PP SYSTEMS

Application Note #2010-01

"Green" scientific investigation helps to inform intelligent Green Roof design

The Green Roof...a seemingly simple concept that underlies an impressive collection of beneficial functions in our sometimes rapidly changing environment. Often the green roof serves as an essential component in sustainable building practices, providing an astonishing array of benefits that range from mitigating building heating and cooling costs, storm water runoff, noise, and urban heat islands, to removal and sequestration of air pollution and carbon dioxide from the atmosphere, to the creation of urban island habitats for a wide variety of fauna (macroinvertebrates, insects, birds, small mammals), to pure aesthetics with associated human health benefits (Oberndorfer et al. 2007, Getter et al. 2009).

Determining the right physiological fit for a given eco-region, and thus enhancing survivability of plant selections, is an area of ongoing research in the development and design of green roofs (Lundholm et al. 2010). Conversely, a poorly-suited plant selection can become an expensive and time-consuming setback in terms of optimal functioning of the green roof system. This is the work of Jeff Licht of Botanicals Nursery, a green roof specialist dedicated to the creation of regionally-appropriate green roof solutions based on native plant selections and soil mixtures (see Licht 2008, Licht and Bergweiler 2010). Teaming with Chris Bergweiler, Applications Scientist at PP Systems, we approached one aspect of this problem using PP Systems' **CIRAS-2 Portable Photosynthesis System** to gather representative physiological data from plants growing in a model green roof.

An array of native species were sampled under ambient conditions on two occasions in 2009: near the perceived physiological maximum phase (1 June) and early senescence phase (9 Sept). Data are means (n=6, summer; n=3, fall) ±1 SD unless otherwise noted. A subset of the data is described below, with emphasis on environmental controls of temperature and water regulation.

Figure 1.

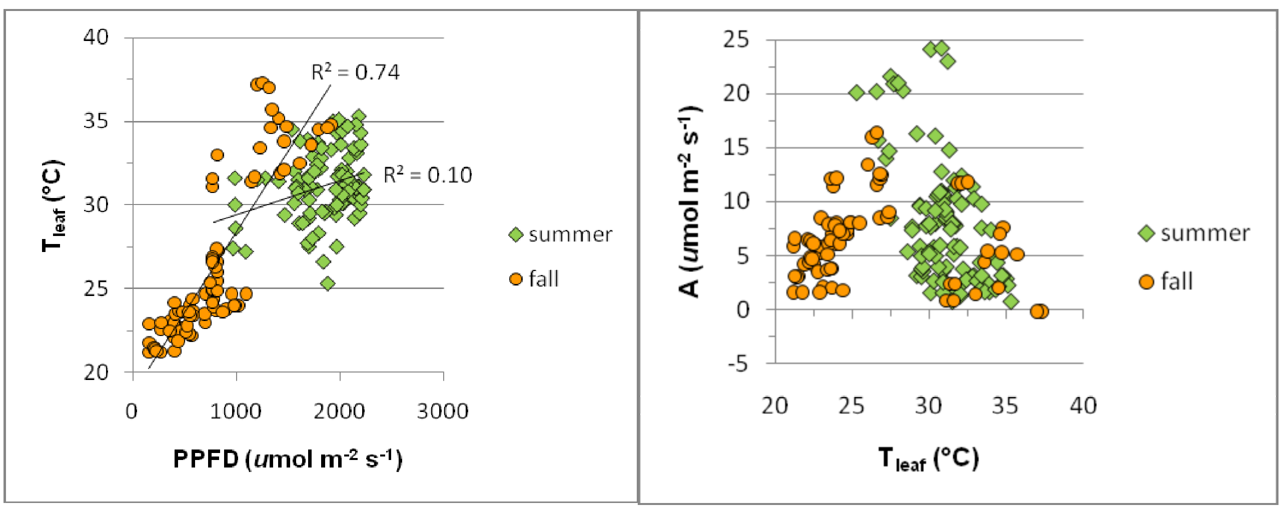

Figure 2.

Summer T_{leaf} was unrelated to solar irradiance, indicating intrinsic leaf temperature regulation at saturating levels of irradiance (Fig. 1). September T_{leaf} was highly correlated to irradiance such that some species could be said to lack sufficient temperature regulation, in some cases contributing to complete suppression of photosynthesis (Fig.2). Overall, it is apparent that A_{max} occurred between 27-28 °C, and then followed a declining trend when T_{leaf} exceeded this threshold in either season.

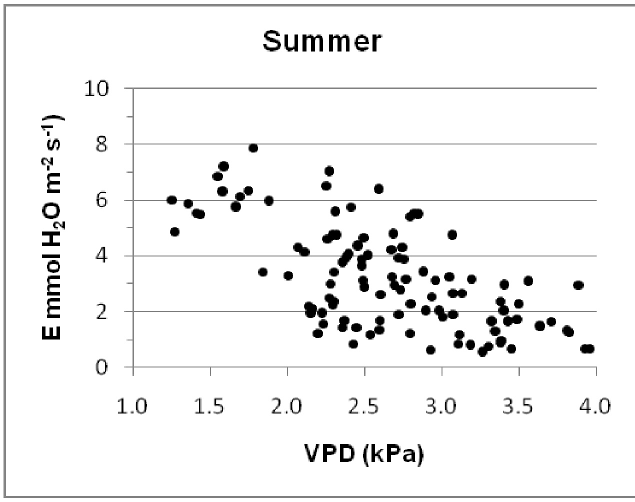

Figure 3.

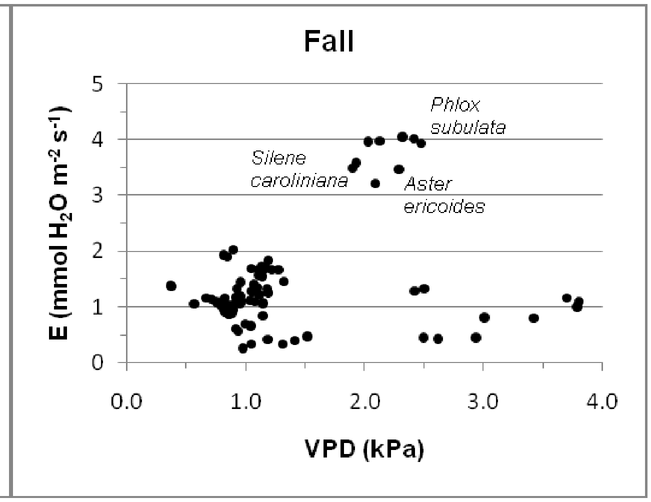

Figure 4.

Summertime transpiration (E) (Fig. 3) was strongly under the influence of higher leaf-to-air vapor pressure deficits. The same cannot be said for data collected in fall (Fig. 4), where named outliers displayed water loss through transpiration in some cases greater than 3x the average species. *Aster ericoides*, *Penstemmon digitalis* and *P. hirsutus pygmaeus* had the highest transpiration rates. In terms of stomatal control of water lost to the atmosphere, our plant selection behaved comparably to plants growing in natural soil regimes (data not shown). Sampling was conducted within a two-hour bracket around solar noon such that species-specific responses are minimally confounded by variability in diurnal microclimate.

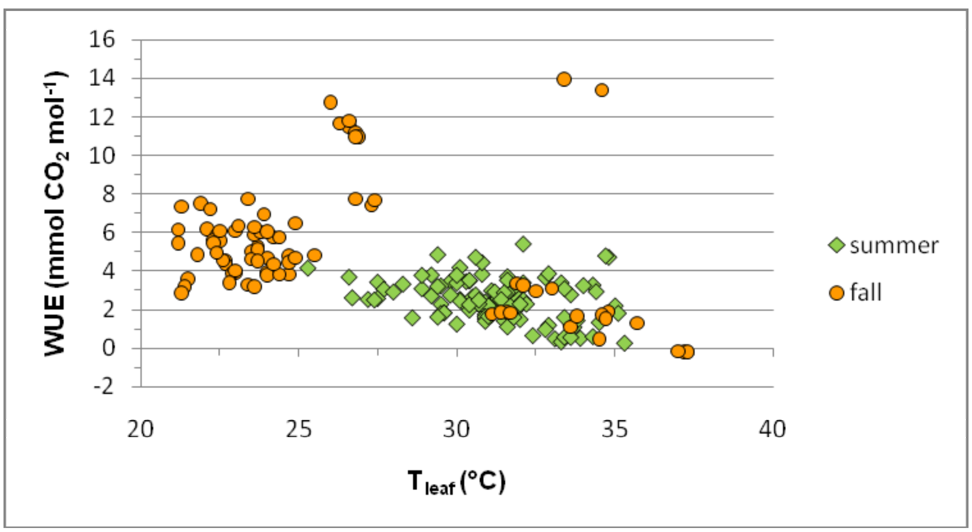

Figure 5.

Water use efficiency (mmol CO_2 fixed per mole of H_2O transpired to atmosphere) is perhaps one of the most logical direct (physiological) measures we could use to assess a given plant selection, especially in a green roof setting where two of the major "selling points" are bio-assisted management of surface runoff and carbon sequestration. At measured summer and fall leaf temperatures we observed a decline in WUE with increasing leaf temperature (Fig. 5). Individual performance of species for the two measurement sessions are shown below in Figs. 6 and 7. Although not entirely consistent, woody genera (*Juniperus*, *Kalmia*, *Pinus* - not so, *Vaccinium*) performed best in both growth periods.

Although preliminary, the results provide important clues as to native species' physiological status associated with abiotic conditions in a green roof environment. The information, combined with survivability studies, is potentially meaningful as an indicator of ideal species associations for various climatic zones. Ideally we would like to expand the scope of this work beyond the i) single-site and ii) observational level to incorporate comparisons of in situ plantings where e.g. soil moisture, nutrition and temperature can be specifically controlled and manipulated.

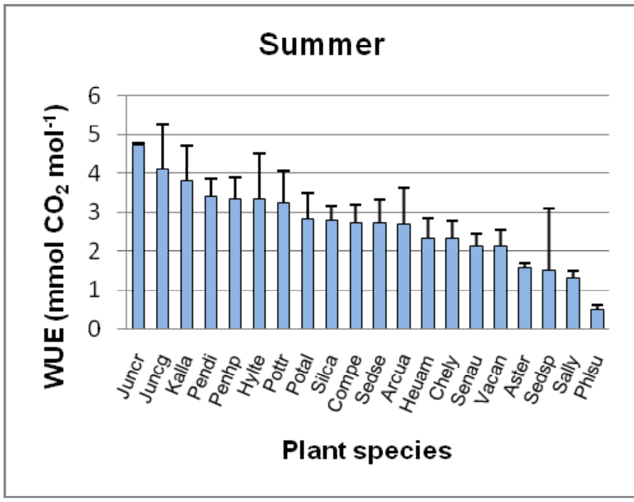

Figure 6.

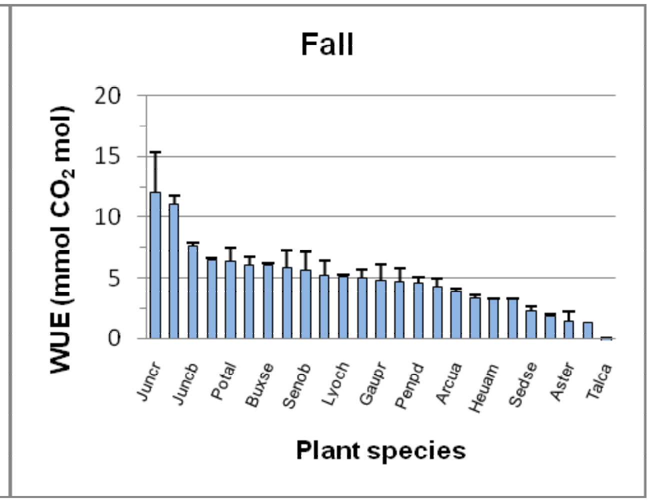

Figure 7.

Acknowledgements:

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References:

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