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Photosynthetic water use efficiency and biomass of *Sorghastrum nutans* (C_4) and *Solidago canadensis* (C_3) in three soils along a CO_2 concentration gradient

P.A. Fay (1), D. Hui (2), A. Procter (2), V.L. Jin (1), H.B. Johnson (1), H.W. Polley (1), and R.B. Jackson (2)

(1) USDA ARS Grassland, Soil and Water Research Laboratory, Temple, TX 76502, USA, (2) Department of Biology and Nicholas School of the Environment and Earth Sciences, Duke University, Durham, NC 27708, USA (pfay@spa.ars.usda.gov / Fax: +1 254-7706561 / Phone: +1 254-7706533)

The water use efficiency (WUE) of leaf photosynthetic carbon uptake is a key regulator of plant production in grasslands. However WUE may differ with soil type because of differences in soil moisture retention and plant uptake efficiency. We measured leaf-level WUE and end-of-season biomass in the C_4 grass *Sorghastrum nutans* and the C_3 forb *Solidago canadensis* in constructed grassland species assemblages growing along a 250 – 500 ppm [CO_2] gradient in the LYCOG Experiment in central Texas, USA. LYCOG consists of eighty intact soil monoliths (1 m x 1 m x 1.5 m) representing 3 soil series, Austin (Udorthentic Haplustolls, a mollisol), Bastrop (Udic Paleustalfs, a sandy loam alfisol) and Houston Black (Udic Haplusterts, a vertisol). The monoliths were vegetated by transplanting 8 native perennial prairie species (5 grasses and 3 forbs), including *S. nutans* and *S. canadensis*. Both are abundant and widespread; *S. nutans* is a dominant species in North American tallgrass prairie. WUE, calculated as the ratio of photosynthesis (A_{CO2}) to transpiration (E), was measured three times during the growing season. Volumetric soil water content (SWC, 30 cm depth, %) was measured biweekly with a neutron probe, and biomass was measured by harvesting all current year growth of these species and drying to constant mass.

Soil water content (0 – 30 cm) was lower on the Bastrop than Austin or Houston soils ($p < 0.0001$). WUE did not differ between soil types for either species, but the biomass of both *S. nutans* and *S. canadensis* was 2 to 4- fold greater on Bastrop and Houston

soils than on the Austin soil ($p \leq 0.05$). Soil water content was not significantly related to [CO_2]. However, photosynthetic WUE increased strongly ($p < 0.0001$) at higher [CO_2] in both species (species x [CO_2] ns), due to a combination of decreasing E and increasing A_{CO2} ($p \leq 0.0055$). Biomass of *S. nutans* was not related to [CO_2], however biomass of *S. canadensis* increased strongly at higher [CO_2] on Bastrop and Houston soils (soil x [CO_2] $p = 0.0003$). We conclude that 1) [CO_2] was the primary control on leaf-level photosynthetic water use efficiency, 2) soil type was the primary control on growth, and 3) there was not a consistent association between WUE and biomass responses to [CO_2] in these species.