Response of Photosynthesis and Yield of Sweetpotato and Peanut to Super-optimal CO_2 levels.

C. K. Bonsi, J. Bullard, D.R. Hilemen, D.G. Mortley, J. Hill, W.A. Hill and C.E. Morris

Center for Food and Environmental Systems for Human Exploration of Space and George Washington Carver Agricultural Experiment Station, Tuskegee University, Tuskegee Alabama USA, 36088 USA cobonsi@tuskegee.edu / Fax (334) 727-8552

The fate of persons involved in long-term space travel and habitation will depend greatly on the ability to provide food and a livable environment for them. In the National Aeronautics and Space Administration (NASA) Advanced Life Support (ALS) program, photosynthesis of higher plants will be utilized to provide food and oxygen, while removing carbon dioxide produced by humans and other heterotrophs, as well as transpiring water that can be recycled for drinking. This plant-mediated process is collectively referred to as Bioregenerative Life Support. Carbon dioxide concentrations on board a space shuttle cabin atmosphere range between 4000 and 6000 μmol mol^{-1} CO_2, but with large crews may exceed 10,000-μmol mol^{-1} CO_2. Thus, it is critical to evaluate the responses of candidate crops to super optimal levels of CO_2. Soybean and potato have been exposed to CO_2 concentrations up to 5000 and 10,000-μmol mol^{-1}.

Very little research has been published about the effects of super-optimal CO_2 levels on sweetpotato and peanut growth and physiology, thus indicating a need for extensive research on these plants. The aim of this study was to evaluate the effects of super-optimal CO_2enrichment on growth of TU-82-155 sweetpotato and Georgia Red peanut in a Microporous Tube Membrane (MPT) using Turface Media and Nutrient Film Technique (NFT) nutrient delivery systems.

Sweetpotato *[Ipomoea batatas (L) Lam]* and peanut (*Arachis hypogaea L.)* were exposed to three CO_2 levels of 400 (ambient), 5000 and 10,000 μmol mol^{-1} in reach-in growth chambers to determine (1) whether super-optimal CO_2 levels affect biomass production, (2) whether photosynthetic rates are affected by super-optimal CO_2, (3) whether there will be any change in stomatal conductance at super-optimal CO_2, and (4) to determine radiation capture by the plants.

For sweetpotato grown in MPT, net photosynthesis was lower at 5000-μmol mol^{-1}CO_2. Stomatal conductance and transpiration were generally lowest in the 400 NFT and 5000 MPT treatments, and highest among plants grown in NFT at 10,000-μmol mol^{-1}CO_2. Carboxylation efficiency decreased at elevated CO_2. Photosynthesis data were not obtained for peanut. However, stomatal conductance, was variable over time, but was generally greatest at 10,000-μmol mol^{-1}CO_2 for both species. Thus the decrease in stomatal conductance, commonly observed at high CO_2 was reversed at supraoptimal levels. Radiation capture by both species increased early in the growing season as the canopies expanded, reaching a peak at about 70 DAP for sweetpotato and at about 50 DAP for peanut. Late in the growing season, radiation capture decreased as the canopies began to senesce. Radiation capture by sweetpotato was generally greatest in the 10,000 μmol mol^{-1}CO_2NFT treatment and lowest in the 400 μmol mol^{-1}CO_2NFT treatment. Chlorophyll content in sweetpotato was highly variable over time, but generally lower in the 400 NFT treatment than in the other three treatments. For peanut chlorophyll content was generally lowest among plants grown in turface at 5000 μmol mol^{-1}$CO_2$and highest among plants grown in NFT at 10,000 μmol mol^{-1}CO_2.Leaf starch content was not significantly affected by elevated CO_2. However, leaf thickness was increased in sweetpotato suggesting a possible increase in starch accumulation. Overall super-optimal CO_2 levels regardless of growth system enhanced plant growth and development.