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Influence of vegetative canopy management on the quality of 'Bordô' grape grown in the ‘Planalto Norte Catarinense’

Influência do manejo do dossel vegetativo na qualidade da uva 'Bordô' cultivada no ‘Planalto Norte Catarinense’

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RESUMO

Na videira, o balanço entre a carga de frutas e a área foliar adequadamente iluminada influência na quantidade e na qualidade da produção, sendo necessário em alguns casos, a realização do manejo do dossel vegetativo. Nesse contexto, objetiva-se com este trabalho avaliar a influência do manejo do dossel vegetativo na qualidade da videira ‘Bordô’, através dos seguintes tratamentos: T1 - sem manejo de desfolha e sem desponte; T2 - sem manejo da desfolha e com desponte; T3 - com manejo da desfolha e sem desponte; T4 - com manejo da desfolha e com desponte. O trabalho foi realizado no munício de Canoinhas - SC, durante o ciclo 2022/2023, em um delineamento de blocos ao acaso, com quatro repetições e dez plantas por parcela. As bagas provenientes do T1 apresentaram, em média, o menor teor de sólidos solúveis (12,9 °Brix), maior valor para acidez titulável (133,1 meq/L) e menor valor para pH (3,23), porém não diferiram do T4 em nenhuma das variáveis. A ausência de poda verde e o manejo da desfolha e desponte não favoreceram as variáveis relacionadas à maturação. As bagas oriundas do T2 apresentaram teor de sólidos solúveis (14,2 °Brix) superior aos T1 e T4, acidez menor que T1 e T4 (116,3 meq/L) e pH 3,30, portanto o desponte favoreceu a qualidade das uvas, em comparação com a testemunha e o tratamento com desponte e desfolha. Os melhores resultados foram constatados no T3, com 15,2 °Brix, 108,9 meq/L de acidez e pH de 3,39. Conclui-se que a prática da desfolha no estádio fenológico de grão chumbinho favorece a maturação e qualidade das uvas.

PALAVRAS-CHAVE: *Vitis labrusca L.; maturação; desfolha; desponte.*

ABSTRACT

In the grapevine, the balance between the fruit load and the adequately lit leaf area influences the quantity and quality of production, making it necessary in some cases to manage the vegetative canopy. In this context, the aim of this work is to evaluate the influence of vegetative canopy management on the quality of the ‘Bordô’ vine, through the following treatments, with the following treatments: T1 - Without leaf removal Management and Without Shoot topping; T2 - Without leaf removal management and with shoot topping; T3 - with leaf removal Management and without shoot topping; T4 - with leaf removal and with shoot topping. The work was carried out in the municipality of Canoinhas - SC, during the 2022/2023 cycle, in a randomized block design, with four replications and ten plants per plot. The berries from T1 had the lowest soluble solids, with a value of 12.9 °Brix, and the highest value for titratable acidity (133.1 meq/L) and the lowest value for pH (3.23). However, it did not differ statistically from the berries from T4 in any of the variables. The absence of pruning and leaf removal + shoot topping did not favor the variables related to maturation. The berries from T2 showed a higher soluble solids content (14.2°Brix) than T1 and T4, lower acidity than T1 and T4 (116.3 meq/L) and pH 3.30. The green pruning favored the quality of the grapes, in comparison with the control and the treatment with leaf removal + shoot topping. The best results were observed for T3, which presented 15.2 °Brix, 108.9 meq/L of acidity and pH of 3.39. It was concluded that the leaf removal at the phenological stage of buckshot berries favors the ripening and quality of grapes.

KEYWORDS: *Vitis labrusca L.; maturation; leaf removal; shoot topping.*

Wine production has spread across Brazil, reaching areas previously deemed unsuitable for grape cultivation, and has become socioeconomically significant. The genetic diversity present in Brazilian viticulture (CAMARGO et al. 2011) has contributed to the expansion, enabling the emergence of new wine-producing regions. In Santa Catarina state, the Planalto Norte is emerging as a promising wine-growing region, particularly for American grape varieties (*Vitis labrusca* L.) and their hybrids, suitable for both processing and fresh consumption (WÜRZ & JASTROMBEK 2022).

Viticulture presents itself as a diversification option for rural properties, especially for family farms. Research aimed at providing growers with decision-making tools, such as selecting better-suited varieties and improved cultivation practices, is crucial for the growth and success of viticulture. In grapevines, as in most fruit-bearing plants, the balance between fruit load (sink) and well-lit leaf area (source) affects both yield quantity and quality. The balance between these two factors is crucial for berry composition and ripening (MARCON FILHO et al. 2015**),** that could lead to insufficient ripening, even in *Vitis labrusca* varieties like 'Bordô', which is widely grown in Southern Brazil.

The 'Bordô' grape may struggle to ripen fully due to imbalances in vegetative growth and production, as well as excessive rainfall and reduced sunlight exposure. These factors can hinder sugar accumulation in the berries, ultimately affecting the quality of the grapes and their derived products, such as grape juice and red table wine (CHIAROTTI et al. 2011). Sugar accumulation occurs during fruit ripening, serving as a precursor for other important compounds such as polyphenols, anthocyanins, aromatic compounds, and the alcohol produced during winemaking (FREGONI 1998).

To enhance grape quality, vineyard management techniques such as green pruning, leaf removal, and shoot or cluster tipping are employed to balance the vine's vegetative growth and fruit production (MIELE & MANDELLI 2012). Vineyard management practices that alter source-sink relationships directly impact grape yield and quality (GONZÁLEZ-NEVES & FERRER 2008).

Leaf removal involves eliminating grapevine leaves, particularly those near flower clusters and grape bunches, increasing temperature, sunlight exposure, and air circulation around the clusters. This results in improved coloration, berry ripening, and reduced bunch rot incidence (MIELE & MANDELLI 2012, DIAGO et al. 2012, SIVILOTTI et al. 2016, WÜRZ et al. 2018, IVANISEVIC et al. 2020). Pruning involves removing about 30 cm from the branch tips, a common practice aimed at limiting vegetative growth by eliminating parts of soft shoots, maintaining the tree's predetermined shape, and improving light penetration (BRIGHENTI et al. 2010). Grapevine photosynthetic efficiency relies on sunlight capture and carbohydrate production by the exposed canopy (PONI 2008).

In the Planalto Norte region of Santa Catarina, research is needed to determine the appropriate canopy management techniques for grape varieties grown locally, in order to support the development of regional viticulture. This study aimed to assess the impact of various canopy management techniques, including green pruning (leaf removal and shoot trimming), on the physicochemical quality of 'Bordô' grape clusters grown in the Planalto Norte region of Santa Catarina.

The current study was conducted in a commercial vineyard located in Pedras Brancas, Canoinhas municipality, Santa Catarina state, Brazil (26° 12' 49.0" S 50° 26' 37.6" W; elevation 870 m) during the 2022/2023 growing season. The area typically experiences average yearly temperatures of 17-18°C (62.6-64.4°F), with annual rainfall ranging from 1,500 to 1,700 mm (59-67 inches). The terrain varies from flat to gently rolling, and the soil is moderately fertile. 2012). The 'Bordô' variety vineyard was established in 2016, with rows spaced 2.5 m x 3.0 m apart, using a pergola training system on 043-43 rootstock.

The experiment involved canopy management through green pruning (leaf removal and shoot trimming), with the following treatments evaluated: T1 - no defoliation management and no stripping (control); T2 - no defoliation management and stripping (carried out at the color change); T3 - defoliation management (carried out on the weeping grain) and no stripping; T4 - defoliation management (carried out on the weeping grain) and stripping (carried out at the color change). The experiment used a randomized block design with four replications and ten plants per plot.

At harvest time in late January 2023, ten randomly selected clusters per plot were sampled for physical analysis, including cluster weight (g), cluster length (cm), berry count, berry diameter (cm), and compactness index. The compaction index was calculated using the formula: CI = [(Bunch weight)/(Bunch length)^2] (TELLO & IBANES 2014).

During harvest, 100 berries per plot were collected to assess grape technological ripeness, measuring soluble solids content (°Brix), total titratable acidity (meq/L), and pH, following the methodology proposed by the International Organisation of Vine and Wine (OIV 2009).

Data were analyzed using ANOVA, followed by Tukey's test at 5% significance level when appropriate.

Table 1 presents the architectural data for the grape clusters subjected to various treatments. No significant differences were observed among treatments for bunch weight, bunch length, berry count, or berry diameter. WÜRZ et. al (2020), studying various defoliation periods of Sauvignon Blanc grapevines, found that the clusters showed similar responses in terms of architecture, supporting the observations made regarding cluster mass, cluster length, and berry count in the present study.

The cluster compactness index was lower for the control treatment, but did not differ statistically from the leaf removal management (T3) and shoot trimming management (T2). The highest cluster compaction, observed in the defoliation + shoot trimming management (T4), is associated with a higher incidence of bunch rot (HERZOG et al. 2015) due to reduced air circulation and light exposure, which also affects the proper coverage of crop protection products applied to the clusters. The defoliation treatment (T3) showed suitable values for the cluster compactness index, as observed in studies conducted by (PONI et al. 2006 and INTRIGLIOLO et al. 2014).

Table 1. Bunch mass, bunch length, number of berries, berry diameter and compaction index of 'Bordô' vine subjected to different green pruning treatments. Canoinhas/SC, harvest 2022/2023.

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Treatment	Bunch Mass (g cluster^{-1})	Bunch length (cm curl^{-1})	Number of berries (bunch of berries^{-1})	Berry diameter (cm baga-^{1})	Compression index
T1	90.2 ns	12.2 ns	40 ns	1.6 ns	0.61 b
T2	111.2	12.7	50	1.5	0.71 ab
T3	91.0	11.8	44	1,4	0.65 b
T4	107.7	11.5	45	1,4	0.8 to
CV (%)	12.5	20.8	15.3	6.5	22.1

*Means followed by different letters in the column differ significantly, according to Tukey's test, with a 5% probability of error.

Table 2 presents the technological maturity data for grape clusters subjected to various treatments. Berries from T1 (control) had the lowest soluble solids content (12.9 °Brix), highest titratable acidity (133.1 meq/L^{-1}), and lowest pH (3.23) compared to other treatments, but didn't significantly differ from T4 (leaf removal + shoot trimming) in any analyzed variables. The lack of pruning and the practice of defoliation and topping did not benefit maturation-related variables.

The plant's vegetative and reproductive functions compete significantly due to the strength of its branches. In grapevines, leaves serve as the source for photosynthetic products, while the growing tips and grape clusters act as sinks (BRIGHENTI et al. 2010). Excessive vigor, due to lack of pruning (T1), reduced the distribution of photoassimilates to the clusters, resulting in lower accumulation of soluble solids in the berries (Table 2). The vigorous branch leads to a higher concentration of nutrients at the growing tip, resulting in reduced nutrient supply to the clusters, which impairs ripening (FREGONI 1998).

Excessive pruning was also detrimental, as the defoliation + topping management reduced the number of leaves available for photosynthesis, decreasing the production of photoassimilates for the clusters, which consequently affected berry ripening, resulting in lower soluble solids content in T4 (Table 2). However, the timing of the green pruning may have also contributed to the negative results in T4. MANDELLI et al. (2008) observed that defoliation + shoot tipping management in 'Merlot' grapevines, performed 21 days before harvest, improved grape ripening, resulting in musts with higher sugar content and lower acidity.

Table 2. Soluble solids, total acidity and pH of 'Bordô' vine berries submitted to different green pruning treatments. Canoinhas/SC, harvest 2022/2023.

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Treatments	Soluble solids	Total acidity	pH

	(°Brix)	(meq L^{-1})	
T1	12.8 °C	133.1 to	3.23 c
T2	14.2 b	116.3 b	3.30 b
T3	15.2 to	108.9 °F	3.39 to
T4	12.9 °F	127.3 to	3.25 c
CV (%)	3.2	4.5	3.3

*Means followed by different letters in the column differ significantly, according to Tukey's test, with a 5% probability of error.

Erro! Vínculo não válido. The timing of green pruning practices significantly influenced the results obtained. Defoliation performed 21 days before harvest, as well as defoliation + shoot trimming at the beginning of flowering, negatively affected 'Merlot' grape quality. These practices didn't promote sugar accumulation in the berries, increased acidity (MANDELLI et al 2008), and the reduced leaf area to fruit ratio likely decreased carbohydrate supply to the berries (PARKER et al.). 2015). Additionally, it's possible that the remaining leaves were insufficient to sustain photosynthetic activity, resulting in reduced photoassimilate production in the topped plants (VASCONCELOS & CASTAGNOLI 2000).

According to legal requirements, table grapes must have a minimum of 14 °Brix for soluble solids and over 50 meq/L for total acidity (BRASIL 2018). Only treatments T2 and T3 exceeded these thresholds for both parameters. Treatment T2 showed higher soluble solids content (14.2 °Brix) compared to T1 and T4, acidity of 116.3 meq/L, lower than T1 and T4, and pH 3.30. Thus, shoot trimming improved grape quality compared to the control and the treatment with shoot trimming plus leaf removal.

According to BRIGHENTI et. al (2010) shoot trimming in 'Merlot' grapevines balanced the plant's source-sink relationship, directing photoassimilates to the clusters and increasing sugar content in the berries. Off-season pruning stimulates lateral shoot growth throughout the branch, negatively impacting the canopy microclimate through competition for light and photosynthates. In vigorous vines, shoot tipping enhances light penetration into the canopy and improves wine quality, but may delay grape ripening and shoot lignification (GIL & PSZCZÓLKOWSKI 2007).

The best outcomes were observed in the defoliation management treatment (T3), which showed 15.2 °Brix, 108.9 meq/L acidity, and a pH of 3.39. According to WÜRZ et. al (2017) early leaf removal up to the veraison stage allows for achieving maturation levels very close to ideal. Leaf removal enhanced the soluble solids content in the berries, supporting the findings of RADÜNZ et al. (2013) on 'Bordô' grapevines found that leaf removal during the berry shot stage increased the soluble solids content in the berries. PONI et al. (2006) and found that defoliation, performed before veraison, enhances grape quality by increasing soluble solids content and reducing total acidity.

Removing leaves near the clusters enhances sunlight exposure to the inner canopy (GIOVANINNI 2008). This radiation is linked to increased accumulation of soluble solids in the berries, showing a positive correlation between sugar content and the intensity of incident solar radiation (TEIXEIRA 2004). Leaf removal also promotes vine balance between vegetative growth and fruit production, helping redirect nutrients to the grape clusters.

Treatments T2 and T3 showed the closest values to the ideal for total acidity. Acidity is crucial for grape quality and wine stability. Ripe grapes should have organic acid levels between 0.65 and 0.85 g/100ml, or 90 to 110 meq/L (CONDE et al.). 2007).

Early leaf removal during phenological stages like berry set, combined with increased sun exposure, reduces total acidity and raises pH due to malic acid breakdown (INTRIGLIOLO et al. 2014, RISCO et. al 2014), which can also be affected by increased cluster temperatures, higher cellular respiration rates, and subsequent acid breakdown (CONDE et al. 2007).

WÜRZ et. al (2017) in a study on Cabernet Sauvignon, leaf removal before veraison led to optimal pH, soluble solids, and total acidity levels for high-quality wine production, making this practice recommended.

Canopy management should be advocated for grapevine cultivation; however, it must be carried out using technical criteria and prior vineyard analysis to improve grape quality. Green pruning should be done carefully, as excessive defoliation can lead to negative outcomes, including inadequate ripening due to reduced soluble solids in the fruit and incomplete branch maturation, as well as sunburn damage to the berries from overexposure to sunlight (LEÃO 2004).

Leaf removal during the peppercorn-sized berry stage enhances ripening and quality of Bordô grapes without negatively impacting cluster architecture, offering a canopy management technique to improve 'Bordô' grape quality.

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