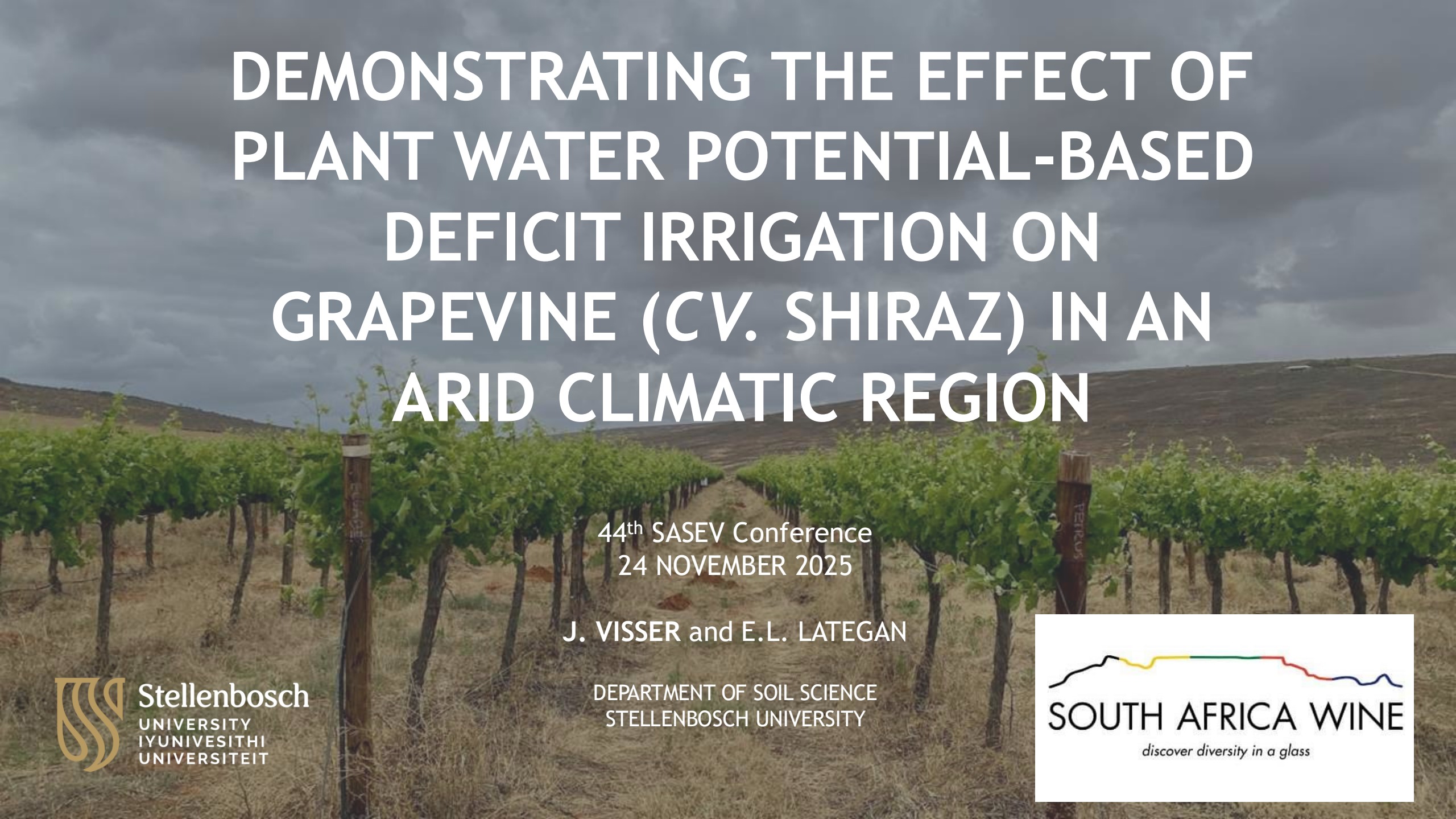
DEMONSTRATING THE EFFECT OF PLANT WATER POTENTIAL-BASED DEFICIT IRRIGATION ON GRAPEVINE (*CV.* SHIRAZ) IN AN ARID CLIMATIC REGION



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J. VISSER and E.L. LATEGAN

DEPARTMENT OF SOIL SCIENCE
STELLENBOSCH UNIVERSITY

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INTRODUCTION

INTRODUCTION

- Droughts are frequent occurrences in South Africa – crop producers need to constantly adapt due to water availability.
- The severity of droughts not deter some farmers to apply excessive amounts of water.
- Excessive irrigation is costly and may cause vigorous vegetative growth that leads to shading of clusters and reduced wine quality (Bureau et al., 2000; Chorti *et al*. 2010; Gao & Cahoon, 1994; Morrison & Noble, 1990).

INTRODUCTION…

- Judicious water management can assist controlling vegetative growth, grape quality and for ensuring vineyard sustainability (Bravdo et al., 1985; Chaves et al., 2010; Fereres & Evans, 2006; Keller et al., 2008; Munitz et al., 2016; Romero et al., 2010).

- If drought stress is used appropriately in certain phenological stages, it can be used to increase the quality of the yield without any reduction in the yield (Girona et al., 2009; Intrigliolo and Castel, 2010).

- The main goal of stress in the plant is to alter the stability at which the plant grows.
- One of the ways drought stress can be properly managed is by using midday stem water potential (Chone et al., 2001).

MATERIALS AND METHODS

BROAD PROJECT INFORMATION

- In 2019 **WINETECH (South Africa Wine) approached the Dept. of Soil Science** to manage an irrigation research project to demonstrate irrigation management of vineyards based on predetermined plant water potential thresholds in three different wine grape producing and climatic regions.

- The main focus of the project was to **demonstrate to producers the results** (vegetative, yield and wine composition responses) in actual vineyard conditions

- The cultivar **Shiraz** was decided on as this cultivar is not only widely planted, but also very responsive to different water availability conditions

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MATERIALS AND METHODS

Experimental vineyards and design

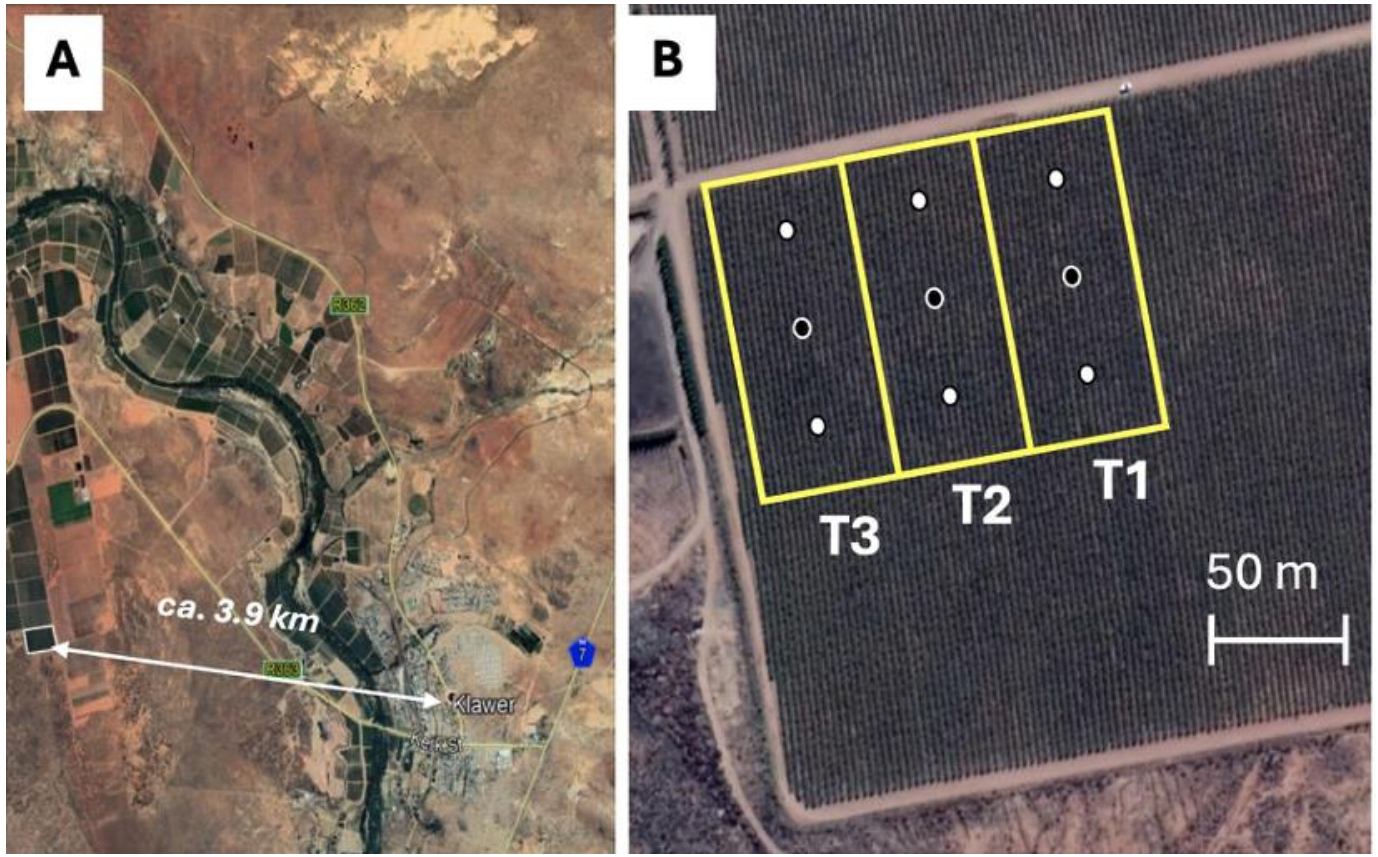

Figure 1 An aerial image illustrating the (A) locality of the selected Shiraz/99R vineyard near Klawer (*ca*. 3.9 km) and (B) the selected areas within the vineyard for the three different treatments applications .

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SITE PROFILE: OLIFANTS RIVER VALLEY

- **Cultivar:** Shiraz (Clone SH9)
- **Rootstock:** 99 Richter
- **Plant spacing:** 2.7 m x 2.0 m
- **Trellis system:** Two strand hedge system with a sprawling canopy.
- The soil was classified as a Garries/Hutton form (sandy soil) with an effective rooting depth of approximately 50 cm.

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MATERIALS AND METHODS

Experimental vineyards and design

Table 1: Irrigation treatments that was applied to the vineyard in the Olifants River Valley

Viticulture region	Irrigation treatment
Treatment 1	Farmer's irrigation practice (± -1.1 MPa)
Treatment 2	-1.5 MPa midday stem water potential
Treatment 3	-1.8 MPa midday stem water potential

All treatments commenced from pea stage up until harvest.

MATERIALS AND METHODS

Measurements

Soil water content determination

- Continuous logging was done using TEROS 11 sensors;
- Sensors were installed in 20 cm intervals, starting at 10 cm below the surface of the soil;
- The soil water balance (SWB) was calculated using the following:
- SWB = R + I – (△SWC)
  - R = rain (mm)
  - I = irrigation (mm)
  - △SWC = difference in soil water content in the beginning and end of season

MATERIALS AND METHODS

Measurements

Plant Water Status

- Midday leaf water potential of full sunlight and shaded leaves were taken together with midday stem water potential readings.
- The pressure chamber technique Scholander *et al*. (1965) was used to measure the water potentials of mature leaves following the protocol of Myburgh (2010).
- Full shaded leaves were chosen close to the cordon with no visible sun flecks (Williams, 2012).

MATERIALS AND METHODS

Measurements

Vegetative growth

- Vegetative growth was calculated after pruning, by using the cane mass of each vine.
- Ten shoots were selected per treatment and stripped from leaves to determine leaf area per vine.
- Leaves, which were cut at the petiole, was weighed and through an equation by Myburgh (1998) converted to leaf area.

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MATERIALS AND METHODS

Measurements

Yield components

- Total titratable solids of 24ºB needed to be reached before harvesting could commence.
- Harvesting was done by hand and bunches counted by means of a mechanical counter.
- Bunch samples were taken on shoots selected for leaf area determination and used for berry analysis.
- Experimental wine was made, and sensorial analyses was performed by Dr Brand (US) using the 7-point scale she perfected.

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RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

Irrigation amounts: Olifants River Valley

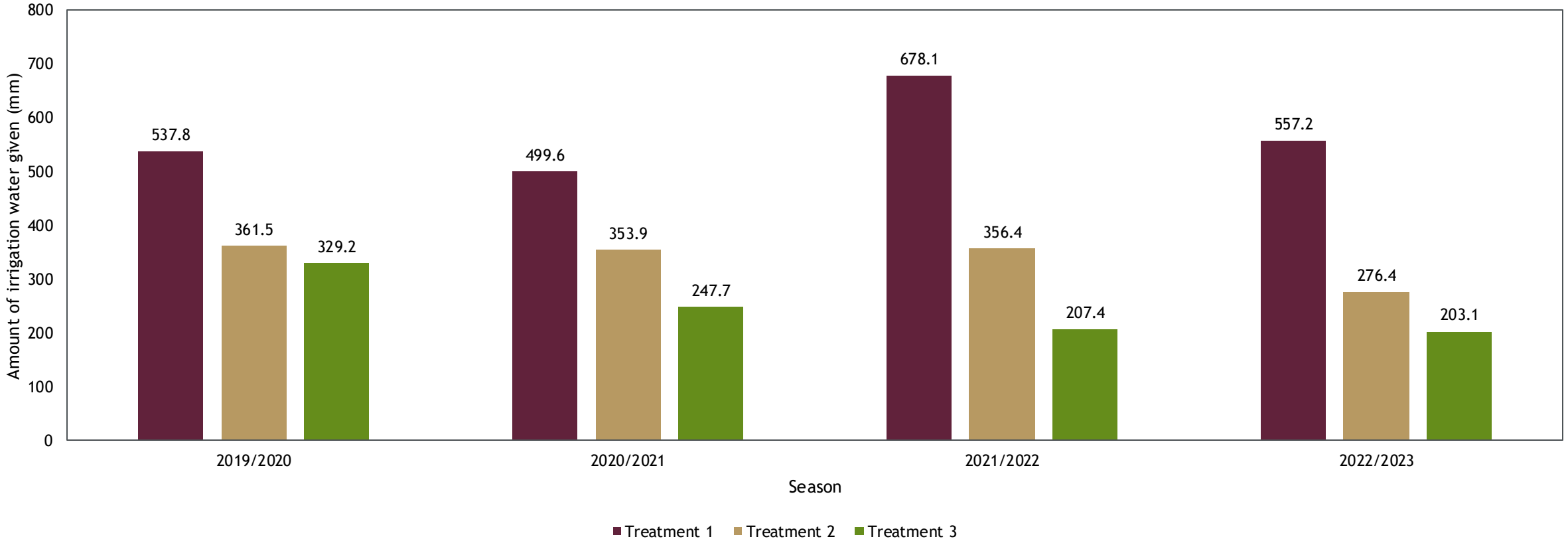

Figure 2. Irrigation amounts for the Olifants River Valley over four growing seasons.

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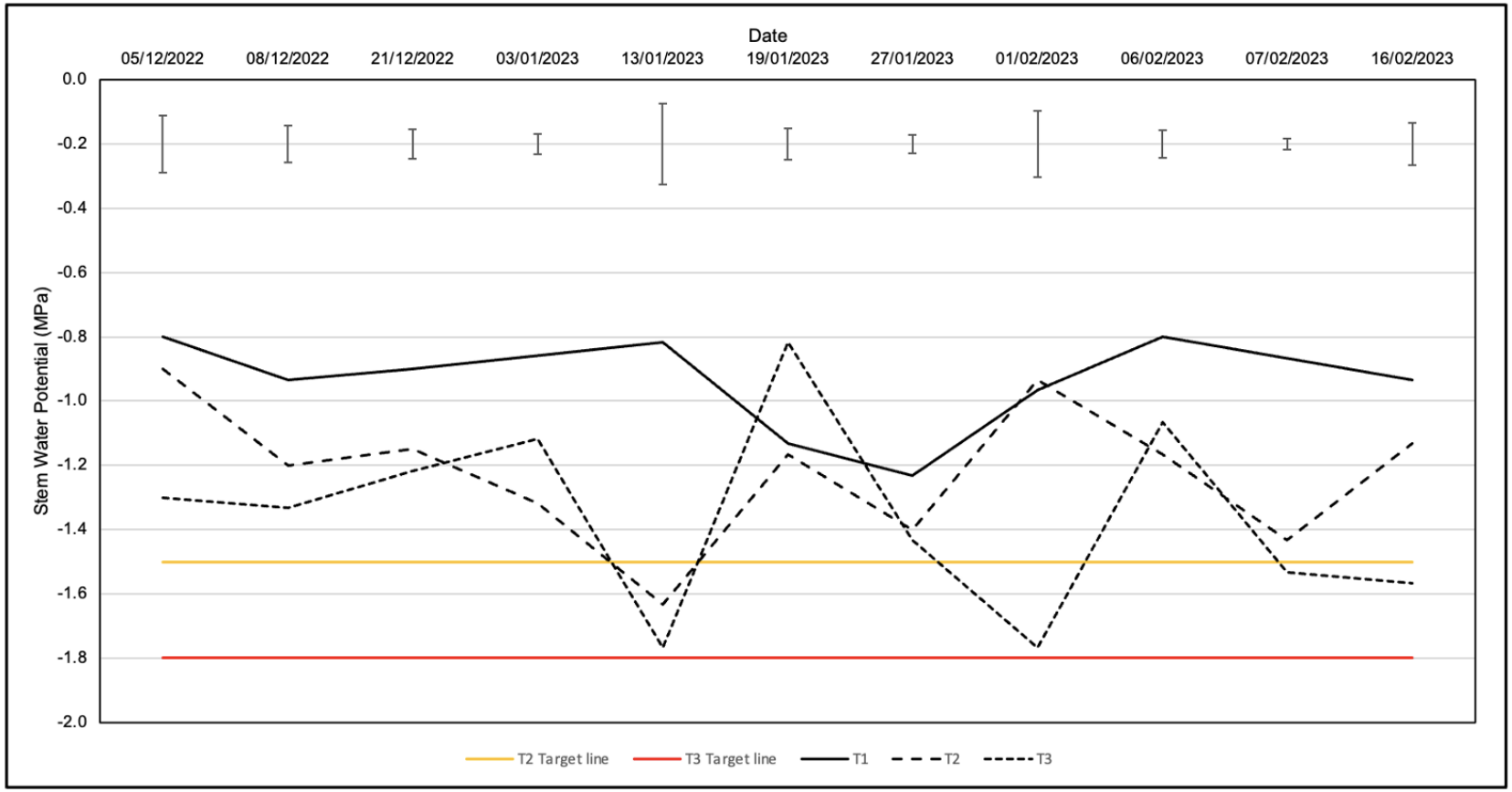
RESULTS AND DISCUSSION

Stem water potential readings over the 2022/23 season



*Error bars indicate the Standard Error between Treatments.

Figure 3. Variation in midday stem water potential in the 2022/23 season of three different irrigation treatments based on plant water potential measurements in the Olifants River Valley. Vertical bars indicate least significant differences ($p < 0.05$)

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RESULTS AND DISCUSSION

Physiological reaction to water constraints

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RESULTS AND DISCUSSION

Vegetative growth: Pruning Mass

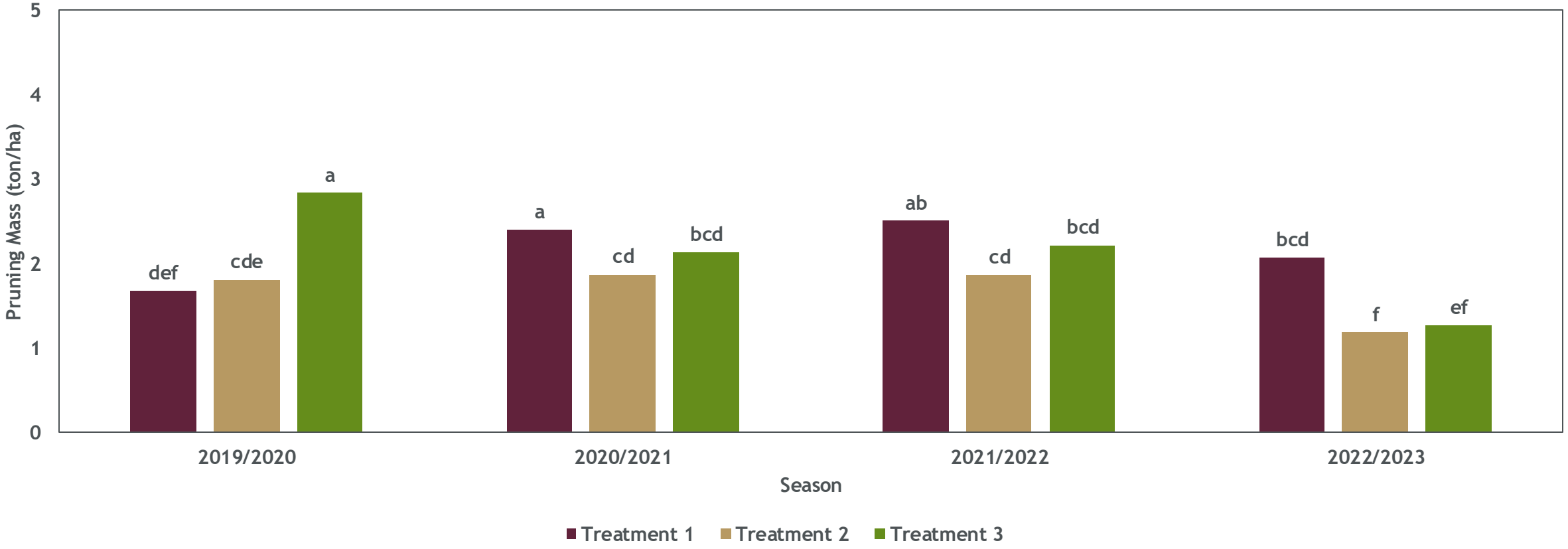

Figure 4. Vegetative responses to irrigation scheduling of Shiraz grapevines in the Olifants River Valley wine grape growing region over the span of four seasons.

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RESULTS AND DISCUSSION

Reproductive growth: Mean Bunch Mass

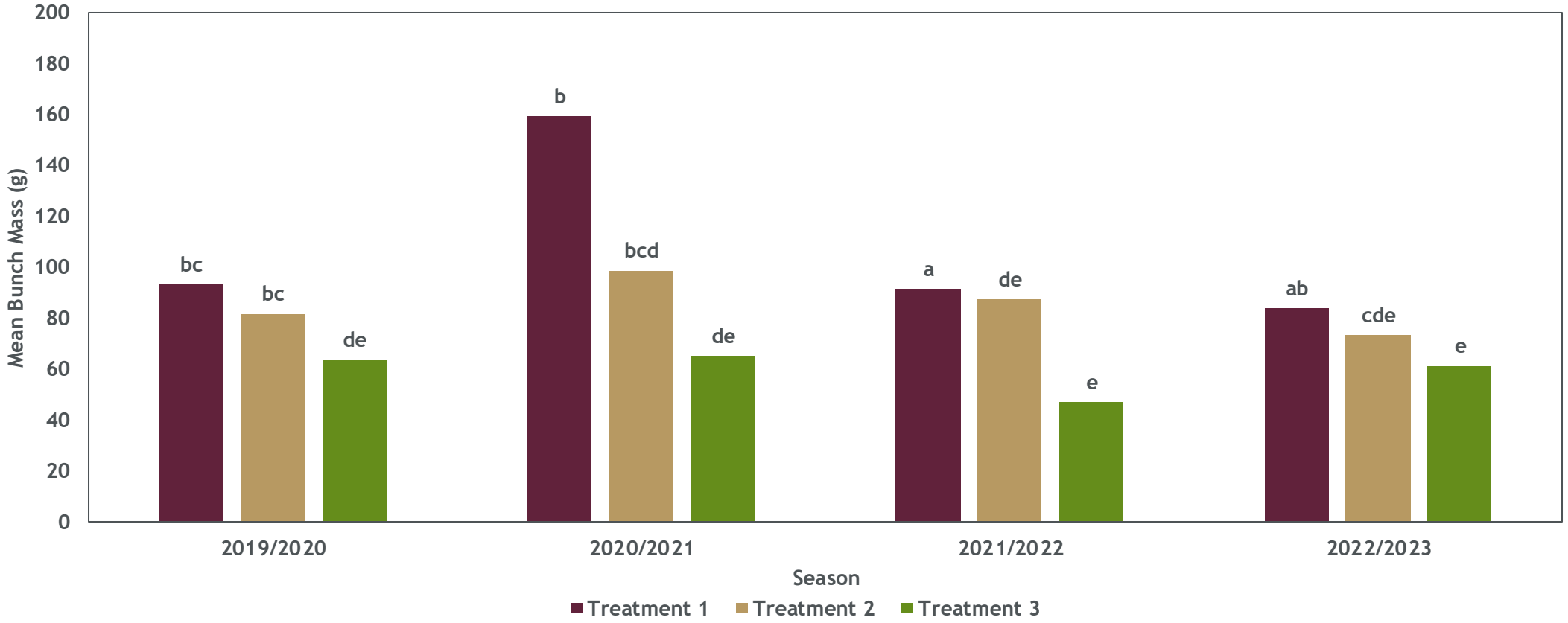

Figure 5. The effect of irrigation scheduling based on stem water potential measurements on berry characteristics in the Olifants River Valley wine grape growing region over the span of four seasons.

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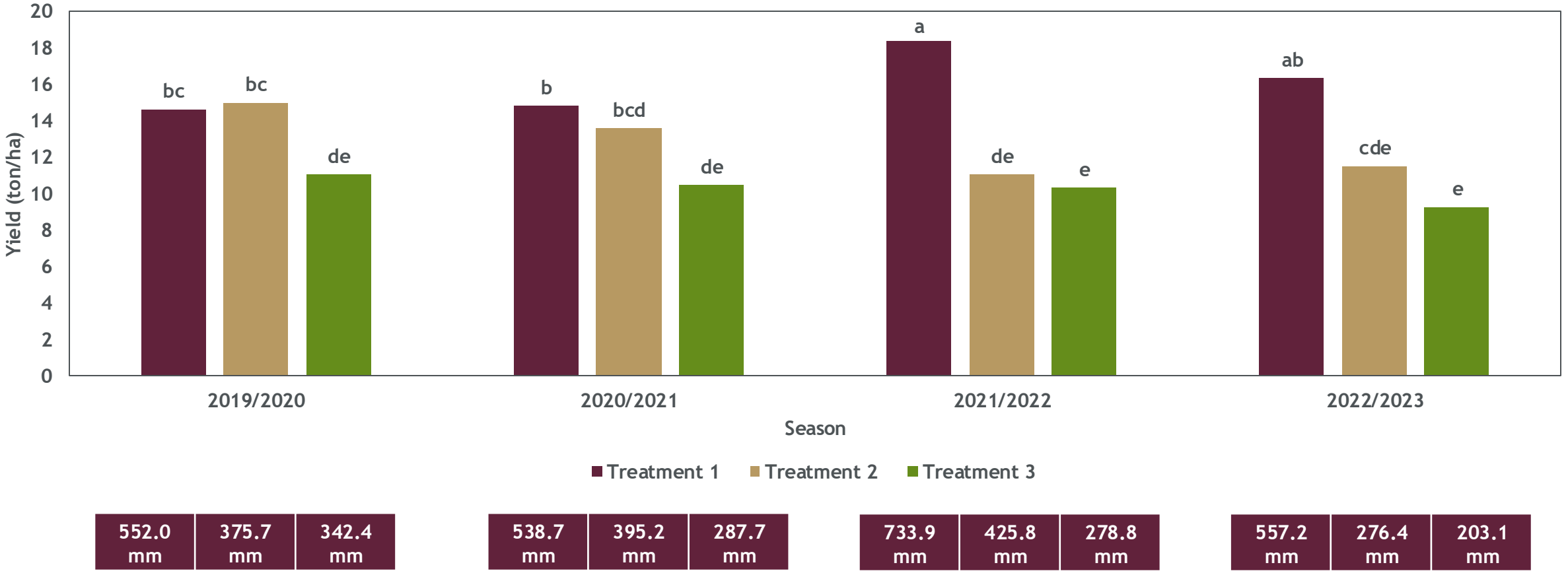
RESULTS AND DISCUSSION

Reproductive growth: Production



552.0 mm	375.7 mm	342.4 mm	538.7 mm	395.2 mm	287.7 mm	733.9 mm	425.8 mm	278.8 mm	557.2 mm	276.4 mm	203.1 mm

Figure 6. The effect of irrigation scheduling based on stem water potential measurements on yield components in the Olifants River Valley wine grape growing region over the span of four seasons.

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RESULTS AND DISCUSSION

Reproductive growth: Production lost due to sunburn

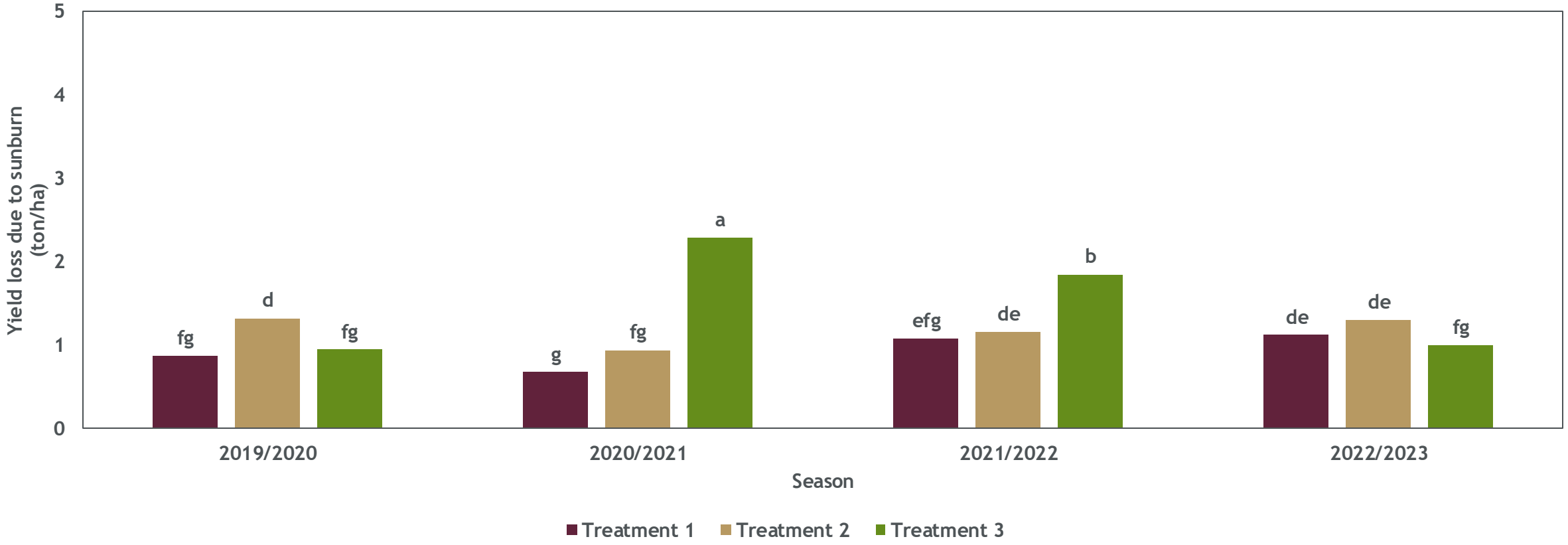

Figure 7. The effect of irrigation scheduling based on stem water potential measurements on yield components in the Olifants River Valley wine grape growing region over the span of four seasons.

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RESULTS AND DISCUSSION

Water Use Efficiency of Production

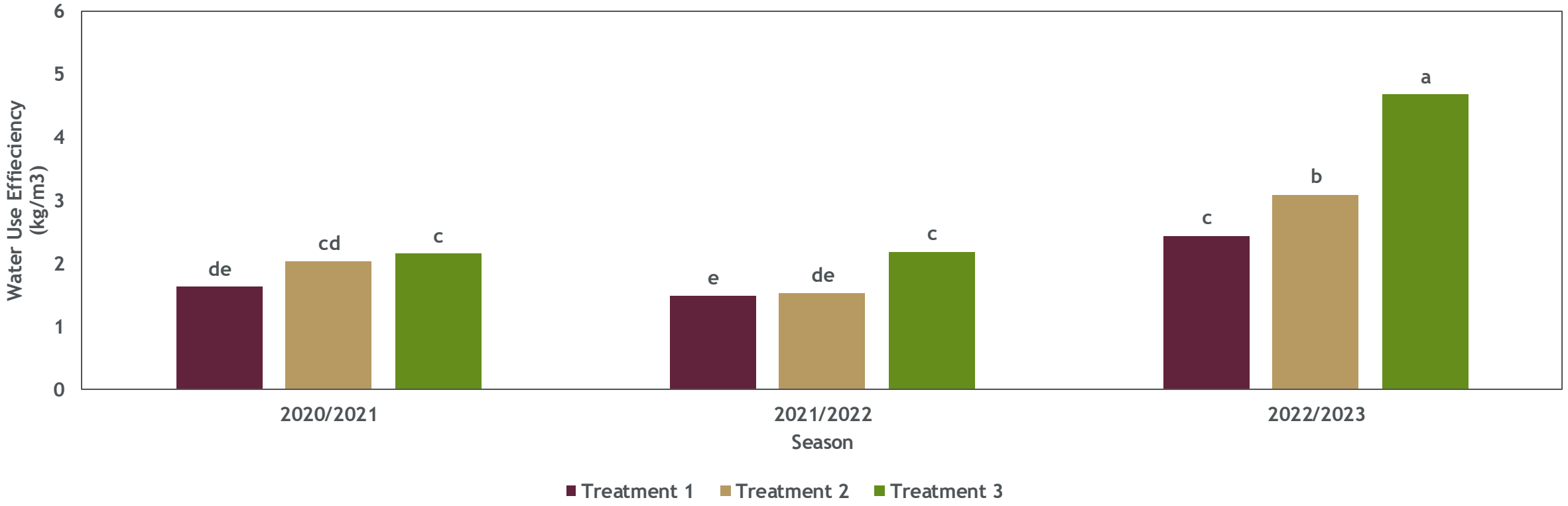

Figure 8. The effect of irrigation scheduling based on stem water potential measurements on yield components in the Olifants River Valley wine grape growing region over the span of four seasons.

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RESULTS AND DISCUSSION

Wine Composition: Mean Percentage over four seasons

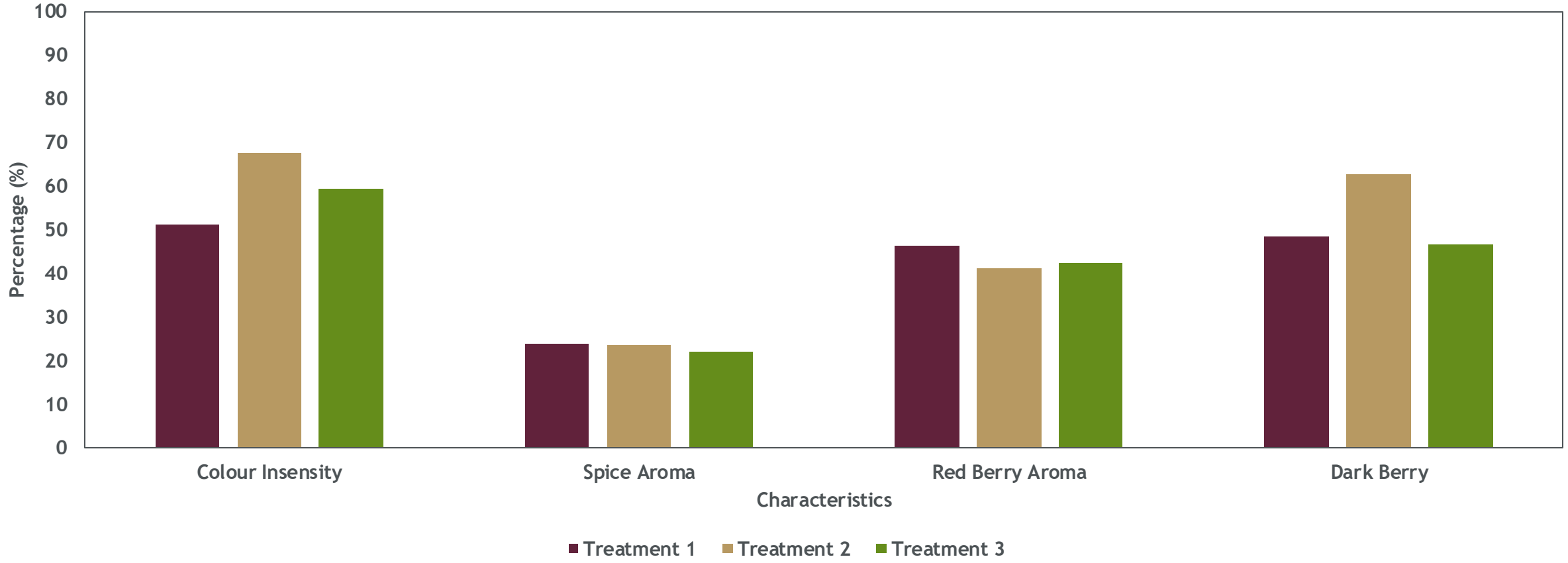

Figure 9. The effect of irrigation scheduling based on stem water potential measurements on sensorial wine components in the Olifants River Valley wine grape growing region over the span of four seasons.

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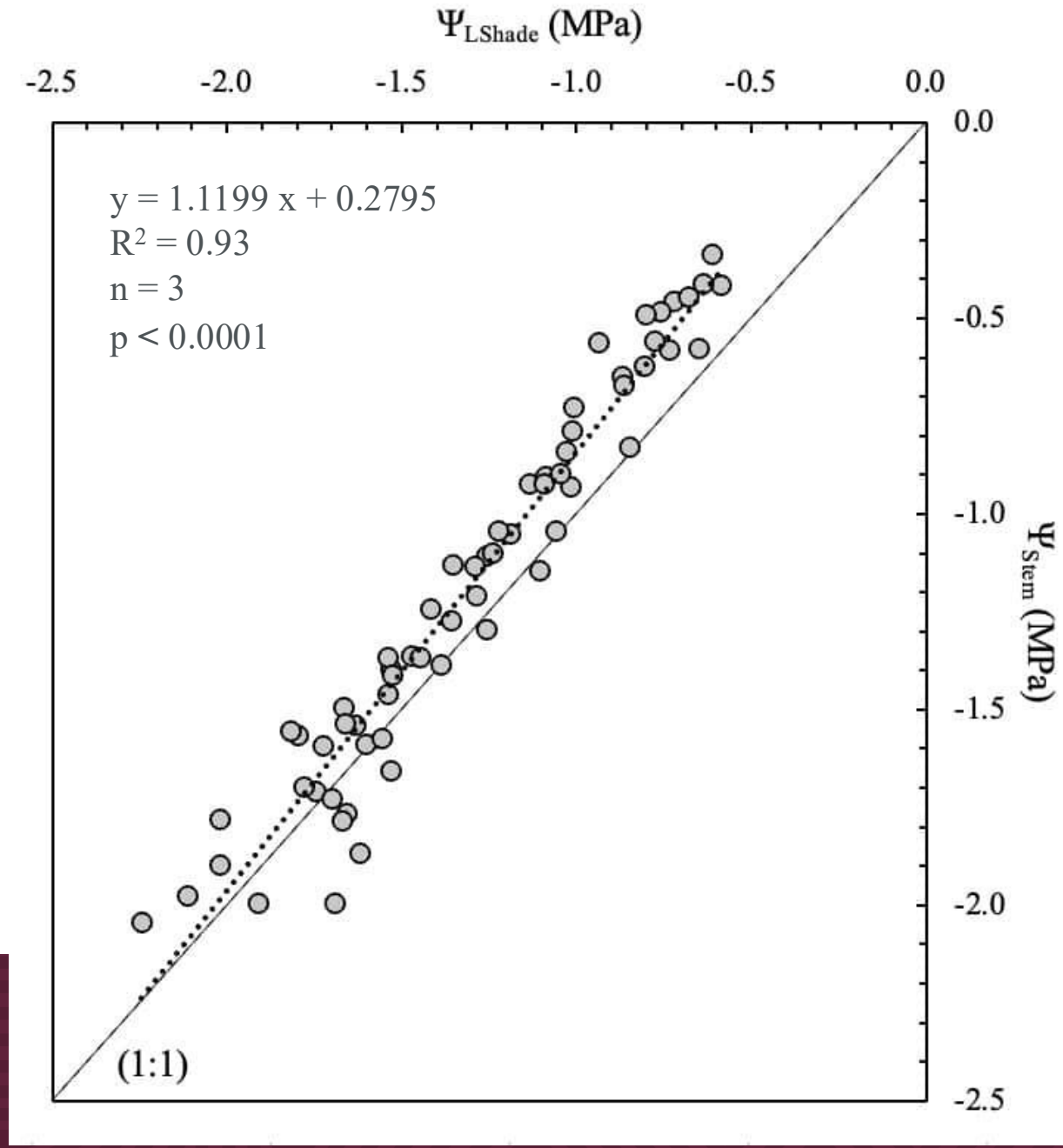

RELATIONSHIP BETWEEN FULL SHADE LEAF WATER POTENTIAL AND MIDDAY STEM WATER POTENTIAL

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CONCLUSION

CONCLUSION

- Stem Water Potential is a useful plant-based measurement to assist in the judicious application of grapevine irrigation to improve WUE_P and wine composition.
- Stem Water Potential measurements can assist in the assignment of refill soil water values within grapevine rootzones (current and past studies).
- Lower irrigation volumes did not necessarily reduce yields.
- Sensorial analyses showed that Treatment 2 produced the best composed experimental wine overall.
- Under conditions of water shortage producers in the Olifants River Valley can utilise stem water potential measurements to optimize WUE_P.

ACKNOWLEDGEMENTS

- South Africa Wine for funding of the project.
- Mr Tehan Engelbrecht for the use of his vineyard.
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- Soil science department of Stellenbosch University's personal.

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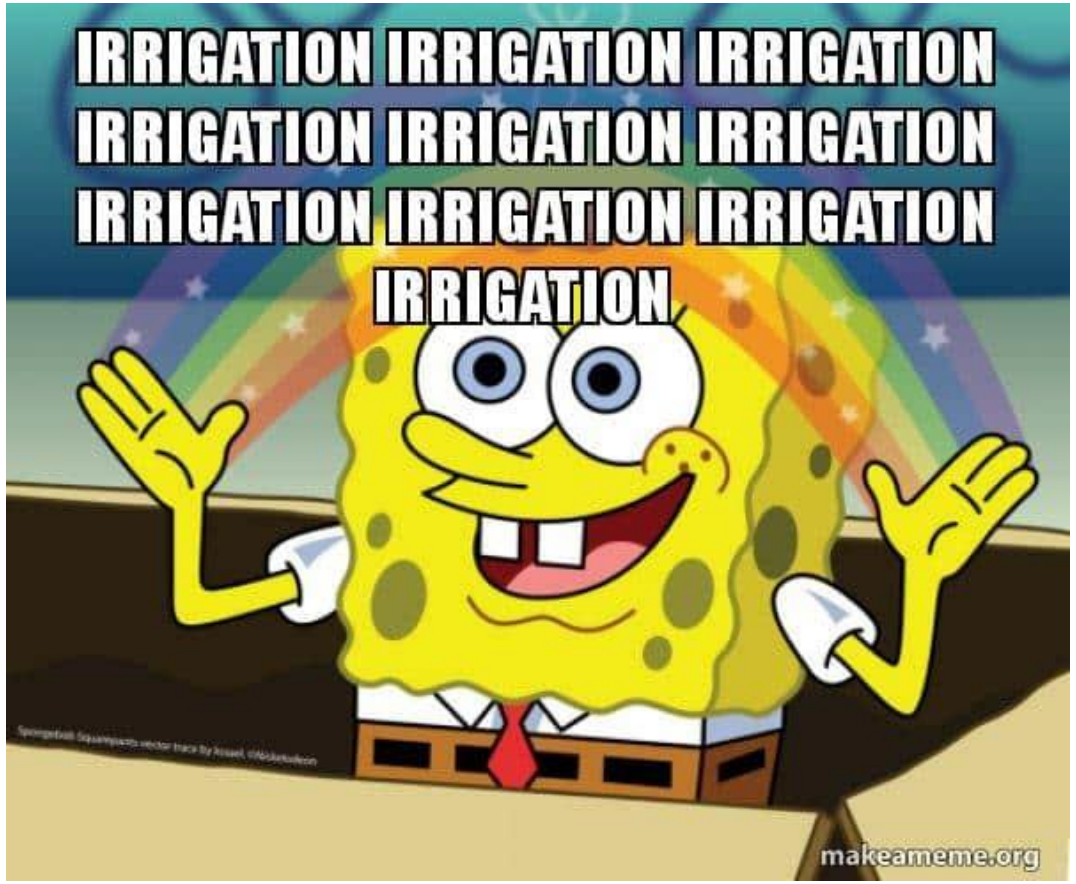
THANK YOU FOR LISTENING AND PLEASE FEEL FREE TO ASK ANY QUESTIONS!



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