ATMOSPHERIC DYNAMICS IN THE "LABORATORY BIOSPHERE" WITH WHEAT AND SWEET POTATO CROPS

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Laboratory Biosphere is a 40 m^3 closed life system equipped with 12000 watts of high pressure sodium lamps over planting beds with 5.37 m^2 of soil. Atmospheric composition changes due to photosynthetic fixation of carbon dioxide and corresponding production of oxygen or the reverse, respiration, are observed in short timeframes, eg. hourly. To focus on inherent characteristics of the crop as distinct from its area or the volume of the chamber, we report fixation and respiration rates in millimoles per hour per square meter of planted area. An 85 day crop of USU Apogee wheat under a 16 hour lighted / 8 hour dark regime peaked in fixation rate at about 100 mmol h^{-1} m^{-2} approximately 24 days after planting. Light intensity was about 840 mol m^{-2} s^{-1}. Dark respiration peaked at about 31 mmol h^{-1} m^{-2} at the same time. Thereafter, both fixation and respiration declined toward zero as harvest time approached. A residual soil respiration rate of about 1.9 mmol h^{-1} m^{-2} was observed in the dark closed chamber for 100 days after the harvest. A 126 day crop of Tuskegee TU-82-155 sweet potato behaved quite differently. Under a 680 mol m^{-2} s^{-1}, 18 hour lighted / 6 hour dark regime, fixation during lighted hours rose to a plateau ranging from about 27 to 48 mmol h^{-1} m^{-2} after 42 days and respiration settled into a range of 12 to 23 mmol h^{-1} m^{-2}. These rates continued unabated until the harvest at 126 days, suggesting that tuber biomass production might have continued at about the same rate for some time beyond the harvest time that was exercised in this experiment. In both experiments CO_2 levels were allowed to range widely from a few hundred ppm to about 3000 ppm, which permitted observation of fixation rates both at varying CO_2 concentrations and at each number of days after planting. This enables plotting the fixation rate as a function of both variables. Understanding the atmospheric dynamics of individual crops will be essential for design and atmospheric management of more complex CES which integrate the simultaneous growth of several crops as in a sustainable remote life support system.