Current Opinion Conferences
Agriculture and Climate Change
Climate ready resource use-efficient crops to sustain food and nutritional security
Sitges, Spain | 26-28 March, 2017

UNIVERSITÀ CATTOLICA del Sacro Cuore

AN AUTOMATED WHOLE-CANOPY MULTI CHAMBER SYSTEM FOR LIVE MONITORING WATER USE EFFICIENCY IN SORGHUM

A. Fracasso, S. Amaducci*

[1]Università Cattolica del Sacro Cuore, Department of Sustainable Crop Production, via Emilia Parmense 84, 29122 Piacenza, Italy
**Corresponding author (alessandra.fracasso@unicatt.it)*

Introduction

Plant growth and productivity are strongly affected by limited water availability in drought prone environments. The current climate change scenario, characterized by long periods without precipitations followed by short but intense rainfall, force plants to implement different strategies to cope with drought stress.

Objective

Understanding how plants use water during these period of limited water availability, and which are the molecular mechanisms at the basis, is of primary importance to identify and select the best adapted genotypes to a certain environment.

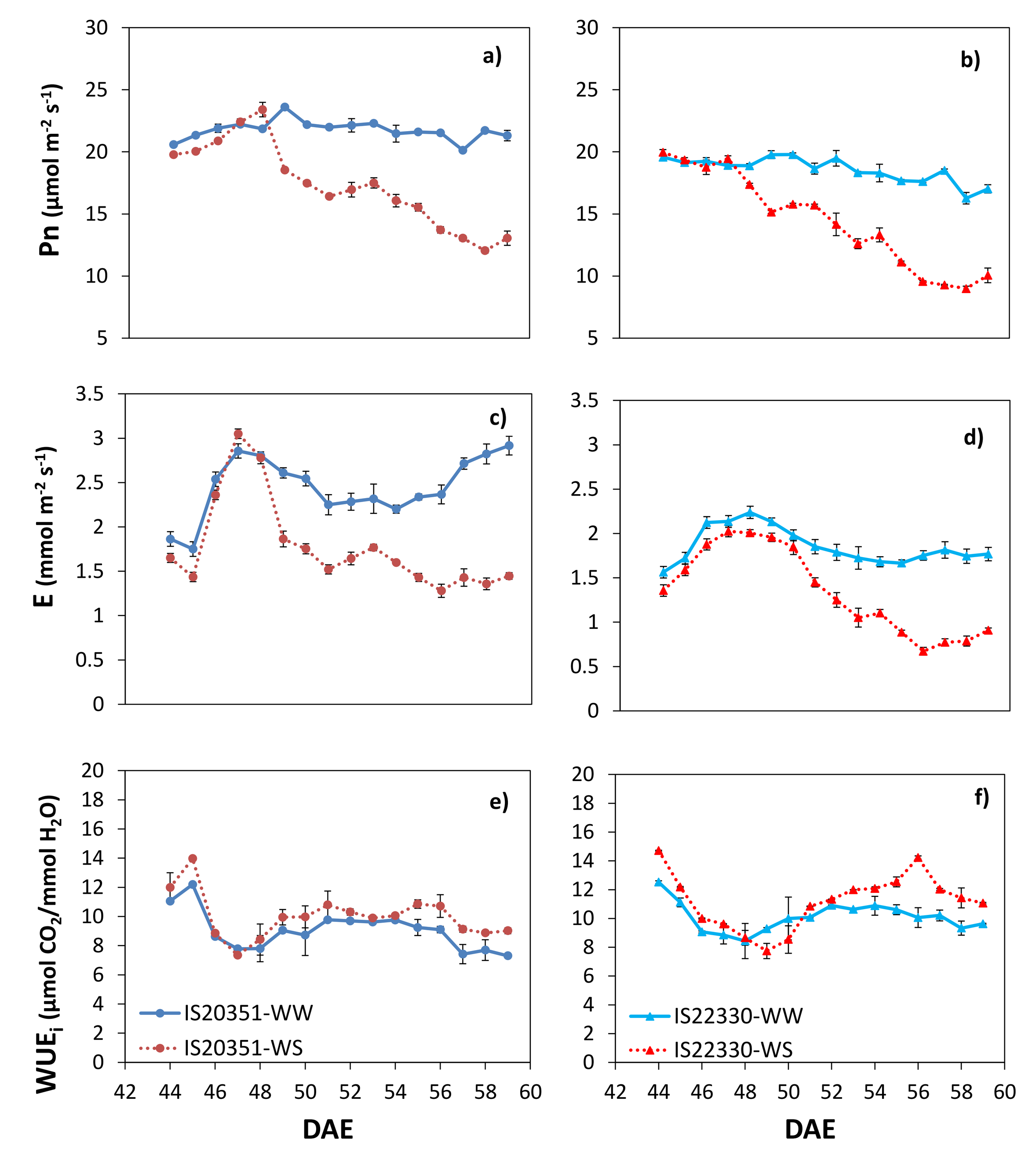
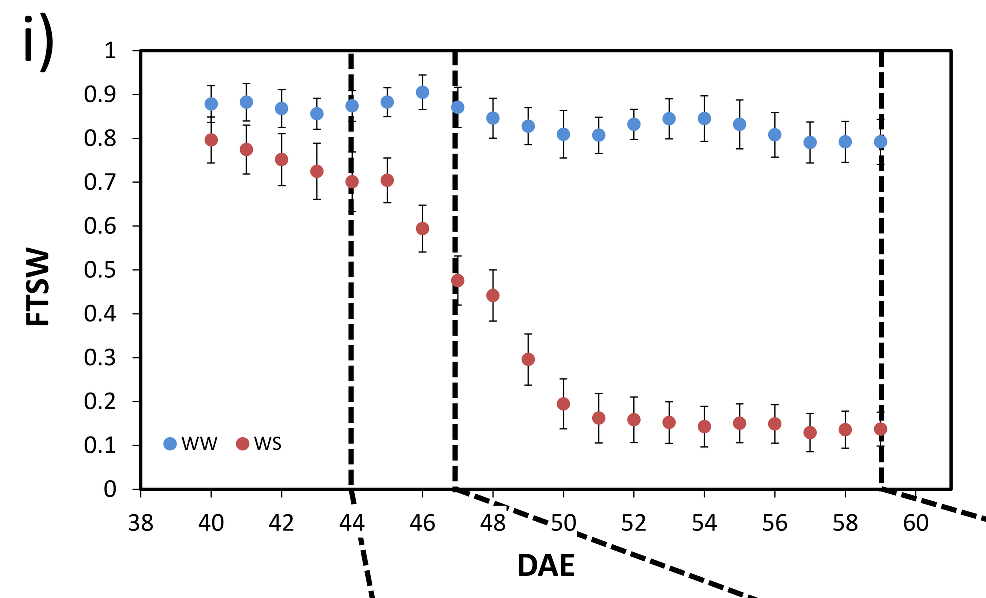
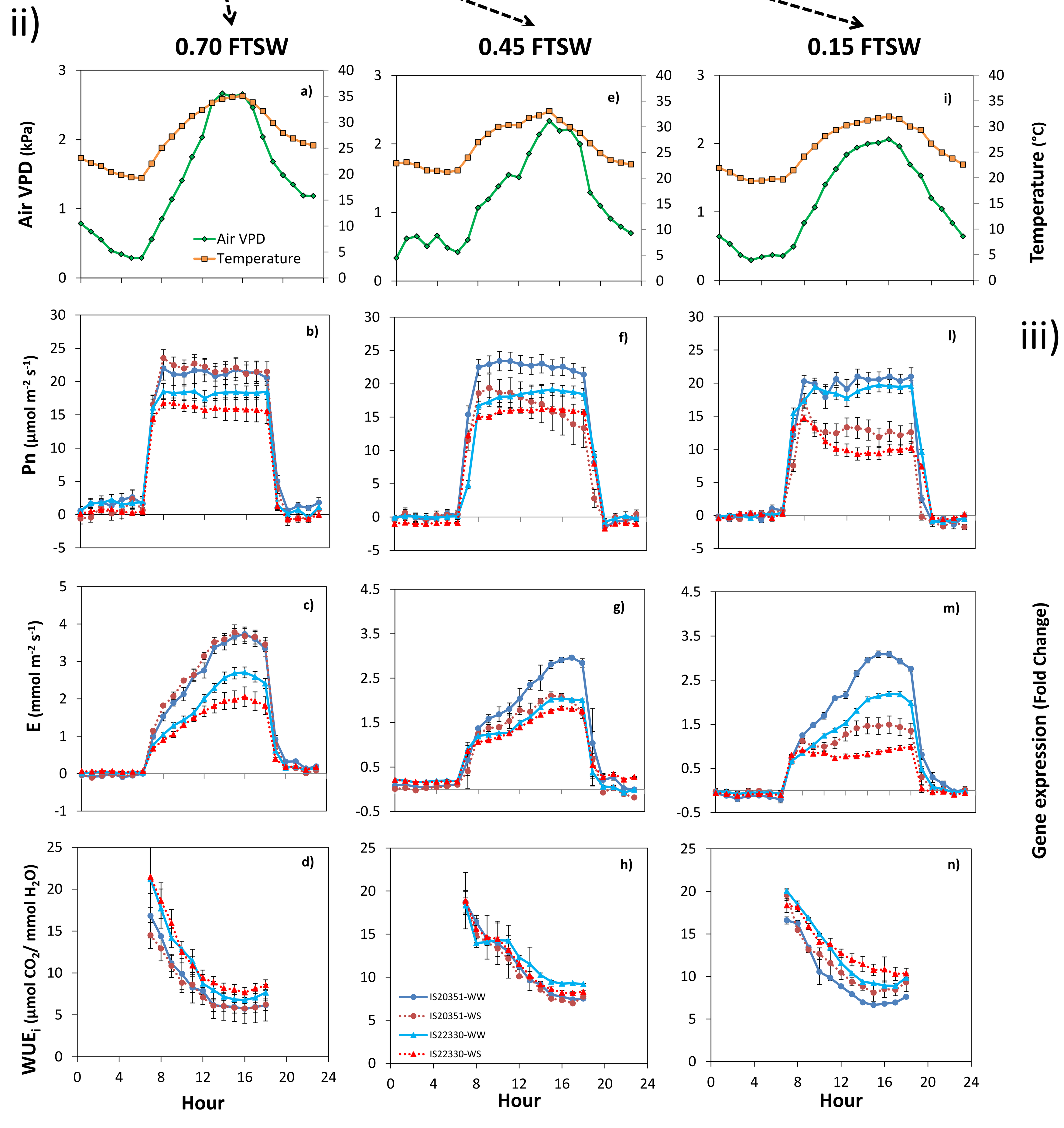


Figure 1: Net photosynthetic rate, transpiration rate and WUE_i recorded at whole-canopy level during the experiment for the two genotype IS20351 (circles) and IS22330 (triangles) under well-watered (WW, blue) and water-stressed (WS, red) conditions.



Material and methods

An automated whole-canopy multi chamber system was used to monitor net photosynthetic rate (Pn), transpiration rate (E) and water use efficiency of two sorghum genotypes (IS20351 and IS22330) during a dry-down experiment (Fig.1 and 2i) with a daily trend (Fig. 2ii). Gene expression dynamics of five drought related genes was evaluated every four hours at 0,15 FTSW (Figure 2iii).



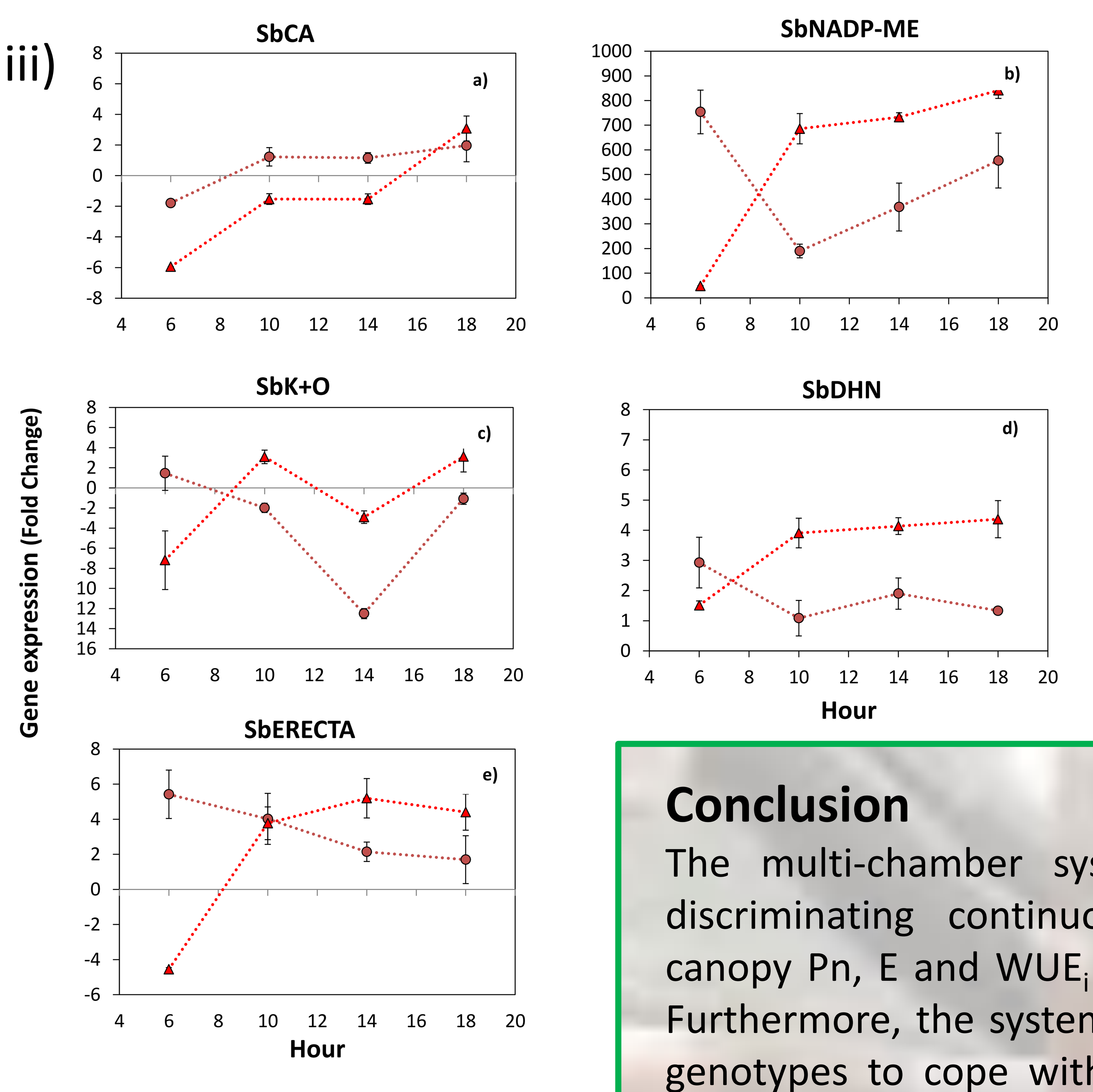


Figure 2: (**i**) Fraction of transpirable soil water (FTSW) dynamics recorded during the dry-down experiment; (**ii**) daily trend of air temperature, air VPD (B, a,e,i), Pn (b, f, and l), E (c, g, and m) and WUE_i (d, h, and n) recorded at 0.70 (44th DAE), 0.45 (47th DAE) and 0.15 FTSW (59th DAE) for the two genotype IS20351 (circles) and IS22330 (triangles) under well-watered (WW, blue) and water-stressed (WS, red) conditions; (**iii**) gene expression dynamics of SbCA (a), SbNADP-ME (b), SbK+O (c), SbDHN(d), and SbERECTA (e) recorded on 60th DAE at 0.15 FTSW for the two genotype IS20351 (circles) and IS22330 (triangles) under water-stressed (WS) conditions.

Results

- Continuous and non-destructive measurements of the **whole-canopy Pn, E and WUE_i** were discriminated in response to progressive drought stress;
- The drought tolerant IS22330 adopts a "pessimistic" strategy, having low Pn and E under WS conditions and achieving overall a WUE_i higher than the drought sensitive IS20351 (Fig. 2B)
- The drought tolerance strategy of IS22330 is pursued through a fine control of stomata apertures involving regulation of K^+ channels expression levels (*SbK+O*) and regulation of C4 cycle gene expression levels (*SbNADP-ME* and *SbCA*).
- *SbERECTA* could be used as a proxy for WUE_i determination while *SbDHN* was confirmed as candidate gene to assess drought tolerance in sorghum.

Conclusion

The multi-chamber system proved to be a valuable tool in discriminating continuously and non-destructively the whole-canopy Pn, E and WUE_i in response to progressive drought stress. Furthermore, the system allowed to unravel strategies adopted by genotypes to cope with drought stress and to identify the right moment to perform destructive sampling for transcriptomic analysis.

Poni, S., Merli, M.C., Magnanini, E., Galbignani, M., Bernizzoni, F., Vercesi, A., Gatti, M. (2014). An improved multichamber gas exchange system for determining whole-canopy water-use efficiency in grapevine. Am. J. Enol. Vitic. 65, 268–276.
Laporte, M.M., Shen, B., Tarczynski, M.C. (2002). Engineering for drought avoidance: expression of maize NADP-malic enzyme in tobacco results in altered stomatal function. J. Exp. Bot. 53, 699–705.
Xing, H.T., Guo, P., Xia, X.L., Yin, W.L. (2011). PdERECTA, a leucine-rich repeat receptor-like kinase of poplar, confers enhanced water use efficiency in Arabidopsis. Planta 234, 229–241.