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Is CO_2-uptake by C4-grass canopies limited by leakage of CO_2 from bundle sheath cells?

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To target global warming, CO_2 mitigation strategies have been identified which include carbon sequestration during biomass production by perennial plant species and plant biomass as a sustainable alternative for fossil fuels in production of static energy. Perennial plant species with the C4 photosynthetic pathway combine high productivity and resource use efficiency with low requirements for agronomic inputs and thus seem well-equipped for biomass-based energy production. For instance, Miscanthus (*Miscanthus* x *giganteus* hybrid) is a perennial C4-grass, with a recorded annual dry matter production up to four kilogram per square meter (Heaton *et al.*, 2004).

However, the physiology of C4-grass canopy growth, development and carbon partitioning is less well understood for annual and perennial crops in temperate climates. Previous studies (Farquhar, 1983; Krall and Edwards, 1990; Henderson *et al.*, 1992; Hatch *et al.*, 1995; Cousins *et al.*, 2007) have shown that photosynthetic efficiency in species with C4 photosynthesis can be limited by leakage of CO_2 from bundle sheath cells, particularly at low light intensities. Such leakage can be resolved by shifts in carbon isotope composition in organic material and in real-time during gas exchange. Leakage may have a large effect under controlled conditions (when 15 to 40% of ini-

tially fixed CO_2 may be lost from the bundle sheath). However, to date there have been no attempts to quantify leakage in a canopy context for C4 crops.

We report work which has measured the extent of leakage in a Miscanthus canopy profile, by using eddy covariance and stable isotopes of carbon to deconvolute respiratory partitioning between soil and crop (by night), and partition the impact of photosynthetic uptake and leakage (by day). Leaf-level measurements of gas exchange and carbon isotope discrimination were used to define photosynthesis within the canopy microclimate. Also, in view of the canopy development associated with such large biomass productivity, the related use of water was taken into account. For the first time we will report how leakage of CO_2 from bundle sheath cells limits C4 canopy photosynthetic efficiency under field conditions, as compared to the overall capacity for carbon sequestration and water use for a temperate C4 biomass perennial crop.