Real-time observation of the soil-plant-atmosphere-continuum substrate moisture responses to forced ventilation events in polytunnel grown raspberry *Rubus idaeus L.* plants

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In this study, we present a method for the real-time observation of the soil-plant-atmosphere-continuum (SPAC) using vapour pressure deficit (VPD) and substrate moisture measurements. The experimental arrangement consisted of 8 raspberry plants (Glen Ample) grown in 4 pots of coir under a polytunnel where forced ventilation is provided by an electric fan when the polytunnel reaches a defined air temperature. Coir substrate specific sources of measurement variance have been addressed by using a substrate temperature correction algorithm for capacitance-based moisture measurements. Precision irrigation, using substrate moisture closed-loop control, was employed to maintain 'stable' substrate water status conditions. The coir moisture level was set to avoid plant water stress and run-off conditions. By using temperature triggered forced ventilation, it was possible to see three regimes of water-use, namely: overnight, early morning high-humidity limited transpiration, and significantly higher water-use under forced ventilation, the latter requiring additional irrigations events to meet demand. Data collected from air temperature, relative humidity and temperature corrected substrate moisture sensors illustrated that substrate moisture responses occurred within minutes of the fan being switched on. The forced ventilation events resulted in a rapid decrease in relative humidity with a reduction in the increase in air temperature, this combination of responses produced a sharp increase in VPD and resulted in significantly higher water-use.

Experimental arrangement and precision irrigation

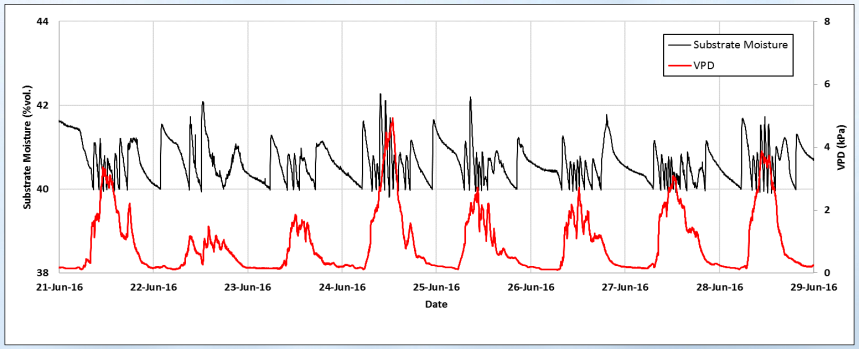
GP2 data logger based functions:

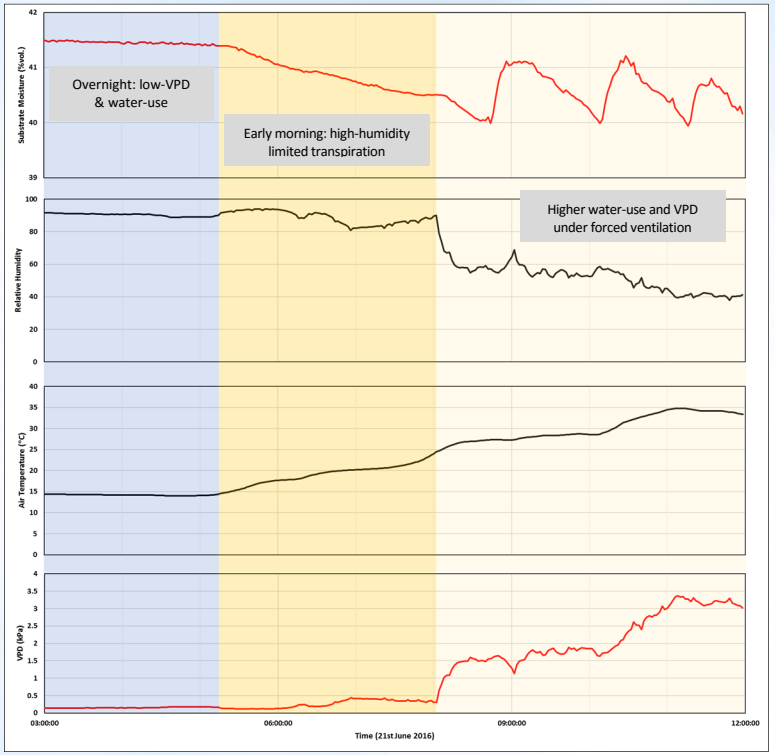
- VPD calculation from air temperature & relative humidity
- Precision substrate moisture (SM150T) irrigation control

Coir substrate moisture managed using precision irrigation control:

- Substrate temperature corrected moisture responses used for irrigation control
- Irrigation trigger point set for zero drainage from pot-grown plants
- Results in the alignment of water-use and VPD diurnal cycles, as shown below

Experimental arrangement with local air temperature & relative humidity (RHT4) sensing. Precision irrigation control, as shown below, was provided by SM150T soil moisture sensors and the GP2 data logger and controller.





Delta-T's polytunnel with an electric fan providing forced ventilation. A GP2 data logger and controller with an air temperature sensor controls extraction fan operation.

Extraction fan operation:

- Controlled by GP2 data logger controller & air temperature sensor
- In this dataset, the effect of the extraction fan being switched on at 8:02 am (GMT) can clearly be seen in the relative humidity, VPD and temperature corrected substrate moisture responses

Conclusions

- By employing a temperature correction to substrate moisture measurements and precision irrigation it is possible to observe substrate water-use responses that result from rapid changes in VPD in real-time
- This SPAC and precision irrigation method has the potential to reduce substrate water status related variances in abiotic-stress plant studies and improve correlations between water-use and environmental drivers

Reference: Goodchild M.S., Kühn K., Nicholl C., & Jenkins M., 2017, Temperature correction of substrate moisture measurements made in coir in polytunnel-grown strawberries, International Symposium on Sensing Plant Water Status - Methods and Applications in Horticultural Science accepted for publication in Acta Horticulturae.

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