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Development of a pCO2 controllable experimental chamber based on chemical equilibrium

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The response of plants to the global environmental change has been an important problem, and extensive researches have been performed on the problem. However, experiments of plant cultivation under a controlled CO_2concentration require a relatively large equipment with a complicated regulation system. It is difficult to run paralleled experiments with various pCO_2 levels.

In this study, we developed a pCO_2controllable experimental chamber, with which paralleled experimental can be conducted in a relatively small space. This is a closed chamber where pCO_2 can be controlled based on a gas-liquid equilibrium between a $NaHCO_3/Na_2CO_3$solution and air.

Five buffer solutions were prepared by mixing $NaHCO_3$and Na_2CO_3in varying ratios keeping the total amount of carbonic acid constant. One of the solutions was introduced into the chamber (30x 30x30 cm, 27 L) and the pCO_2in the closed air was monitored together with water temperature, air temperature and pH of the solution. A non-dispersive infra red CO_2sensor (Vaisara, GMP343) was employed to monitor pCO_2.

pCO_2values from 30 to 600 ppm was realized in the chamber by changing mixing ratios of the two reagents. The values were dependent on water temperature. Using the results, an empirical formula to express pCO_2in this chamber was obtained as a function of mixing ratio and water temperature, and the pCO_2estimated by the formula was compared with the measured pCO_2. The estimated pCO_2agreed with the measured pCO_2within plus or minus 10 ppm in any experimental conditions.

In conclusion, this equipment can regulate $pCO_2$by setting mixing ratios of the two reagents and water temperature, and is suitable for paralleled experiments in a limited place because pCO_2in the chamber can be understood by the empirical formula without employing CO_2sensors.

In order to apply the equipment to plant cultivation experiments, pCO_2stability of the chamber are now being checked in the presence of plants with varying media.

Keywords: buffer solution, plant, carbon dioxide, gas-liquid equilibrium