

Notas Científicas

Effect of shoot topping intensity on 'Cabernet Franc' grapevine maturity in high-altitude region

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Abstract – The objective of this work was to evaluate the chemical composition of 'Cabernet Franc' grape subjected to different levels of shoot topping. The experiment was conducted in the 2008 and 2009 vintages, and the levels of shoot topping consisted of: control, without topping; and reductions of 15, 30, and 45% in total leaf area. The effect of shoot topping intensity on the chemical composition of the 'Cabernet Franc' grape berries was observed. A reduction of 26% in the vegetative canopy through a moderate shoot topping increased the total polyphenol index and the anthocyanin content. Shoot topping is a practice that must be carried out with caution, since severe shoot topping, i.e., a reduction greater than 26% of the leaf area, may negatively impact grape quality by reducing the content of soluble solids and decreasing the total polyphenol index and the content of anthocyanins of 'Cabernet Franc' grape berries.

Index terms: *Vitis vinifera*, Courdec 3309, summer pruning, vegetative growth.

Efeito de intensidade de desponte na maturação de 'Cabernet Franc' cultivada em região de altitude

Resumo – O objetivo deste trabalho foi avaliar a composição química da uva 'Cabernet Franc' submetida a diferentes intensidades de desponte. O experimento foi conduzido nas safras 2008 e 2009, e os níveis de desponte consistiram em: controle, sem desponte; e reduções da área foliar nas proporções de 15, 30 e 45% em relação à área foliar total. Observou-se efeito da intensidade de desponte na composição química da uva de 'Cabernet Franc'. A redução de 26% do dossel vegetativo por meio de desponte moderado aumentou os índices de polifenóis totais e o conteúdo de antocianinas. O desponte é uma prática que deve ser realizada com cautela, uma vez que um desponte de ramos severo, isto é, com redução superior a 26% da área foliar, pode afetar negativamente a qualidade da uva, ao reduzir o conteúdo de sólidos solúveis e diminuir o índice de polifenóis totais e o conteúdo de antocianinas da uva de 'Cabernet Franc'.

Termos para indexação: *Vitis vinifera*, Courdec 3309, poda verde, crescimento vegetativo.

In high-altitude regions of the state of Santa Catarina, Brazil, 'Cabernet Franc' grapevine has shown a great potential for winemaking of fine red wines (Marcon Filho et al., 2015). This variety reaches adequate maturity levels 20 days earlier than 'Cabernet Sauvignon' (Brighenti et al., 2013), which runs the risk of not maturing completely, particularly in cold and/or rainy years. Therefore, 'Cabernet Franc' could be an alternative to replace it in vineyards located at 1,100 m above sea level or higher, in which 'Cabernet Sauvignon' have been grafted on or eliminated (Vianna et al., 2016).

However, the viticulture of these high-altitude regions in Santa Catarina show edaphoclimatic conditions of high water availability and soils with high organic matter content (> 3.5%), which promotes excessive vegetative growth to the detriment of the productive performance of the vines (Zalameña et al., 2013; Marcon Filho et al., 2015).

In grapevines, as in most fruitful species, the balance between the fruit load (drain) and the adequately illuminated leaf area (source) influences the quantity and quality of production. The balance between these

two parameters is determinant for the composition and maturation of grape berries (Marcon Filho et al., 2015), and in this sense, shoot topping is an alternative to control the excessive vigor and to promote adequate grape maturation.

A study conducted by Brighenti et al. (2010) has shown that a moderate shoot topping may increase soluble solids and anthocyanins content in 'Merlot' berries, when applied to vines grown in the high-altitude regions of Santa Catarina. However, it is emphasized that the variety, climate, soil and production system influence the vigor of the grapevine, determining the characteristics of the canopy, microclimate, sanity and maturation of the grape, which are factors that determine the quality of the wine (Reynolds & Vanden Heuvel, 2009), and it is necessary to determine the appropriate shoot topping intensity for the 'Cabernet Franc' variety in a high-altitude region of Santa Catarina.

The objective of this work was to evaluate the chemical composition of 'Cabernet Franc' (*Vitis vinifera* L.) subjected to different levels of shoot topping.

The experiment was conducted in a commercial vineyard, located in the municipality of São Joaquim, in the state of Santa Catarina, Brazil (28°17'39"S, 49°55'56"W, at an altitude of 1,230 m a.s.l.), during the 2008 and 2009 harvests. According to Köppen classification, the local climate is Cfb climate, humid mesothermic, without dry season and with mild summer (<22°C). The average maximum temperature varies from 19.4 to 22.3°C, and the minimum temperature from 9.2 to 10.8°C. The annual rainfall varies from 1,360 to 1,600 mm (Luciano et al., 2013). In the experiment, five-year-old 'Cabernet Franc' vines, grafted on 3309 Couderc, were planted in a north-to-south row orientation, at a spacing of 3.0 m between rows and 1.2 m between plants. The plants had uniform vigor and development. Vines were pruned to two-bud spurs in a bilateral cordon, with a height of 1.2 m, trained on a vertical shoot position (VSP), and covered with an anti-hail net. The shoot topping treatments were performed at veraison, which occurred in the first week of February in both cycles, during the phenological stage of berry color change. This stage coincides with the time when the shoot growth rate decreases (Borghesan et al., 2012). The experiment was arranged in a randomized complete block design, with four treatments, four replicates and ten plants per plot.

The treatments consisted of different levels of shoot topping, represented by percentage reductions of the total leaf area (LA): control, with no shoot topping, maintaining a 5.92 m² of leaf area per kg of grape; reduction of 15% of total leaf area, maintaining a LA of 5.00 m² per kg of grape; reduction of 30% of the total leaf area, maintaining a LA of 4.10 m² per kg of grape; and the reduction of 45% of the total leaf area, maintaining a LA of 3.20 m² per kg of grape. The LA per plant was estimated after the shoot topping treatments were performed. To do so, the number of leaves of all plants in each treatment was counted, and the resulting value was multiplied by the mean area per leaf. To measure the mean area per leaf, 100 leaves were collected in the experiment block and analyzed in a LI-3050A leaf area integrator (LI-COR, Lincoln, Nebraska, USA).

On the dates of harvests, i.e., 4/2/2008 and 4/6/2009, which were determined by the company, 150 berry samples were collected per replicate for technological and phenolic maturation analyses. The berries were crushed by hand, in order to separate the skin from the pulp. Technological maturation analyses were performed by assessing the soluble solids (SS) and titratable acidity (TA) contents in the must, through official methodologies of the International Organization of Vine and Wine (OIV, 2009). The SS were measured in an ITREFD-45 digital refractometer (Instrutemp: Instrumentos de Medição, São Paulo, SP, Brazil) with the results expressed in °Brix. The TA was obtained by titrating the must with standardized alkaline solution of 0.1 N sodium hydroxide, using bromothymol blue as the indicator and the results being expressed in meq L⁻¹. Based on the skin, the phenolic maturation was assessed by analyzing total polyphenols index (TPI) and anthocyanin contents. To this end, the skins underwent an extraction process with 50% v v⁻¹ hydroalcoholic solution of methanol (Marcon Filho et al., 2016). The TPI and the anthocyanins were determined in the extract solutions according to the methodologies proposed by Ribéreau-Gayon et al. (1998). Data were subjected to polynomial regression analysis (p<0.05) as a function of the percentage of leaf area reduction.

The different levels of shoot topping resulted in a linear decrease of the soluble solids content in 'Cabernet Franc' grape berries in the different intensities of shoot topping, in both cycles evaluated (Figure 1).

The higher the intensity of shoot topping, the lower the accumulation of soluble solids, which leads to the inference that the reduction in the ratio of leaf area to fruit caused a decrease in the carbohydrate supply to the berries (Parker et al., 2015). In addition, one can take into account the hypothesis that the remaining leaves were not able to increase the photosynthetic activity of plants that received the treatments (Vasconcelos & Castagnoli, 2000).

Shoot topping did not have a consistent effect on the titratable acid content in the grape berries, since only in the 2008 harvest, there was a reduction in the titratable acidity levels as a function of the levels of shoot topping. In this case, the lowest acidity value was reached with the reduction of 25% in the leaf area, from which an increase in the acidity content was observed.

The synchrony between the sugar and acid contents in the grape berries of *Vitis vinifera* seems to be a

factor that depends on the variety used. For example, the results of the present study are in agreement with those obtained with 'Pinot Noir', in which reductions of the leaf area up to 50% caused a decrease in the accumulation of soluble solids, but no alteration in the acid content (Parker et al., 2015). However, in studies conducted with 'Syrah' (Leão et al., 2016) and 'Sauvignon Blanc' (Šuklje et al., 2013) grapevines, subjected to reductions of 12 and 44% in the total leaf area, respectively, no differences were observed in the concentration of SS. However, these authors found differences in titratable acidity contents. These results set the precedent for the hypothesis that there is an optimum ratio of leaf area to fruit load for each variety and cultivation site for vine.

There was an increase in total polyphenol content, from 40.5 (A_{280}) to 50.1 (A_{280}), when increasing the shoot topping intensity up to 26% (leaving a leaf area of 4.38 m² kg⁻¹ of grape) (Figure 2). From this point on,

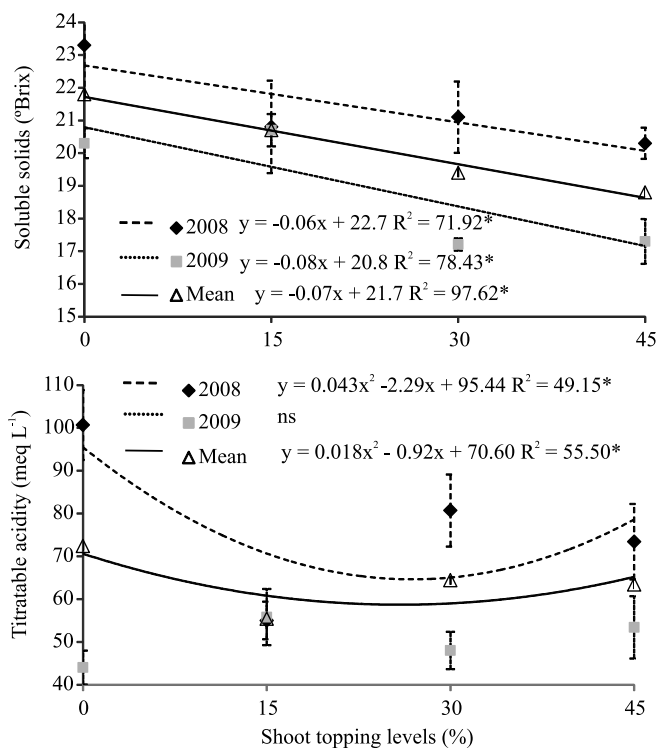


Figure 1. Effect of shoot topping levels (0, 15, 30, and 45% in reduction of leaf area) on the technological maturation – soluble solids (°Brix) and titratable acidity (meq L⁻¹) – of 'Cabernet Franc' grape berries, in the 2008 and 2009 harvests. *Significant polynomial regression ($p < 0.005$). ^{ns}Nonsignificant.

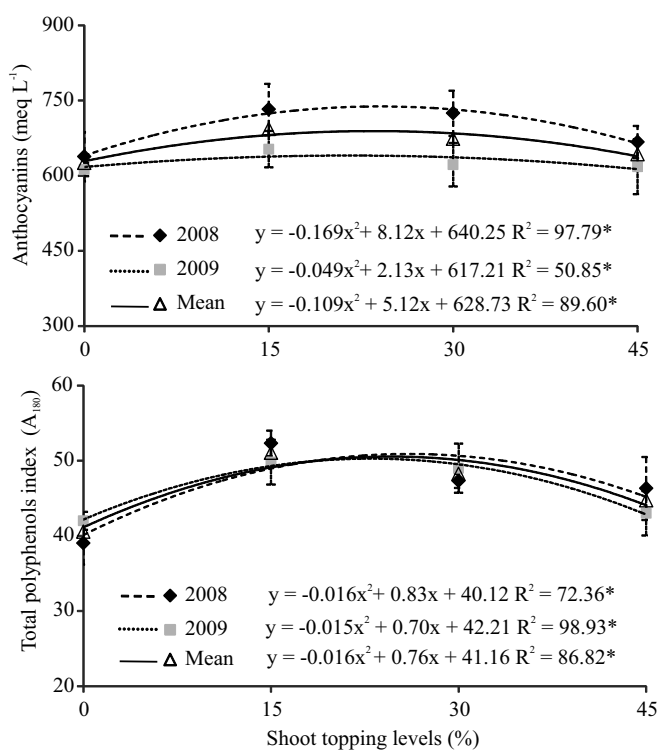


Figure 2. Effect of shoot topping levels (0, 15, 30, and 45% in reduction of leaf area) on the phenolic maturation – total anthocyanins (meq L⁻¹) and total polyphenols index (D.O.280) – of 'Cabernet Franc' grape berries, in the 2008 and 2009 harvests. *Significant polynomial regression ($p < 0.005$).

increases in shoot topping caused reductions in TPI. The results obtained for anthocyanins were similar to those obtained with total polyphenols, in which the increase of shoot topping intensity up to 24% (leaving 4.49 m² kg⁻¹ of grape) promoted the increment of its content. The management of the vegetative canopy results in alterations of grape berries chemical components, through the reduction of shading and the increase of light incidence on the bunches (Meyers & Vanden Heuvel, 2008). In this sense, it is hypothesized that reductions around 25% of the vegetative canopy through shoot topping may reduce the shading on the bunches, and the best distribution of the incident light on the canopy can be a factor that improves the phenolic maturation of the 'Cabernet Franc' grape berries.

Reductions greater than 24% resulted in decreased anthocyanin content. Similar results were observed by Brighenti et al. (2010) with 'Merlot' vines grafted on 3309 Couderc, in which increases in the anthocyanin index were obtained through a moderate shoot topping. With reduction of apical dominance, shoot topping promotes the balance in the distribution of carbohydrates between the vegetative canopy and the clusters (Mota et al., 2010).

Considering the results found in this study, the influence of leaf area management in the maturation of 'Cabernet Franc' grape berries was observed. A moderate shoot topping (with reductions no greater than 26% of the vegetative canopy) improved the phenolic maturation, with an increase in total polyphenol index and the anthocyanins content. However, severe shoot topping, i.e., with reductions greater than 26% of the vegetative canopy, may negatively impact grape quality by reducing the content of soluble solids and decreasing the total polyphenol index and the content of anthocyanins of 'Cabernet Franc' grape berries, in high-altitude regions of the Southern Region of Brazil.

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