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ORIGINAL ARTICLE

Response of fluoride stress on plasma membrane H^+-ATPase and vacuolar H^+- ATPase activity in semi-arid plants

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Abstract The plasma membrane associated H^+-ATPase (P-type) and vacuolar membrane associated H^+-ATPase (V-type) enzymes are known to be the site of functional alterations during fluoride (F) stress. The present study was conducted on three species of semi-arid region, viz., *Acacia tortilis, Cassia fistula* and *Prosopis juliflora* that are found to be hyperaccumulator for F. The enzyme activities were assayed in microsomal fractions (10,000 g supernatant fractions). A decrease in P-ATPase and V-ATPase activity was associated with F stress of varying degrees in all the species tested. Both enzymes showed highest activities in *P. juliflora* and lowest in *C. fistula*. In general P-ATPase activity of leaves was more inhibited by increase in F concentrations ranging from 10–50 mg kg^{-1} in the medium as compared with V-ATPase. The aim was to examine the relationship between F stress and adaptive responses as improved tolerance in the plants by investigating changes in the V-ATPase and P-ATPase activities of *A. tortilis, C. fistula* and *P. juliflora.*

Keywords *Acacia tortilis* · *Cassia fistula* · Fluoride · Hyperaccumulator · *Prosopis juliflora* · Plasma membrane-H^+-ATPase · Vacuolar-H^+-ATPase

Fluoride (F), a common environment pollutant is released into water, air, and soil through natural weathering and anthropogenic activities. F contaminated drinking water and foods are the major sources of F accumulation in humans and pose a major health risk to millions of people around the world. Many regions of India are severely affected from F pollution (Meenakshi and Maeshwari 2006). F rich soil is a potential source of its contamination in groundwater. Phytoremediation is an economically viable and effective method to decontaminate soils from F. Plants that accumulate F to high levels in their body parts and also demonstrate tolerance and resistance to F toxicity provide a better solution for remediation. The prospect of using plants in the reclamation of soils contaminated with heavy metals (Zhang et al. 2009; Hegazy et al. 2011) and non-metals (Baunthiyal and Sharma 2012) have been reported in recent years. The phytotoxic effects of F ranges from alteration at the sub-cellular level to tissue destruction (Pushnik and Miller 1990).

Cell membrane and transport processes have been suggested to be among the initial targets of soil F action on plants (Zwiazek and Shay 1987, 1988). The Plasma membrane-H^+-ATPase (P-ATPase) plays a central role in plant nutrition and growth as the major ion pump (Palmgren 1991). The plasma membrane proton pump also plays a role in plastic adaption of plants to changing environmental conditions, and under stress by maintaining ionic balance and replenishing the loss of essential substances implicated in tolerance under such conditions through increased generation of a proton gradient that results in a proton-motive force used by secondary active transport for transport of various nutrients/ions. Thus, P-ATPase and Vacuolar-H^+-ATPase (V-ATPase) can be resistance mechanisms that are activated in various stress conditions and thus provide an accurate technique for detecting and quantifying the tolerance of plants to stress. Studies have indicated that P-ATPase and V-ATPase may be among initial sites of F injury to plant as well as initial sites of defense reaction.

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