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Water Uptake and Carbon Assimilation in Maize at Elevated and ambient CO_2: Modeling and Measurement.

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Potential transpiration in crops is dependent on both plant and environmental properties. Carbon dioxide content of the atmosphere is linked to potential transpiration because CO_2 diffuses onto water saturated surfaces within plant stomata. At high CO_2 concentrations, CO_2 diffuses rapidly into stomata and therefore stomata do not have to remain open to the atmosphere for long periods of time. This results in lower transpiration rates per unit CO_2 assimilated at elevated CO_2 concentrations. The objective of this study was to measure CO_2 assimilation and water uptake by maize under different irrigation regimes and two CO_2 concentrations. The data were then used to evaluate the ability of the maize model MaizSim to simulate the effects of water stress and CO_2 on water use and photosynthesis. MaizSim uses a Farquhar type photosynthesis model coupled a Ball-Berry stomatal control model. Non-linear beta functions are used to estimate the effects of temperature on growth and development processes. The experimental data come from experiments in outdoor, sunlit growth chambers at the USDA-ARS Beltsville Agricultural Research Center. The eight treatments comprised two levels of carbon dioxide concentrations (400 and 800 ppm) and four levels of water stress (well-watered control, mild, moderate, and severe). The water stress treatments were applied at both CO_2 levels. Water contents were monitored hourly by a Time Domain Reflectometry (TDR) system. The model simulated higher water contents at the same time after applying water stress at the high CO_2 treatment than for the low CO_2 treatment as was found in the measured data. Measurement of water uptake by roots and carbon assimilation rates in the chambers will be addressed.