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Agronomic performance of 'Sauvignon Blanc' grapevine with different bud loads, in an altitude region of Brazil

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Abstract – The objective of this work was to evaluate the effect of an increased bud load on the agronomic performance of 'Sauvignon Blanc' grapevine cultivated in an altitude region of the state of Santa Catarina, Brazil. The experiment was carried out during the 2016/2017 and 2017/2018 vintages, in a commercial vineyard, located in the municipality of São Joaquim. The treatments consisted of four levels of bud load: 15, 30, 50, and 75 buds per plant. Productive and vegetative variables, cluster architecture, and technological maturation were evaluated. Data were subjected to the analysis of variance and compared by Tukey's test, at 5% probability. In both evaluated vintages, leaf area per plant increased with the increase in bud load. Although the load of 75 buds per plant resulted in a greater leaf area, it presented the most adequate vegetative-productive balance indices. The increase in the bud load of 'Sauvignon Blanc' results in an increased yield, improving vegetative-productive balance and maintaining similar cluster architecture and technological maturation levels between the different bud loads per plant.

Index terms: *Vitis vinifera*, pruning, technological maturation, vegetative-productive balance.

Desempenho agronômico da videira 'Sauvignon Blanc' com diferentes cargas de gemas, em região de altitude do Brasil

Resumo – O objetivo deste trabalho foi avaliar o efeito do aumento da carga de gemas no desempenho agronômico da videira 'Sauvignon Blanc' cultivada em região de altitude do estado de Santa Catarina, Brasil. O experimento foi conduzido durante as safras de 2016/2017 e 2017/2018, em um vinhedo comercial, localizado no munícipio de São Joaquim. Os tratamentos consistiram em quatro diferentes níveis de cargas de gemas: 15, 30, 50 e 75 gemas por planta. Foram avaliadas variáveis produtivas e vegetativas, arquitetura de cachos e maturação tecnológica. Os dados foram submetidos à análise de variância e comparados pelo teste de Tukey, a 5% de probabilidade. Nas duas safras avaliadas, a área foliar por planta aumentou com o aumento da carga de gemas. Embora a carga de 75 gemas por planta tenha resultado em maior aumento da área foliar, apresentou os índices de equilíbrio vegetativo-produtivo mais adequados. O aumento da carga de gemas da videira 'Sauvignon Blanc' aumenta sua produtividade, melhorando seu equilíbrio vegeto-produtivo e mantendo uma arquitetura de cachos e níveis de maturação tecnológica similares entre as diferentes cargas de gemas por planta.

Termos para indexação: *Vitis vinifera*, poda, maturação tecnológica, equilíbrio vegeto-produtivo.

Introduction

In the high altitude region of the state of Santa Catarina, Brazil, vineyards (*Vitis vinifera* L.) are located at an altitude from 900 to 1,400 m above sea level (Wurz et al., 2017), resulting in longer phenological cycles than in other wine-producing regions of the country (Brighenti et al., 2013) and, consequently, in wines with a better quality in color and aroma (Marcon Filho et al., 2015; Wurz et al., 2017). However, the high-altitude region is characterized by a high water availability and soils with high levels of organic matter (Bem et al., 2016), which can lead to an excessive vegetative growth and low bud fertility, affecting vineyard vigor, productivity, and grape maturation (Brighenti et al., 2014).

Winter pruning is an alternative to increase the productivity and improve the vegetative balance of vineyards by increasing the number of buds per plant in an inexpensive way (Würz et al., 2020). However, although winter pruning is performed annually to regulate vine yield, the increase in bud load per plant can cause a series of phenological and chemical effects, as on grape quality, for example (Würz et al., 2020). Depending on the intensity and type of pruning, there are differences in the vegetative vigor and final composition of grape berries both for fresh consumption and vinification (O'Daniel et al., 2012).

The literature on bud load increase includes a pioneering research carried out in New Zealand by Jackson et al. (1984), who described a curvilinear behavior for 40 to 150 buds per plant in five cultivars, including 'Sauvignon Blanc'. The authors found that the increase from 43 to 86 buds per plant doubled yield, which was only 12% higher when the number of buds increased to 150. Greven et al. (2015) reported an increase in yield from 4.8 to 12.7 Mg ha^{-1} with the increase from 24 to 72 buds per plant, respectively. In their study, Würz et al. (2020) observed that an increase in bud load per plant in 'Cabernet Franc' increased the number of shoots and clusters per plant, increasing yield. However, the adaptive processes used by vines to respond to an increased number of buds may also include a reduced vegetative growth, reduced bud fertility, shorter branches with shorter internodes, higher yield and greater number of clusters per plant, and longer clusters with smaller berries (Clingeleffer, 2009).

According to Würz (2020), an increased bud load allows of obtaining a better vegetative-productive balance, with a reduction in pruning weight, as well as the most suitable Ravaz index for the production of quality wines. However, the search for vegetative-productive balance is a challenge in the conditions of the high-altitude regions of Santa Catarina, where the humid climate and fertile soil make growth control difficult (Wurz, 2019).

The objective of this work was to evaluate the effect of an increased bud load on the agronomic performance of 'Sauvignon Blanc' grapevine cultivated in an altitude region of the state of Santa Catarina, Brazil.

Materials and Methods

The experiment was carried out during the 2016/2017 and 2017/2018 vintages, 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 1,230 m altitude). Plants from the Sauvignon Blanc cultivar grafted on the 'Paulsen 1103' rootstock were used. The vineyards, with a history of low productivity, were established in 2004, with plants spaced at 3.0x1.5 m, in rows arranged in the north-south direction, trained in a vertical shoot position (VSP), pruned in a double spur cordon at a 1.2 m height, and covered with an anti-hail protection net.

The soils in the region are classified as Humic Cambisol, Litholic Neosol, and Haplic Nitosol, developed from rhyodacite and basalt rocks (Santos et al., 2018). The climate is considered cold and humid, with cold nights, an heliothermal index of 1,714, an average annual rainfall of 1,621 mm, and an average annual relative humidity of 80% (Tonietto & Carbonneau, 2004).

The treatments consisted of four bud-load levels: 15, 30, 50, and 75 buds per plant. After pruning, 8, 15, and 25 spurs with two buds each were left for the treatments with 15, 30, and 50 buds per plant, but, 30 spurs with two buds and two canes with 8 buds each for 75 buds per plant; therefore, the latter treatment was pruned in the mixed pruning system, characterized by the presence of spurs and canes.

On the harvest date, the following production data were recorded for each plant of each treatment: productivity (kg), number of clusters, and number of shoots. Productivity per plant was determined with an

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electronic field scale, and the results were expressed in kilogram per plant. Estimated yield (Mg ha^{-1}) was obtained by multiplying production per plant by the planting density of 2,222 plants per hectare. The number of clusters per shoot was obtained by dividing the number of clusters per plant by the number of shoots per plant. The number of shoots per linear meter of canopy (shoots per meter) was obtained by dividing the number of shoots per plant by the spacing between plants. Finally, the number of shoots was determined by counting the number of shoots of four plants per treatment. These values were used to calculated the percentage of sprouting, which consists of the relationship between the number of buds left after pruning and the number of buds that sprouted and gave rise to shoots.

To determine plant vigor, the weight of the pruned material and the Ravaz index were used. At the time of pruning, in August 2017 and 2018, the pruned shoots of four plants per block were weighed with the aid of a precision scale, and the results were expressed in kilograms. The Ravaz index was considered as the a ratio between the weight of the produced grapes and the weight of the pruned material. Internode distance was obtained through the relationship between the length of the shoot and the number of buds that each shoot contained, allowing to determine the average internode distance of the shoot.

During grape harvest, leaf area was estimated. For this, ten shoots, located in the middle third of the spur cordon, were selected per treatment. The length (cm) of the central vein of all leaves on the shoot was measured using a graduated ruler. The total leaf area per shoot was obtained according to the mathematical models developed by Borghezan et al. (2010).

Shoot diameter (mm) was also determined, with the aid of a digital caliper, at two points of the shoot: in the first and tenth bud. In addition, throughout the vegetative development cycle, the vegetative growth of four shoots and four secondary shoots per block was evaluated with the aid of a tape measure, with results expressed in centimeters.

For the cluster analysis, five clusters were collected per replicate, totaling 20 clusters per treatment. In these clusters, cluster (g) and rachis (g) mass were determined using a semi-analytical balance, cluster length (cm) was measured with a ruler, and the number of berries per cluster was counted. From these data, the percentage of rachis mass was calculated in relation to the total mass of the cluster, as well as the compactness index (CI) (Tello & Ibáñez, 2014), through the following formula: CI = [(cluster mass) / (cluster length) ^{2}].

Soluble solids (ºBrix), total acidity (meq L^{-1}), and pH were determined from the must, obtained by macerating the berries according to the methodology proposed by Organisation International de la Vigne et du Vin (OIV, 2020).

The used experimental design was randomized complete blocks, with four blocks and five plants per plot. The data were subjected to the analysis of variance and compared by Tukey's test, at 5% probability.

Results and Discussion

For the productive variables of 'Sauvignon Blanc', there was an effect of bud load per plant in 2016/2017 and 2017/2018. A similar behavior was observed in relation to number of shoots per plant, also in both vintages. After sprouting, the loads of 15, 30, 50, and 75 buds per plant resulted in 17, 30, 49, and 67 shoots in 2016/2017 and in 17, 30, 48, and 67 shoots in 2017/2018, respectively (Table 1). Sprouting showed a similar behavior since this variable is obtained from the ratio between the number of buds left after pruning and the number of sprouted buds. The percentage of bud break for the loads of 15, 30, 50, and 75 buds per plant was 113, 102, 96, and 89% in 2017/2018 and 114, 102, 98, and 89% in 2016/2017, respectively. Therefore, an increased bud load led to a reduction in the percentage of bud sprouting. Despite their lower percentage of sprouting, plants with the highest bud load had the highest number of shoots. Likewise, Van Schalkwyk & de Villiers (2001) found that the increase in bud load per linear meter from 8 to 40 buds caused a reduction from 94 to 81% in sprouting.

Plants with a higher number of buds had a higher number of shoots and, consequently, produced a higher number of clusters per plant. For the loads of 15, 30, 50, and 75 buds per plant, the number of clusters was 11, 28, 44, and 60 in 2016/2017 and 10, 21, 27, and 49 in 2017/2018, respectively. The reduction in the number of clusters in 2017/2018 is related to the reduction in the bud fertility index that occurred in this vintage (Table 1). In 2016/2017, a higher fertility index of 0.90, 0.91, and 0.89 clusters per shoot was observed for the loads of 30, 50, and 75 buds; however, in 2017/2018, there was no effect of bud load on this index, whose values, ranging from 0.59 to 0.73 clusters per shoot, were lower than those of the previous vintage.

Productivity and yield increased as bud load increased. In the 2016/2017 vintage, when the number of buds increased from 15 to 75 per plant, there was an increase from 1.0 kg to 6.6 kg per plant, that is of 660%, in productivity, and of 2.2 to 14.7 Mg ha^{-1} in yield. Although a similar bud load effect was observed in 2017/2018, this vintage showed a lower productivity and yield, with increases of 0.7 to 3.3 kg per plant and of 1.7 to 7.3 Mg ha^{-1}, respectively (Table 1).

Jackson et al. (1984) found that yield presents a curvilinear response in relation to the increase in bud load per plant. When doubling the bud load from 43 to 86 buds per plant, the authors observed an increase of 100% in vineyard yield; however, when increasing the load to 150 buds per plant, the increase was only 12% higher. Therefore, it is possible to conclude that the increase in productivity is directly related to the number of clusters per plant since, in some studies, no effects of bud load were observed on cluster weight (Fawzi et al., 2010). Clingeleffer (2009), however, found that vines respond to bud load increases through adaptive processes, including a reduced bud fertility, shorter shoots, shorter internodes, higher yields, and a higher number of clusters per plant.

The number of buds per plant may influence the productive variables of the following year, as observed in the present study, in which the 2017/2018 vintage showed a reduction in productivity and yield in relation to the previous one. Greven et al. (2015) concluded that bud load can have long-term effect due to a reduction in leaf area, causing a lower number of fertile buds in the next crop, whereas Trought & Bennett (2009) suggested that bud load can affect the growth rate of main and secondary shoots, leading to a reduction in total leaf area.

Regarding pruning weight, there was no significant effect of bud load in 2016/2017, with values of 1.6 kg for 15 and 30 buds per plant and of 1.5 kg for 50 and 75 buds per plant (Table 1). In 2017/2018, the lowest pruning weight of 1.1 kg was observed for the load of 75 buds per plant, which did not differ significantly from that of 1.8 kg for the load of 15 buds per plant.

Table 1. Effect of bud load on productive variables of 'Sauvignon Blanc' grapevine (*Vitis vinifera*) in a high-altitude region of the state of Santa Catarina, Brazil, in the 2016/2017 and 2017/2018 vintages[(1)].

Variables	Bud load (buds per plant)				CV (%)
	15	30	50	75	
			2016/2017 vintage		
Number of shoots	17d	30c	49b	67a	2.1
Sprouting (%)	114a	102b	98c	89d	2.8
Number of clusters	11d	28c	44b	60a	10.8
Productivity (kg per plant)	1.0d	2.9c	4.5b	6.6a	15.5
Yield (Mg ha^{-1})	2.2d	6.5c	10.1b	14.7a	12.7
Fertility index	0.78b	0.90a	0.91a	0.89a	12.7
Pruning weight (kg)	1.6^{ns}	1.6	1.5	1.5	14.6
Ravaz index	0.6a	1.9b	3.0bc	4.3c	24.5
			2017/2018 vintage		
Number of shoots	17d	30c	48b	67a	3.3
Sprouting (%)	113c	102b	96bc	89bc	4.8
Number of clusters	10c	21b	27b	49a	11.7
Productivity (kg per plant)	0.7d	1.4c	2.0b	3.3a	11.7
Yield (Mg ha^{-1})	1.7d	3.1c	4.5b	7.3a	11.6
Fertility index	0.59^{ns}	0.68	0.57	0.73	14.6
Pruning weight (kg)	1.8a	1.5b	1.3c	1.1d	4.6
Ravaz index	0.40c	0.93c	1.55b	3.0a	16.7

[(1)]Averages followed by equal letters, in the lines, do not differ by Tukey's test, at 5% probability. ^{ns}Nonsignificant by the analysis of variance, at 5% probability.

There was an effect of bud load on the Ravaz index in both vintages. In 2016/2017, the observed values were 0.6, 1.9, 3.0, and 4.3 for 15, 30, 50, and 75 buds per plant, respectively. In 2017/2018, the Ravaz index was 0.40 and 3.0 for the load of 15 and 75 buds per plant, respectively. In the literature, the Ravaz index ranged from 5 to 10 to reach grape maturation (Kliewer & Dokoozlian, 2005).

Increasing and adjusting bud load through pruning is an economic way of seeking a balance between vegetative growth and production (Smart & Robinson, 1991). The importance of performing a balanced pruning has been recognized for over a century (Ravaz & Sicard, 1903). Howell (2001) suggested that balanced pruning, maintaining a fixed number of buds per unit of pruning mass, is an adequate method to describe the number of buds in winter pruning. Studying the Vignoles cultivar, the authors found that 0.45 kg winter pruning weight allows of fruits to ripen properly in the following season by developing a canopy sufficiently capable of storing reserve carbohydrates.

Total pruning weight was not significantly affected by bud load. Similar results were observed by Greven et al. (2014) when evaluating the effect of bud load on the vegetative performance of 'Sauvignon Blanc' cultivated in New Zealand. In relation to shoot vigor (expressed by shoot diameter), an increased bud load reduced shoot diameter, influencing shoot length. The results of the present study and those of Greven et al. (2014) suggest that an increasing bud load causes a reduction in shoot diameter, also reducing the growth of main and secondary shoots, i.e., vine vegetative vigor.

There was an effect of bud load on the vegetative variables (Table 2). Shoot length was affected in both evaluated vintages. In 2016/2017, the increased bud load reduced shoot length, which was 242, 216, and 208 cm for the loads of 15, 30, 75 buds per plant, but only 185 cm for that of 50 buds. In 2017/2018, similar results were observed, with the longest shoot length of 246 and 207 cm for the loads of 15 and 30 buds per plant, and the shortest of 175 cm, for the load of 75 buds.

Similarly, secondary shoot length showed a reduction with the increase in bud load in both vintages. In 2016/2017, the length of the longest secondary shoots was 76 and 50.7 cm for the loads of 15 and 30 buds per plant, respectively, and the shortest was 38 and 30.5 cm for the loads of 50 and 75 buds. In 2017/2018, a longer secondary shoot length of 75.2 and 49.7 cm was also

Table 2. Effect of bud load on vegetative variables of 'Sauvignon Blanc' grapevine (*Vitis vinifera*) in a high-altitude region of the state of Santa Catarina, Brazil, in the 206/2017 and 2017/2018 vintages[(1)].

Variables	Bud load (buds per plant)				CV (%)
	15	30	50	75	
			2016/2017 vintage		
Length of main shoot (cm)	242.0a	216.7b	185.0c	208.0b	16.3
Length of secondary shoot (cm)	76.0a	50.7ab	38.0b	30.5b	26.6
Number of leaves per shoot	27.2[ns]	30.2	28.7	28.7	20.1
Internode distance (cm)	6.7[ns]	6.2	5.7	6.1	7.6
Leaf area (m^2)	7.5c	11.3bc	16.1b	26.3a	21.3
Productivity/leaf area (kg m^{-2})	0.13b	0.26a	0.26a	0.29a	23.6
Leaf area/productivity (cm^2 g^{-1})	77.0a	42.7b	38.5b	43.4b	23.8
			2017/2018 vintage		
Length of main shoot (cm)	246a	207ab	195b	175c	8.5
Length of secondary shoot (cm)	75.2a	49.7ab	34.7b	28.5b	29.6
Number of leaves per shoot	31.2a	30.7ab	29.7ab	25.7a	8.3
Internode distance (cm)	6.9[ns]	6.2	6.1	5.9	7.4
Leaf area (m^2)	8.4c	12.6bc	16.2b	26.7a	14.3
Productivity/leaf area (kg m^{-2})	0.08[ns]	0.11	0.13	0.12	18.6
Leaf area/productivity (cm^2 g^{-1})	112.4b	90.2ab	82.0ab	80.2b	15.4

[(1)]Averages followed by equal letters, in the lines, do not differ by Tukey's test, at 5% probability. [ns]Nonsignificant by the analysis of variance, at 5% probability.

observed for the loads of 15 and 30 buds per plant, and a shorter one of 34.7 and 28.5 cm for the loads of 50 and 75 buds, respectively. In their research, Benismail et al. (2007) found that balanced pruning resulted in a better balance in vegetative canopy development, reducing the growth of secondary shoots.

As observed in the present study, Greven et al. (2014) related an increased bud load to a reduction in shoot length and diameter, number of leaves per shoot, and in the distance between nodes, which are phenotypically recognized as a reduction in vine vegetative vigor. Similarly, Rühl & Clingeleffer (1993) found that a lower pruning intensity causes a shorter internode distance and smaller shoot diameter. Therefore, the effect of bud load on canopy characteristics, as shown by the results of the vegetative variables, causes changes in leaf area, shoot length, secondary shoot length, and in the leaf area/productivity ratio. The variable number of leaves per shoot was influenced by bud load in 2017/2018, when the load of 15 buds per plant resulted in the longest shoot length and, consequently, in the highest number of leaves.

Leaf area per plant increased with the increase in bud load in both evaluated vintages (Table 2). For the loads of 15 and 75 buds, leaf area was 7.5 and 26.3 m^2 per plant in 2016/2017 and 8.4 and 26.7 m^2 per plant in 2017/2018, respectively. Despite the greater leaf area of the load of 75 buds per plant, this treatment presented the most adequate vegetative-productive balance indices.

The vegetative-productive balance, obtained both by the productivity/leaf area and leaf area/productivity ratios, was affected by bud load (Table 2). This result was more evident in the 2016/2017 vintage, in which the productivity/leaf area ratio showed more adequate values of 0.26, 0.26, and 0.29 kg m^{-2}, respectively, for the loads of 30, 50, and 75 buds per plant. A similar behavior was observed for the leaf area/productivity ratio. In 2017/2018, the productivity/leaf area ratio did not differ significantly between the different bud loads. However, there was an effect for leaf area/productivity, whose best values were 112.4, 82.0, and 80.2 cm^2 g^{-1} for the loads of 15, 50, and 75 buds per plant, respectively.

Overall, in the literature, vineyard yield and fruit quality are described by an optimal curve, in which fruit quality decreases with an increase in yield (Rühl & Clingeleffer, 1993; Howell, 2001; Poni et al., 2004). However, several studies on minimum pruning or higher bud loads suggest that vineyard yield can be increased without affecting fruit quality (Rühl & Clingeleffer, 1993; Intrieri et al., 2011; Poni et al., 2016). This balance can be defined by the productivity/leaf area ratio, with values from 0.8 to 1.2 kg m^{-2} considered optimal to ensure adequate levels of soluble solids and berry color (Kliewer & Dokoozlian, 2005). In altitude vineyards of Southern Brazil, ideal ratios between leaf area and yield were established as 23 cm^2 g^{-1} for 'Merlot' and 24.5 cm^2 g^{-1} for 'Malbec' (Silva et al., 2008; Borghezan et al., 2011). With the increase in bud load, the vines showed a better vegetative balance, which will result in positive effects on grape maturation and quality.

Considering similar results for the productivity x sugar concentration ratio of grape must, it is fair to conclude that the wine will have higher ethanol contents. Although lower yields favor wines with higher concentrations of their main constituents, such as alcohol, dry extract, ash and polyphenols, certain works have found that there is a very little or even no effect on wine quality (Jackson & Lombard, 1993).

The cluster architecture of 'Sauvignon Blanc' was little influenced by the different bud loads (Table 3). In 2016/2017, there was no significant effect for the variables weight of 100 berries, cluster weight, number of berries per cluster, rachis weight, and compactness index. Only cluster length increased with increasing bud loads, with values of 11.5, 13.0, 12.7, and 12.4 cm for the loads of 15, 50, 75, and 30 buds per plant, respectively. Fawzi et al. (2010) found a reduction in average cluster weight and cluster length, but only linked cluster weight to bud load effect. Palanichamy et al. (2004) concluded that bud load has a high influence on berry weight and quality, observing an increase in berry weight with a reduction in bud load, which is an indicative that these are inversely proportional variables. In 2017/2018, cluster architecture was also little affected by the different bud loads. As in 2016/2017, the longest cluster lengths of 12.9 and 12.3 cm were observed for the loads of 75 and 50 buds per plant, while the shortest ones of 10.3 and 11.1 cm, respectively, were obtained for the loads of 15 and 30 buds (Table 3).

There was an effect of bud load on the cluster compactness index, which is directly related to cluster length. The compactness index values were the lowest (0.61) for the load of 75 buds per plant, intermediate

(0.73 and 0.71, respectively) for the loads of 30 and 50 buds, and the highest (0.82) for the load of 15 buds. In general, there was a lower incidence of compact clusters when bud load increased. Since cluster compactness is not favorable from a phytosanitary point of view, as it may increase plant susceptibility to attacks by pathogens, especially *Botrytis cinerea* (Evers et al., 2010), the cluster compactness index is considered an important factor in the evaluation of grape quality (Tello & Ibáñez, 2014).

The technological maturation of 'Sauvignon Blanc' berries in the 2016/2017 and 2017/2018 vintages is shown in Table 4. In 2016/2017, there was no effect of bud load on the variables soluble solids, total acidity and pH, whose values varied from 21.1 to 21.6 °Brix, 101.6 to 93.6 meq L^{-1}, and 3.14 to 3.19 for the loads of 15 and 75 buds per plant, respectively. In 2017/2018, there was an effect of bud load for total acidity and pH, but not for soluble solids content (Table 4). The increase in bud load caused a reduction in the total acidity of 'Sauvignon Blanc' berries, with values of 67.5 and 61.6 meq L^{-1} for the loads of 15 and 30 buds per plant, respectively, and similar values of 60.6 and 60.4 meq L^{-1} for the loads of 50 and 75 buds. As a result of the change in total acidity, an effect of bud load on pH values was also observed. The highest values of

Table 3. Effect of bud load on cluster architecture of 'Sauvignon Blanc' grapevine (*Vitis vinifera*) in a high-altitude region of the state of Santa Catarina, Brazil, in the 2016/2017 and 2017/2018 vintages[(1)].

Variables	Bud load (buds per plant)				CV (%)
	15	30	50	75	
			2016/2017 vintage		
Weight of 100 berries (g)	116.3^{ns}	113.4	113.2	114.5	5.8
Cluster weight (g)	107.7^{ns}	126.3	137.1	131.6	12.5
Number of berries per cluster	55.0^{ns}	63.0	68.0	68.0	10.7
Cluster length (cm)	11.5b	12.4ab	13.0a	12.7a	3.9
Compactness index	0.82^{ns}	0.80	0.79	0.79	7.9
			2017/2018 vintage		
Weight of 100 berries (g)	86.7^{ns}	85.9	87.8	90.0	3.5
Cluster weight (g)	88.2^{ns}	91.1	104.1	107.7	10.8
Number of berries per cluster	67.0^{ns}	66.0	66.0	68.0	9.1
Cluster length (cm)	10.3b	11.1b	12.3a	12.9a	3.73
Compactness index	0.82a	0.73ab	0.71bc	0.61c	6.6

[(1)]Averages followed by equal letters, in the lines, do not differ by Tukey's test, at 5% probability. ^{ns}Nonsignificant by the analysis of variance, at 5% probability.

Table 4. Effect of bud load on technological maturation and berry color of 'Sauvignon Blanc' grapevine (*Vitis vinifera*) in a high-altitude region of the state of Santa Catarina, Brazil, in the 2016/2017 and 2017/2018 vintages[(1)].

Variables	Bud load (buds per plant)				CV (%)
	15	30	50	75	
			2016/2017 vintage		
Soluble solids (°Brix)	21.3^{ns}	21.6	21.4	21.1	1.3
Total acidity (meq L^{-1})	101.6^{ns}	98.6	98.9	93.6	4.5
pH	3.14^{ns}	3.17	3.18	3.19	0.9
			2017/2018 vintage		
Soluble solids (°Brix)	20.6^{ns}	20.8	20.5	20.8	0.9
Total acidity (meq L^{-1})	67.5a	61.6ab	60.6b	60.4b	4.6
pH	3.11b	3.11b	3.17a	3.18a	0.5

[(1)]Averages followed by equal letters, in the lines, do not differ by Tukey's test, at 5% probability. ^{ns}Nonsignificant by the analysis of variance, at 5% probability.

3.17 and 3.18 were found for the loads of 50 and 75 buds per plant, respectively, and the lowest of 3.11, for the loads of 15 and 30 buds.

The levels of soluble solids and total acidity were appropriate for the production of quality wines despite the high total acidity at harvest time, which is considered normal due to the cold climate of high-altitude regions that slows down the degradation of acids. Likewise, Brighenti et al. (2013) found similar values when studying 'Sauvignon Blanc' in Brazilian altitude regions. O'Daniel et al. (2012) concluded that a greater vegetative canopy, obtained through the increase in the number of buds, did not affect cluster maturation, measured by the contents of soluble solids and pH.

According to Greven et al. (2014), most studies about pruning are restricted to data from one or two years, but longer experimental periods from 4 to 7 years are needed to better understand the influence of bud load on vine behavior in relation to yield and excessive vigor control, which can help the wine industry since bud load also affects plant phenology and fruit quality.

Conclusion

The increase in the bud load of 'Sauvignon Blanc' (*Vitis vinifera*) results in an increased productivity, improving vegetative-productive balance and maintaining a similar cluster architecture and technological maturation levels between the different loads of buds per plant.

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