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Mechanisation of pre-flowering leaf removal under temperate climate conditions

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Grapevine leaf removal (LR) in the cluster area is a common practice in temperate and cool climates, usually done between berry-set and cluster closure to create a less favourable microclimate for fungal diseases and to improve grape ripening. When applied before flowering, LR affects berry-set and is, therefore, an effective yield-control tool, reducing time-consuming manual cluster thinning; it also improves berry structure and composition (i.e., total soluble sugars [TSS], titratable acidity [TA] and polyphenols)[1]. The present five-year trial follows a previous study about pre-flowering LR under identical environmental conditions[2]; it validates the sustainability of moderate pre-flowering LR and its possible mechanisation under Swiss climatic conditions, using low-pressure double airflow.

Material and methods

The trial was conducted from 2016 to 2020 in the experimental vineyards of Agroscope in Nyon, Switzerland (46°23'52.4"N 6°13'48.7"E) on the cultivars Doral and Gamay (planted in 2003 and 2007 respectively). For each cultivar, three treatments were applied: 1) mechanical post-berry-set LR, 2) manual pre-flowering LR, and 3) mechanical pre-flowering LR. Manual LR of the cluster area consisted of removing by hand the first six leaves from the base of each shoot, including the leaves of the laterals. Mechanical LR of the equivalent area consisted of using a tractor-mounted compressed-air leaf remover (E 3000 3P, 2003; Collard, Bouzy, France), with different speeds for pre-flowering and post-berry-set treatments. Tractor speed was lower for pre-flowering LR (0.6 km/h) due to the smaller leaf area at that early stage (Figure 1). Field measurements, and leaf and grape analyses were realised. Cluster thinning was completed per treatment at once before bunch closure to match the regional quotas and obtain comparable yields per treatment; wines were made per treatments and then tasted by a panel. Complete material and methods are published in *OENO One* 57(2)[3].

FIGURE 1. Low-pressure double airflow leaf remover (Collard, Bouzy, France) in action at pre-flowering stage (speed 0.6 km/h). Cultivar Gamay, Nyon, Switzerland.

Pre-flowering versus post-berry-set LR

When compared with mechanical post-berry-set LR only, mechanical pre-flowering LR affected the vineyard observations and the must composition at harvest, although the gain in grape maturity at harvest was small and primarily related to year and cultivar. Pre-flowering LR induced lower berry-set resulting in fewer berries per cluster (–26 % and –31 %, for Doral and Gamay respectively) and a proportionally lower yield estimation before cluster thinning for both cultivars (Figure 2). Despite climate unpredictability (year*treatment interaction), pre-flowering LR had a consistent effect on vine physiology: the intensive mechanical pre-flowering LR led consistently to approximately 30 % yield loss (i.e., 33±11 and 29±11 kg/m^2, on average for Doral and Gamay respectively) in comparison to the post-berry-set mechanical LR. Cluster thinning was higher in pre-flowering LR in 2016 and 2019, because the bunches were smaller in this treatment (less berries per bunch) than in the post berry-set treatment.

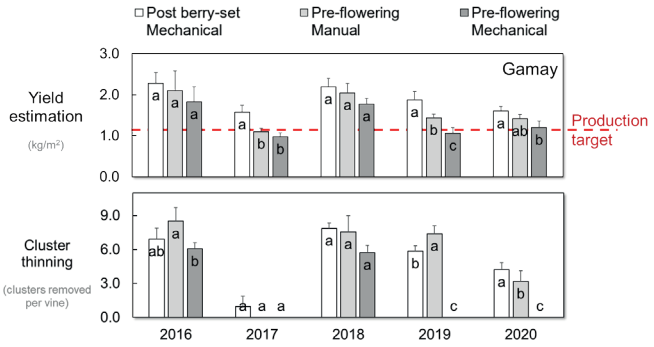

FIGURE 2. Annual yield estimation before veraison and related cluster thinning as a function of leaf removal treatment. Cultivar Gamay, Nyon, Switzerland. Cluster thinning was completed per treatment at bunch closure stage, to match the regional quotas and obtain comparable yields at harvest. Values followed by different letters are significantly different per year (Tuckey's test, p-value < 0.05).

Although the gain in grape maturity was not significant in each year, a trend was observed over the years: pre-flowering LR induced on average increased TSS accumulation (+3 % and +2 %, for Doral and Gamay respectively) along with a lower concentration of tartaric acid (–3 % and –4 %, respectively). This could be explained by the lower yield and the earlier exposure to the sun.

Mechanising pre-flowering LR

When only compared with manual LR on the same date, mechanical pre-flowering LR was more brutal to the plant: it induced some inflorescence loss –thus affected the yield formation– and delayed grape ripening. With mechanical LR, lateral shoots were allowed to grow and partially cover the cluster area, while they were completely removed with manual LR (Figure 3). This could be of interest in the context of a warmer climate. The number of berries per cluster was lower (–14 % and –11 %, respectively) along with the estimated yield (–20 % and –16 %, respectively). Still in comparison to manual pre-flowering LR, mechanical pre-flowering LR induced a lower TSS accumulation in the must for Doral (i.e., –1 %), while it remained unchanged for Gamay; it also induced a higher TA (+2 % and +6 % for Doral and Gamay respectively), mainly due to more malic acid (+8 % and +13 % respectively).

When compared two-by-two, no difference was observed among Doral wines in terms of sensory analysis, while Gamay wines from mechanical LR tended to be slightly less bitter (–7 %) with smoother tannins (+6 %) than wines from manual LR (both p-values < 0.10).

FIGURE 3. Manual (A) versus mechanical (B) pre-flowering leaf removal. Cultivar Doral just before harvest, Nyon, Switzerland. With mechanical LR, lateral shoots were allowed to grow and partially cover the cluster area, while they were completely removed via manual LR.

The sustainability of mechanical pre-flowering LR

The low-pressure dual airflow provided an effective pre-flowering LR without damaging any fragile shoots, although the loss of a few flower buds was observed on the inflorescences. A lower speed was required compared with post-berry-set LR to maintain an LR efficiency equivalent to manual LR, due to the smaller leaf area at that early stage of the season. After mechanical pre-flowering LR, cluster thinning work was reduced by 69 % and 27 % in terms of number of clusters removed for Doral and Gamay respectively, in comparison with post-berry-set LR (results for Gamay in Figure 2).

The seasonal conditions strongly affected plant physiology, particularly the yield parameters bud fruitfulness, berry number and cluster weight, which determine yield potential. Despite the variability caused by seasonal differences, primarily due to climate unpredictability and cultivar, yield loss was generally proportional to yield potential. In the context of this experiment, despite the positive impact on Gamay wines, pre-flowering mechanical LR seemed too intense and induced a loss in bud fruitfulness in the following year in comparison to post-berry-set LR (i.e., –10 % and –8 % on average for Doral and Gamay respectively). The leaves were removed at a time the vines require an important source of carbon for flowering, which potentially affected the carbon reserves for the following year. This reduction in carbohydrates might have had an impact on both flower initiation (next year's fruitfulness), as well as on this season's fruitset[4]. The risk of the long-term impact of intensive pre-flowering LR has already been pointed out by other researchers, that is, reduction of the grapevine reserves, vigour and fruitfulness[5 6 7 8]. This risk can especially arise under restrictive conditions; i.e., in the cases of young vines, water deficit or nutritional deficiency.

Moreover, even if no shoots were broken during mechanical LR, some damage was observed on the inflorescences due to the intensity of the treatment, which resulted in a lower number of berries per cluster and a lower yield than with manual LR.

Conclusion

Confirming previous trials we conducted under similar conditions[3], we can conclude from the present study that moderate pre-flowering LR appears to be a sustainable and prophylactic practice under temperate climatic conditions for effectively limiting yield while improving grape ripening in some years. In addition, the present trial validates the sustainability of moderate mechanical pre-flowering LR using low-pressure double airflow for reducing the time and cost of laborious manual leaf removal. ■

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1 VanderWeide, J., Gottschalk, C., Schultze, S. R., Nasrollahiazar, E., Poni, S., & Sabbatini, P. (2021). Impacts of Pre-bloom Leaf Removal on Wine Grape Production and Quality Parameters: A Systematic Review and Meta-Analysis. *Frontiers in Plant Science, 11*. https://doi.org/10.3389/fpls.2020.621585

2 Verdenal, T., Zufferey, V., Dienes-Nagy, A., Bourdin, G., Gindro, K., Viret, O., & Spring, J.-L. (2019). Timing and Intensity of Grapevine Defoliation: An Extensive Overview on Five Cultivars in Switzerland. *American Journal of Enology and Viticulture, 70*(4), 427-434. https://doi.org/10.5344/ajev.2019.19002

3 Verdenal, T., Zufferey, V., Dienes-Nagy, Á., Bourdin, G., & Spring, J.-L. (2023). Mechanisation of pre-flowering leaf removal under the temperate climate conditions of Switzerland. *OENO One, 57*(2), 291-302. https://doi.org/10.20870/oeno-one.2023.57.2.7424

4 Vasconcelos, M. C., Greven, M., Winefield, C. S., Trought, M. C., & Raw, V. (2009). The flowering process of *Vitis vinifera*: a review. *American Journal of Enology and Viticulture, 60*(4), 411-434.

5 Palliotti, A., Gardi, T., Berrios, J. G., Civardi, S., & Poni, S. (2012). Early source limitation as a tool for yield control and wine quality improvement in a high-yielding red *Vitis vinifera* L. cultivar. *Scientia Horticulturae, 145*, 10-16. https://doi.org/10.1016/j.scienta.2012.07.019

6 Risco, D., Pérez, D., Yeves, A., Castel, J. R., & Intrigliolo, D. S. (2014). Early defoliation in a temperate warm and semi-arid Tempranillo vineyard: vine performance and grape composition. *Australian Journal of Grape and Wine Research, 20*(1), 111-122. https://doi.org/10.1111/ajgw.12049

7 Sabbatini, P., & Howell, G.S. (2010). Effects of early defoliation on yield, fruit composition, and harvest season cluster rot complex of grapevines. *HortScience 45*(12): 1804-1808. https://doi.org/10.21273/HORTSCI.45.12.1804

8 Uriarte, D., Picón, J., Mancha, L. A., Blanco, J., Prieto, M. H., Moreno, D., Gamero, E., Valdés, E., Risco, D., Castel, J. R., & Intrigliolo, D. S. (2012). Early defoliation of "Tempranillo" grapevines in semi-arid terroirs of Spain. *Acta Horticulturae. 931*, 299-306. https://doi.org/10.17660/ActaHortic.2012.931.33