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Effect of two pruning methods on the agronomic performance of 'Chardonnay' grapevines in high altitude region of Santa Catarina

Efeito de dois métodos de poda no desempenho agronômico da videira 'Chardonnay' cultivada em região de altitude de Santa Catarina

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RESUMO

O objetivo deste trabalho foi avaliar o efeito de dois métodos de poda no desempenho agronômico da videira 'Chardonnay' cultivada em região de altitude de Santa Catarina. O presente trabalho foi realizado durante a safra 2018/2019, em um vinhedo comercial localizado no município de São Joaquim. Na poda curta foram deixados esporões com duas gemas, e na poda longa, duas varas com oito gemas cada e um esporão contendo duas gemas para renovação no ano seguinte. Avaliou-se: produção (kg/planta), número de cachos (cachos/planta), produtividade (t ha^{-1}), comprimento de cachos (cm), massa de cachos (g), número de bagas, sólidos solúveis (°Brix), acidez total titulável (meq L^{-1}) e pH. O método de poda influenciou diretamente o desempenho agronômico da videira 'Chardonnay', no entanto, apesar da poda curta resultar em maior número de cachos/planta, esse método de poda apresentou cachos com menor número de bagas e menor massa de cachos, resultando em produção e produtividade semelhantes entre os dois métodos de poda. Além disso, a diferença de maturação tecnológica pode estar diretamente relacionada a arquitetura de cachos, visto que índices produtivos foram semelhantes entre os tratamentos, no entanto, a poda longa apresentou menor acúmulo de sólidos solúveis, e apresentou maior número de bagas/cacho, e maior massa de cachos.

PALAVRAS-CHAVE: *Vitis vinifera* L.; maturação tecnológica; índices produtivos; arquitetura de cachos.

ABSTRACT

The aim of this study was to evaluate the effect of two pruning methods (short pruning and long pruning) on the agronomic performance of 'Chardonnay' vines grown in the high-altitude region of Santa Catarina. This work was carried out during the 2018/2019 harvest in a commercial vineyard located in the municipality of São Joaquim. Short pruning left spurs with two buds, and long pruning left two rods with eight buds each and a spur containing two buds for renewal the following year. In the experiment were evaluated: yield (kg/plant), number of bunches (bunches/plant), productivity (t $hectare^{-1}$), bunch length (cm), bunch mass (g), number of berries, soluble solids (°Brix), total titratable acidity (meq L^{-1}) and pH. The pruning method directly influenced the agronomic performance of the 'Chardonnay' vine. However, although short pruning resulted in a greater number of bunches/plant, this pruning method had bunches with a lower number of berries and lower bunch mass, resulting in similar production and productivity between the two pruning methods. In addition, the difference in technological ripeness may be directly related to the architecture of the bunches, since the yield indices were similar between the treatments; however, the long pruning had a lower accumulation of soluble solids and had a higher number of berries/bunch, and a higher mass of bunches

KEYWORDS: *Vitis vinifera* L.; technological ripeness; production indices; bunch architecture.

In Brazil, wine-growing regions are distributed across temperate, subtropical, and tropical zones, each with distinct characteristics regarding production cycles, harvest periods, cultivars, cultural practices, and product types (PIMENTEL JUNIOR et al. 2019).

In this viticultural scenario, the high-altitude regions of Santa Catarina (SC) are characterized by vineyards located between 900 and 1,400 meters above sea level (WURZ et al. 2017), and has emerged as a region for the production of high quality wines, mainly white varieties (WURZ et al. 2021), for presenting greater availability of solar radiation and lower night temperatures in the final ripening phase, resulting in grapes with greater enological potential (MALINOVSKI et al. 2016), with greater complexity and intensity of aromas and greater acidity of the wines, compared with other wine regions.

Pruning is a crucial management practice for successful grape cultivation, as its absence leads to inconsistent yields and small, low-quality clusters (VILLA et al. 2018), according to RADUNZ et al. (2015), pruning is one of the external factors to the plant that most influence the production and quality of the fruits, and aims to change the architecture of the vegetative winery of the vine, influencing the productive components, the composition of the grape must and the sensory characteristics of the wine (PANCERI et al. 2018), enabling improvements in the biochemical and physiological processes of the plant and fruit, increasing the productivity of the vineyard and the quality of the grape and wine (MIELE & RIZZON 2013).

The most common pruning methods employed by viticulturists are spur-pruned cordon, which involves short pruning with one or two buds per spur, and single or double Guyot, which uses long pruning with spurs and canes maintained either on both sides (double) or on one side of the vine (single) (HIDALGO 2003). According to MENDONÇA et al. (2016), pruning methods determine bud load, which subsequently influences leaf area, cluster number, and yield. According to EULEUTERIO et al. (2010), each cultivar requires a specific pruning method, which is primarily determined by the cultivar itself and the local soil and climatic conditions. According to PANCERI et al. (2018), in the highlands of Santa Catarina, most cultivated varieties experience year-to-year yield fluctuations.

In general, for the vine ‘Chardonnay’ has applied the traditional pruning in double sprinkled cord (REGINA et al. 2010). However, it is not known if this would be ideal in an altitude region (MENDONÇA et al. 2016). This study aimed to evaluate the effects of two pruning methods (spur and cane pruning) on the agronomic performance of 'Chardonnay' grapevines grown in São Joaquim, Santa Catarina State, Brazil.

This study was conducted as a field experiment during the 2018/2019 growing season in a commercial vineyard located in São Joaquim, Brazil (28°17'39" S, 49°55'56" W) at an elevation of 1,230 m above sea level. The soils of the region are considered of the classes Cambissolo Humico, Neossolo Litólico and Nitossolo Háplico, developed from riodactic and basaltic rocks (SANTOS et al. 2018). The climate of the region is classified, according to Koppen-Geiger, as 'Cold, 'Cold Nights' and Moist', with a Heliothermal Index of 1,714, average annual rainfall of 1.621 mm and average annual relative humidity of 80% (TONIETTO & CARBONNEAU 2004).

'Chardonnay' vines grafted onto 'Paulsen 1103' rootstock were used. The vineyard was established in 2004, with vines planted at 3.0 x 1.5m spacing in N-S oriented rows, trained on a vertical shoot positioning trellis system at 1.2m height, protected by anti-hail netting, and has historically shown low yields.

The experiment was conducted in a randomized block design with four blocks per treatment and ten plants per block. Vineyard management practices (pruning, shoot thinning, training, leaf removal, and harvesting) were conducted by the Fruit Science Research Group at the Center for Agricultural and Veterinary Sciences, Santa Catarina State University, following commercial standards and ensuring optimal experimental control.

Two pruning systems were evaluated: spur pruning (cordon) and cane pruning (Double Guyot). Na poda curta foram deixados esporões com duas gemas, e na poda longa, duas varas com oito gemas cada e um esporão contendo duas gemas para renovação no ano seguinte. The pruning took place in early August 2018.

The harvest date was determined according to the winemaking patterns, taking place in February 2019. Production (kg) and number of bits in each plant were recorded and samples of bits and berries were collected for physical-chemical analysis. Plant yield was determined using a field electronic scale and expressed as kg/plant. Productivity (t ha^{-1}) was estimated by multiplying production per plant by plant density (2.222 plants/ha). The number of clusters per branch was calculated by dividing the number of clusters $plant^{-1}$ by the number of branches $plant^{-1}$.

Twenty bunches were sampled per replicate, with four replicates. Bunch mass (g), bunch length (cm), and number of berries per bunch were measured using a semi-analytical balance and a ruler.

For chemical composition analyses, 100 berries per replicate were collected at harvest and crushed to

obtain the must. The must was analyzed for soluble solids (°Brix), titratable acidity (meq L^{-1}), and pH according to Organisation International de la Vigne et du Vin (OIV) protocols (2016). The physicochemical analyses of clusters and berries were performed at the Oenology Laboratory of the Agricultural Sciences Center at Santa Catarina State University (UDESC).

The variables were subjected to analysis of variance (ANOVA) using the 'F Test' at a 5% probability of error, using Sisvar software.

The effect of two pruning methods on productive variables and curve architecture in the ‘Chardonnay’ vine are described in Table 1. The number of clusters/plant was influenced by the pruning method, with 36.0 clusters $plant^{-1}$ in the short pruning and only 25.0 clusters/plant in the long pruning. However, the higher number of bunches did not lead to increased yield rates. These data do not corroborate those observed by PANCERI et al. (2018), with the vine ‘Chardonnay’ grown in the altitude region of Santa Catarina, when a greater number of bumps/plant was observed in the long pruning. Already in a study conducted by MENDONÇA et al. (2016), with the vine ‘Chardonnay’ in the height of the Brazilian Cerrado, the short pruning resulted in a greater number of bumps/plant.

Regarding yield (kg/plant), pruning methods showed no significant differences, with values ranging from 4.6 to 4.9 kg/plant for long and short pruning, respectively. As a result, productivity was similar between both pruning methods, reaching 10.3 t/ha and 10.8 t/ha for long and short pruning systems, respectively (Table 1). The values observed in this study are higher than those observed with the Chardonnay variety by WURZ et al. (2021), at altitude of Santa Catarina, and higher than those observed by PANCERI et al. (2018).

Table 1. Effect of two pruning methods (short pruning and long pruning) on the productive variables and cluster architecture of the 'Chardonnay' grapevine grown in an altitude region. São Joaquim – SC, safra 2018/2019.

Variables	Poda Method		F Test (ANOVA)	CV
	Short	Long	p<0.05	(%)
Cluster Length (cm)	12,5	12,6	ns	9,9
Cluster mass (g)	103,6	146,7	*	10,6
Number of Berries (bags/cacho)	79,0	105,0	*	12,3
Number of Cluster (cluster/plant)	36,0	25,0	*	9,2
Production (kg/plant)	4,9	4,6	ns	9,8
Productivity (t/hectare)	10,8	10,3	ns	9,6

* = significant by variance analysis (ANOVA) at 5% probability of error. ns = not significant by variance analysis (ANOVA) at 5% probability of error.

Short pruning promotes a higher number of buds per plant compared to long pruning systems; however, this increased bud count did not translate into higher productivity indices, which may be directly linked to bud fertility in 'Chardonnay' grapevines, as demonstrated by WURZ et al. (2019), basal buds averaged 1.0 cluster/bud, while middle and apical buds produced 1.4 and 1.7 clusters/bud, respectively.

According to Table 1, pruning methods significantly influenced cluster architecture variables. According to HEAZLEWOOD et al. (2006), retaining a higher number of buds during pruning does not necessarily result in a linear increase in yield, as the vine tends to compensate for this increase in bud number by reducing shoot production, cluster number, or cluster mass.

Cluster architecture was influenced by pruning method, although cluster length remained unaffected, measuring 12.5 and 12.6 cm for short and long pruning systems, respectively. Long pruning resulted in an increase in the number of berries and the mass of clusters, with average values of 105 berries/ cluster and 146.7 g/ cluster, while short pruning had an average of 79 berries $cluster^{-1}$ and 103.6 g/ cluster.

According to SCHMIDT et al. In 2023, studies with 'Grano D'Oro' grapevines demonstrated that long pruning leads to modified cluster architecture, notably resulting in increased cluster mass. Another study by WURZ et al. (2023), with the 'White Niágara' vine resulted in an increase in the bulk mass and number of berries when using mixed pruning compared to short pruning.

The technological ripening of 'Chardonnay' grapevines was affected by pruning methods, as shown in Table 2. Caches from plants subjected to short pruning presented the highest soluble solids content, 19,5 °Brix, while the long pruning presented mean values of 18,0 °Brix. Similar findings were reported by WURZ et al. (2023), evaluating different pruning methods with the grape grape 'Grano D'Oro'.

Table 2. Effect of two pruning methods (short pruning and long pruning) on the technological ripeness (soluble solids, pH and total titratable acidity) of 'Chardonnay' grapevines grown in an altitude region. São Joaquim – SC, safra 2018/2019.

Variables	Poda Method		F Test (ANOVA)	CV
	Short	Long	p<0.05	(%)
Soluble Solids (° Brix)	19,5	18,0	*	7,5
Total Titratable Acidity (meq L^{-1})	104,9	113,8	ns	12,5
pH	2,88	2,97	*	2,3

ns = not significant by variance analysis (ANOVA) at 5% probability of error. * = significant by variance analysis (ANOVA) at 5% probability of error.

Total titratable acidity was not affected by pruning method, with values of 104.9 and 113.8 meq L^{-1} for short and long pruning, respectively. However, pH values were affected by pruning methods, with values of 2.88 and 2.97 for short and long pruning systems, respectively. Regarding pH values, this was the only variable that remained below the ideal range for winemaking, according to RIZZON et al. (2004), the pH value should be between 3,10 and 3,30.

The data regarding technological maturation indicate the quality of fruit within the ideal ranges for production of sparkling wines (Soluble Solids: 17 to 19 ºBrix; Total Acidity: 90 to 110 meq L^{-1}; pH: 3,00 to 3,20) (GUERRA & PEREIRA 2018). Study conducted by PANCERI et al. (2018) verified data similar to those observed in this paper related to technological maturity.

The pruning method directly influenced the agronomic performance of 'Chardonnay' grapevines. Although spur pruning resulted in a higher number of clusters per plant, this method produced clusters with fewer berries and lower cluster mass, resulting in similar yield (kg/plant) and productivity (t/hectare) between both pruning methods. In addition, the difference in technological ripeness may be directly related to the cluster architecture, since the yield indices were similar between the treatments; however, the long pruning showed a lower accumulation of soluble solids, a higher number of berries/cluster and a higher cluster mass.

Short pruning resulted in a higher number of clusters per plant; however, the pruning method did not affect vineyard yield. The pruning method influenced cluster architecture, with long pruning resulting in clusters with higher berry count and greater cluster mass. Technological maturity was influenced by pruning method, with short pruning yielding more suitable maturation parameters for premium wine production.

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