

Growth and stress responses of Nuttall's waterweed *Elodea nuttallii* (Planch) St. John to water movements

Keerthi Sri Senarathna Atapaththu ·
Takashi Asaeda

Received: 1 August 2014 / Revised: 27 November 2014 / Accepted: 29 November 2014 / Published online: 23 December 2014
© Springer International Publishing Switzerland 2014

Abstract Understanding the interactions between aquatic plants and environmental factors is important to clarify aquatic ecosystem functioning. The mechanisms governing the interactions between water flow and plants are not yet fully understood, and the responses of plants to main flow (without turbulence) compared to turbulence are largely unknown. Here, we compared the growth and stress responses of the aquatic macrophyte *Elodea nuttallii* to exposure to turbulence and main flow. Turbulence and main flow were generated using a vertically oscillating horizontal grid and a recirculating system, respectively and the experiment lasted for 3 weeks. A decrease in shoot elongation coupled with an increase in radial expansion was observed in plants exposed to water movements. These effects were further accompanied by significant increases in cellulose and lignin. Turbulence reduced total chlorophyll by approximately 40% compared to plants in the control and main flow. Mechanical stress induced by turbulence leads to increased oxidative stress and tissue rigidification. The turbulence triggered stress in *E. nuttallii* is more severe than that induced by main flow. Our findings

can offer insights for explaining the habitat preferences of macrophytes and contribute to a better planning of the criteria that benefit in aquatic ecosystem management.

Keywords Turbulence · Main flow · *Elodea nuttallii* · Stress · Antioxidant

Introduction

Aquatic macrophytes play a crucial role in maintaining the integrity of aquatic ecosystems. The main ecological functions of aquatic plants include the provisioning of habitats, refuge and food for fish and invertebrates, primary production and the regulation of sediment transportation and contributions to biogeochemical cycles (Bornette & Puijalon, 2011; Folkard, 2011; Nepf, 2012). Macrophytes are subjected to a wide range of fluctuations in biotic and abiotic factors such as water movement, water level, substrate characteristics, nutrient availability in both the sediment and water column, light penetration, UV irradiation, heavy metals, temperature, etc. (Barko et al., 1982; Dale, 1986; Madsen et al., 2001; Handley & Davy, 2002; Babu et al., 2003; Asaeda et al., 2005; Cao et al., 2007; Mony et al., 2007; Šraj-Kržič et al., 2007; Thomaz et al., 2007; Zhang et al., 2010; Olson et al., 2012). Plants are persistently challenged by environmental stresses due to the highly dynamic

Handling editor: Sidinei Magela Thomaz

K. S. S. Atapaththu · T. Asaeda (✉)
Department of Environmental Science and Technology,
Saitama University, 255 Shimo-okubo, Sakura-ku,
Saitama 338-8770, Japan
e-mail: asaeda@mail.saitama-u.ac.lk