Application of low-cost CO_2 sensor systems as a tool for continuous uptake/emission measurements in Lemna toxicity tests

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1. Introduction

The relation between respiration and photosynthesis reflects the exchange of CO_2 with the atmosphere in plants [1]. Until now, only a few studies have measured whole-plant or plant-community CO_2 release/uptake directly and continuously without disturbances [2]. Although these measurements implement methods of high accuracy, they are still cost ineffective, require complex experimental setups, and provide discrete and discontinuous output data.

This work presents an application of real-time continuous monitoring of the emission and uptake rate of CO_2 concentrations in Lemna toxicity test, implementing a low-cost Arduino platform-based respiratory activity measuring system (ResTox).

2. Materials and methods

2.1. Plant material

Cultures of *Lemna minor* were maintained in conditions that resulted in doubling time less than 2.5 days as required by standard protocols [3].

2.2. Experimental setup

One experimental set consisted of six test chambers (including control) for each test compound and one reference chamber. In each chamber containing culturing medium 21 fronds were placed. The experiments began in darkness, when a single dose of tested compound was added to the medium. Metal treatments consisted of Hg, Cu, Cd and Co, while herbicides chosen were diquat, tembotrione, nicosulfuron and clopyralid. Concentration ranges were chosen based on preliminary tests.

2.3. Measurements

The experimental setup was kept in darkness for 3h, and during that time an outburst of CO_2 was recorded. During the next 3h period the lights were switched on and the CO_2 decrease was recorded.

All measurements were made with an Arduino platform-based respiratory activity measuring system for real-time emission/uptake CO_2 measurements (ResTox), a prototype developed and assembled by the research team (Figure 1).

Figure 1: ResTox, a respiratory activity measuring system comprising multiple sensors based on NDIR technology.

3. Results and discussion

Measurements of CO_2 concentrations were reported as dynamic curves (Figure 2). The results of CO_2 measurements demonstrated that tested metals and herbicides stimulated CO_2 exchange rate at low doses, while at high doses inhibited CO_2 exchange rate, which is a typical hormetic effect. Among metals, the strongest inhibitory effect was observed in the highest concentration of Cu, while in the case of herbicides significant stimulation of CO_2 exchange flux was determined for tembotrione.

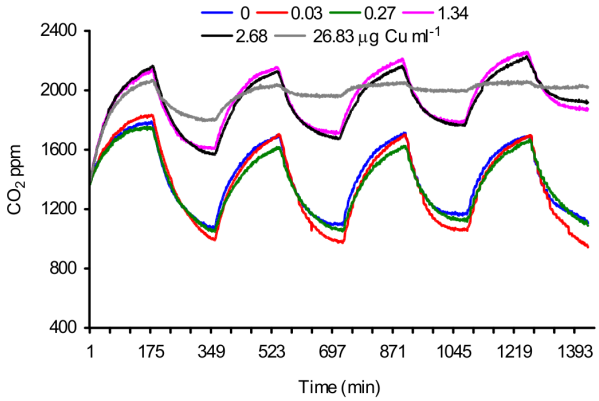

Figure 2: Example of CO_2 dynamic curves.

4. Conclusion

The approach presented in this work enabled evaluation of acute toxicity mechanisms using CO_2 exchange flux rate as an endpoint during phytotoxicity experiments.

5. References

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