# Impact of Rare Earth Elements on the growth and photosynthetic efficiency in *Myriophyllum aquaticum*

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**Introduction:** Rare earth elements (REE) are naturally present in the environment, constituting a chemical group of 17 elements sharing similar characteristics [1]. Increasing amounts of REE-containing by-products are reaching the environmental systems as never before because of their use in many advanced technological applications [2]. *Myriophyllum* spp. is widely considered a suitable bioassay plant for assessing whole sediment toxicity as well as the toxicity of sediment-bound substances [3]. The objective of the present work is to provide a comprehensive investigation of *Myriophyllum aquaticum* responses upon La, Ce, Nd, and Gd exposure to study the potential toxicity of these elements.

**Methods:** Non-axenic pre-cultures of *M. aquaticum* were grown in artificial sediment and saturated with Steinberg medium under defined growth conditions in a growth chamber. Various concentrations of 50, 250 and 500 mg $kg^{-1}$ of Ce, Nd, La and Gd were prepared in a modified Steinberg medium and were used for spiking. The observation parameters are the fresh weight change (FWC), measured at the beginning and the end of the 10-day exposure duration and the non-invasive measure of the photosynthetic status over time using IPAM.

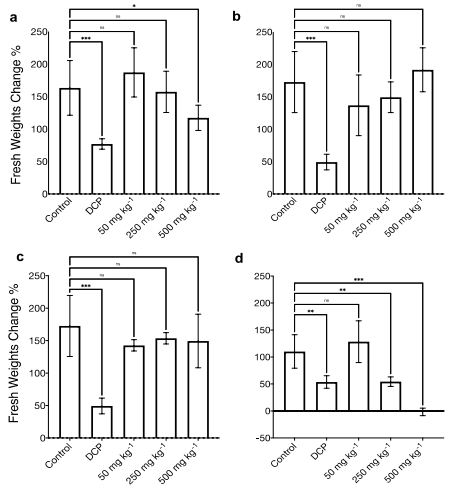


*Figure 1.* Fresh weight change (a-d) of *M. aquaticum* whorls in control and spiked sediments after a 10-day exposure in %. Sediments were spiked with La (a), Ce (b,) Nd (c), and Gd (d) at three concentrations.

**Results:** Whorls treated with Ce and Nd did not show a significant FWC at all concentrations. La induced significant FWC at 500 mg $kg^{-1}$, while at the lowest concentration (50 mg $kg^{-1}$), the FWC was significantly higher than the control. Gd had the highest effect at 250 and 500 mg $kg^{-1}$. Ce and Nd for the two highest concentrations showed a decrease in the yield on the first three days of the experiment, but towards the end of the test, it did not differ from the control. La showed a steady stability of the Y(II) of the exposed whorls throughout the experiment. Whorls treated with Gd showed time and concentration-dependent effects. Here, the highest concentration showed a fast response within 1 day, followed by a steady decrease in Y(II) throughout the remaining experiment.

**Discussion:** The various REEs have a different effect on the non-invasive parameters measured on *M. aquaticum*. The measurement of the effective quantum yield of the PS II was found to be a useful additional effect observation and of high environmental relevance. The difference in sensitivity between the functional and growth observation may give hints about the mode of action of contaminants in sediments to macrophytes and offer scope for an advanced hazard assessment. Due to its emersed growth, *M. aquaticum* is especially suited for investigating naturally polluted sediments. We will further explore the results in the presentation.

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**References:** [1] Balaram (2019) *Geoscience Frontiers*; [2] Gjata et al., (2022) *Frontiers in Environmental Science*; [3] Feiler et al., 2014. Environ Toxicol Chem 33:662–670.