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MEASURING THE CO2 AND H2O GAS EXCHANGE OF PLANTS AND CANOPIES

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In many ecological and agricultural studies, the instantaneous responses of plants to environmental effects is a fundamental interest, and non-invasive online measurements of the carbon dioxide (CO_2) and water (H_2O) gas exchange of plants are excellent techniques to measure such responses. Therefore, a system for measuring the gas exchange in complete crops in eight almost airtight greenhouse cabins with a floor area of 28.8 m² was designed. The measuring facility consists of a set of mass flow meters allowing air exchange rates between 0.5 and 19 h^{-1} and CO_2 supply rates up to 4 l min^{-1}, and sensors for measuring the concentrations of CO_2 and H_2O. There are four below-ground troughs per cabin which serve as a root environment. The troughs can be separated from the aboveground cabin volume, and their temperature can then be controlled independently by heating and cooling. In addition, the troughs can be operated as individual gas exchange chambers measuring the below-ground gas release. If the troughs are kept open, their cooling capacity can also be used for cooling and dehumidifying the cabin air, and thus, to some extent, for operating the cabin in the closed chamber mode. In contrast to conducting measurements on single leaves or plants within a set time frame, the gas exchange in this facility is monitored continuously and for large batches of plants. Except for some situations with high ambient temperatures in combination with high global radiation in summer, gas exchange measurements are possible throughout the year. All of the eight cabins and 32 troughs can be accessed and controlled independently, which makes it possible to set up experiments with different climate conditions. This contribution outlines a demonstration of the possibilities and constraints for measuring the gas exchange of complete crops under various conditions, and discusses them along with examples.

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