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Exploring grapevine canopy management: effects of removing main leaves or lateral shoots before flowering

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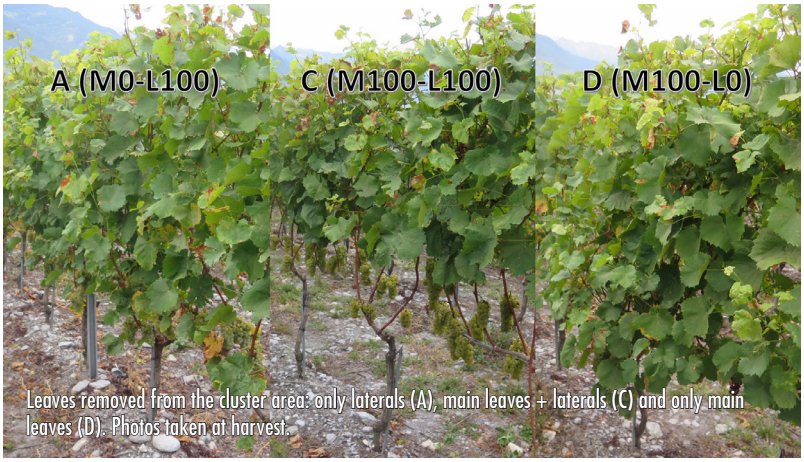
This study highlights the physiological effects of pre-flowering leaf removal from the fruiting zone of the Swiss white grape variety Petite Arvine, which is rich in varietal thiols. Pre-flowering removal of main leaves instead of lateral shoots appears to be a viable practice with a moderate effect on both the yield potential and the must composition; that is, higher concentrations of malic acid, yeast-assimilable nitrogen and glutathione.



Leaves removed from the cluster area: only laterals (A), main leaves + laterals (C) and only main leaves (D). Photos taken at harvest.

Introduction

Leaf removal (LR) is a common practice in viticulture for limiting fungal attack and promoting grape ripening. Research shows that the timing of LR is critical and should be adjusted to regional climatic conditions and the viticulturist's objectives. When applied after berry set, LR typically has no effect on yield. However, when applied before flowering, it can significantly reduce yield by 40-50 % by limiting the carbon source required for berry set[1]. Pre-flowering LR also affects grape composition and the wine sensory profile. However, LR effects are a function of factors such as grape variety, climatic conditions, timing and LR intensity. For instance, pre-flowering LR has been found to enhance colour and mouthfeel in Pinot noir, while in Gamay these attributes were less intense[2].

A key consideration when adjusting LR intensity is which leaves to remove. Younger leaves have low photosynthetic activity, while older leaves retain much of their assimilative capacity. In addition, lateral shoots become more efficient than primary shoots from veraison onwards, highlighting their importance in grape ripening[3]. However, these lateral shoots may not be fully developed at the time of pre-flowering LR, making their removal difficult.

Overall, this article highlights the importance of pre-flowering LR intensity and provides further insights into the physiological roles of main leaves and lateral shoots in the cluster area, offering practical advice for grape growers on optimising grape quality and wine characteristics.

Material and methods

Full details of the methods are given in the original article[4]. This trial was carried out at Agroscope's experimental vineyard in Leytron, Switzerland, from 2016 to 2021. The grape variety studied was Petite Arvine, planted in 2011 at a density of 6,200 vines/ha and trained using the Guyot system. The experimental design followed a randomised complete block format with four blocks and four treatments (A to D, Table 1), involving different combinations of main leaf and/or lateral shoot removal from the cluster area (from the base of the shoot to the sixth leaf), all applied at the phenological stage of 'separated flower buds' (BBCH 57) in May. Treatment A served as the control, representing local practices. Crop thinning was applied before the 'cluster closure' stage (BBCH 77) to meet regional production quotas. The grapes of the different treatments were vinified separately following standardised protocols.

Results and discussion

The full data are presented in the original article[4].

1. Effect of pre-flowering LR intensity (treatments A, B and C)

Pre-flowering LR significantly affected vine performance, reducing berry set and yield in particular. Removal of all lateral shoots and main leaves (M100-L100) resulted in an average yield loss of 37 % from 2017 to 2021, confirming findings from previous studies[1] (Figure 1). In comparison, a 50 % main leaf removal (M50-L100) limited yield loss to 5 %-21 %, demonstrating that moderate LR can mitigate adverse effects. Environmental factors also played an important role in yield formation. For instance, cooler temperatures and reduced sunlight before flowering in 2016 led to exceptionally low yields: treatments C (M100-L100) showed a drastic 82 % yield loss due to cluster necrosis and poor berry set.

Intensive LR (M100-L100) had a minimal effect on the accumulation of soluble solids (23.7 ± 0.3 Brix), but it increased the concentration of tartaric acid (Figure 2).

Wine composition showed negligible differences due to intense pre-flowering LR, except for increased polyphenol concentrations related to smaller berry size, thicker berry skin and higher light exposure[2]. Interestingly, removing all the leaves and laterals from the cluster area (M100-L100) tended to reduce Cys-3MH (thiols precursor) concentrations (–21 %; $p < 0.10$) when compared to treatment A (M0-100).

TABLE 1. Pre-flowering LR treatments applied on the canopy in the cluster area, from shoot base to sixth leaf of each shoot.

Treatment	Leaf removal treatment (removed from the cluster area)	
	Main leaves	Lateral shoots
A. M0-L100	—	100 %
B. M50-L100	50 %	100 %
C. M100-L100	100 %	100 %
D. M100-L0	100 %	—

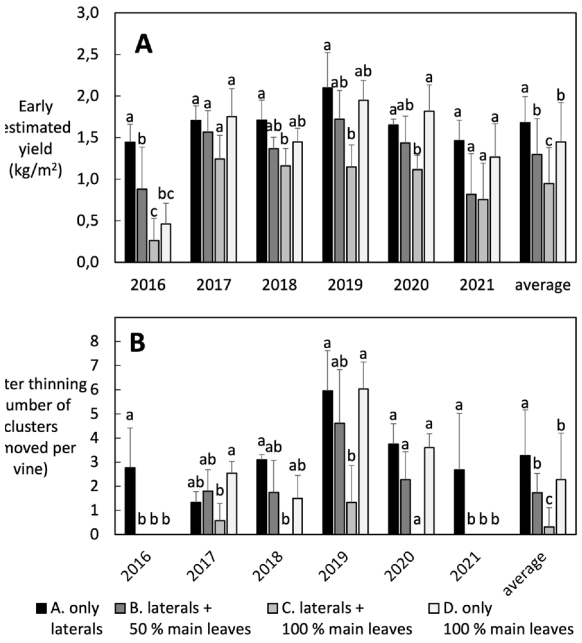


FIGURE 1. Potential yield before cluster thinning (A) and cluster thinning (B) as a function of canopy removal treatment. Different letters within a year, indicate significant differences.

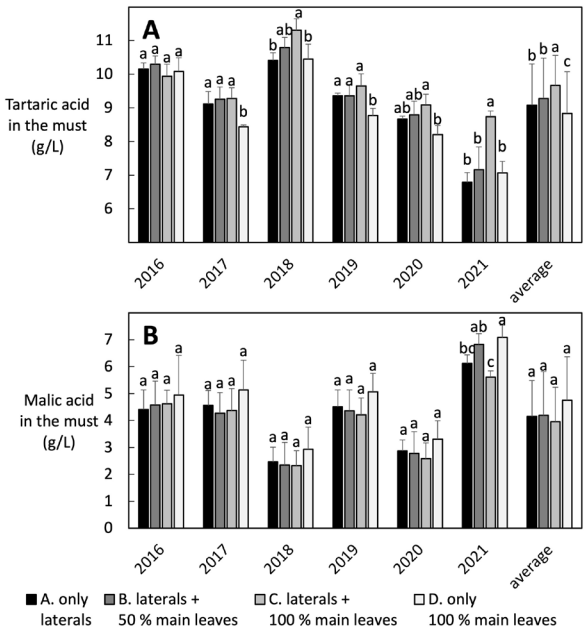


FIGURE 2. Concentration of tartaric and malic acids in the must at harvest as a function of canopy removal treatment. Different letters within a year, indicate significant differences.

2. Comparison of leaf and lateral shoot removal (treatments A and D)

Removal of the main leaves only (M100-L0) resulted in a larger exposed leaf area (+15 %) compared to removal of the lateral leaves (M0-L100), mainly due to the growth of the lateral leaves in the cluster area. This resulted in a lower yield potential (–14 %), mainly due to fewer berries per cluster (–11 %). The total photosynthetic activity of the canopy was reduced until berry set due to the higher proportion of young leaves and laterals, which had not yet reached their maximum photosynthetic capacity[3 5].

The cooler microclimate due to the larger leaf area - resulting in less abiotic stress - probably contributed to these higher levels of malic acid (+0.5 g/L, 12 %) and glutathione (+6 mg/L, 11 %) in musts from treatment D (M100-L0), compared to those from treatment A (M0-L100)[6]. Notably, the increase in titratable acidity (+4 %), especially malic acid, may be appropriate in the current context of global warming, which strongly influences the balance between total soluble sugars and titratable acidity[7]. The treatment D (M100-L0) showed the lowest concentration of tartaric acid and the highest concentration of malic acid. Removing only the main leaves increased the glutathione concentration in must compared to the other treatments (+13 %; $p < 0.001$). Glutathione is essential for the preservation of aromas and colour in wines. While no significant differences in TSS, pH or Cys-3MH concentrations in musts were found between lateral shoot removal (A) and main leaf removal (D), concentrations of yeast-assimilable nitrogen increased (+26 mg/L, 10 %). The resulting wine from treatment D showed greater colour intensity and less vegetal aromas than treatment A.

Conclusions

The trial confirmed the significant effect of pre-flowering LR from the cluster area on the potential yield at harvest. The berry-set rate was related to the LR intensity and to the unpredictable climatic conditions around the flowering stage in the same year (up to 80 % loss in 2016).

Intensive pre-flowering LR tended to reduce the concentration of the aroma precursor Cys-3MH in the must at harvest, with no significant effect on wine aromas averaged over six years. Given both the risk of not achieving the production target and the negligible effect on white wine composition, we do not recommend intensive pre-flowering LR (*i.e.* more than 50 % LR in the cluster area).

Pre-flowering removal of main leaves from the fruiting zone instead of lateral shoots appears to be a viable practice with a moderate effect on both the yield potential and the must composition at harvest; that is, higher concentrations of malic acid, yeast-assimilable nitrogen and glutathione. Further research is encouraged to focus on this practice for improved vineyard management. ■

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