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The interrelationship of pCO_2, soil moisture content, and biomass fertilization expressed in the $\delta^{13}C$ value of C_3 plant tissue

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Hundreds of chamber and field experiments have shown an increase in C_3 plant biomass in response to elevated atmospheric carbon dioxide (pCO_2); however, secondary water and nutrient deficits are thought to limit this response. Some have hypothesized that secondary limitation might be self-alleviating under elevated pCO_2 as greater root biomass imparts enhanced access to water and nutrients. Here we present results of growth chamber experiments designed to test this hypothesis: we grew 206 *Arabidopsis thaliana* plants within 5 growth chambers, each set at a different level of pCO_2: 390, 685, 1075, 1585, and 2175 ppmv. Within each growth chamber, soil moisture content (θ_m) was maintained across a spectrum: 1.50, 0.83, 0.44, and 0.38 g g^{-1}. After 3 weeks of total growth, tissues were analyzed for both biomass and net carbon isotope discrimination ($\Delta^{13}C$) value. From these values, we calculated $\Delta_{residual}$, which represents the residual effect of water stress after subtraction of the effect of pCO_2 due to photorespiration. Across the full range of moisture content, $\Delta_{residual}$ displayed a significant ~2.5‰ increase with increasing pCO_2. This further implies a ~0.1 unit increase in c_i/c_a, consistent with decreased water stress at elevated pCO_2. The influence of CO_2 fertilization on the alleviation of water stress was further evidenced in a positive correlation between percent biomass change and $\Delta_{residual}$, such that a doubling of plant biomass yielded a 1.85‰ increase in carbon isotope discrimination. In addition to providing new insight into water uptake in plants growing under elevated carbon dioxide, these data underscore the importance of separating the effects of increased pCO_2 (*via* photorespiration) and altered c_i/c_a (*via* stomatal conductance) when considering changes in the $\Delta^{13}C$ value of C_3 land plants during the Anthropocene, or across any geological period that includes a marked change in global carbon cycling.