Notas Científicas

Botrytis bunch rot on 'Sauvignon Blanc' grapevine on the Y-trellis and vertical shoot-positioned training systems

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Abstract – The objective of this work was to evaluate the effect of the Y-trellis (YT) and vertical shoot-positioned (VSP) training systems on the incidence and severity of *Botrytis cinerea*, on cluster compactness, and total polyphenol (TP) contents of 'Sauvignon Blanc' grapevine (*Vitis vinifera*) in the municipality of São Joaquim, in the state of Santa Catarina, Brazil. Field trials were carried out in a randomized complete block design during the 2013/2014 and 2014/2015 crop seasons, with assessments performed at harvest. The YT system causes a higher incidence and severity of botrytis bunch rot under climatic conditions favorable to the pathogen, as well as greater cluster compactness, than the VSP system, without affecting the content of total polyphenols of 'Sauvignon Blanc' grapevine.

Index terms: *Botrytis cinerea*, *Vitis vinifera*, polyphenol.

Podridão cinzenta em videira 'Sauvignon Blanc' sob sistemas de sustentação ípsilon e espaldeira

Resumo – O objetivo deste trabalho foi avaliar o efeito dos sistemas de sustentação em Y e espaldeira sobre a incidência e a severidade de *Botrytis cinerea*, a compactação de cachos e os polifenóis totais em videiras 'Sauvignon Blanc' (*Vitis vinifera*), em São Joaquim, Santa Catarina. Os experimentos em campo foram conduzidos em delineamento de blocos ao acaso, nas safras 2013/2014 e 2014/2015, com avaliações realizadas no momento da colheita. O sistema de sustentação em Y propicia maiores incidência e severidade de podridão cinzenta em condições climáticas favoráveis ao patógeno, além de maior compactação de cachos, que o sistema em espaldeira, sem alterar a concentração de polifenóis totais, em videiras 'Sauvignon Blanc'.

Termos para indexação: *Botrytis cinerea*, *Vitis vinifera*, polifenóis.

In the last decade, the highlands of Southern Brazil have stood out as a region where grapes (*Vitis vinifera* L.) are grown for fine wine production (Malinovski et al., 2016). The 'Sauvignon Blanc' variety is well adapted to the climate of the region due to its late-sprouting phenological cycle, which avoids problems related to late frost (Brighenti et al., 2013). This characteristic, associated with specific terroir factors, allows developing better-quality white wines with high aromatic intensity, complexity, and typicity, which shows the high potential of this variety for the region (Marcon Filho, 2015).

The climatic conditions in Southern Brazil, however, are favorable to many fungal pathogens. One of the most important grape diseases is gray mold or botrytis bunch rot caused by the fungus *Botryotinia fuckeliana* (de Bary) Whetzel, sexual stage of *Botrytis cinerea* Persoon ex Fries (Ellis, 1971).

Botrytis bunch rot can significantly reduce both grape yield and quality. The disease causes light-brown necrosis on grape peduncles, followed by the drying out of cluster parts, which leads to premature bunch fall. In table grapes, significant losses in fruit quality occur in field conditions, during storage and transportation; and, in grapes for processing, the damage is attributed to changes in the chemical composition of the diseased cluster. Botrytis bunch rot can affect most plant parts, with onset in spring. However, the greatest damage

occurs on clusters during the ripening process. Over the blooming period, flower parts and individual flowers that develop into berries can become infected; and calyptra, stamens, and unfertilized flowers are infected under moist conditions. Any time after bloom, under high humidity, the floral debris will produce spores that can infect the rachis and other cluster parts. The initial symptoms of the disease occur in the internal tissues of the berry; the berry turns dark – which is easy to observe in a white variety like 'Sauvignon Blanc' –, the pulp softens, and the skin easily splits or slips off the pulp when touched (Hed et al., 2009).

Disease control is generally achieved by the use of fungicides, but is not always possible or effective due to the phenological stage of the plant, pre-harvest spray interval restrictions, and/or environmental conditions. Chemical alternatives, such as shoot thinning and leaf removal before fruit set, have been shown to reduce botrytis bunch rot (Sanzani et al., 2012). Recently, significant effort has been made to match vineyard design and trellis system to the site-specific factors that affect potential vine growth. It should be noted that a wide range of plant densities and training/trellis systems are routinely adopted in Southern Brazil, in order to reduce the effect of climatic conditions on *B. cinerea* intensity (Bem et al., 2015). The management of training systems determines the spatial distribution of leaves and shoots across the vineyard. New training systems that offer better internal air circulation reduce cluster humidity and, consequently, disease severity (Chavarria & Santos, 2009).

Grape cultivars, such as Sauvignon Blanc, with dense canopies, thin skins, and/or compact clusters are more susceptible to botrytis bunch rot (Hed et al., 2009), since their ripening stage and harvest season coincide with the period of heavy rain (average of 195 mm per month) in Southern Brazil. According to Bem et al. (2015), the vertical shoot-positioned training system, compared with the Y-trellis one, reduced botrytis bunch rot intensity in 'Cabernet Sauvignon' under the edafoclimatic conditions of the highlands of the state of Santa Catarina.

In grape and other fruit crops, the fruit load is associated with the relationship between vegetative and reproductive weights, whereas the balance between fruit load (drain) and illuminated leaf area (source) affects production quality and rate. In vineyards, grape production is directly related to cluster compactness and thinning intensity; the balance between these two parameters is a determining factor in the evaluation of total polyphenol composition and contents of ripe cherries and grape juice. The balance between grape drain/source can be maintained through management strategies such as pruning, leaf removal, and cluster thinning (Borghezan et al., 2011).

The objective of this work was to evaluate the effect of the Y-trellis and vertical shoot-positioned training systems on the incidence and severity of botrytis bunch rot, on cluster compactness, and on total polyphenol contents of 'Sauvignon Blanc' grapevine in the municipality of São Joaquim, in the state of Santa Catarina, Brazil.

The experiments were carried out in commercial vineyards (28°14'S, 49°58'W, at an altitude of 1,300 m), in the municipality of São Joaquim, in the state of Santa Catarina, Southern Brazil, during the 2013/2014 and 2014/2015 crop seasons. The vineyards consisted of five-year-old 'Sauvignon Blanc' (*V. vinifera*) grapevine grafted on the 'Paulsen 1103' rootstock, either on YT or vertical shoot positioned (VSP) at distances of 3.0×1.5 m. In both training systems, vines were cordon-trained and spur-pruned at 1.0-m height, with the thinning of two and three bud sets in the YT and VSP systems, respectively, leaving, on average, 45 and 74 bud sets per plant. A total of 250 g 100 L^{-1} mancozeb (Dithane PM) and 400 mL 100 L^{-1} chlorothalonil (Bravonil 500 SC) were applied at bloom, pre-close, and veraison to maintain low levels of botrytis bunch rot, but still allow evaluating the training systems regarding the disease.

The climate of the region is humid mesothermic according to Köppen's classification, and the soil type is an Inceptisol characterized by high clay and organic matter contents. Heavy rainfall occurs from October to March, with averages of approximately 138 mm per month. Daily rainfall, relative humidity, and hourly temperatures were registered by Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina (Figure 1).

Botrytis bunch rot incidence and severity, cluster compactness, and total polyphenol (TP) contents were evaluated at harvest on 3/6/2014 and 2/12/2015 in the 2013/2014 and 2014/2015 crop seasons, respectively. Botrytis bunch rot incidence was determined by counting diseased clusters, with five replicates per treatment, whereas disease severity was obtained as

the percentage of rotten berries per cluster. Cluster compactness was calculated as the ratio between the number of berries and the length of the rachis (cm) according to Hed et al. (2009). For each plot, 30 random clusters were evaluated per training system (treatment).

The experiment was carried out in a randomized complete block design with five replicates, using five plants per experimental plot. Data on the average incidence and severity of the disease were transformed into the arc sine of the square root to standardize the statistical distribution. Tests for significance were performed using the analysis of variance and the F-test, at 5% probability. The SAS software, version 9.1 (SAS Institute, Inc., Cary, NC, USA), was used for the data analyses.

TP contents were evaluated in 100 berries harvested manually per plot and treatment. For this, 100 g of grape skins were used to obtain an extract solution (Marcon Filho et al., 2015), from which the TP contents were determined with the Folin-Ciocalteu method (Amerine & Ough, 1976). Briefly, 0.1 mL of the previously-diluted (1:100) extract solution was reacted with 0.5 mL of 0.2 mol L^{-1} Folin-Ciocalteu reagent for 4 min, and then 1.5 mL saturated sodium carbonate solution (20%) was added to the reaction mixture. The absorbance readings were taken at 760 nm after incubation at darkroom temperature for 2 hours. Gallic acid was used as a reference standard, and the results were expressed as milligram gallic acid equivalent per gram of dry weight of material.

For the 2013/2014 and 2014/2015 crop seasons, accumulated rainfall, average temperature, and relative

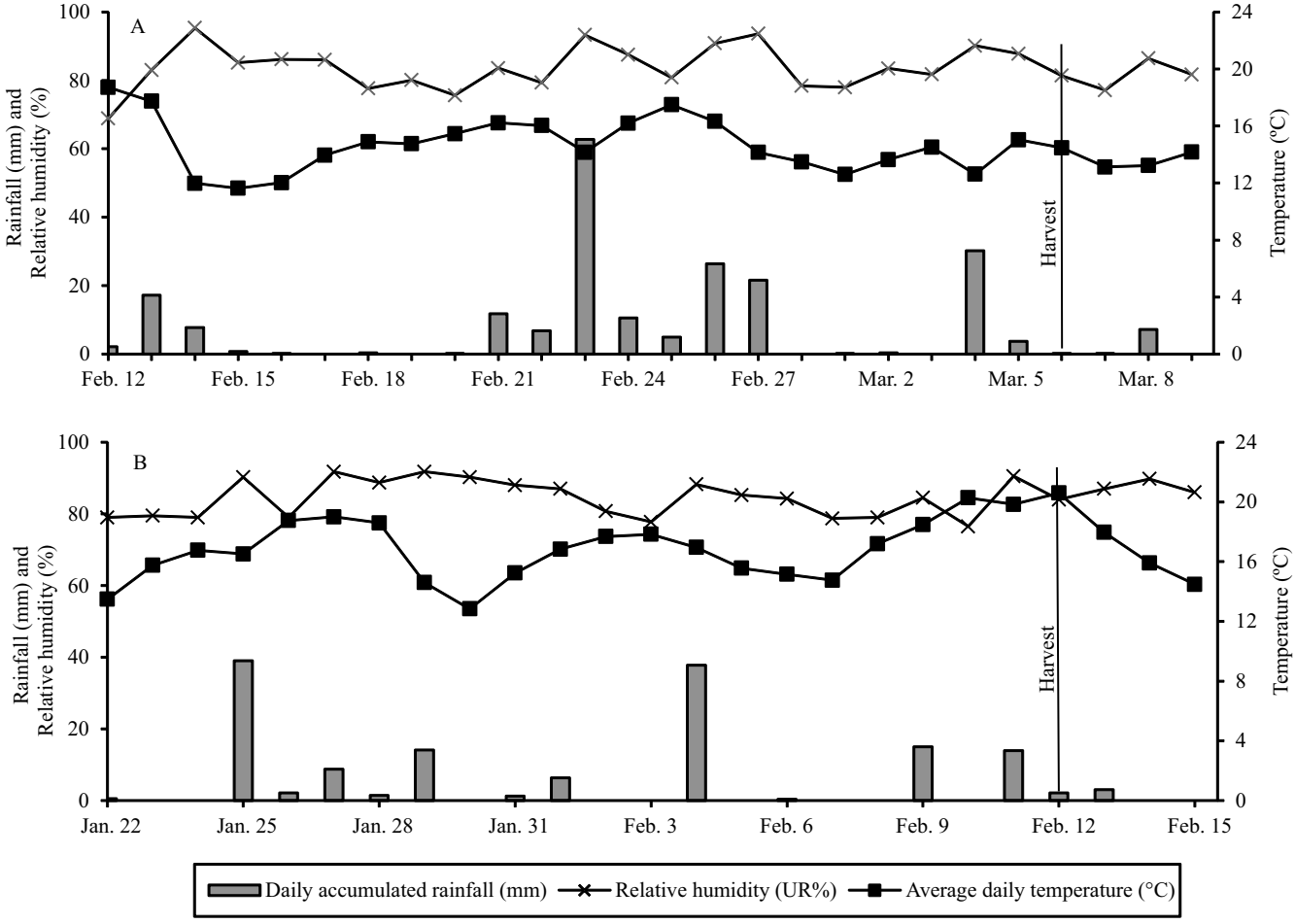

Figure 1. Daily rainfall, relative humidity, and average temperature in the municipality of São Joaquim, in the state of Santa Catarina, Southern Brazil, during the harvest period of 'Sauvignon Blanc' grapevine (*Vitis vinifera*) in 2014 (A) and 2015 (B).

humidity 15 days prior to harvest were, respectively, 179 and 90 mm, 16.5 and 18.5°C, and higher than 80% (Figure 1). A combination of frequent rainfall, mild temperature, and constant humidity, particularly during the harvest period, created wet conditions, which favored infections by *B. cinerea*, especially in the 2013/2014 crop season. Previous studies have shown that, for this fungus, optimal growth is at 15–23°C (Hed et al., 2009).

Botrytis bunch rot incidence and severity were significantly higher in the YT than in the VSP training system in the 2013/2014 crop season, because the climate conditions were favorable to *B. cinerea* infection and development (Table 1). Plants trained to the YT system showed significant increases of 16.7, 7.6, and 1.1%, respectively, in botrytis bunch rot incidence and severity, cluster compactness, and TP contents in the 2013/2014 crop season. Cluster compactness was the only morphological variable that had a significant increase in this training system in the 2014/2015 crop season.

The increase in rainfall during the 2013/2014 crop season, associated with greater canopy compactness in the YT system, which favored double shoots and leaves, was the factor that most contributed to the overall increase in botrytis bunch rot incidence and severity. More compact canopies reduce the exposure to sunlight and wind during most of the day, favoring *B. cinerea* development, even when there is no marked increase in temperature. This data is in alignment with Bem et al. (2015), who recently evaluated botrytis bunch rot intensity on 'Cabernet Sauvignon' grapes on the VSP and YT training systems, also in the municipality of São Joaquim. The authors observed significantly lower area under the disease (incidence and severity) progress curve in the VSP system.

The YT system is recommended because it favors a greater number of buds and shoots, increasing productivity and allowing a better vine vegetative-reproductive balance, without losses in fruit quality (Marcon Filho et al., 2015). However, to avoid phytosanitary issues, the grape producer must carry out additional cultural practices, such as sprouting, removal of diseased leaves and clusters, shoot positioning, trellising, and the use of cultivars with different plant architecture, which have been shown to improve production by altering the microclimate of the canopy.

Greater cluster compactness was observed in the YT system both in the 2013/2014 and 2014/2015 crop seasons (Table 1). The highlands of the state of Santa Catarina are characterized by heavy rainfall and soil with high levels of organic matter, which may have been contributing factors to increase cluster compactness, causing increased vegetative growth in the VSP system (Zalamena et al., 2013). The YT system tends to reduce plant vigor, leading to a balance between vegetative growth and production, resulting in increased grape production and quality (Reynolds & Vanden Heuvel, 2009); however, due to the higher nutrient flow to the cherries, there is also an increase in cluster compactness (Hernandes et al., 2013). It should be highlighted that more compact clusters favor the action of several pathogens, especially *B. cinerea*.

No significant differences were observed in TP contents of 'Sauvignon Blanc' grape juice on either the YT or VSP training system in the 2013/2014 and 2014/2015 crop seasons (Table 1). The average TP content (285.3 mg L^{-1}) obtained in the present study is in the expected range for the 'Sauvignon Blanc' variety (Ehrhardt et al., 2014). An increase of 59.5 mg L^{-1} in TP contents was verified in the 2013/2014 crop season, when botrytis bunch rot was higher in the YT system, and can be related to high plant stress caused by *B. cinerea* infection. Ribéreau-Gayon et al. (2003)

Table 1. Botrytis bunch rot incidence and severity, total polyphenol contents of berry skin, and cluster compactness in commercial vineyards of 'Sauvignon Blanc' grapevine (*Vitis vinifera*) on the Y-trellis (YT) and vertical shoot-positioned (VSP) training systems, in the municipality of São Joaquim, in the state of Santa Catarina, Brazil, during the 2013/2014 and 2014/2015 crop seasons.

Variable	YT	VSP	CV[(2)] (%)
	2013/2014 crop season		
Incidence (%)	90.7Aa[(1)]	74.0Ba	12.1
Severity (%)	13.2Aa	5.6Ba	12.5
Total polyphenol contents (mg L^{-1})	304.3Aa	302.0Aa	10.3
Cluster compactness	5.6Ab	4.5Bb	1.7
	2014/2015 crop season		
Incidence (%)	40.5Ab	36.0Ab	14.9
Severity (%)	1.95Ab	1.26Ab	24.3
Total polyphenol contents (mg L^{-1})	244.8Ab	290.4Aa	13.6
Cluster compactness	8.0Aa	6.4Ba	11.2

[(1)]Means followed by equal letters, uppercase in the rows and lowercase in the columns between training systems and crop seasons, respectively, do not differ by the F-test, at 5% probability. [(2)]Coefficient of variation.

showed that the synthesis of phenolic compounds, mainly from the stilbene class, increased plant stress due to adverse environmental conditions or diseases.

Cultural and genetic control measures are important components of integrated pest management and may allow the reduction of fungicide applications or the use of more environmentally safe fungicides. The advancements in vineyard design, trellis and training systems, and canopy management practices have dramatically improved wine grape productivity and quality all over the world.

The obtained results provide information that can be used to choose the correct training system to manipulate vine vigor and canopy structure; to cause environmental changes in the canopy; and, consequently, to partially or completely control diseases such as botrytis bunch rot when combined with adequate management practices and/or fungicide strategy.

Acknowledgments

To Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes), for scholarship granted.

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Received on August 24, 2016 and accepted on January 6, 2017