

Title: Effects of temperature on plant growth and arsenic removal efficiency of *Pteris vittata* in purifying arsenic-contaminated water in winter: A two-year year-round field study

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Abstract: [Phytoremediation](#) is a cost-effective and eco-friendly alternative method for arsenic (As) contaminated water treatment. This study conducted a two-year year-round field study (cycle1 and cycle2) in a temperate area (Sendai, Japan) using small As-hyperaccumulator [Pteris vittata](#) seedlings to reduce pre-cultivation time and associated costs. The number of seedlings was changed from 256 in the cycle1 period to 165 in the cycle2 period to evaluate the As removal efficiency of *P. vittata* for As-contaminated water in field conditions with different plant densities. Before the winter season, with continuously increasing [fronds](#), rhizomes, and [roots growth](#), this reduction did not affect the plant's As removal efficiency for As-contaminated water to decrease the As concentration from 30 µg/L to the environmental quality standard for As in water, set at 10 µg/L in Japan. During the winter season, we found that cold weather caused *P. vittata* to wither and release the accumulated As into water without a greenhouse (cycle1). In the meantime, the [bioaccumulation factor](#) (BAF) and the [translocation factor](#) (TF) values for [fronds](#) of *P. vittata* decreased (BAF for fronds: from 66,089 to 8,460; TF for fronds: from 13.4 to 3.4). On the other hand, with greenhouse protection (cycle2), *P. vittata* did not severely wither and kept accumulating As. Moreover, BAF and TF values for fronds of *P. vittata* increased (BAF for fronds: from 24,372 to 36,740; TF for fronds: from 5.2 to 17.2). Maintaining the air temperature inside the greenhouse, particularly around the rhizomes, above 0 °C may be the reason why *P. vittata* remained alive and functional during the cold winter. These results indicate that a single-layer polyethylene greenhouse was sufficient for the tropical-subtropical As-hyperaccumulator fern *P. vittata* to survive the cold winter and snow in the temperate area, enabling year-round phytoremediation treatment of As-contaminated water in the open field.

Key words: *Pteris vittata*; Arsenic removal; Phytoremediation; Contaminated water; Winter growth; Temperature effects; Field study; Heavy metal uptake;

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