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Impacts of Pre-bloom Leaf Removal on Wine Grape Production and Quality Parameters: A Systematic Review and Meta-Analysis

Joshua VanderWeide[1,2], Chris Gottschalk[1], Steven R. Schultze[3], Esmaeil Nassrollahiazar[1,4], Stefano Poni[5], Paolo Sabbatini[1,*]

1 Department of Horticulture, Michigan State University, East Lansing, MI, United States
2 Faculty of Land and Food Systems, Wine Research Center, The University of British Columbia, Vancouver, BC, Canada
3 Department of Earth Sciences, University of South Alabama, Mobile, AL, United States
4 Michigan State University Extension, East Lansing, MI, United States
5 Department of Sustainable Crop Production, Università Cattolica del Sacro Cuore, Piacenza, Italy

*Corresponding author: Paolo Sabbatini (sabbatin@msu.edu; fax: +1 517 353 0890)

Introduction

- The primary objective of early leaf removal practices is the mitigation of yield loss from cluster rot diseases, such as gray mold (Botrytis cinerea) and sour rot, particularly in compacted cluster varieties (Poni et al., 2017). In warm/hot, dry growing regions, gray mold is more prominent. Gray mold is a necrotrophic fungus ubiquitous to crops and particularly fruit production (Ky et al., 2012).
- The second major objective of early leaf removal is to enhance fruit and wine quality (Tardaguila et al., 2010; VanderWeide et al., 2018). Crop load regulation is required in specific regions to meet yield standards in some prominent production regions, such DOCG in Italy or AOC in France. Additionally, in warm/hot, dry growing regions, the yield of highly fruitful cultivars must be reduced to maintain vine balance, and early leaf removal provides an effective tool to achieve targeted crop levels. This, in turn, leads to an improvement in both basic fruit quality components as well as total anthocyanins (Tardaguila et al., 2012; Poni and Gatti, 2017; Silvestroni et al., 2018).

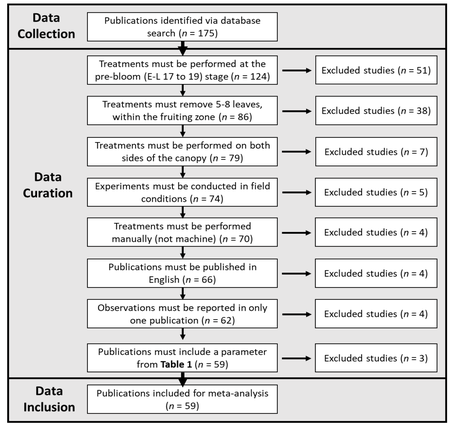
Objectives and Hypothesis

- **Objective 1:** To understand whether pre-bloom leaf removal has a consistent impact on production and fruit quality parameters, regardless of differences in climate, cultivar, rootstock, vine age, or berry color.
- **Objective 2:** To assess whether factors, such as climate, cultivar, rootstock, vine age, or berry color influence the "success" of pre-bloom leaf removal on production and fruit quality parameters.

Materials and Methods

Treatments: Data from publications containing both "control" and "pre-bloom leaf removal" treatments were mined and compared for 5 categorical variables and 16 dependent variables important to viticulture.

Figure 1. Flowchart demonstrating the data collection, data curation, and data inclusion process utilized in this meta-analysis.



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Conclusions

1. **Pre-bloom leaf removal significantly decreased:**
   - **yield (-26%)**
   - **cluster compactness (-25%)**
   - **bunch rot disease (-60%)**
2. **Pre-bloom leaf removal significantly increased:**
   - **total soluble solids (+5.2%)**
3. **Pre-bloom leaf removal is an important strategy for viticulture to decrease yield, bunch rot disease, and increase fruit quality.**

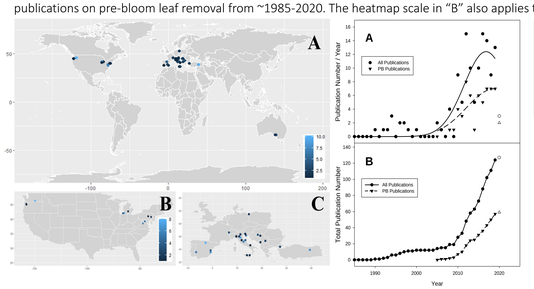
Scan to locate the paper and poster citations

https://doi.org/10.3389/fpls.2020.621585

Contact: jvande09@mail.ubc.ca
sabbatin@msu.edu

Results and Discussion

Figure 2. **(left, A-C)** Location of vineyards from studies utilized in this meta-analysis, and **(right, A-B)** the evolution of publications on pre-bloom leaf removal from ~1985-2020. The heatmap scale in "B" also applies to "C".



- Many studies were conducted in the northeast USA or east-central Europe.
- Studies on the topic are declining after ~15 years.

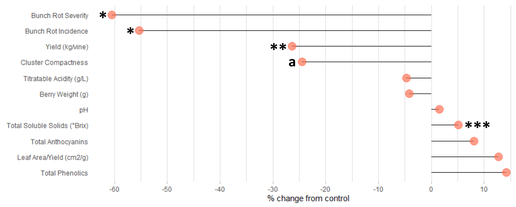
Table 1. Listing of parameters, variable type, and number of observations (comparing control versus pre-bloom leaf removal).

Acronym	Parameter	Variable	Total observations[a]	Significant observations[b]
DEPENDENT VARIABLES				
Yield	Yield (kg/vine)	Production	103	82 (80%)
LAY	Leaf area/Yield (cm^2/g)	Production	62	19 (31%)
BW	Berry weight (g)	Production	97	39 (40%)
CCI1	Cluster Compactness Index (berry number/cm^2)	Production	20	10 (50%)
CCI2	Cluster Compactness Index (berry weight (g/cm^2))	Production	19	13 (68%)
CCI3	Cluster Compactness Index (OIV visual rating)	Production	33	27 (82%)
BRI	Bunch rot incidence (%)	Production	26	16 (62%)
BRS	Bunch rot severity (%)	Production	20	12 (60%)
TSS	Total soluble solids (°Brix)	Fruit quality	108	56 (52%)
pH	pH	Fruit quality	102	25 (25%)
TA	Titratable acidity (g/L)	Fruit quality	105	34 (32%)
ANT1	Total anthocyanins (mg/100 g) FW skins	Fruit quality	14	7 (50%)
ANT2	Total anthocyanins (mg/100 g) FW berry	Fruit quality	73	44 (60%)
PHE1	Total phenolics (mg/100 g) FW skins	Fruit quality	15	8 (53%)
PHE2	Total phenolics (mg/100 g) FW berry	Fruit quality	53	34 (64%)
PHE3	Total phenolics (Absorbance Units)	Fruit quality	12	4 (33%)
CATEGORICAL VARIABLES				
BC	Berry color	–	136	–
CL	Climate	–	136	–
CUL	Cultivar	–	136	–
RS	Rootstock	–	123	–
VA	Vine age (years)	–	121	–

[a] *Number of observations comparing between C and PB.*
[b] *Number of observations where PB was significantly larger or smaller ($p < 0.05$) than C.*

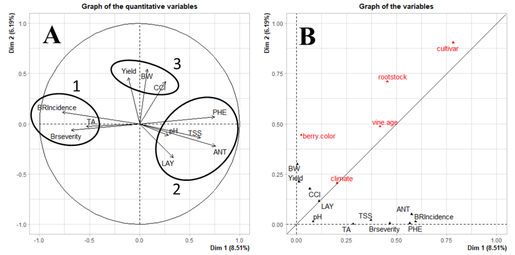
- Yield, cluster compactness, bunch rot disease, and anthocyanins/ phenolics per berry were most consistently altered by pre-bloom leaf removal.
- TSS was only increased in approximately half of observations in response to pre-bloom leaf removal.

Figure 3. Lollipop plot visualizing the percent change in dependent variables by pre-bloom leaf removal compared to the control. a; CCI, two of three parameters representing this value were significant. *p<0.05; **p<0.01; ***p<0.001 via ind. samples t-test.



- Bunch rot severity and incidence were similarly decreased (55-60%).
- Both yield and cluster compactness[a] were decreased by approximately 25%.
- Despite lower bunch rot, the yield of healthy fruit was not impacted by treatment.

Figure 4. **(A)** Principal component analysis displaying **(A)** the relationship between dependent variables, and **(B)** the relationship between dependent variables and categorical variables. Data were expressed as a percent change from the control.



- Fruit quality components were positively correlated with vine balance.
- Bunch rot was related to TA.
- Yield and berry weight were not negatively correlated with quality components.
- "Cultivar" and "rootstock" had the greatest influence on the "success" of pre-bloom leaf removal, while "climate" was less influential.