Technical Note

ARC TRAINING CENTRE FOR INNOVATIVE WINE PRODUCTION

How does rootstock choice effect methoxypyrazine concentrations in Cabernet Sauvignon grape and rachis?

Investigators: Ross Sanders, David Jeffery

Background and Aims

Rootstock uptake throughout Australian wine regions is increasing to address various biotic (e.g., pests, diseases) and abiotic (e.g., salinity, drought) challenges. As this uptake occurs, it is important to consider how changes in grapevine related chemistry due to rootstock variety might impact the flavour of wine. Recent research revealed that Shiraz grown on Ramsey rootstock can have significantly higher concentrations of methoxypyrazines, particularly 3-isobutyl-2-methoxypyrazine (IBMP), in the bunch stem (rachis) at harvest compared with own roots.[1] Investigating such a rootstock phenomenon for Cabernet Sauvignon, a variety typically associated with IBMP in berry and wine, was proposed to be highly relevant and was the aim of this work. Methoxypyrazines such as IBMP are varietal compounds that can contribute flavours of "green capsicum", "leafy", and "grassy" to wine at low nanogram-per-litre concentrations.[2] Although considered desirable at lower concentrations, when IBMP exceeds 15 ng/L, the associated green aromas can become unbalanced, decreasing both the perception of desirable fruity aromas and appeal of such wines for consumers.[3] Considering that the removal of methoxypyrazines from finished wine has unresolved technical challenges,[4] the best control point for methoxypyrazines so far is to regulate their production within grape and rachis within a vineyard or limit the amount extracted during fermentation from material other than grape, including rachis.

Key outcomes

Our research explored the impact of rootstock, vine vigour, and spatial distribution of vine vigour on the concentrations of methoxypyrazines in the rachis of Cabernet Sauvignon grown in the Coonawarra rootstock trial for the 2018/19 and 2019/20 vintages. Nine rootstocks (Börner, 1103 Paulsen, 110 Richter, 140 Ruggeri, Ramsey, Merbein 5512 (M5512), Merbein 5489 (M5489), and Merbein 6262 (M6262)) and own roots were sampled at technological maturity in 2019 (average of 22.5 °Brix) and 2020 (average of 23.6 °Brix), and methoxypyrazines were quantified in rachis and berry using gas chromatography-mass spectrometry.

Full outcomes are described in the publication by Sanders et al (2022).[5] Briefly, key results can be summarised as:

- Rootstock significantly affected the concentration of IBMP in rachis and berry at harvest.
- The concentration of IBMP in rachis at harvest was positively correlated with rootstock-mediated vine vigour (average cane weight (g)) (Figure 1). Figure 1 (next page) shows that low vigour rootstocks (i.e., M5512, M5489, M6262) are gathered near the origin, whereas high vigour rootstocks (i.e., 140 Ruggeri, 1103 Paulsen, 110 Richter, and Ramsey) are further away.

Therefore, rootstock vigour characteristics are an important consideration for IBMP concentrations in Cabernet Sauvignon rachis.

- Differences in vine vigour across the vineyard appeared to be related to IBMP concentration, independent of rootstock. This conclusion is based on the similar spatial relationships in Figure 2 and lack of an evident pattern reflecting the rootstock trial block design. This result was attributed to the effect on vigour of variable soil depth across the trial block, with the latter being a known characteristic of the Terra Rossa soils of the Coonawarra.

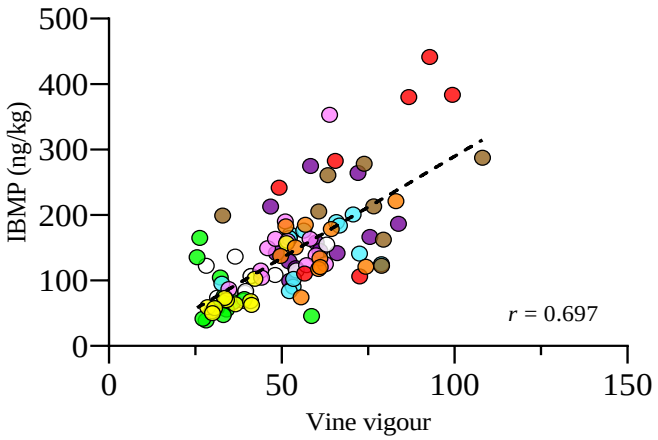

Figure 1: Correlation between rachis IBMP (ng/kg) and a measure of vine vigour (average cane weight (g)) for own roots (white); Börner (yellow); 1103 Paulsen (brown); 110 Richter (orange); 140 Ruggeri (red); Ramsey (purple); M5512 (blue); M5489 (pink); M6262 (green). Reprinted with permission from Sanders, R. D., Boss, P. K., Capone, D. L., Kidman, C. M., Bramley, R. G. V., Nicholson, E. L., & Jeffery, D. W. (2022). Rootstock, vine vigour, and light mediate methoxypyrazines in the grape bunch rachis of *Vitis vinifera* L. cv. Cabernet Sauvignon. *Journal of Agricultural and Food Chemistry*, 70, 5417-26. Copyright 2022 American Chemical Society.

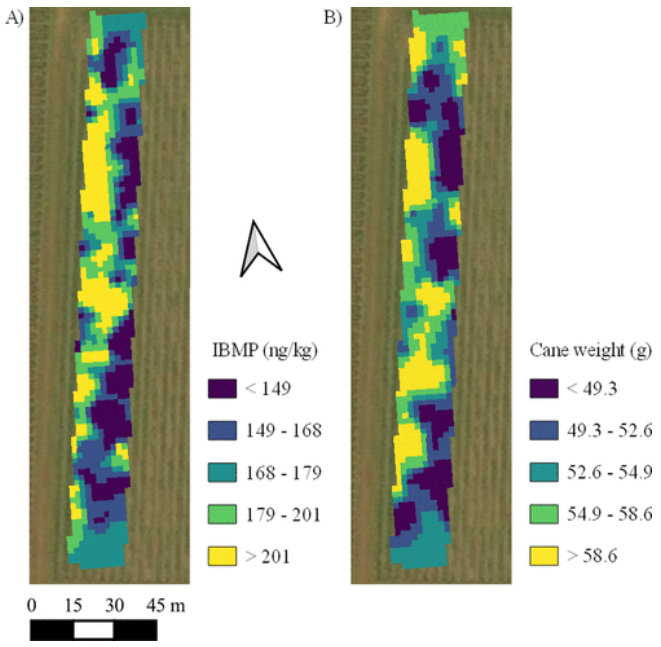

Figure 2: Patterns of spatial variation in A) IBMP concentration (ng/kg) in rachis and B) vine vigour (cane weight in g) across the Coonawarra rootstock trial at harvest in 2020. Reprinted with permission from Sanders, R. D., Boss, P. K., Capone, D. L., Kidman, C. M., Bramley, R. G. V., Nicholson, E. L., & Jeffery, D. W. (2022). Rootstock, vine vigour, and light mediate methoxypyrazines in the grape bunch rachis of *Vitis vinifera* L. cv. Cabernet Sauvignon. *Journal of Agricultural and Food Chemistry*, 70, 5417-26. Copyright 2022 American Chemical Society.

Recommendations

If methoxypyrazines are of concern in terms of grape variety and wine style, consideration should be given to the potential effect of rootstock when establishing new rootstock plantings that may influence the concentration of IBMP in the rachis and berry. Rootstocks that are known to impart low vine vigour may be more suitable due to the lower accumulation of IBMP in the berry and rachis of Cabernet Sauvignon scions.

Aside from rootstock choice, vine vigour is correlated with IBMP concentration. As vine vigour can be modified through established vineyard management practices, it appears to be a convenient method for controlling IBMP concentrations in rachis and berry at harvest. For vineyards/wineries that are not able, or decide against, altering vine vigour, an alternate option is to prevent rachis from entering the fermenter through appropriate assessment and sorting techniques.

What's next?

Research is being extended into the effect of rootstock, vigour, and region on the concentration of methoxypyrazines in Shiraz. Furthermore, studies are being undertaken to understand the variation of methoxypyrazines across the rachis of Cabernet Sauvignon and Shiraz, the influence of light, and the implications of rachis on wine style.

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References

1. Capone DL; Francis IL; Clingeleffer PR; Maffei S M; Boss PK. Evidence that methoxypyrazine accumulation is elevated in Shiraz rachis grown on Ramsey rootstock, increasing 'green' flavour in wine. *Aust. J. Grape Wine Res.* **2022,** *28,* 304-315.
2. Roujou de Boubée D; Van Leeuwen C; Dubourdieu D. Organoleptic impact of 2-methoxy-3-isobutylpyrazine on red Bordeaux and Loire wines. Effect of environmental conditions on concentrations in grapes during ripening. *J. Agric. Food Chem.* **2000,** *48,* 4830-4834.
3. Hein K; Ebeler SE; Heymann H. Perception of fruity and vegetative aromas in red wine. *J. Sens. Stud.* **2009,** *24,* 441-455.
4. Pickering GJ; Willwerth J; Botezatu A; Thibodeau M. Prevalence and management of alkyl-methoxypyrazines in a changing climate: Viticultural and oenological considerations. *Biomolecules* **2021,** *11,* 1521.
5. Sanders RD; Boss PK; Capone DL; Kidman CM; Bramley RGV; Nicholson EL; Jeffery DW. Rootstock, vine vigour, and light mediate methoxypyrazines in the grape bunch rachis of *Vitis vinifera* L. cv. Cabernet Sauvignon. *J. Agric. Food Chem.* **2022,** *70,* 5417-5426.

Contact

For further information, please email or visit our website:
Ross Sanders: ross.sanders@adelaiade.edu.au; **David Jeffery**: david.jeffery@adelaide.edu.au
ARC Training Centre for Innovative Wine Production; https://www.arcwinecentre.org.au

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