

Casting its Shadow Ahead: Preliminary Results on the Impact of Agri-PV on Grapevine

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Background

German winegrowers face increasing challenges. Beyond market pressures and regulatory frameworks, extreme weather events linked to climate change - including excessive heat-waves, droughts, and hailstorms - can cause losses in both yield and quality.

Agricultural photovoltaic (Agri-PV) systems offer a potential adaptation strategy for changing environmental conditions providing multiple benefits for vineyards:

- Protection: Shields grapes from excessive solar radiation, reducing the risk of thermal damage and sunburn. Safeguards soil from desiccation and protects vines from hail and severe precipitation.
- Microclimate Regulation: Mitigates extreme temperature fluctuations, both high and low.
- Economic Diversification: Electricity generation provides supplementary income for winegrowers and supports the energy transition.

Viti-PV at the WBI



Fig. 1: Three different types of modules are installed at Blankenhornsberg: semi-transparent (left), single-axis tracking longitudinal (middle) and single-axis tracking transverse (right)

The facility was established over an vineyard at Blankenhornsberg, Ihringen. The vineyard features two distinct Pinot Noirs clones: FR-1602 on SO4 rootstock and FR-1801 on 125AA rootstock. The PV System spans 0.44 hectares with a capacity of 240 kWp. evaluate the impact of varying shading levels on the vines, three distinct solar module configurations were integrated:

- Upper Section: 19 rows of stationary, semi-transparent modules providing uniform shade.
- Lower Section: four rows of transversely arranged modules, three rows of longitudinally arranged modules. These modules are equipped with sun-tracking capabilities (Fig. 1).

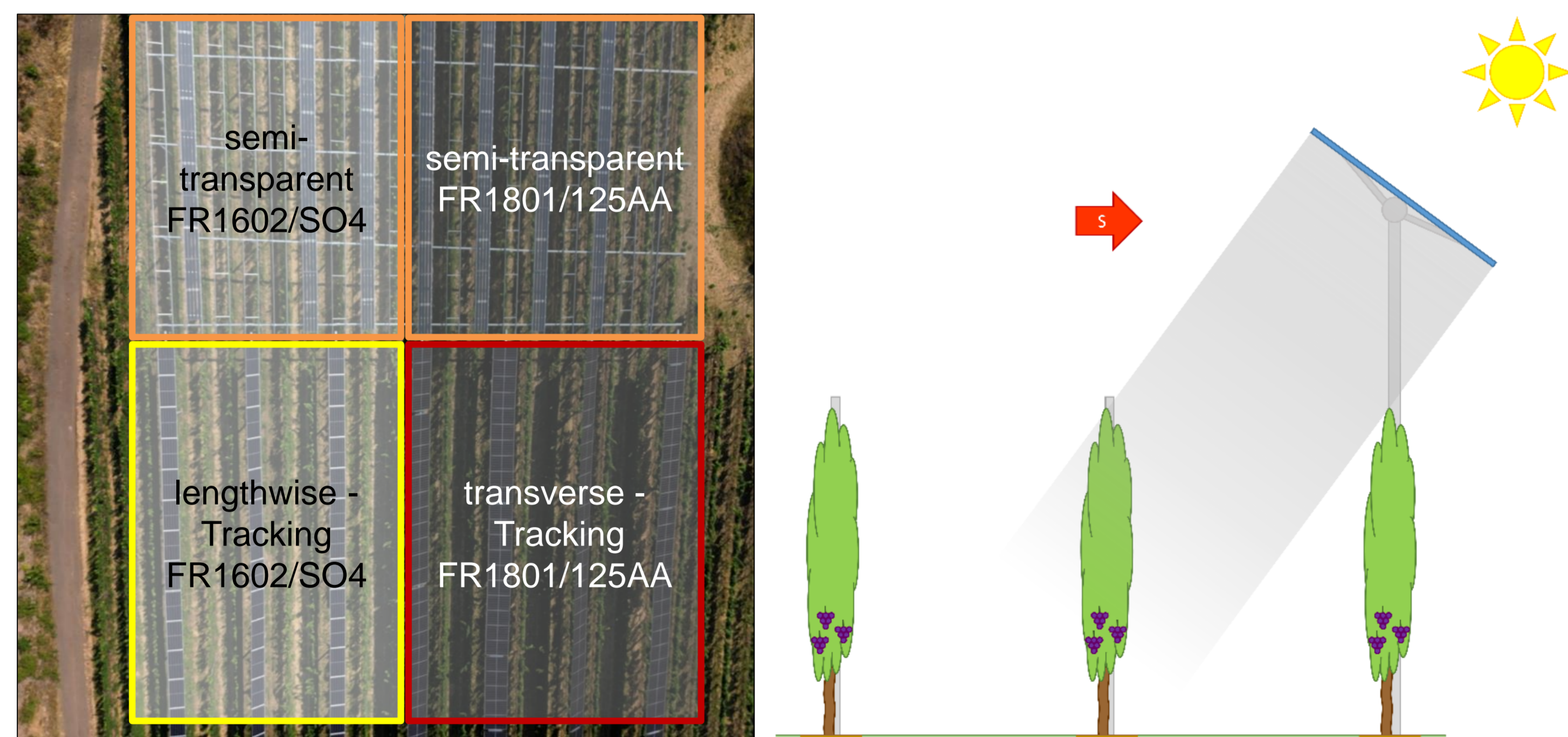


Fig. 2: Left → Classification of the plant into module types and by clone + rootstock. Right → different shade levels in the lower part of the plant

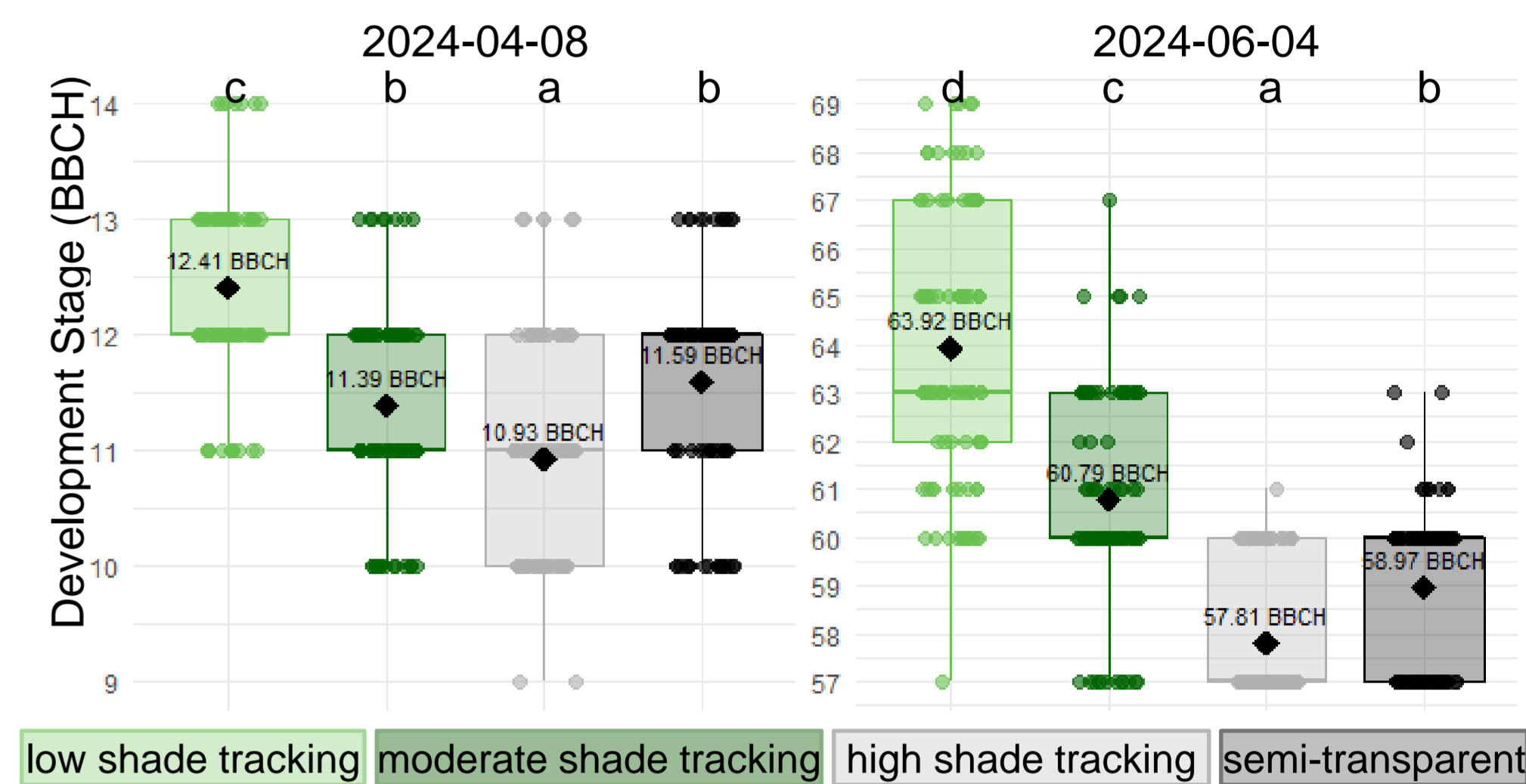
The solar module configurations create three distinct shading levels between rows: "high shade," "moderate shade," and "low shade." Combining these shade levels with the two Pinot Noir clones (FR-1602 on SO4 and FR-1801 on 125AA) results in eight unique experimental variants (Fig. 2).

Throughout the vegetation period, various vegetative and generative parameters were examined.

Results and Discussion

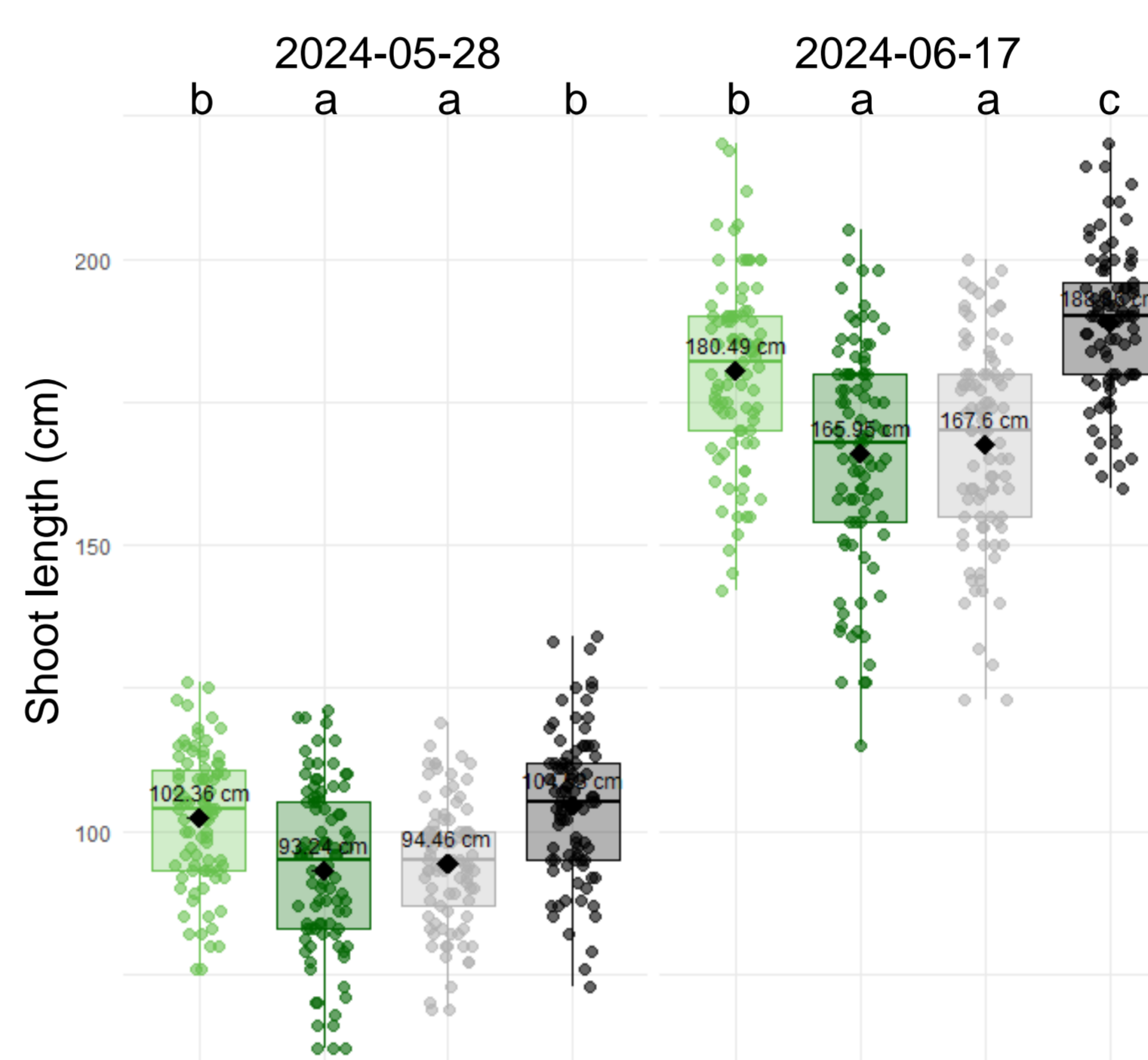
Impact on Phenology

- Significant differences in the developmental stages of bud break and flowering were observed among the individual shading variants.
- The highly shaded variant consistently exhibited significantly later bud break and flowering.
- Compared to lightly shaded variants, vines under the semi-transparent modules showed significantly delayed bud break and flowering.



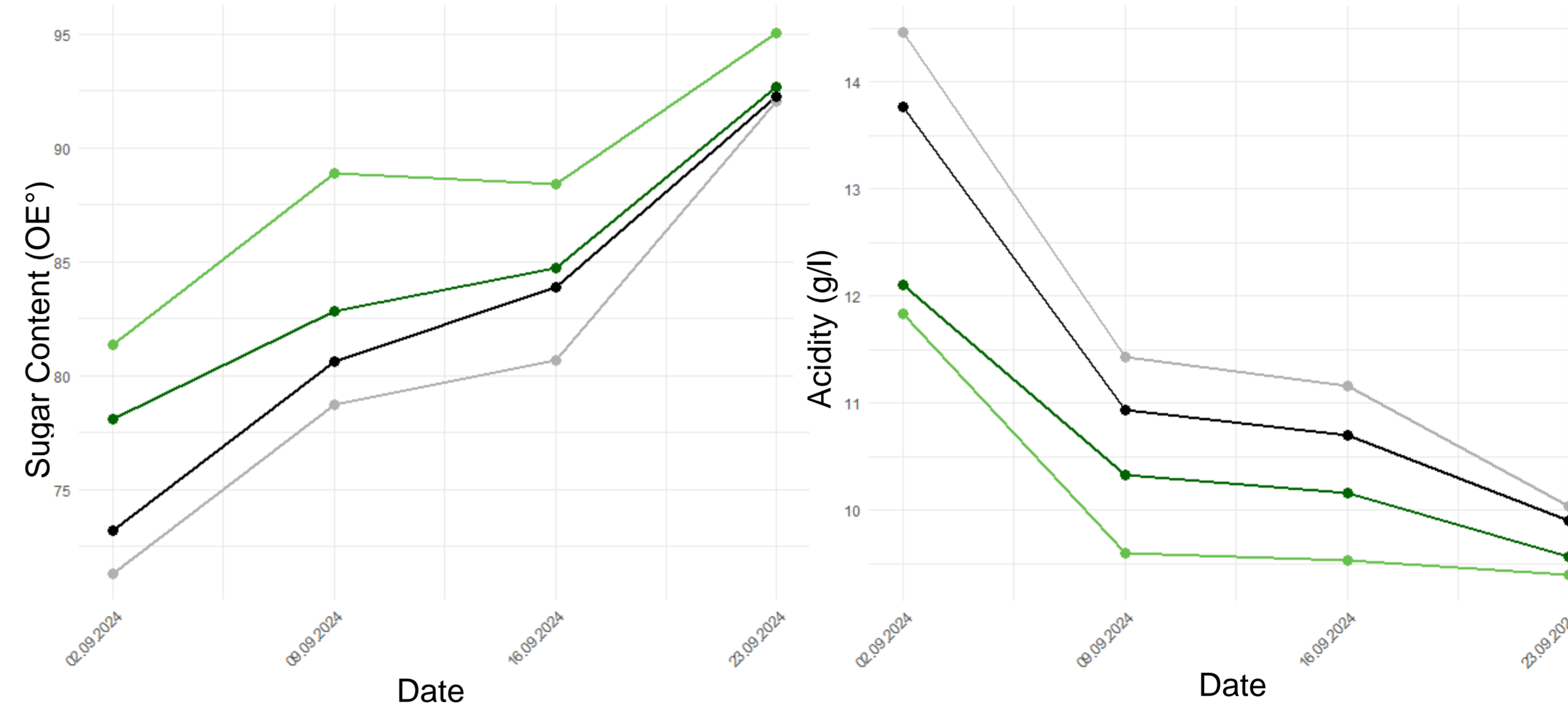
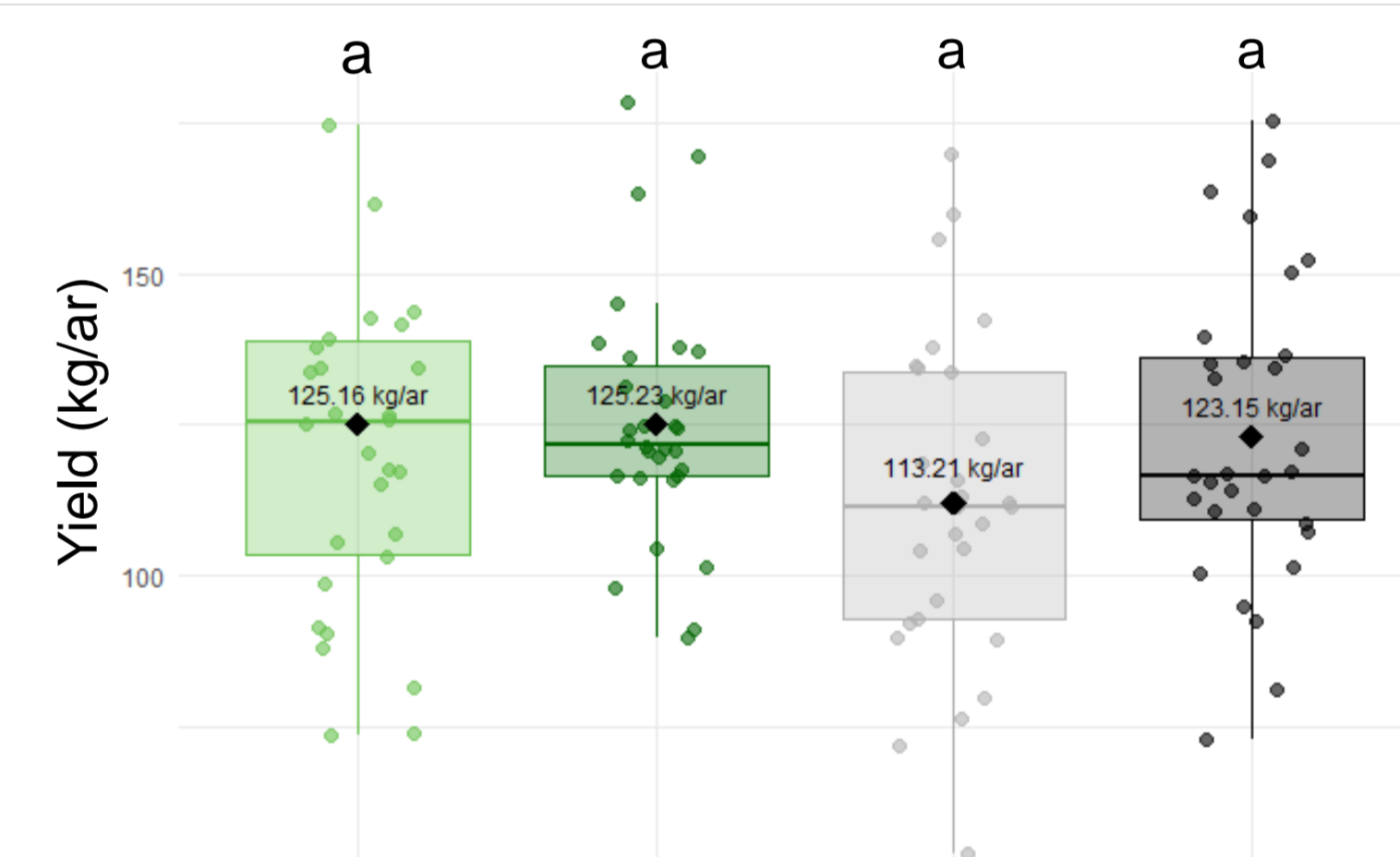
Total shoot length

- Initial Measurement: Shoot length beneath semi-transparent modules showed significant differences compared to highly and moderately shaded variants.
- Subsequent Measurement: By the second assessment, shoot length under semi-transparent modules was significantly longer than all other experimental variants.



Total yield

Yield did not significantly differ across the various shading variants.



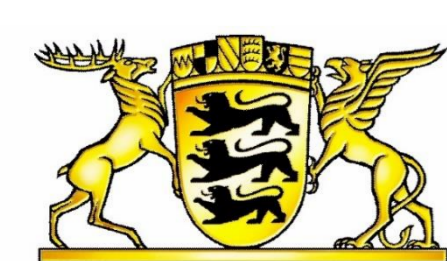
Ripening process Grapes under highly shaded and semi-transparent modules exhibited a delayed ripening process. This was characterized by delayed sugar accumulation and later acid degradation.

Conclusion

Preliminary results suggest that vines exhibit an adaptive response to varying degrees of shading, particularly in vegetative characteristics. Greater shading was associated with a delay in vegetative development, which can be a favorable outcome for winegrowers.

However, no significant influence on generative characteristics (e.g., yield) was observed.

Crucially, these findings are based on a single year's data. Definitive conclusions require multi-year datasets to account for annual variability. Future research must also quantify the precise degree of shading for a conclusive evaluation.



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