A Greenhouse Mesocosm System for Integrated Environmental Sensing, Root Phenotyping, and New Sensor Development

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Current methods of root sampling typically only obtain small or incomplete sections of root systems and do not capture their true complexity. To facilitate the visualization and analysis of entire, full sized root systems of crop plants, mesocosm growth containers were developed with an internal volume of 45 ft3 (1.27 m3). Mesocosms allow for unconstrained root growth, excavation and preservation of 3-dimensional RSA, and modularity that facilitates the use of a variety of sensors. Sensors arrays monitoring matric potential, temperature and CO2 levels are buried in a grid formation at depths of 1.25, 2.75, & 4.25 ft to assess environmental fluxes at regular intervals. Additionally, 3-dimensional water availability can be measured using ERT inside of root mesocosms. Methods of 3D data visualization of fluxes were developed to allow for comparison with root architectural traits. Following harvest, the recovered root system can be digitally reconstructed through photogrammetry, which is an inexpensive method requiring only an appropriate studio space and a digital camera. Initial metrics inferred from the 3D models include root system biomass (occupied voxels), volume, flatness, convex hull volume and solidity with depth. Root systems are finally dissected and biomass measurements are made in a 3-dimensional matrix of the growth zone, while the crown is saved for X-ray CT analysis.