EnvironmentAsia
The international journal by the Thai Society of Higher Education Institutes on Environment

EnvironmentAsia 17(2) 2024 106-115
DOI 10.14456/ea.2024.24
ISSN 1906-1714; ONLINE ISSN: 2586-8861

Effects of Sodium Chloride and Sodium Sulfate on *Ceratophyllum demersum* under Laboratory Controlled Conditions

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Received: January 3, 2024; Revised: March 18, 2024; Accepted: April 4, 2024

Abstract

Salinity is one of the most significant abiotic stresses for plant growth. This study aims to study how salinities on the *C. demersum* L plant, by using sodium chloride (NaCl) and sodium sulfate (Na_2SO_4) separately as well as in combination, affect fresh weight, relative plant growth, total chlorophyll and protein, and proline content. The experiments were conducted for 14 days. The result showed that the effect of Na_2SO_4 salt is more toxic than NaCl. Whereas the combined experiments with both salts show that their effects together were more harmful to the plant species at the same concentrations. The findings also revealed that high salt concentrations had a significant impact on the morphological and physiological characteristics. In the experiment assessing the impact of salt stress on plant growth and physiology, the treatment with a combination of 75 mM NaCl and 75 mM Na_2SO_4 resulted in significant reductions in several key parameters compared to the control group. Specifically, the treatment led to decreases in fresh weight (from 18.742 g to 5.723 g), dry weight (from 2.543 g to 0.845 g), relative growth rate (from 1.236 to 0.380), total chlorophyll content (from 10.212 µg/g to 2.699 µg/g), and protein content (from 42.03% to 30.180%). Additionally, this salt stress condition was associated with an increase in proline content, indicating a physiological response to the imposed salt stress. These results highlight the negative effects of elevated salt concentrations on plant growth and metabolic functions.

Keywords: Aquatic plant; Plant growth; Salinity stress; Toxicological effect

1. Introduction

Salinity is one of the critical environmental stressors affecting the aquatic ecosystem and negatively impacts water quality and biodiversity because salinity can inhibit the growth and productivity of plants worldwide (Ziarati *et al* 2019; Mahmood *et al.,* 2021; Santini, 2022). Furthermore, it affects a variety of plant morphological and biochemical processes, resulting in lower economic production (Balal *et al.,* 2022).

High concentrations of soluble salts can be found in both terrestrial and aquatic environments, and they can arise naturally or because of human activity (Gomes *et al.,* 2011; Mahmoud *et al.,* 2021). Because of anthropogenic activities, salinity is a global problem with ramifications that are not limited to a single location. It has been one of the most severe issues in Arabian countries. It has contributed to the loss of agricultural land, deteriorated crop productivity, and forced thousands of residents to migrate due to excessive salt tides and animal deaths due to a lack of freshwater. Only 10% of the world's agricultural land is unaffected by environmental stressors (Dogan *et al.,* 2020).

In an aquatic environment, salinity stress is a critical factor that affects the spread and distribution of aquatic plants (Makherana *et al.,* 2022; Abd *et al.,* 2015).