Nitrogen Management May Affect Carbon Isotope Ratios in Grape Juice

Steven Jachym, Nataliya Shcherbatyuk, Pierre Davadant, and Markus Keller
Dept. of Viticulture and Enology, IAREC: 24106 North Bunn Road, Prosser, WA. Steven.Jachym@wsu.edu

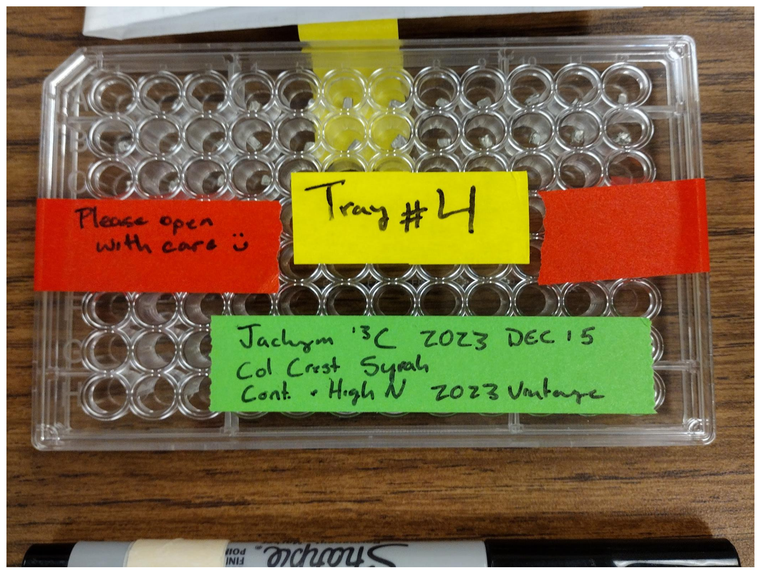
WASHINGTON STATE UNIVERSITY

Introduction

The stable carbon isotope ratio ($\delta^{13}C$) – termed "delta c thirteen" – found in grape juice has gained international attention as a potential marker of vine seasonal water status. Due to a unique ratio dependent on growing conditions, the $\delta^{13}C$ can also be thought of as the grape juice's "carbon signature." **Proponents of this measure suggest the carbon signature is dependent wholly on the seasonal irrigation status of the vine** and theorize the signature may someday be useful in grower's contracts – allowing a winemaker to price, accept, or reject loads dependent on perceived water stress. **The objective of this study was to shed light on the potential for nitrogen management to influence the carbon isotope signature.** Juice analysis shows nitrogen can significantly affect $\delta^{13}C$, and using $\delta^{13}C$ solely as a marker of irrigation management may be against industry interests.

Materials & Methods

- Year: 2023
  - Note: this experiment was also conducted in 2022 with different methods and no significance was found.
- Location: Ste. Michelle Wine Estates' Columbia Crest Vineyard. Paterson, WA
- Material: Two varieties; Sauvignon Blanc and Syrah. 16 vines per treatment, 64 vines total.
- Midday leaf water potential shown as seasonal average (two measurements pre- and two measurements post-veraison).
- Nitrogen Treatments:
  - UAN32 split at bloom and fruit set
    - **Syrah vines received 0 lbs./ac in "low"** blocks and **80 lbs./ac in the "high"** treatment
    - **Sauvignon Blanc vines received 20 lbs./ac in low** blocks and **80 lbs./ac in high** treatments
- Statistics: Two-tailed T-tests and Spearman correlations.



For isotope analysis, small amounts of grape juice (approx. 5-10 microliters) are placed into small tin capsules. Those capsules are dried in an oven to dehydrate the juice, leaving only solid residue behind. The capsule is folded to contain the solids, and loaded into a well plate. The well plate is shipped off to a separate lab (WSU Stable Isotope Lab, Pullam), where isotope content is measured with a specialized mass spectrometer. Each capsule is smaller than a tic-tac.

Results

Syrah showed an increase in $\delta^{13}C$ of ≈0.5‰ (‰ = "per-mil") in the high nitrogen treatment. $\delta^{13}C$ correlated with the seasonal average of midday leaf water potential, but no photosynthetic factors.

Sauvignon blanc showed an increase in $\delta^{13}C$ of ≈0.35‰ in the high nitrogen treatment. This result coincided with a significant correlation between $\delta^{13}C$ and mid-day leaf water potential, but no photosynthetic factors

Midday leaf water potential was measured with a pressure chamber, and photosynthetic parameters were collected with an infrared gas exchange device. Pictured: Steven Jachym.

Discussion

Data indicate that changes in $\delta^{13}C$ result from a difference in water status between treatments. All vineyard blocks were irrigated equally, so this difference in water potential was not caused by irrigation strategies, but rather by varying levels of nitrogen in the soil. This finding contrasts with previously published research on grapevines which suggests nitrogen has no effect on $\delta^{13}C$. Our findings show this phenomenon needs further investigation before the industry considers new pricing standards.

Conclusion

Varying levels of Nitrogen have the potential to alter $\delta^{13}C$ in field-grown grapevines. $\delta^{13}C$ values in grape juice do not solely reflect grower irrigation practices.

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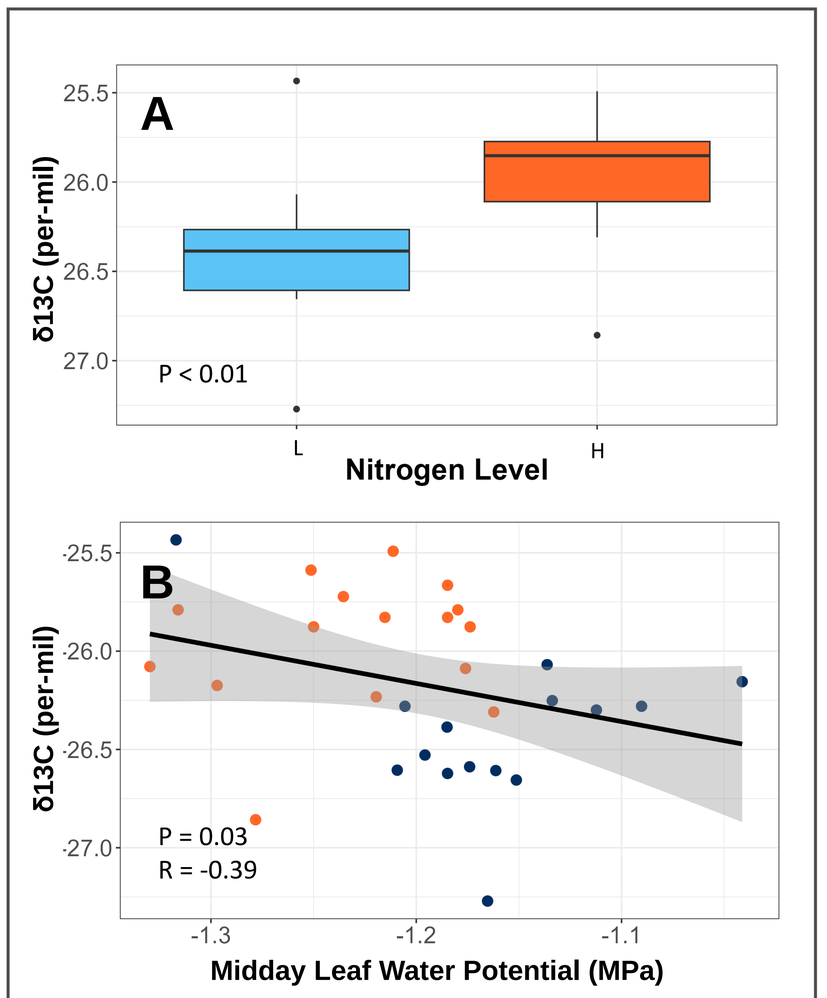
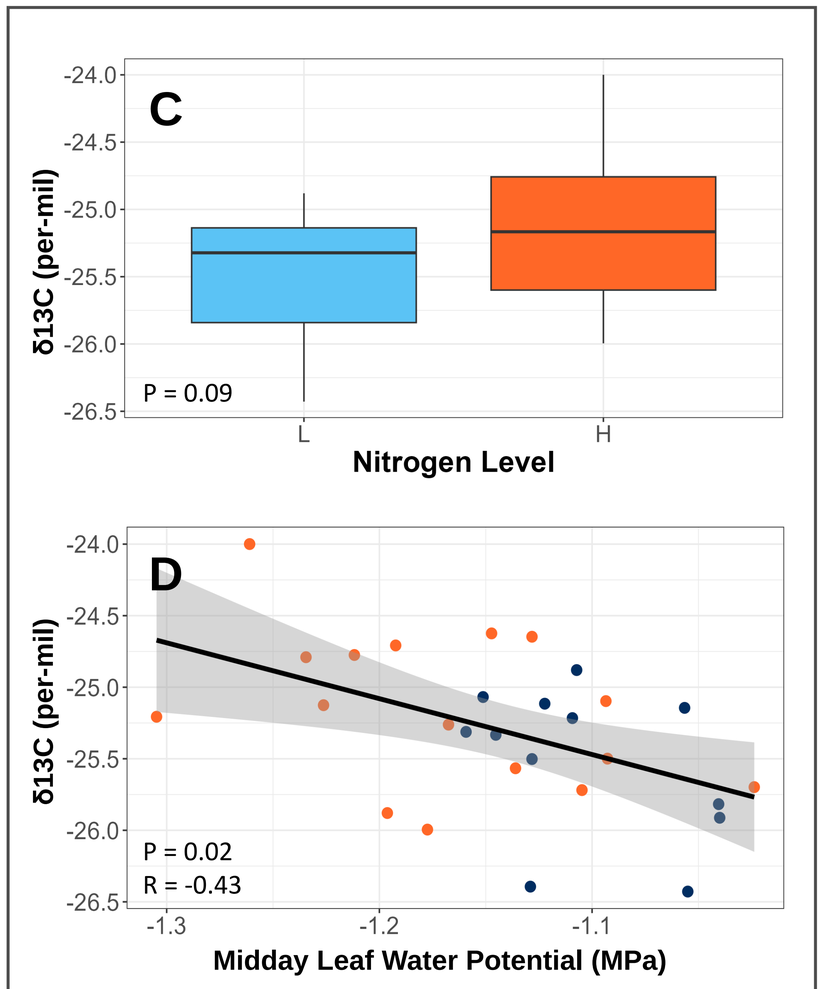


Syrah

A: Boxplots depicting the differences in $\delta^{13}C$ from juice collected at harvest between low (L) and high (H) nitrogen treatments.
B: Correlation analysis between $\delta^{13}C$ and midday leaf water potential. As the vines become stressed (more negative potential), the vine utilizes more ^{13}C.



Sauvignon blanc

C: Boxplots depicting the differences in $\delta^{13}C$ from juice collected at harvest between low (L) and high (H) nitrogen treatments.
D: Correlation analysis between $\delta^{13}C$ and midday leaf water potential. As the vines become stressed (more negative potential), the vine utilizes more ^{13}C.