred in this study.

Table 1. Number of bunches per plant, bunch mass, mean production and estimated yield of the cultivar 'Marselan' subjected to two pruning types, in the 2016/2017 and 2017/2018 productive cycles in Encruzilhada do Sul, Rio Grande do Sul state, Brazil.

Pruning type	Number of bunches per plant	Bunch mass (g)	Mean production (Kg plant ⁻¹)	Estimated yield (t ha ⁻¹)
2016/2017				
Spur Pruning	28.12 b	140.87 b	3.96 b	11.87 b
Double Guyot	33.50 a	148.43 a	4.96 a	14.88 a
2017/2018				
Spur Pruning	27.06 b	145.36 b	3.93 b	11.79 b
Double Guyot	34.06 a	149.33 a	5.08 a	15.26 a

Means followed by the same letter in a column are not significantly different according to the T-test ($p < 0.05$).

Furthermore, the smaller number of bunches may be related to the variation in bud fertility according to the variety used in the vineyard, and the position of the buds throughout the plant; in most grapevines, the buds at the base of the shoots present low fertility (Silveira, 2012). The study performed by Rosa et al. (2014) is an example, which verified a larger number of fertile buds in the median and apical portions of the Cabernet Sauvignon and Nebbiolo varieties cultivated in the municipality of São Joaquim. In this manner, it is possible to verify that the Spur Pruning system can eliminate most of the fertile buds in the shoots of these varieties, leading to a smaller number of bunches

per shoot and, consequently, to lower fertility in the same season (Munhoz et al., 2016).

The vigor measures were significantly affected by the type of pruning employed in the 'Marselan' grapevines (Table 2). The plants subjected to Spur Pruning produced, on average, 28.31 shoots per plant, whereas the plants subjected to the Guyot pruning system produced, on average, 16.37 shoots per plant. The mass of the pruned material in the Spur Pruning system was 1.14 kg, being higher, on average, than the material pruned in the plants subjected to the double Guyot pruning system (0.58 kg).

Table 2. Number of shoots, shoot mass and Ravaz Index of the cultivar 'Marselan' subjected to two pruning types, in the 2016/2017 productive cycle in Encruzilhada do Sul, Rio Grande do Sul state, Brazil.

Pruning type	Number of shoots (shoots plant ⁻¹)	Shoot mass (kg.plant ⁻¹)	Ravaz Index (kg grape.kg shoots ⁻¹)
Spur Pruning	28.31 a	1.14 a	3.93 a
Double Guyot	16.37 b	0.58 b	9.44 b

Means followed by the same letter in a column are not significantly different according to the T-test ($p < 0.05$).

The larger number of shoots found in the grapevines pruned in the Spur Pruning system probably occurred due to the higher accumulation of reserves in the trunk and roots of the plants, in the previous year. Another situation that corroborates with it is that the photoassimilates stored in the cordons, which are kept in the grapevines pruned in the Spur Pruning system, might have a positive relation for shoot vigor, whereas in the Guyot system the cordons are renewed every year, reducing the accumulation of reserves (Mendonça et al., 2016).

The Ravaz Index was used as an indicator of the balance between the fruit load and the vegetative canopy, which is based on the ratio between the production and the pruning mass in winter. This ratio allows evidencing the behavior of the plants as to the vegetative and productive balance. The considered indices are between 5 and 10 since values below 5 indicate an excess of vigor in the grapevines, and values

above 10 are indicative of excessive production (Smart & Robinson, 1991).

The results observed for the Ravaz Index variable, in Table 2, differed significantly between the type of pruning applied. For the Spur Pruning system, an unbalance can be identified in the grapevines as a consequence of the low production and intense vegetative development. The value found for the grapevines subjected to the double Guyot system was considered as ideal, indicating that the plants subjected to this type of pruning presented vegetative-productive balance.

In view of these results, the double Guyot pruning for the 'Marselan' grapevine can be considered as a promising technique, since the higher production trend observed works as a mitigating factor to the low must yield of this cultivar. However, excessive fruit loads must be avoided since in the subsequent cropping seasons there is a great risk of production alternation, therefore, it is recommended to perform a cluster thinning in order

to balance the vegetative and productive vigor of the grapevines.

Regarding the soluble solids content variable (Table 3), no significant difference was verified between the two pruning systems. The soluble solids values found in

the 2016/2017 productive cycle, for both pruning types, reached levels between 18 and 22 °Brix, considered appropriate for the elaboration of fine wines, according to Brighenti et al. (2014).

Table 3. Qualitative characteristics of the cultivar 'Marselan' subjected to two pruning types, in the 2016/2017 and 2017/2018 productive cycles in Encruzilhada do Sul, Rio Grande do Sul state, Brazil.

Pruning type	Soluble solids (° Brix)	pH	Titrateable acidity (g of tartaric acid in 100 ml of must)	SS/AT
2016/2017				
Spur Pruning	20.67 ns	2.25 ns	7.47 a	2.49 a
Double Guyot	20.42	2.40	6.51 b	2.82 b
2017/2018				
Spur Pruning	26.92 ns	3.48 ns	6.07 b	4.41 ns
Double Guyot	26.97	3.47	6.30 a	4.18

Means followed by the same letter in a column are not significantly different according to the T-test ($p < 0.05$).

There was no significant result for the pH variable. Acidity regulates the pH, which is very important in the performance of the malolactic fermentation, flavor, biological stability, and wine coloration (Brighenti et al., 2014). Considering the ideal pH strip for red wines (3.1- 3.6) reported by Mota et al. (2009), ideal levels are verified in the second productive cycle, in both pruning systems. However, very high pH levels can destabilize the wine, both biologically and in the physical-chemical perspective since it makes it more susceptible to oxidation and microbial proliferation, thus affecting its shelf life.

The titrateable acidity was higher in the must of the grapevines subjected to the Spur Pruning system in the 2016/2017 productive cycle, with the opposite occurring in the second cycle, in which the Guyot system provided the highest mean (Table 3). According to Regina et al. (2010), this characteristic is favorable for the grapes destined for the production of sparkling wine, since the acidity content contributes to the organoleptic quality of the product.

Regarding acidity, there are reports in the literature that indicate the occurrence of a negative correlation between the vineyard yield and grape acidity, although there are also studies that demonstrate that no significant correlation occurs between these variables (Sun et al., 2012; Keller et al., 2008). According to Miele & Rizzon (2013), these results suggest that the management performed in the vineyard can influence plant production, but this effect may or may not be verified in the physical-chemical composition of the grape must, at least regarding the variables related to sugar and acidity. That is, within certain limits, plants exert a self-regulating power between the vegetative-productive and physiological-biochemical parts (Panceri et al., 2018).

The climatic conditions during the maturation

and harvest periods can influence acidity. Generally, very high temperatures in the maturation period are harmful to must quality, being poorly balanced and with low acidity; temperatures close to 30°C are considered ideal so that the acidity in the berries is not high (Giovannini, 2014). In the present work, the maturation period started in February, and the harvest occurred in March 2017, months with rainfall index above 200 mm and maximum temperatures of approximately 29°C in the referred year (INMET, 2017). Therefore, acidity degradation may have been lower due to climatic conditions.

For the SS/AT ratio, the double Guyot pruning system provided the highest must value in the 2016/2017 harvest; as for the 2017/2018 harvest, the results were not significantly different. The values obtained in this study are similar to those found by Arenhart (2015), who observed a 3.74 value for the must of 'Marselan' grapes from the Serra do Sudeste region, in the 2014 harvest. According to Pimentel Junior et al. (2019), the SS/AT ratio can indicate the ideal balance between sugar and acidity, allowing to characterize the maturation of cultivars in a determined region. However, attention should be paid to the use of this maturation index since the increase in the SS concentration not always indicates an equal reduction in the AT.

The contents of total polyphenols and anthocyanins in the must of the 'Marselan' grapes were not significantly influenced by the pruning types (Figure 2). The contents of total polyphenols and anthocyanins of the grapes, responsible for flavor, aroma, astringency, color, chemical properties, and wine sensations vary according to the species, variety, maturity, climatic conditions, and vineyard management (Girardello et al., 2017). Therefore, these variables become an important tool in the definition of grape maturation and the best time for harvest.

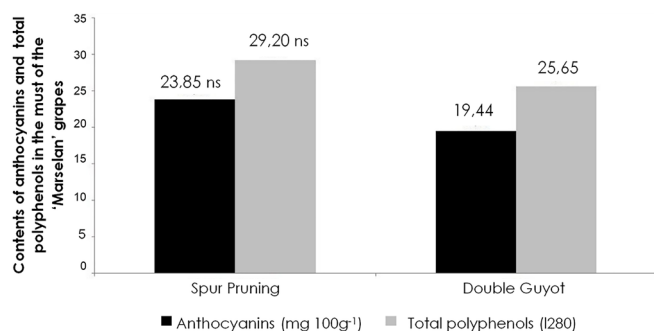


Figure 2. Anthocyanins and total polyphenols in the must of the cultivar 'Marselan' subjected to two pruning types, in the 2016/2017 productive cycle in Encruzilhada do Sul, Rio Grande do Sul state, Brazil.

Although the results did not present significance between each other, it is possible to observe that the Spur Pruning system increased the concentration of total polyphenols in relation to the double Guyot system since there is a negative correlation between productivity and quality, according to Silva et al. (2008). A similar thing occurred in the present study since the Spur Pruning system presented higher values for total polyphenols, but provided lower yields in relation to the Guyot system, in both production cycles.

Although significant differences were verified in production and vigor, in the two pruning systems applied, the results regarding the content of anthocyanins and polyphenols did not indicate that such unbalance may have affected these characteristics of the bioactive compounds of these grapes. The conditions imposed on the vegetative canopy by the pruning system of the cultivar 'Marselan' did not seem to influence the content of phenolic compounds, suggesting that the remaining abiotic factors can exert a suppressive effect.

Temperature and radiation are climatic factors of greater importance in the synthesis of phenolic compounds when considering their interference in the primary and secondary metabolisms of plants (Taiz & Zeiger, 2013). However, since the climatic conditions during maturation and harvest, in this study, were closer to what is considered ideal, it is believed that the production of the grapevines may have been the factor the most affected the accumulation, synthesis, or even the degradation of these compounds.

Conclusions

The double Guyot pruning system provides a reduction in the vigor of the vineyard and an increase in plant productivity; the Spur Pruning system leads to the increase in the vegetative vigor and to productivity reduction in 'Marselan' grapevines. Both pruning systems do not negatively influence the quality of the grapes in the municipality of Encruzilhada do Sul, Serra do Sudeste

region, Rio Grande do Sul state, Brazil.

The double Guyot pruning system has the potential to be employed in this cultivar, in the Serra do Sudeste region. However, its comparative study in different cropping seasons is recommended.

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