iVES Technical Reviews vine & wine

terclimpro

https://doi.org/10.20870/IVES-TR.2024.8396

This article is published in cooperation with the 2nd edition of TerclimPro (18–19 February 2025), Bordeaux & Cognac, France.

Effect of biodynamic preparations 500 and 501 on vine and berry physiology, pedology and the soil microbiome

Markus Rienth✉, Frederic Lamy, Clément Chessex, Thierry Heger

University of applied sciences and arts western Switzerland, Haute école de viticulture et oenologie de Changins

The increasing interest in organic and biodynamic wine production is driven by a desire for sustainability and reduced reliance on synthetic inputs. As of 2021, organic viticulture accounted for 6.4 % of the global vineyard surface, with biodynamic practices gaining traction, particularly among high-end wineries seeking to differentiate their products through unique, environmentally conscious cultivation methods. Biodynamic viticulture, while rooted in organic principles, incorporates specific biodynamic preparations (notably preparations 500 and 501), with proponents asserting benefits such as enhanced soil vitality, vine resilience, and superior wine quality. However, the scientific community remains divided on whether biodynamic methods offer substantial advantages over organic practices alone. Previous studies[1, 2] have shown minimal differences between the two in terms of vine performance and berry quality. This study aims to evaluate the long-term effects of biodynamic preparations 500 and 501 on vine physiology, berry quality, and soil properties in a Swiss vineyard.

Methods

The experiment began in 2015 and was conducted in a 0.76-hectare commercial vineyard in Mont-sur-Rolle, Switzerland, planted in 2012 with *Vitis vinifera* L. cv. Chasselas on 3309C roostock. Using a randomised block design, a biodynamic treatment consisting in the application of 500 and 501 was compared to an organic control; all other management practices were the same for both the biodynamic treatment and the control. Vine physiology (yield, pruning weight assessed by weighing the penultimate cane on the fruiting shoot, leaf nitrogen content, net photosynthesis), berry quality (sugar, organic acids), soil physical properties (bulk density, water holding capacity, structural stability), and soil microbial communities were assessed over five years.

Results and discussion

Yield and Vine Vigour

Vine physiological parameters, such as yield per square meter, pruning weight per meter of shoot, and leaf nitrogen content (N-tester readings) did not show significant differences between biodynamically treated and control

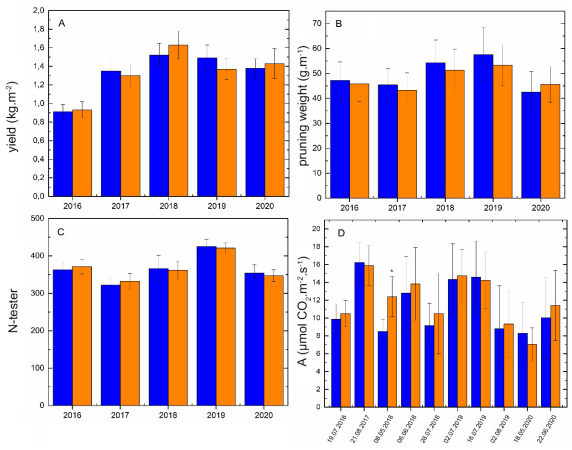


FIGURE 1. Yield and vine physiology. A) Yield per square meter, B) Pruning weight per metre of shoot as a proxy for vigour, C) N-tester, and D) net photosynthesis. Blue bars: blocks treated with water (without biodynamic preparations); orange bars: blocks treated with biodynamic preparations 500 and 501. * Indicates significant differences between treated and non-treated blocks in the respective year.

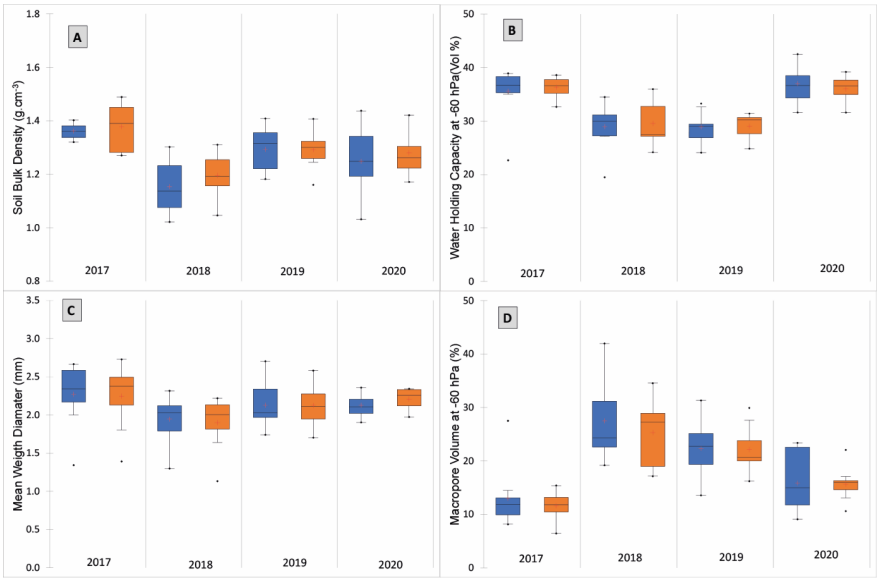


FIGURE 2. Soil physical properties. A) Soil bulk density, B) Water-holding capacity at -60 hPa, C) Soil structural stability, assessed by Mean Weight Diameter, and D) Macropores volume at -60 hPa. Orange bars: plots treated with biodynamic preparations 500 and 501; blue bars: plots treated without biodynamic preparations. * Indicates outliers.

The translation of this article into English was offered to you by Moët Hennessy.

vines (Figure 1). This aligns with previous research, indicating that biodynamic preparations have minimal impact on vine vegetative growth[1]. The absence of yield differences corroborates findings from studies on various grape varieties, including Merlot, Sangiovese, Cabernet Sauvignon, and Riesling[1].

Photosynthesis

Net photosynthesis exhibited a significant difference at only one measurement point (8 May 2018; Figure 1D). This isolated finding suggests that the biodynamic preparations may have had a transient effect on photosynthetic activity, though it was not consistent across other measurement periods. This result is consistent with other long-term studies on Riesling, which also reported negligible differences in photosynthetic rates between biodynamic and organic treatments[1].

Berry Quality

Berry quality parameters, including sugar concentration, individual berry weight, and organic acid concentrations (malic and tartaric acids), did not differ significantly between the treatments. This is consistent with most published studies, which generally report no significant differences in sugar concentrations between biodynamic and organic management[1].

Water Status

The results of the carbon-13 discrimination analysis of sugars in berries from 2017 and 2018 suggest that the vines did not experience water deficit during berry ripening, regardless of treatment[3]. This contrasts with other studies that observed lower pre-dawn water potentials in biodynamic plots[1], which might be attributed to methodological differences or site-specific conditions.

Soil Abiotic Properties

The analysis of soil physical properties, including bulk density, water holding capacity, structural stability, and macropore volume, revealed no significant differences between the biodynamic and control treatments over the study period (2017-2020; Figure 2). These findings are in line with previous research indicating minimal impact of biodynamic preparations on soil physical properties[4].

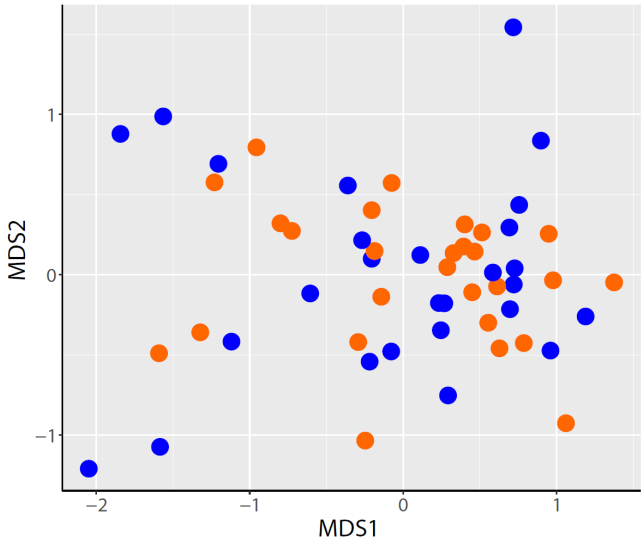


FIGURE 3. Non-metric multidimensional scaling (NMDS) plot showing differences in fungal composition across soil samples. This ordination indicates no significant differences in fungal communities between samples treated with biodynamic preparations (red dots) and water (blue dots). Dots (i.e. fungal communities) that are closer to one another are more similar than those further apart.

Soil Microbial Communities

DNA sequencing of soil fungal communities showed no significant differences in fungal diversity or community composition between plots treated with biodynamic preparations versus water (Figure 3). This supports findings from Hendgen *et al.* (2018)[5], who also reported negligible short-term effects of biodynamic preparations on microbial communities.

Comparative Studies and Broader Implications

Our findings align with a broad body of literature, suggesting that biodynamic viticulture does not confer significant advantages or disadvantages over organic viticulture in terms of vine and berry physiology, soil physical properties, or soil microbiome composition reviewed by Döring *et al.* (2019)[1]. However, some studies have noted minor differences in sensory properties and yield under specific conditions[6].

The lack of consistent and significant benefits of biodynamic preparations in our study raises questions about the added value of these practices, especially considering the higher production costs associated with biodynamic farming, which are 10 to 15 % higher than in organic production[7]. While biodynamic farming is promoted for its potential environmental benefits and improved crop quality, our results suggest that these claims require further substantiation through controlled, long-term (>6 years) studies in which different measurement parameters are included.

Conclusion

The five-year study conducted in a commercial vineyard in Switzerland provides evidence that biodynamic preparations 500 and 501 do not significantly enhance vine physiology, yield, berry quality, or soil health compared to organic management. These findings contribute to the ongoing debate regarding the efficacy and value of biodynamic practices in viticulture. Further research, particularly that focusing on long-term and multi-site studies, is essential to fully understand the potential benefits and limitations of biodynamic viticulture. ■

1 Döring, J., Collins, C., Frisch, M., & Kauer, R. (2019). Organic and Biodynamic Viticulture Affect Biodiversity and Vine and Wine Properties: A Systematic Quantitative Review. *American Journal of Enology and Viticulture*. https://doi.org/10.5344/ajev.2019.18047

2 Rienth, M., Lamy, F., Chessex, C., & Heger, T. (2023). Effects of biodynamic preparations 500 and 501 on vine and berry physiology, pedology and the soil microbiome. *OENO One, 57*(1), 207-216. https://doi.org/10.20870/oeno-one.2023.57.1.7218

3 Rienth, M., & Scholasch, T. (2019). State of the Art of tools and methods to asses vine water status. *OENO One, 53*(4). https://doi.org/10.20870/oeno-one.2019.53.4.2403

4 Longa, C. M. O., Nicola, L., Antonielli, L., Mescalchin, E., Zanzotti, R., Turco, E., & Pertot, I. (2017). Soil microbiota respond to green manure in organic vineyards. *J Appl Microbiol, 123*(6), 1547-1560. https://doi.org/10.1111/jam.13606

5 Hendgen, M., Hoppe, B., Döring, J., Friedel, M., Kauer, R., Frisch, M., Dahl, A., & Kellner, H. (2018). Effects of different management regimes on microbial biodiversity in vineyard soils. *Scientific Reports, 8*(1), 9393. https://doi.org/10.1038/s41598-018-27743-0

6 Parpinello, G. P., Ricci, A., Rombolà, A. D., Nigro, G., & Versari, A. (2019). Comparison of Sangiovese wines obtained from stabilized organic and biodynamic vineyard management systems. *Food Chemistry, 283*, 499-507. https://doi.org/10.1016/j.foodchem.2019.01.073

7 Delmas, M. A., & Grant, L. E. (2014). Eco-Labeling strategies and price-premium:the wine industry puzzle. *Business & Society, 53*(1), 6-44. https://doi.org/10.1177/0007650310362254

This work is licensed under a Creative Commons Attribution 4.0 International License.