Continuous detection of new plant water status indicators in stage I of nectarine fruit growth

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INTRODUCTION

Conventional irrigation management is often inefficient in responding to seasonal changes of tree water needs. Leaf and fruit-based sensors may provide helpful insights on tree water status, although poorly adopted.

Leaf patch clamp pressure **(LPCP) probes** are used for water status assessment in fruit crops (e.g. olive, clementine, persimmon, etc.). Sensor outputs are expressed in **attenuated pressure of leaf patches (p_p)** in response to clamp pressure. p_p = Inverse of cell turgor pressure (p_c)

Fruit gauges based on linear variable displacement transducers can determine continuous fruit-size fluctuations and may provide valuable insights on water deficit, as fruit growth rate decreases with midday stem water potential (Ψ_{stem}).

AIM

Test leaf and fruit-mounted sensors at stage I of nectarine fruit growth (Fig.1) to determine the suitability of leaf turgor pressure and fruit size dynamics as indicators of water deficit.

Figure 1. 'September Bright' fruit growth in the 2017/18 season in days after full bloom (DAFB).

MATERIALS AND METHODS

EXPERIMENTAL DESIGN

- Research station of Agriculture Victoria, Tatura (36.43°S, 145.28°E, elev. 114 m), Australia
- Summer 2017/18
- Four-year-old 'September Bright' nectarine trees trained to an open Tatura system (2222 tree/ha).
- **Four irrigation treatments in fruit growth stage I**: control (100% of ET_c), deficit irrigation at 40% of ET_c (DI_40), deficit irrigation at 20% of ET_c (DI_20) and rainfed (no irrigation, DI_0).
- Randomized block design (6 blocks).

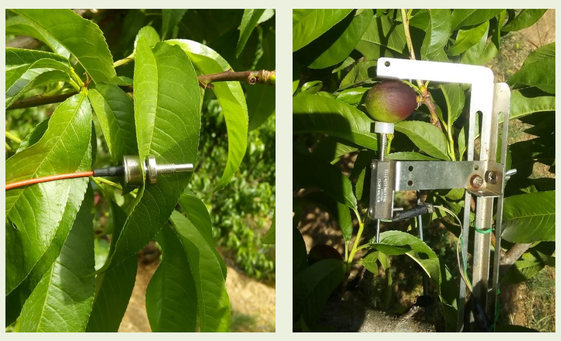

Figure 2. LPCP probe (left) and fruit gauge (right) on a 'September Bright' nectarine tree at stage I.

EQUIPMENT

- **Fruit gauges (Fig. 2)** for continuous measurements of fruit size fluctuations in the second half of stage I (48 to 64 DAFB)
- **LPCP probes (Fig. 2)** for continuous measurements of leaf turgor pressure in the second half of stage I (48 to 64 DAFB)
- **Pressure chamber** for determination of Ψ_{stem} at weekly intervals and daily curves at 50 DAFB
- **DeltaT AP4 dynamic porometer** for leaf stomatal conductance (g_s) in the first (44 DAFB) and second half (63 DAFB) of stage I
- **Calibit** (digital calliper) for fruit diameter measurements at weekly intervals

Fruit gauge and LPCP probe raw data smoothed and converted into fruit diameter and p_p z-scores (standard scores) to allow comparison among treatments.

RESULTS

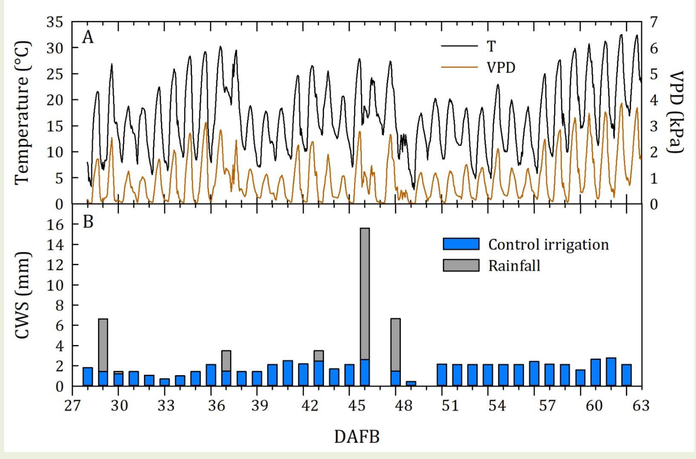

Figure 3. Temperature and vapour pressure deficit (VPD) trends (A), and daily crop water supply (CWS, B) at fruit growth stage I.

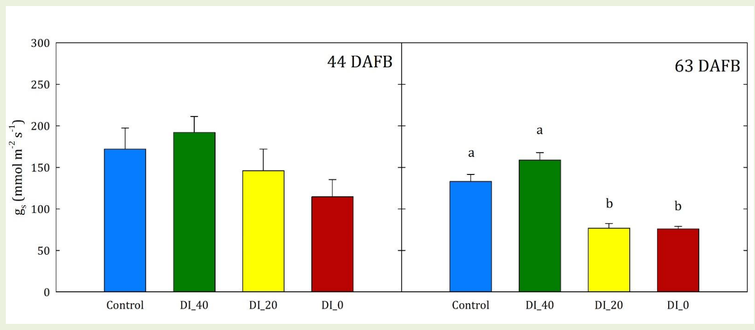

Figure 4. Mid-morning leaf g_s at 44 and 63 DAFB.

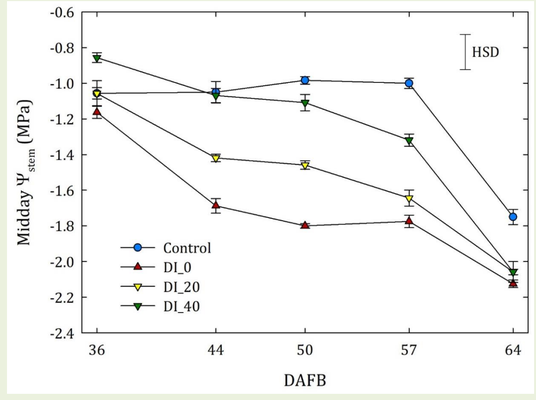

Figure 5. Midday Ψ_{stem} at fruit growth stage I.

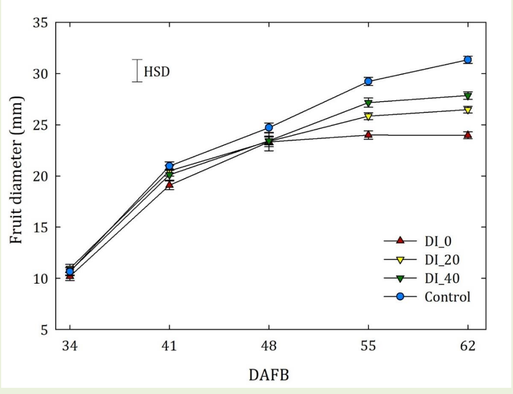

Figure 6. Fruit growth in stage I.

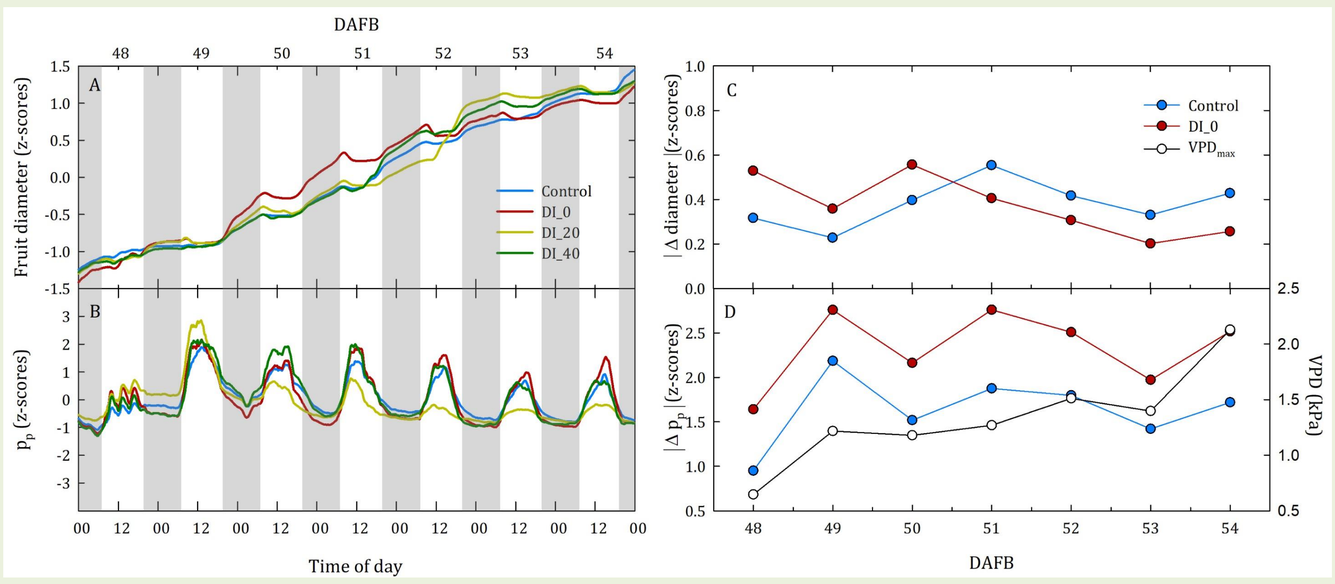

Figure 7. Fruit diameter (A) and p_p (B) weekly fluctuations in 'September Bright' nectarines. Grey and white areas emphasize night and day hours, respectively. Panels C and D show 24-hour absolute changes in fruit diameter (|Δ diameter|) and p_p (|Δ p_p|), respectively, for the Control and DI_0 treatments, and daily maximum VPD (VPD_{max}).

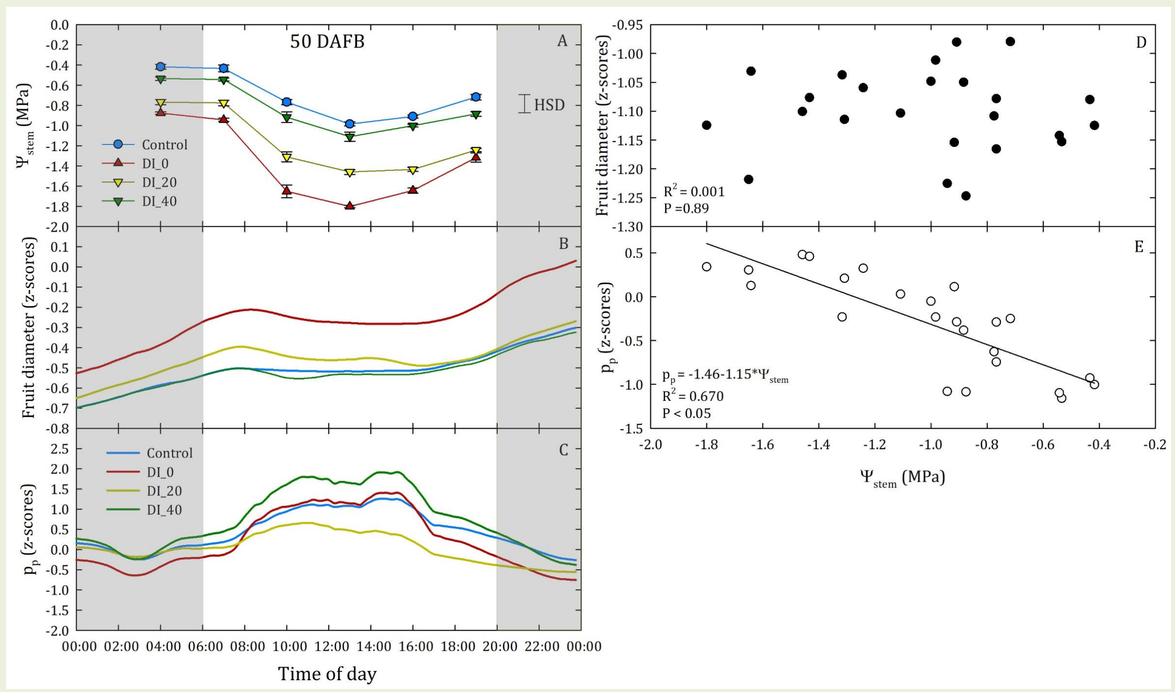

Figure 8. Ψ_{stem} (A), fruit diameter (B) and p_p (C) diel trends at 50 DAFB. Panel A. Panels D and E show linear regression analysis of fruit diameter and p_p vs Ψ_{stem}, respectively.

KEY-FINDINGS

Diel fruit growth (Δ diameter) deceleration anticipated by one day in DI_0 trees (51 DAFB) compared to control trees (Fig. 7C)

p_p influenced by environmental variables: (a) at 48 DAFB similar trends to T and **VPD** (Fig.3), (b) also |Δ p_p| follows VPD_{max} (Fig. 7D).

p_p (pooled data from all treatments) **linked to Ψ_{stem} by an inverse linear relationship** (Fig. 8E).

CONCLUSIONS

Results from weekly and diel trends suggest that **both the sensors under study may represent valuable tools for determining plant water deficit** already at stage I of nectarine growth, although data from the two sensors require different analytical approaches.

ACKNOWLEDGEMENTS

The technical support and assistance of Dave Haberfield, Jim Selman, Andrew O'Connell, Athulya Jancy Benny and Cameron O'Connell is gratefully acknowledged. Advice and feedback from the Stonefruit Field Laboratory Advisory Committee is appreciated. The experiment was supported by a PhD project funded with a scholarship issued by the Italian Ministry of Education and the University of Palermo, and by the stone fruit experimental orchard project (SF17006 Summerfruit Orchard - Phase II) funded by Hort Innovation using Summerfruit levy and funds from the Australian Government with co-investment from Agriculture Victoria.