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Effect of the time of shoot topping on the architecture of the bunches and the temporal dynamics of Botrytis bunch rot (*Botrytis cinerea*) in the 'Sauvignon Blanc' grapevine

Efeito da época de desponte na arquitetura de cachos e na dinâmica temporal da podridão cinzenta (Botrytis cinerea) na videira 'Sauvignon Blanc'

Douglas André Würz *[1(ORCID 0000-0001-6109-9858)], **Leo Rufato** [2(ORCID 0000-0001-9545-7035)], **Bruno Farias Bonin** [3(ORCID 0000-0001-6983-2970)]

[1]Federal Institute of Santa Catarina, Canoinhas, SC, Brazil. *Author for correspondence: douglaswurz@hotmail.com
[2]State University of Santa Catarina, Lages, SC, Brazil.
[3] Federal University of Paraná, Curitiba, PR, Brazil.

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RESUMO

O desponte da videira é um manejo que busca equilíbrio vegeto-produtivo da videira, no entanto, são poucas informações sobre seu efeito na arquitetura de cachos, e na ocorrência da podridão cinzenta. Nesse contexto, tem-se como objetivo deste trabalho avaliar o efeito de diferentes épocas de desponte na arquitetura de cachos e na dinâmica temporal da podridão cinzenta na videira 'Sauvignon Blanc'. O trabalho foi realizado na safra 2016/2017, em um vinhedo comercial, localizado no munícipio de São Joaquim - SC. Os tratamentos consistiram na realização do manejo do desponte, retirando-se aproximadamente 50 cm da porção apical dos ramos em diferentes estádios fenológicos: plantas sem desponte (testemunha), inflorescência separada, plena florada, baga ervilha e veráison. Avaliou-se a arquitetura de cachos e dinâmica temporal da podridão cinzenta. O manejo do desponte da videira 'Sauvignon Blanc' não influenciou a arquitetura de cachos, independente do estádio fenológico que foi realizado. Em relação a podridão cinzenta, não houve efeito para diferentes épocas de desponte no início do aparecimento dos sintomas, tempo para atingir máxima incidência e tempo para atingir máxima severidade, assim como para as variáveis incidência e severidade da doença. No entanto, houve efeito na área AACPID e AACPSD, sendo observado maior valor no estádio fenológico plena florada para AACPID e no veráison para AACPSD. Portanto recomenda-se sua realização na baga ervilha.

PALAVRAS-CHAVE: *Vitis vinifera L.;* poda verde; doenças da videira; vinhos de altitude.

ABSTRACT

Shoot topping is a management method in the search for a vegetative and productive balance in the grapevine. However, there is little information about its effect on the architecture of the bunches and on the occurrence of *Botrytis bunch* rot. In this context, the aim of this study was to evaluate the effect of different shoot topping times on cluster architecture and the temporal dynamics of Botrytis bunch rot in 'Sauvignon Blanc' grapevines. The work was carried out in the 2016/2017 harvest, in a commercial vineyard located in the municipality of São Joaquim. The treatments consisted of the management of the shoot topping, removing approximately 50 cm from the apical portion of the branches at different phenological stages: plants without shoot (control), separate inflorescence, full bloom, pea-sized berries and veráison. Bunch architecture and the temporal dynamics of Botrytis bunch rot were evaluated. The shoot topping the 'Sauvignon Blanc' grapevine did not influence the architecture of the bunches, regardless of the phenological stage at which it was carried out. About Botrytis bunch rot, there was no effect for the different shoot topping times on the onset of symptoms, time to reach maximum incidence and time to reach maximum severity, as well as for the disease incidence and severity variables, although there was an effect on the AUDIPC and AUDSPC areas, with the highest values being observed in the full bloom phenological stage for AUDIPC and in the veraison for AUDSPC. Therefore, it is recommended to carry it out on the pea berry.

KEYWORDS: *Vitis vinifera L.;* green pruning; vine diseases; high-altitude wines.

INTRODUCTION

The high-altitude region of Santa Catarina produces wine grapes with exceptional oenological potential; however, the soils in this region exhibit elevated organic matter content (ZALAMENA et al. 2013), high water availability (BEM et al. 2016), the deployment of vineyards with vigorous graft carrier, and driving system in the back (VIANNA et al. 2016), which result in excessive vegetative growth (BORGHEZAN et al. 2011, BRIGHENTI et al. 2011) and it is necessary to carry out the management of the vegetative winery, in order to promote the balance of the vineyard (BORGHEZAN et al. 2011).

In the vineyard, as in most fruit species, the balance between the load of fruit (drenage) and the foliar area (source) influences the quantity and quality of production, and the balance between these two parameters is determining for the ripening of the vineyard (MARCON FILHO et al. 2015). In this sense, deponte is an alternative to control excessive vegetative growth and promote adequate maturation (WÜRZ et al. 2017a).

The deponte of the vine is a common practice in grapes, to contain the cup in its pre-established dimensions and maintain the luminosity, with the purpose of limiting vegetative growth by eliminating parts of herbaceous branches (BRIGHENTI et al. 2010). In addition to the reduction of vigor, the deponte can improve the microclimate of the vegetative desert, increase the efficiency of phytosanitary treatments, in addition to favouring the maturation of the vines, which is a common practice (LEÃO et al. 2016). These factors may be crucial for reducing gray mold epidemics, as reported by AUSTIN et al. (2011), wine practices have pronounced effects on the development of the disease.

Sauvignon Blanc has compact clusters, and its ripening-harvest phase coincides with periods of high rainfall in the region (averaging 195 mm), compared to other traditional wine-growing regions. Cultivars with dense canopy, thin skin, and compact clusters such as 'Sauvignon Blanc' are more susceptible to gray mold. Canopy management in grapevines is an alternative to reduce the effect of climatic factors on *B. cinerea* epidemiology. (WÜRZ et al. 2020).

B. cinerea is one of the most important pathogens causing curl rot (MOLITOR et al. 2012). Catarinian climatic conditions are favorable to the development of various diseases, due to high precipitation, and favorable temperatures, making cultural control, through the management of the vegetative desert, fundamental for reducing the damage caused by the disease (WÜRZ et al. 2017b).

Studies have evaluated shoot trimming in high-altitude vineyards, focusing mainly on trimming intensity. However, information regarding timing and its effects on grapevine diseases remains limited. This study aims to assess how different shoot trimming periods affect bunch architecture and Botrytis cinerea epidemiology in 'Sauvignon Blanc' grapevines cultivated in the high-altitude regions of Santa Catarina.

MATERIAL AND METHODS

The study was conducted during the 2016/2017 growing season in a commercial vineyard located in São Joaquim municipality (28°17'39" S, 49°55'56" W) at 1,230 m above sea level. The experimental design was randomized complete blocks with four blocks and ten plants per replicate.

The region's climate is classified as 'Cool, Cool Night and Humid', with a Heliothermal Index of 1,714, mean annual rainfall of 1,621 mm, and mean annual relative humidity of 80% (TONIETTO & CARBONNAU 2004). The soils in the region fall into the classes Cambissolo Humico, Neossolo Litólico and Nitossolo Háplico, developed from riodacito and basalt rock (SANTOS et al. 2018).

A 'Sauvignon Blanc' vineyard grafted onto 'Paulsen 1103' rootstock, established in 2004 and characterized by excessive vegetative growth, was evaluated. Furthermore, according to WÜRZ et al. (2020), the variety is susceptible to gray rot, having the disease present in the vineyard in previous years. The vineyard was planted in north-south oriented rows spaced at 3.0 × 1.5 m, trained on a double cordon system at 1.2 m height, and protected with anti-hail netting.

The treatments consisted of shoot trimming management by removing approximately 50 cm of the apical portion of shoots at different phenological stages, according to BAILLOD & BAGGIOLINI (1993) scale: untrimmed vines (control), separated inflorescence, full bloom, pea-sized berries, and veraison. Thinning was performed manually using pruning shears.

All other cultural practices (pruning, shoot thinning, leaf removal, and phytosanitary treatments) were performed according to standard technical recommendations across all treatments.

At harvest, twenty clusters per plot were randomly sampled for physical analyses: cluster length (cm), measured with a digital caliper; cluster mass (g); and number of berries per cluster, obtained by manual counting. The cache compactation index was obtained by the relationship [(Cache mass) / (Cache length) ²] proposed by TELLO & IBANEZ (2014).

Gray mold incidence was determined by counting the number of clusters with at least one berry infected by the fungus, and disease severity was assessed using the diagrammatic scale proposed by HILL et al. (2010), based on twelve levels of severity of the disease: 1, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80 and 90%. Twenty random bunches per plot were evaluated for each treatment. Evaluations were conducted weekly from veraison onwards.

Disease progress curves for incidence and severity of *B. cinerea* were plotted, and the epidemic was analyzed based on: time of symptom onset (TSO) (days); time to reach maximum disease incidence and severity (TRMDI and TRMDS) (days); maximum incidence (Imax) (%) and severity (Smax) (%); and Area Under the Disease Progress Curve for both Incidence (AUDPCI) and Severity (AUDPCS). The area under the disease progression curve (AUDPC) was calculated using the formula: AUDPC = Σ ((Yi+Yi+1)/2)(ti+1 –ti), where Y represents disease intensity (incidence and severity), t represents time, and i represents the number of assessments over time (CAMPBELL & MADDEN 1990).

Meteorological data were obtained from the Automated Weather Station of the Environmental Resources and Hydrometeorology Information Center of Santa Catarina (EPAGRI/CIRAM), located at the EPAGRI Experimental Station in São Joaquim. The meteorological variables were: average air temperature (ºC) and daily rainfall (mm) during the months of November to April of the 2016/2017 harvests.

Disease incidence means were transformed using arcsine square root transformation for statistical normalization. The variables were subjected to analysis of variance (ANOVA) and when treatment effects were detected, the Tukey test was used to compare means at a 5% probability of error.

RESULTS AND DISCUSSION

There were favorable climatic conditions for the development of gray rot during the evaluation of the experiment (Figure 1). In the 2016/2017 cycle, the average temperature was 17.3°C, precipitation during the vegetative cycle was 532.7 mm, and relative humidity was 81.2%. The climatic conditions in Santa Catarina promote disease development, highlighting the need to better understand how canopy management can reduce fungal diseases.

The effects of shoot trimming timing on cluster architecture are shown in Table 1. Cluster tipping did not affect cluster architecture (cluster mass, cluster length, berry number, and compactness index).

Among the variables evaluated, buck compaction is considered an important qualitative parameter of the vine, as compact buckets are more susceptible to the attack of *B. cinerea* (HED et al. 2015), having a direct effect on the epidemiology of the disease.

Shoot trimming, which removes more than 30 cm of shoot tips, is a common practice in *Vitis vinifera* L. grapevines when vigor has not been controlled through other management practices, to maintain the canopy within its pre-established dimensions. 2010).

Early shoot trimming, performed before veraison, was expected to modify cluster architecture; however, this effect was not observed. Due to excessive vegetative growth, shoot regrowth occurred at different phenological stages. Thus, according to BRIGHENTI et al. (2010) Berry thinning should be performed during veraison to prevent excessive lateral shoot growth.

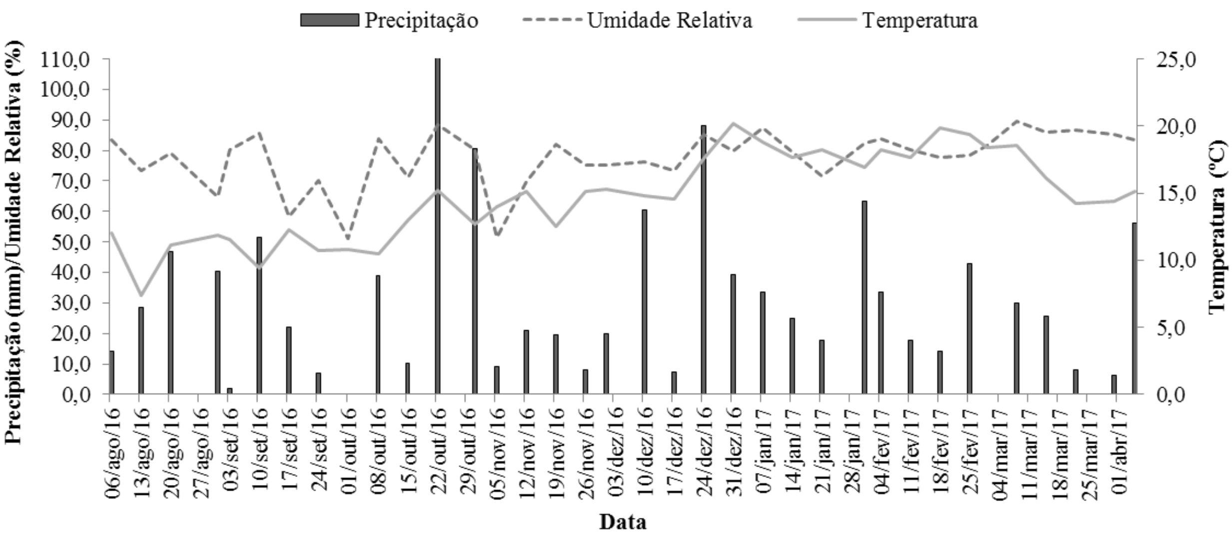

Figure 1. Accumulated rainfall (mm), relative air humidity (%) and average air temperature (ºC) for São Joaquim/SC during the 2016/2017 harvests.

Table 1. Effect of the deponture season on the architecture of the Sauvignon Blanc (*Vitis vinifera* L.) vineyard in the high altitude region of Santa Catarina. Safra 2017.

Period of Desponte	Grape Cluster Mass (grams)	Length of Cluster (cm)	Number of berries (berries cluster^{-1})	Compacting Index
Without deponte	128,0 ns	12.4 ns	64 ns	0.82 ns
Separate inflorescence	121,7	12,2	65	0,79
Full flower	126,3	12,7	70	0,77
Shot Berries	124,1	12,1	65	0,84
Veráison	131,5	12,0	66	0,91
CV (%)	16,4	6,6	15,2	8,4

*Averages followed by the same letter, in the line, do not differ by Tukey test at 5% error probability. ns = not significant by variance analysis (ANOVA) at 5% error probability.

In a study conducted by WÜRZ et al. (2020), with the management of the vegetative desert (desponte) of the vine 'Sauvignon Blanc', also did not result in changes in the architecture of curves. In another study published, SILVA et al. (2018), evaluating the effect of different shoot trimming levels, found no effect on cluster architecture variables.

The effect of the decay season on the onset of symptoms (OS), time to reach maximum incidence (TRMI) and time to reach maximum severity (TRMS) of gray rot in Sauvignon Blanc vine (*Vitis vinifera* L.) are described in Table 2. The OS occurred 7 days after the initial assessment for all pruning periods, with no differences observed between treatments.

Regarding TRMI, values ranged from 29 days for tipping performed at separated inflorescence and full bloom phenological stages to 33 days when no tipping was performed, with no significant differences observed among tipping times. The TRMS was 35 days after the initial assessment, coinciding with the bunch harvest period.

Sauvignon Blanc has compact curves and is susceptible to gray rot (WÜRZ et al. 2020) where the maturation-harvest phase coincides with periods of high rainfall in the region (Figure 1), and thus, at the onset of maturation (early February), symptoms began to appear, increasing significantly until harvest time. This phenomenon occurs because immature berries exhibit high resistance to *B. cinerea* due to their cell wall structure during the period between fruit set and veraison, unlike ripening berries where symptoms become visible (SHTIENBERG 2007).

Table 2. Effect of the fall season at the onset of symptoms (OS), time to reach maximum incidence (TRMI) and severity (TRMS) of gray rot in the Sauvignon Blanc vine (*Vitis vinifera* L.) in high altitude region of Santa Catarina. 2017 harvest.

Period of Desponte	OS (days)	TRMI (days)	TRMS (days)
Without deponte	7 ns	33 ns	35 ns
Separate inflorescence	7	29	35
Full flower	7	29	35
Shot Berries	7	31	35
Veráison	7	31	35
CV (%)	0,0	13,1	0,0

*Averages followed by the same letter, in the line, do not differ by Tukey test at 5% error probability. ns = not significant by variance analysis (ANOVA) at 5% error probability.

The effect of different outbreaks on epidemiological variables is described in Table 3. Disease incidence and severity were not affected by this management practice, ranging from 91 to 100% and 14.4 to 17.9%, respectively.

Table 3. Timing of shoot tipping and its influence on Botrytis bunch rot epidemiology in high-altitude vineyards of Sauvignon Blanc (Vitis vinifera L.) in Santa Catarina, Brazil 2017 harvest.

Period of Desponte	Incidence (%)	Severity (%)	AUDPCI	AUDPCS
Without deponte	100 ns	17.2 ns	2362,8 ab	258,3 ab
Separate inflorescence	96	14,4	2210,8 bc	214,8 b
Full flower	96	18,7	2601,6 a	252,2 ab
Shot Berries	91	15,1	1989,1 c	222,3 b
Veráison	93	19,7	2397,5 BC	346.4 a
CV (%)	3,9	17,4	6,4	19,8

*Averages followed by the same letter, in the line, do not differ by Tukey test at 5% error probability. ns = not significant by variance analysis (ANOVA) at 5% error probability.

In relation to the variables AUDPCI and AUDPCS, the effect of the evaluated treatments was observed. The AUDPCI value observed for shoot trimming performed at full bloom phenological stage (2601.6) was higher than other treatments, except for the control (2362.8), while the lowest value was observed for shoot trimming performed at pea-sized berry stage (1989.1), compared to other trimming timings.

The highest AUDPC value was observed in the treatment where shoot trimming was performed at veraison (346.4), which did not differ statistically from the control (258.3) and full bloom (252.2) treatments.

Figure 2 shows the disease progress curves for incidence (A) and severity (B) of gray mold in relation to different topping times. Symptom onset occurred on February 2nd, seven days after initial assessment. Regarding AUDPC, there was a significant increase between February 2nd and February 9th, followed by incremental increases in AUDPC values at each subsequent assessment until reaching its peak at harvest time on March 9th.

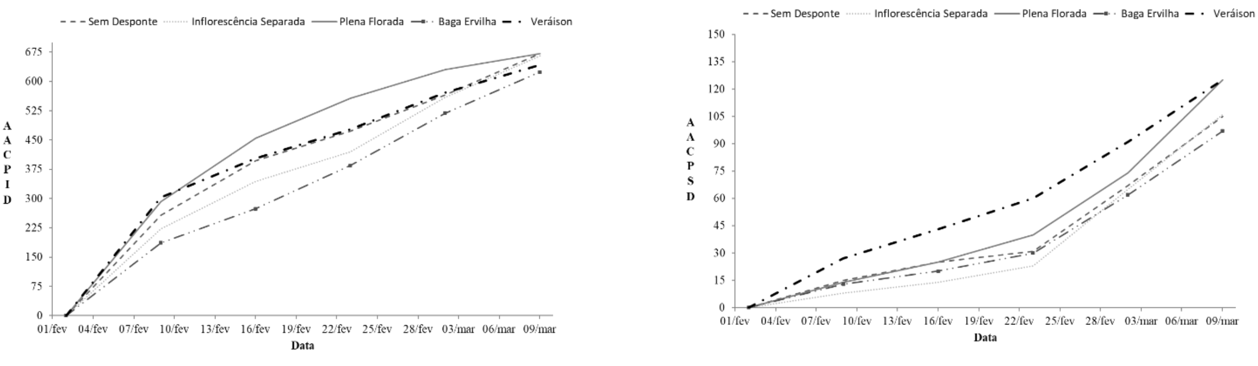

Figure 2. Effect of the fall season in the area below the curve of progress of incidence (A) and severity (B) of gray rot Sauvignon Blanc (Vitis vinifera L.) in high altitude region of Santa Catarina. 2017 harvest.

Regarding AUDPCS, there was a moderate increase until February 22nd, followed by a substantial rise, with peak values at harvest observed in treatments involving shoot trimming during veraison, full bloom, and non-defoliated vines.

When comparing the AUDPCS data with climatic variables (Figure 1), February showed higher rainfall frequency and volume, which may directly explain the significant increase in AUDPCS values during this period.

Although shoot trimming did not show significant effects on disease incidence and severity, shoot trimming at separated inflorescence and pea-sized berry stages reduced AUDPCS in overly vigorous 'Sauvignon Blanc' vines. It is essential to implement alternative control methods to reduce disease pressure in the field and prevent crop damage.

CONCLUSION

Shoot trimming of 'Sauvignon Blanc' grapevines did not affect cluster architecture, regardless of the phenological stage at which it was performed.

With respect to gray rot, there was no effect for different depound times for OS, TRMS, TRMI, Imax and Sma. However, there was an effect in the AUDPC and AUDPCS area, with higher values observed in the phenological stage full-flower for AUDPC and verasion for AUDPCS.

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