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Investigation note

Late pruning: an alternative for adapting viticulture to climate change?

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Abstract

The quality and production of the vine depend on the climate; therefore, changes in it can affect its sustainability. For Chile, an increase of at least 1 °C in temperatures in the Central Valley has been projected, which can directly affect the ripening process of vines, accelerating the accumulation of sugars, affecting organic acids, and decreasing phenolic compounds, which translates into an imbalance of ripening. Considering this, to ensure the sustainability of viticulture in the face of climate change, management alternatives that allow optimal ripening in the face of changing climatic conditions are sought. One of these alternatives is late pruning. Late pruning proposes to delay the pruning dates after bud break and before flowering, eliminating the reserves already mobilized in the plant, thus generating a phenological delay. This delay in growth would allow for less accelerated ripening. To assess the effectiveness of this technique, three pruning dates: traditional pruning (TP), pruning at bud break (BP), and pruning in 2-3 leaves (LP), were evaluated in a commercial vineyard of the *cv* Cabernet Sauvignon in the Central Valley during the 2020-2021 season. The preliminary results of this study show positive expectations of this technique, delaying the phenology of the crop and the harvest dates. However, this seems to depend on the phenological moment where late pruning is performed and the varietal characteristics. The BP presented a delay of the harvest time of six days without affecting the production or the initial quality of the berries. Likewise, the LP affected the set of bunches and did not delay the harvest. The results showed that it is possible to delay harvest dates; nevertheless, it is relevant to consider other variables such as variety, phenological moment, soil, and climate.

Keywords:

Vitis vinifera, climate change, imbalance, phenology, pruning, ripeness, temperature.

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Grape cultivation in Chile is characterized by its geographical, socioeconomic, and agro-climatic diversity. According to the 2021 national wine census carried out by the Agricultural and Livestock Service (SAG, for its acronym in Spanish) of Chile, the country has 139 179 ha of vines destined for winemaking, with a predominance of strains such as Cabernet Sauvignon, Merlot, Carmenere, and Syrah, among others.

It is recognized that the quality and production of the vine depend on the climate; therefore, changes in it can affect the sustainability of the crop. Different analyses of climate change scenarios in Chile have projected that the temperature will increase by around 1 °C in the period until 2030, 1-2 °C in the period 2040-2070, and between 3 and 4 °C by the end of the century (Cepal, 2012; Vicuña *et al*., 2017).

However, the effects of climate change have already been observed in the Chilean wine industry; wine production decreased between 2016 and 2017, which was mainly related to high temperatures during the summer and rains during harvest, producing smaller berries and bunches and decreasing production by 25% compared to a normal year (Banfi, 2017).

Temperature and its effects on ripening

The high temperatures during the development of the vineyard and especially during the ripening process are a phenomenon that has begun to gain relevance because it can directly affect production and increase the effects of lack of water availability. The effects of temperature can begin to be evident in the development and growth of the crop, where there may be changes in the bud break dates and shortening of phenological periods (Van Leeuwen *et al*., 2016).

Phenological shortening and changes in harvest dates have already been reported by some authors, who evidenced early flowering, veraison and harvests (Salazar-Parra *et al*., 2010). The phenological shortening produced between veraison and ripening due to temperature has been linked to the accelerated accumulation of sugars in berries (Bock *et al*., 2013) and imbalances in organic acids. Added to this are the effects on phenolic compounds, where it has been widely studied that the concentration of anthocyanins decreases with temperature (Yamane *et al*., 2006).

Time of harvest and alcohol content

In general, to determine the optimal harvest time, two parameters are mainly evaluated: technological and phenolic ripeness. Producers cannot harvest their red grapes when phenolic ripeness is not adequate; that is, without the right color. Under increasing temperature conditions, the accumulation of anthocyanins may be delayed, and producers may decide to 'wait' until optimum phenolic ripeness is obtained.

Nevertheless, when this happens, the berries continue to accumulate sugar in an accelerated way, so at the time of harvesting, berries with high sugar content and, therefore, higher levels of alcohol in wines are obtained. To face these effects, it is possible to seek agronomic management that allows a better development of ripening, ideally longer and in a period of lower temperature, allowing the accumulation of phenolic compounds without an increase in the concentration of sugars. In this sense, an interesting strategy could be to delay the phenological stages by days or weeks, allowing a less accelerated development of the crop.

Is late pruning an alternative for adaptation to climate change?

Among the management alternatives that could allow a delay of phenology is late pruning, this technique has been used mainly as a management in the control of frost and cold periods, delaying bud break (Poni *et al*., 2022), and it has been observed that it may be capable of generating delays in other phenological stages and even in harvest dates.

Traditional pruning occurs between leaf fall and bud break; nevertheless, late pruning is carried out after the bud break of the vines (spring), when the plant has already mobilized its reserves

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for the growth of its buds, which produces a weakening of growth and a possible phenological delay. The goal of late pruning is to move or delay the ripening of the berries, moving the harvest by days or even weeks. Internationally, late pruning has reported positive results without affecting the productivity and quality of the vineyard (Sadras, 2016; Zheng *et al*., 2017).

Up to 27 days of delay were reported in *cv* Cabernet (Concha, 2015), 16 days in *cv* Maturana (Zheng *et al*., 2017), and up to 12 days in Syrah. Some of these studies showed that they have not found effects on the quality or production of the vineyard, for example, in *cv* Cabernet Sauvignon, a late pruning on buds of 2-3 leaves achieved a delay of 10 days without affecting the yield.

Similarly, in *cv* Malbec, pruning did not affect the length of buds, sugar level, pH, or composition of the grape (Bustos, 2019) or buds (Hamman *et al*., 1990). Although the technique in the studies presented fulfills its objective, it is important to note that several of the results were made at different phenological moments between bud break and flowering, added to different effects depending on the area and variety used.

We must not fail to emphasize that late pruning could have some negative effects on the growth of the vineyard. One of them could manifest itself in the weakening of the vineyard as a result of the elimination of mobilized reserves, which would later be discarded. On the other hand, it is important to consider that, in varieties with greater apical dominance, the inhibitory effect of the upper buds must be evaluated so as not to affect the viability of the basal buds.

Given this, the application of the technique must consider a previous study to determine the optimal phenological moment of late pruning in each climatic context. The use of late pruning as a strategy against climate change has the advantage that it does not imply increases in execution costs, does not require new workforce training, and can be quickly adapted to the current agronomic management of the vineyard.

Preliminary progress in the evaluation of late pruning in Chile

During the 2020-2021 season, late pruning was evaluated in the Central Valley of Chile, specifically in the locality of Isla de Maipo, using *Vitis vinifera cv* Cabernet Sauvignon in a commercial vineyard. Three pruning treatments were evaluated, classified according to the Eichhorn and Lorenz phenology scale modified by Coombe (1995): traditional pruning (TP), with winter buds, late pruning at bud break (BP) when the plants began their bud break, and leaf pruning (LP) when the plants had 3-4 developed leaves.

Biweekly phenological monitoring was carried out from the moment of traditional pruning, considering from bud break to harvest. The phenology of the crop was differentiated with the different pruning times; the phenological monitoring until veraison observed in Figure 1 showed an evident phenological delay of the late pruning treatments until flowering and even the set of the berries. The LP pruning was the one that showed the greatest delay.

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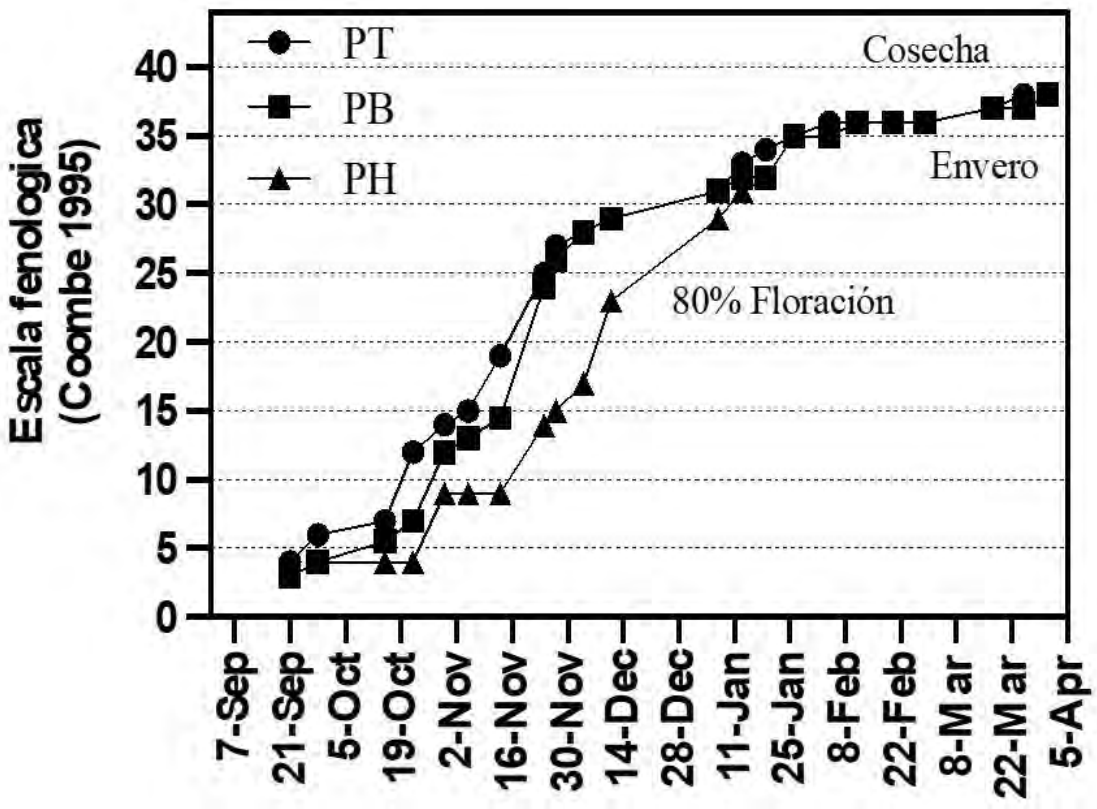
Figure 1

Phenology of the treatments of traditional pruning (PT ●); pruning at bud break (PB ■) and pruning in 2-3 leaves (PH ▲) in *cv* Cabernet Sauvignon, according to the phenological pattern of Eichhorn and Lorenz modified byCoombe (1995).



The data presented correspond to the period between bud break and harvest and are expressed as the mode among the phenologies of the plant's buds. However, as veraison approached, these differences decreased. In addition to the phenology, to define the growth of the vineyard, the length of the buds was determined, prior to the tipping, measuring from the base to the apex in three buds per plant and treatment. Figure 2A represents the length of the buds prior to the tipping of the vineyard, where a significantly shorter length is shown in both late pruning treatments.

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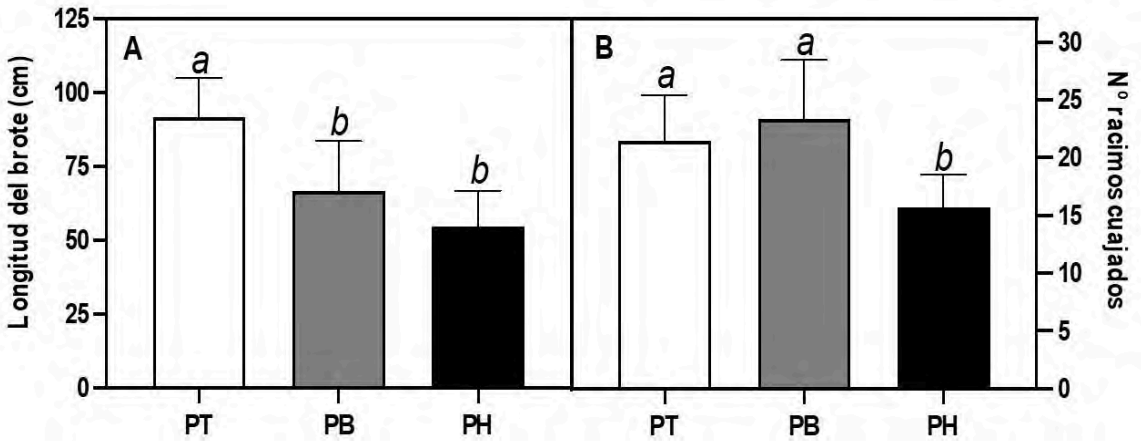
Figure 2. A) length of buds (cm); and B) number of bunches set in the treatments of traditional pruning (PT); pruning at bud break (PB) and pruning in 3-4 leaves (PH) in *cv* Cabernet Sauvignon. Mean ± SD (n= 8). Different letters indicate significant differences ($p< 0.05$), according to the Anova and Tukey test.



Nevertheless, despite the phenology and length of the buds, it was observed that the LP is the pruning that most delayed and presented problems in the field, in a smaller number of bunches in flowering and fewer bunches set, Figure 2B, finally translating into a lower yield. The smaller number of bunches could occur due to the effect of the removal of the most developed buds at the time of the latest pruning (LP). On the other hand, BP showed a shorter bud length (Figure 2A), maintaining the number of set bunches compared to TP (Figure 2B).

Finally, the plants were harvested when each treatment reached 22 °Brix. Table 1 indicates the harvest dates and days of delay with respect to the TP. It was observed that only BP achieved a delay of 6 days with respect to TP, and that despite the phenological delays that occurred during development, LP pruning reached 22 °Brix in the same period as TP, which could be due to a lower yield derived from the lower fruit set.

Table 1. Harvest dates and days of harvest delay with respect to traditional pruning (TP) in late pruning treatments: pruning at bud break (BP) and pruning in 3-4 leaves (LP) in *cv* Cabernet Sauvignon.

	Date of harvest	Days of delay*
TP	25-March 2021	0
BP	31-March 2021	6
LP	25-March 2021	0

*= with respect to the control.

Conclusions

It is important to note that these results are preliminary and should be corroborated with a new study season. However, with these results, there are positive expectations that this simple, low-cost, and rapid-implementation technique can be an alternative to delay the phenology of the crop, delaying key stages such as bud break, flowering, and ripening.

Late pruning at bud break showed a delay of six days of harvest (end of March) without affecting the yield of the crop (number of bunches set) (Figure 2B) and maintaining a phenological delay throughout the development of the plant (Figure 1). It was not the case in the pruning in 2-3 leaves, which showed problems of bunch set and did not delay the harvest.

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Considering these results, it seems that the phenological moment when the late pruning is performed is decisive for obtaining good results, with the moment of bud break being optimal for the *cv* Cabernet Sauvignon in the Central Valley of Chile. In order to corroborate this information, INIA continues to work on this research to provide winegrowers with results that can be extrapolated to their vineyards.

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Bibliography

1 Banfi, S. P. 2017. Antecedentes de los mercados del vino y de la uva vinífera julio de 2017. Chile. Oficina de Estudios y Políticas Agrarias (ODEPA). 1-18 pp.

2 Bustos, M.; Prieto, J.; Fanzone, M.; Sari, S. y Pérez, J. 2019. La poda tardía podría mitigar el daño de las altas temperaturas en la calidad del vino. Campo Andino. 50:26-27.

3 Bock, A.; Sparks, T.; Estrella, N. and Menzel, A. 2013. Climate induced changes in grapevine yield and must sugar content in Franconia, Germany between 1805 and 2010. PLOS ONE. 8(7):1-10. https://doi.org/10.1371/journal.pone.0069015.

4 CEPAL. 2012. Comisión Económica para América Latina y el Caribe. La economía del cambio climático en Chile. CEPAL. 134 p.

5 Concha, V. C. 2015. Efecto de distintas fechas de poda sobre la brotación y tiempo a envero en vides de cabernet Sauvignon. Memoria de Título. Escuela de Pregrado, Facultad de Ciencias Agronómicas-Universidad de Chile. 33 p.

6 Coombe, B. G. 1995. Growth stages of the grapevine: adoption of a system for identifying grapevine growth stages. Australian Journal of Grape and Wine Research. 1(2):104-110.

7 Hamman, R.; Renquist, A. R. and Huges, H. G. 1990. Pruning effects on cold hardiness and water content during deacclimation of merlot bud and cane Tissues. American Journal of Enology and Viticulture. 41(3):251-260.

8 Poni, S.; Sabbatini, P. y Palliotti, A. 2022. Facing spring frost damage in grapevine: recent developments and the role of delayed winter pruning a review. American Journal of Enology and Viticulture . 73(4):211-249. https://doi.org/10.5344/ajev.2022.22011.

9 Sadras, V. 2016. Decompressing harvest and preserving wine identity. Final report to Australian grape and wine authority. SARDI Plant Research Center. 1-36 pp.

10 Salazar-Parra, C.; Aguirreolea, J.; Sánchez-Díaz, M.; Irigoyen, J. J. y Morales, F. 2010. Effects of climate change scenarios on tempranillo grapevine (*Vitis vinifera* L.) ripening: response to a combination of elevated CO_2 and temperature, and moderate drought. Plant and Soil. 337:179-191.

11 Van Leeuwen, C. and Darriet, P. 2016. The impact of climate change on viticulture and wine quality. J. Wine Econ. 11(1):150-167.

12 Vicuña, S.; Bustos, E.; Cabrra, C.; Cifuentes, L.; Valdés, J. M. y Gironas, J. 2017. Cambio climático en la región Metropolitana de Santiago. En estrategia de resiliencia gobierno metropolitano de Santiago. Santiago. Centro UC cambio global y GreenLabUC. 74 p.

13 Yamane, T.; Jeong, S. T.; Goto, Y. N.; Koshita, Y. and Kobayashi, S. 2006. Effects of temperature on Anthocyanin biosynthesis in grape berry skins. American Journal of Enology and Viticulture . 57(1):54-59. https://doi.org/10.5344/ajev.2006.57.1.54.

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14 Zheng, W.; García, J.; Balda, P. and Martínez, T. F. 2017. Effects of late winter pruning at different phenological stages on vine yield components and berry composition in La Rioja, North-central Spain. OENO One. 51(4):363-372. https://doi.org/10.20870/oeno-one.2017.51.4.1863.

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